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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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NOTES.

Last night the Institution of Electrical Engineers departed somewhat from its customary routine of reading and discussing Papers, and devoted itself to the philanthropic task of evolving, for the benefit of the profession, a "Form of Model General Conditions," for use in connection with electrical engineering contracts. The Committee which has framed the model clauses is desirous that, before these become irrevocably crystallised members, shall have an opportunity to assist in moulding them into the most useful shape. Accordingly, they were presented for discussion at yesterday's meeting. There is, however, a wider circle to which these model clauses must appeal than the actual members present at that meeting, and we hope, therefore, by giving a *résumé* of the draft at the earliest possible date—viz., in our present issue—to evoke from some of those who were not present at the debate an expression of their views.

Opinions may, indeed, be divided on the very main point of the draft—viz., as to whether the profession really stands in need of any sort of "model conditions" for its guidance. Some may consider that a consulting electrical engineer, if he is to be considered worthy of the name, should be capable of framing his own conditions *de novo*, and that, by accepting model conditions, he will be tying his hands in regard to taking account of local and special conditions. Others may hail with delight the action of the Institution, from a belief that model conditions must tend in the direction of standardisation. There is, further, the question whether the Institution's proposed conditions actually do promote standardisation, or unification, in any important degree. Relative to this aspect of the question, some discussion is called for as to what it is that electrical engineers need to standardise, and how much they may safely leave in a plastic and unstandardised condition, mouldable at the discretion of the engineer. Obviously, there must be some part of the business to be left to his discretion; otherwise consulting electrical engineering ceases to be a profession. The question is: How much?

Thus we come to a discussion of details. So profuse are the details in the draft that the impression is naturally created that a single evening's debate is altogether inadequate. Some of the clauses, however, deal with matters of form that admit of little or no useful discussion. Others appeal directly to the prejudices and practices of various sections of the electrical fraternity, and should not be rigidly specified until their purport and effect have been freely ventilated. Contractors, for instance, may wish to say something about that penalty clause, entitled "Damages for Delay in Completion." It is conceivable that some of them may wish to have it omitted in its entirety. On the other hand, consulting engineers may wish for more explicit information as to how such a clause is to be enforced. No one, of course, will suspect us of here raising a question of more than doctrinaire significance, at least as regards the past—but there is always the future to be provided for.

Then, again, there is that interesting little clause headed "Patent Rights." Here the patentee has a *locus standi*, and he may have some pertinent remarks to make. How different would have been the history of electrical patent litigation if such a clause always had been enforced from the first; different, certainly, but not obviously for the better. However, as it now stands, the contractor will have to look sharply after his liabilities; and the patentee will be put to the trouble of calculating whether he can be sure of getting his royalties at 20s. in the pound. As to the clause providing for "Inspection and Testing at Maker's Works," inflammable as the subject naturally is, there is nothing in it to precipitate a heated discussion between engineers and contractors. Some such clause is palpably necessary, and the terms of the clauses relating thereto are manifestly fair to both parties. The same remarks apply to the "Tests on Completion" clauses. Finally, as pouring oil on any possibly disturbed part of the waters, there is the "Arbitration" clause, which abundantly meets all requirements.

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Our esteemed contemporary the *Journal of Gas Lighting* has taken up our challenge to gas authorities in *The Electrician* for April 11th, to prove that gas at 2s. 7d. per 1,000 cubic ft., used with incandescent mantles, costs less than one-tenth the cost of electric light at 6d. per unit, for equal amounts of light. Examination of our contemporary's defence reveals that its notion of electric light efficiency is limited to the 8 c.p. incandescent lamp consuming 4 watts per candle, and with this it considers it fair to compare the initial performance of an incandescent mantle giving 50 candles. If it is thus permissible to compare large things with small ones, we take the liberty to put forward the arc lamp as the electrical competitor. This, however, our contemporary, for some reason best known to itself, has thought fit to discount beforehand. Perhaps our contemporary will be satisfied to compare lamps of equal candle power, and in that event we may call its attention to the Nernst lamp, the efficiency of which is something better than "4 watts per candle." We are told that "ordinary electricians usually exhibit a childlike faith in the superstition that all they have to meet is an imaginary flat-flame gas burner consuming gas at the rate of 5 cubic ft. per hour, never more nor less." Surely, if "ordinary electricians" nurture such a superstition, it is a mere reflex of the superstition that electric lighting knows nothing better than "4 watts per candle."

Those whose minds recall the uncompromising hostility of the London County Council to every proposal to extend the tramways of South London across the Thames bridges and along the Embankment when those tramways were owned by a company, must observe with amused curiosity the complete *volte face* of that ambitious local authority now that the lines have passed into its own hands. What was sauce for the company goose is not now sauce for the municipal gander; and the loud outcry once raised against the spoliation of "the finest boulevard in Europe" becomes hushed to silence when it is the protesting party who will benefit by the work of spoliation.

We cannot, however, agree with those speakers in the debate in the House of Commons on Monday, who professed to see in the L.C.C. scheme for an Embankment tramway, merely an isolated shuttle line, serving little public good and creating an inconvenience and a hideous nuisance in a hitherto beautiful thoroughfare. It is far more than this. We are in perfect agreement as regards the inutility and objectionable character of the tramway; but the fact must not be overlooked that to its promoters it signifies much more than an isolated shuttle line. Indeed, we here once again see the too familiar thin end of the L.C.C. wedge. Once constructed, this tramway would be used as the weapon for fighting all opposition to the complete connecting-up of the Council's northern and southern lines; its existence, indeed, would provide the chief part of the missing link. Tramways are admirable aids to locomotion in the suburban and rural districts of London; but even electric tramways are not to be preferred to underground tubes for the busy thoroughfares nearer to and within the City boundaries.

In another column will be found a digest of the Cable Committee's report, recognising frankly the valuable service rendered to the British empire and to the commerce of the whole world by the telegraph cables established under private enterprise. As is so often the case when vague charges of monopoly, extortionate rates, &c., are impartially examined, they melt into thin air, and the "unreasonableness" is found to be on the part of those who make impracticable suggestions without adequate knowledge or even any attempt to work out results by common sense and simple arithmetic. Although to any one competent to form an opinion the idea of Government purchase of international cables has always been impracticable, it is well to have it authoritatively knocked on the head. With regard to Government lines, such as the Pacific Cable, the report states that "Unless special circumstances exist, as in that case, we think that, as a rule, private enterprise is better qualified to undertake the management of cable business than the State." This recalls a remark made last year by the Marquess of Tweeddale that there would be no more State-owned cables, especially as it is hardly open to doubt that the loss on the working of the Pacific line will be heavy even for Governments.

And, after the manner in which the Committee have dealt with the crude proposals of Mr. Henniker Heaton and Sir E. Sassoon, it is to be hoped that the columns of the daily Press will be spared the advocacy of impossible reductions of tariff and the attempt to create impracticable land-line routes in opposition to cables. It does not really seem brilliant policy for the inhabitants of an island, which controls the sea and has established the bulk of the cables of the world, to agitate for continental land-line routes. The Committee may be congratulated on an able, a much-needed, a valuable, and a most interesting report. In speaking of these the Committee say that unless we maintain our own more secure alternative cable routes, our most serious interests, the safety of our dependencies, or even our existence as a nation, may be imperilled.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinheiro	Mar. 8, 1902
Suakim—Jeddah	April 16, 1902
Bolama	April 19, 1902

Royal Society.—At yesterday's meeting the following were among the Papers down for reading:—Dr. A. D. Waller, F.R.S., on "Skin-Currents. Part III.—The Human Skin"; and J. E. Cullum, on "Absolute Magnetic Observations at the Valencia Observatory (Cahirciveen, Co. Kerry), 1899, 1900 and 1901."

Institution of Electrical Engineers.—An extra meeting of the Institution of Electrical Engineers will be held in the rooms of the Institution of Civil Engineers at 8 p.m. on Thursday, May 1st, when Mr. S. G. Brown's Paper on "Automatic Relay Translation for Long Submarine Cables" will be read, and a demonstration of the working of the author's apparatus will be given.

Dublin Section of the Institution of Electrical Engineers.—At a meeting of this section of the Institution of Electrical Engineers, the following were announced as the committee for the ensuing session:—Chairman, J. W. Towle; vice-chairman, F. Gill; members, Prof. W. F. Barrett, F.R.S., W. Brew, W. Brown, A. T. Kinsey, H. Luttrel Elward, G. F. Pilditch, A. E. Porte, P. S. Sheardown, W. Tatlow, and Prof. W. E. Shrift.

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Origin of the Fahrenheit Thermometer Scale.—With reference to our note on this subject last week (see *The Electrician*, Vol. XLVIII., p. 1,008), Mr. Gilbert Ram calls our attention to a letter contributed by him to *Nature* on February 27th. In this letter, at too great length for us to quote, Mr. Ram discusses the Fahrenheit scale, and traverses the statements advanced in our note, which we quoted from *Knowledge*.

Coronation Festivities.—To encourage the use of electrically-lighted devices during the Coronation, the Electrical Power Distribution Co. have decided to suspend the operation of the maximum-demand system during the month of June at the following of their stations :—Sutton, Weston, Penarth, Lewes, Hertford, Barnet, Durham, and Gateshead. This course will assure consumers that they will not register a high maximum demand by making an effective display of lights.

Application for Patent Amendment.—The Reason Manufacturing Co., of Brighton, have applied for leave to amend the specification of letters patent No. 3409, of 1896, granted to Arthur Wright, for "Improvements in or connected with recording electric meters." Particulars of the proposed amendment were set forth in the illustrated official *Journal* issued on the 16th inst. Persons may give notice of opposition to the amendment (on Form G) at the Patent Office, 25, Southampton-buildings, W.C., within one calendar month of the date of the *Journal*.

International Association of Municipal Electricians.—The seventh annual convention of this association is to be held at Richmond, Virginia, on October 7, 8, 9, 1902. A number of interesting Papers bearing on important electrical subjects are to be read, among them being "Joint Use of Conduits," "Telephone Service in connection with Fire and Police Signal Systems," and "Electrical Government in Small Cities." Other Papers will deal with "Municipal Inspection and Control" and "Report of Committee on Rules for Electrical Inspection and Control." The city of Richmond, we are informed by the association secretary, is making great preparations for the entertainment of the convention, and matters seem to point to a successful result.

American Electro-chemical Society.—The first meeting of this society was held on April 3rd to 5th at Philadelphia, and previous to the reading of some 20 Papers the members visited the works of Harrison Bros. & Co. to see the production of sodium and nitric acid from nitrate of soda, by electrolytic means. Prof. J. W. Richards, president of the society, read a Paper on "A University Course in Electro-chemistry," in which he outlined the best course for a four years' study for students graduating from a high school. A large number of other Papers were then read, dealing with such subjects as "Electrodes," the "Electrolytic Reduction of Lead," the "Electrolytic Rectifier," and the meeting was brought to a close with a strong recommendation for the adoption of the metric system.

Electric Traction.—Mr. Philip Dawson read a Paper on this subject before the Gloucestershire Engineering Society on the 15th inst., Mr. Hamilton Kilgour, president of the society, being in the chair. The Paper dealt with the subject in a broad manner, showing the progress in England during recent years. The total capital invested last year was stated at £51,000,000, and there were 1,252 miles of tramways and railways in operation. Compared with New York, London had not the same facilities in the shape of electric traction, there being almost three times the power installed in the former city for traction and power purposes. Traction engineers were not at present prepared to equip long-distance lines, and unless railway companies could be certain of great operating economies, they were unlikely to convert their existing lines.

Tests of a High-tension Switch.—At the Colgate power house of the Bay Counties Power Co., California, a single pole switch was placed across the 40,000 volt 'bus bars, thus receiving current from generators rated at 7,500kw. capacity. The switch was closed and opened 10 times in the space of two minutes, and upon each occasion it safely opened the short circuit, without damage to itself, the transformers or the connections. One of the two lines in parallel with the Colgate plant was then cut out at the station end, but left in parallel with a station 120 miles distant, and the switch was connected across this line, thus giving 240 miles of line between the switch and the 'bus bars. The switch was closed and then opened under these severe conditions, but it performed its work successfully, and there was no damage done to the surrounding apparatus.

Telephone Oratory.—There seems, says the *Court Journal*, to be a growing partiality in the United States for what is known as "telephone oratory"—that is, the delivering of after-dinner speeches from a distance of 200 or 300 miles through the telephone. When once the novelty has worn off, however, it must be a rather dispiriting affair, especially for the orator, whose powers must suffer when he is called upon merely to address a receiver instead of an audience, and when facial play and gesture are so much wasted energy. There is, however, one advantage in the telephone system of after-dinner speaking, and that is that each guest, being provided with a receiver, can listen or not as he pleases; a boring speaker can be allowed to deliver his opinions at one end of the telephone, while, at the other, the diners can leave the receivers on the table before them.

German Export and Import Trade.—The Foreign Office has published particulars of the German trade in 1900–1901, and from this report we find that the amount of electrical machinery sent to that country from the United Kingdom during this time was 317 metric tons, of turbines 164 metric tons, and other machinery for transmitting power 886 metric tons. Corresponding items from the United States were 624, 4 and 18 metric tons respectively. By far the greatest amount of electrical manufactures was sent from Austro-Hungary and Switzerland, though in both these cases the year 1901 showed a large decrease in the quantities exported to Germany. The exports of electrical goods to the United Kingdom for the two years totalled 2,470 metric tons, but the United States received only 17 metric tons. Switzerland was supplied with 784 and Austro-Hungary with 2,319 metric tons, but in both the latter cases the amount decreased during 1901.

Wireless Telephony.—Mr. A. F. Collins, in the *Electrical World* of New York, gives a brief description of a system of wireless telephony which he has devised. From the description, which we quote verbatim below, it will be seen that he does not give any very definite information as to the method employed :—

> When a current of sufficient potential and frequency is permitted to discharge into the earth, and then allowed to restore the equilibrium, the bound ether radiates waves, very much the same as the Hertzian oscillator, in the air; and if a suitable receiver is provided these waves will be picked up, transformed and reproduced in articulate speech. The same apparatus may accomplish the results in free air, but to no effective distance, thus following coincidently the analogue of sound transmitted in media of different densities, as when a bell struck under water, sends out sound waves many times as far as when struck in free air. By this system I was able to reproduce speech, in 1900, a distance of 200ft.; in 1901 about 1 mile; and in 1902, faintly, at about 3 miles. The trials were made in open country, but I intend to determine the performance of the instruments in the city in a short time.

Silicon in Commercial Aluminium.—A recent number of the *Zeitschrift für Electrochemie* contains a letter from Dr. Hans Goldschmidt, of Essen, relating to the estimation of silicon in commercial aluminium. Haber and Geipert, in a research upon the laboratory production of the metal, had stated that from commercial materials, they were able to produce aluminium containing only 0·034 per cent Si by the electrolytic method. Goldschmidt is of opinion that this extremely low percentage of silicon is not correct, and that the error is due to the method used for its determination. Haber and Geipert used the method recommended by Moissan, which depends upon the solution of the aluminium in hydrochloric acid. This solution, according to Goldschmidt, may lead to loss of silicon as SiH_4. Wöhler and Von Buff are said to have already observed such evolution of SiH_4 when dissolving commercial samples of aluminium containing silicon as an impurity. Goldschmidt has himself carried out experiments upon this point, and has found SiH_4 in the gases liberated when cuttings of commercial aluminium were dissolved in pure hydrochloric acid of 1·12 specific gravity. In

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order to overcome the difficulty created by this evolution of SiH_4, Goldschmidt recommends that a slight excess of bromine should be added to the acid, before the solution of the metal is commenced.

The Autocar.—Sir J. H. A. Macdonald, K.C.B., delivered a popular lecture with this title as a Friday evening discourse at the Royal Institution last week. The first part was taken up with a historical sketch of his subject, some excellent and amusing illustrations being shown on the screen. Following this, the lecturer gave some interesting figures to show how much we were still indebted to foreign countries for our autocars, owing to our legislative restrictions having retarded the commencement of the industry in this country. The imports during the first three months of the present year were £48,855, £52,682 and £70,518 respectively, making a total of £167,050, or an equivalent of £668,200 for the year. The lecturer then explained in elementary language, and with abundance of homely illustrations, the principle of the spirit-driven engine, and referred briefly to the electric autocar, which he considered as a luxury, but the one most suited to town work, for which long-distance and high-speed runs were not required. He concluded his Paper with a sketch of the great service the autocar was destined to be from the commercial, social and hygienic standpoint, and appealed to every member of the community to look on motor-traction in a broad and unbiassed manner.

Lord Kelvin in America.—On the 19th inst. Lord Kelvin visited Columbia University, New York, to witness the ceremony of the installation of Prof. N. B. Butler, the new President of the University. Among those present were President Roosevelt, and the presidents of Harvard, Yale and Princeton Universities. Many of the papers contain accounts of the discoveries and inventions of the distinguished scientist, the New York *Sun* publishing an interview with him, in which he expressed the opinion that young Americans going to Oxford with Rhodes scholarships would do good. On Monday, the 21st, a reception was given at Columbia University by various scientific societies in honour of Lord and Lady Kelvin. The American Institute of Electrical Engineers and the National Academy of Sciences were among those represented, and Messrs. Elihu Thomson, J. B. Crocker, R. S. Woodward and Prof. Butler delivered addresses relating to Lord Kelvin's scientific achievements. On rising to reply, Lord Kelvin, who was loudly cheered for several minutes, referred to the name of Cyrus Field in connection with the laying of the Atlantic cable, and paid a high tribute to the work accomplished by Mr. Edison, who rose and bowed his acknowledgments. At the conclusion of his remarks, he predicted that a power plant would be established at Niagara, which would transmit current at 40,000 volts a distance of 300 miles.

Nominations for the New Council of the Inst. E.E.—The following is a list of the Council nominations, for the election of Council and hon. officers for 1902-03, as announced at the general meeting last night:—

President.

Mr. James Swinburne.

Vice-Presidents.

Major P. Cardew. | Mr. John Gavey.
Mr. S. Z. de Ferranti. | *Prof. O. Lodge, F.R.S.

Members of Council.

Mr. H. H. Cunyngham, C.B.	*Sir J. Wolfe Barry, K.C.B.	Hon. C.A. Parsons, F.R.S.
Mr. Hugo Hirst.	*Mr. B. Drake.	Mr. W. H. Patchell.
Mr. J. E. Kingsbury.	*Mr. S. Dobson.	Mr. J. H. Rider.
Mr. C. P. Sparks.	Lt.-Col. H. C. L. Holden, R.A., F.R.S.	Mr. Mark Robinson.
Mr. H. E. Harrison, B.Sc.		*Mr. R. Kaye Gray.
		*Mr. A. A. C. Swinton.

Associate Members of Council.

Mr. W. R. Cooper, M.A., B.Sc. | Mr. W. Duddell.
*Mr. S. Morse.

Hon. Auditors.

Mr. F. C. Danvers. | Mr. S. Sharp.

Hon. Treasurer.

Prof. W. E. Ayrton, F.R.S.

Hon. Solicitors.

Messrs. Wilson, Bristows and Carpmael.

The names marked by an asterisk are those of gentlemen nominated to fill the vacancies in the Council in accordance with Article 45 of the Articles of Association. All the honorary officers, being eligible, are nominated for re-election.

Industrial Freedom League.—A meeting was held at the Westminster Palace Hotel, on Tuesday, for the formation of this league, the chair being taken by Mr. A. Henderson, M.P., supported on the platform by Lord Claud Hamilton, Lord Avebury, Sir Charles R. Wilson and others. The chairman referred to the alarming growth of municipal enterprise, and considered it a great menace to both public and private good. The league was formed to set limits to it, and every effort would be made to interpose in the granting of money to local bodies for such municipal work as electricity and gas supply and tramway operation. Sanitation, water supply and markets represented the fields of municipal work, but beyond this it was the opinion and object of the league that public control should not go. Comparisons were then drawn between public and private management of certain undertakings, special reference being made to the London County Council. Lord Claud Hamilton then proposed that "this meeting is of opinion that freedom of industrial enterprise is essential to the prosperity of British trade, and that every effort should be made to liberate such enterprise from undue interference and rate-aided competition," and further added that municipal trading, if widely extended, would do great harm. Mr. Vicary Gibbs, M.P., Mr. A. F. Hills and Mr. B. Greenwood supported the resolution, which was put to the meeting and carried unanimously. Lord Avebury then proposed that the formation of the league be welcomed and members be enrolled forthwith. This was supported by Sir Charles Rivers Wilson and Mr. R. P. Porter (America), the latter remarking that municipal enterprise in the United States was inclined to spread on account of the glowing accounts of its development in the mother country, but the private capital invested was very large indeed, 350 millions being laid out on electricity schemes alone. The meeting terminated by the proposal of a vote of thanks to the chairman by Sir J. Rolleston, M.P.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 25th.

INSTITUTION OF CIVIL ENGINEERS.

4 p.m. Repetition of the Tenth "James Forrest" Lecture on "Metallurgy in Relation to Engineering," by Sir W. C. Roberts-Austen, F.R.S.

PHYSICAL SOCIETY.

5 p.m. Meeting at Burlington House. Agenda: (1) "An Exhibition of a Mechanical Break for Induction Coils," by Dr. Dawson Turner; (2) "A Temperature Indicator for Use with Platinum Thermometers in which Readings are Automatically Reduced to the Gas Scale," by R. S. Whipple; (3) "Note on the Compound Pendulum," by S. A. F. White.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Dr. J. M. Davidson, F.R.S., on "X-Rays and Localisation."

SATURDAY, April 26th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

9:15 a.m. Visit to the Works of Messrs. Easton & Co., at Erith. 8.15 a.m. train from London Bridge.

MONDAY, April 28th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III.: "Glass for Optical Instruments," by Dr. R. T. Glazebrook, F.R.S.

WEDNESDAY, April 30th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 28, Victoria-street. Paper to be read: "The Electro-Deposition of Metals," by R. Smith.

THURSDAY, May 1st.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Extra General Meeting. Paper to be read: "Automatic Relay Translation for Long Submarine Cables," by S. G. Brown, with demonstration.

RÖNTGEN SOCIETY.

8:30 p.m. Ordinary General Meeting at 20, Hanover-square, W. Discussion evening. Subject: "The Relation between X-Rays and Allied Phenomena in Light and Electricity."

FRIDAY, May 2nd.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Ordinary Meeting at Westminster Palace Hotel. Paper to be read: "Some Factors in Colonial Railway Construction," by Lewis H. Rugg.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by A. E. Tutton, F.R.S., on "Experimental Researches on the Constitution of Crystals."

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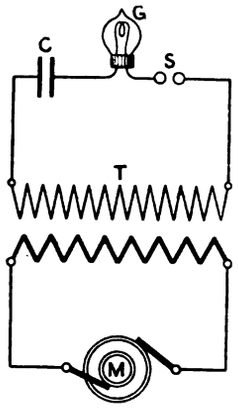
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Oscillatory Charging Currents.—Just as a condenser may be discharged by an oscillating spark, so it may be charged by introducing a spark-gap which produces oscillation. H. Andriessen describes an interesting experiment in this connection. Let M (see diagram) be an alternating current which feeds the transformer T. The circuit of the latter contains a condenser C, a glow-lamp G and a spark-gap S. Let the spark-gap be short-circuited in the first instance, and the transformer brought up to 6,000 effective volts at 50 periods, then the charging current of the condenser is not strong enough to make the lamp glow. Now open the spark-gap to 0·5mm. Then the lamp glows in whatever portion of the circuit it is inserted. It glows even with only 2,100 volts. The author explains this remarkable result by the increased quantity of electricity which passes the lamp, owing to the charging current of the condenser being of an oscillatory character. This may be of practical importance for a watt-less introduction of capacity whenever the object is to get rid of noxious inductive phase-displacements. It also accounts for the superiority of oil insulation as against air insulation, since the latter leads to the appearance of oscillating sparks which are damped out in the former.



[H. ANDRIESSEN, *Ann. der Physik*, No. 4, 1902.]

Ultra-Violet Spectrum of Mercury.—Our knowledge of the spectrum of mercury has been extended to the wave-length 193·04$\mu\mu$ by the work of H. Lehmann and R. Straubel. They used a vacuum tube with mercury electrodes, fed by a high-tension alternate current. The tube was heated up to a temperature at which it suddenly began to glow with an intense light. At that moment the flame was removed, and the tube continued to glow for about 25 minutes. The photographs of the spectrum were taken on Gebhard's Berolina engraving plates, and developed with glycin. The quartz-fluorspar lenses for the spectroscope and camera were furnished by H. T. Simon. The lines were located by comparison with the aluminium spark spectrum, and with the shortest waves measured by Eder and Valenta, who got as far as 215·06$\mu\mu$. The strongest lines appearing on the negative were 218·66, 212·67, 211·00, 209·78, 204·80, 199·05 and 197·01. The total number of lines recorded between 193$\mu\mu$ and 221$\mu\mu$ is 27. The authors point out that the newly-discovered lines do not obey the rules laid down by Kayser and Runge for the visible spectrum. The shortest wave-length which falls in with their formula is 215$\mu\mu$. But this failure to agree with the Kayser-Runge formula is not isolated, as the new hydrogen lines discovered by V. Schumann show a similar irregularity.

[LEHMANN and STRAUBEL, *Ann. der Physik.*, No. 4, 1902.]

Determination of Atmospheric Potential.—Comparative tests of the indications of flame collectors and of collectors provided with radio-active salts have been made in the laboratory by F. Henning. Dorn found in the open air that a radio-active collector indicates a lower potential than a flame collector. This would indicate that a flame indicates, not the surrounding potential, but the potential of a point a few centimetres above it. This matter can, however, only be definitely decided in the laboratory, and this has now been done by F. Henning by mounting the collectors between two sheets of wire gauze kept at a definite potential, and thus providing a well-determined field. The radio-active salt was barium chloride of activity 240, which was fixed on by means of shellac or sugar. When the two charged surfaces were placed vertically, the indications both of the flame collector and the radio-active collectors were practically correct. But when one surface was put to earth and the other, 62cm. above the first, was charged to some 200 volts, both surfaces being horizontal, the indications were wrong by 49 volts in case of the flame, and by 20 to 23 volts in case of the radium preparations, the potentials being too high in each case. In the case of the flame, this is due to the upward motion of the gases, and in the case of the radium salts, to the superior mobility of the negative ions.

[F. HENNING, *Ann. der Physik*, No. 4, 1902.]

Ionic Theory of Self-Discharge.—As J. Stark has shown in his theory of ionic shock, ionisation is usually produced by the impact of an existing positive or negative ion on neutral molecules. The force of the impact is due to the kinetic energy acquired by the ion in running down the slope of potential, and the difference of potential necessary to secure an ionising shock is between 20 and 50 volts in the case of the negative electron, and 200 to 400 volts in the case of the positive ion. As regards spontaneous discharge, the same author proves that that is not due to the emission of ions by the electrode. The fact that a very considerable difference of potential may be maintained between two electrodes placed very close together without producing a discharge, shows that there is some kind of contact force which prevents the ions from penetrating into the gas surrounding the metal. The author therefore attributes all self-discharge to what he has called "frontier ionisation." The ions most concerned in that type of ionisation are the positive ions, and discharge begins to set in as soon as the difference of potential traversed by the positive ion in its mean free path is sufficient to make it produce an ionisation shock.

[J. STARK, *Ann. der Physik.*, No. 4, 1902.]

Damping of Electric Oscillations.—J. Zenneck describes a method of studying the damping of rapid electric oscillations by means of a Braun cathode-ray tube. The trace of such oscillations on the luminescent screen consists of a line of beads or bright patches extending on both sides of a bright centre, and becoming fainter and wider apart the further they are away from the zero or middle position. These beads, the author points out, are the turning points of successive oscillations. They become visible owing to the reduced velocity, and, consequently, greater illuminating power of the oscillating cathode rays at those points. Hence the distances between the beads and the zero position mark the successive amplitudes of the oscillations. When a large number of discharges take place in short succession under the same conditions, the beads appear stationary, and may be photographed. At all events they furnish a delicate test for the regularity of the discharge, and show the influence of inductance, resistance and spark potential. The author reproduces photographs obtained with a frequency of over a million per second, and some 600 discharges per second, the deflection bsing either magnetic or electric.

[J. ZENNECK, *Ann. der Physik.*, No. 4, 1902.]

Cathode Drop and Current Strength.—The normal cathode drop of potential in the case of the glow current is fairly well established. According to the measurements of Hittorf and Warburg it is independent of the pressure of the gas and of the current strength. The law of the abnormal cathode drop is less determined. Both Schmidt and Skinner (see *The Electrician*, Vol. XLVIII., p. 332) declare it to vary in a linear and positive manner with the current strength. J. Stark maintains, on the other hand, that the true relation is indicated by a curved line. He shows that the few measurements of Hittorf result in curves. He explains Schmidt's contrary result by the small range of current strength and the high pressures

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used. As regards Skinner's results, he maintains that the straight lines on Skinner's diagrams do not faithfully represent the numerical results, but that they are artificially straightened out. He traces new curves from the same figures which show a distinct curvature, but omits the points belonging to E.M.F.s below 300 volts. He believes that the curvature would come out more clearly by employing a greater variety of currents, and that the abnormal cathode drop is represented by a formula of the form

$$K = K_n + \frac{k}{pf^{\frac{1}{2}}}(i - j_n f)^{\frac{1}{2}},$$

where K_n is the normal drop, p the pressure, i the current, f the glowing surface, and j_n the current density at normal cathode drop.

[J. STARK, *Physikal Zeitschr.*, April 1, 1902.]

THE SCIENTIFIC BASIS OF SPARK TELEGRAPHY.*

In December, 1900, Dr. Slaby described his new method of wireless telegraphy and gave, in collaboration with Count Arco, a demonstration of long-distance transmission between Berlin, Charlottenburg and Schöneweide.† This was the first practical solution of the "tuning" problem published. An account of the scientific basis of the method was then promised, and the following Paper fulfils that promise. The exact mathematical method is not attempted, a simpler, more experimental method being chosen.

OSCILLATIONS IN STRAIGHT WIRES.

The following experiments were made to examine the production of the oscillations in straight wires:—A bare copper wire of about 10 metres (33ft.) in length and 1mm. thick was connected with one pole of an induction coil, stretched horizontally and insulated. The other pole of the coil was earthed

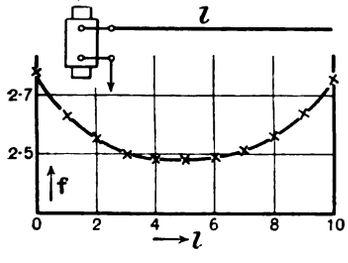

FIG. 1.

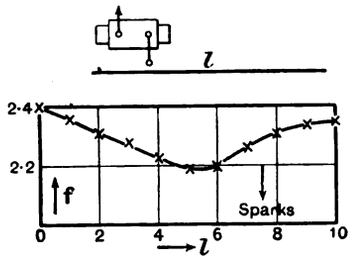

FIG. 2.

or connected to a large capacity. When sparks pass the wire affords all the phenomena of rapidly alternating currents. As the mode of oscillation proves to be independent of the mode and frequency of sparking, it is permissible to speak of the proper period of the oscillations in the wire. The character of the oscillation may be determined by investigating at chosen points the mean current or potential there. In the first case a hot-wire instrument might be used; in the second case the spark-micrometer is found convenient. The following experiments were made with a spark-micrometer having a divided head, and measuring spark lengths to 0·01mm. Instead of metal spheres the micrometer possessed a blunt metal cone opposed to the ground end of a piece of arc carbon. Actual examination by this means of the wire arranged as above gave the curve in Fig. 1, where micrometer spark-length and distance from the end of the wire are plotted. A standing wave with potential loops at the ends and a relative node at the middle of the wire is thus detected. It is noteworthy that other oscillations possible in the straight wire, the so-called overtones, are so trifling as to be negligible practically. If the induction coil, however, be attached not to an end of the wire, but to some other chosen point, the same standing wave is found, but distorted (Fig. 2).

* Abstract of a Paper by Dr. A. Slaby, *Elektrotechnische Zeitschrift*, No. 9, 1902.

† See *The Electrician*, Vol. XLVI, p. 475.

Thus any electric concussion starts an insulated wire into its own proper vibration.

If two equal wires be arranged in line on either side of the induction coil, and connected respectively to each pole as shown in Fig. 8 the compound system vibrates as a single wire made continuous by the spark-gap. To apply the spark-micrometer method the nearer of the two poles must be earthed, as otherwise the almost direct spark of the secondary overwhelms that to be observed. For Fig. 3, wires each 1 metre (3·3ft.) long by 3mm diameter were used, the sparks passing between the rounded ends of the wires. The curve is, roughly, a sine curve, and shows that the harmonic law is followed.

An experiment was performed in which several incandescent lamps with straight filaments were connected end to end to build up a similar wire system to the last. The greatest

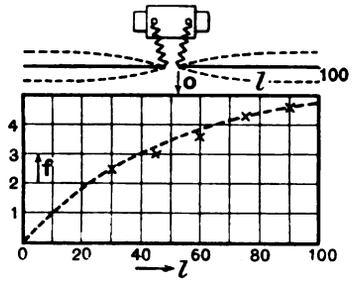

FIG. 3.

luminosity occurred towards the centre. Micrometer measurements at the lamp terminals showed that there was 90deg. phase difference between the potential and the current. The lamps indicated nodes of current at the ends and a current loop at the centre.

An insulated secondary wire was then stretched parallel to the system sketched in Fig. 2, and at some distance from it. If the secondary wire be at first longer than the primary, and be gradually shortened by cutting equal amounts from each end, then micrometer measurements at an end show first an increase and then a decrease of potential as the shortening proceeds. This is shown by Fig. 4. There is a determinate length where the effect is a maximum. This length might be called the resonance length. For this length the proper

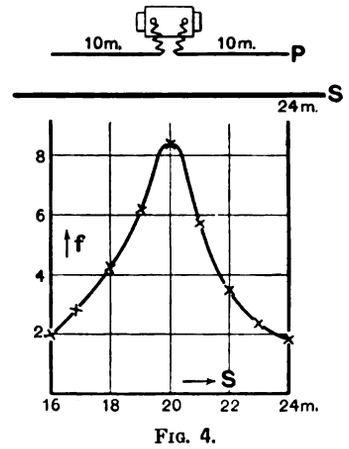

FIG. 4.

frequency of the secondary wire is in harmony with that of the primary exciting oscillation. This always occurs, whatever be the lengths of primary used. Moreover, the curves show that the wave-length of the oscillations in the secondary wire is, at the resonance length, the same as that in the primary.

The fact that the induced wave-length stands in such a simple relation to the wave-length in the sender may appear casual, and valid only for the selected diameter of the wires. To remove doubt, a brass tube of 51mm. (2in.) diameter was constructed and compared with copper wire of 0·25mm. diameter. Flat brass strips 51mm. wide by 1 metre long were also used as primaries. In all cases the secondary was

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of copper wire 1mm. diameter, and the resonating length of this was determined. The results are here tabulated :—

Sender.	Length of sender.	Resonance length.	Percentage difference.
Wire of 0·25mm. diam....	724cm.	735cm.	+1·5
Tube of 51mm. diam. ...	724cm.	710cm.	-1·9
Strip, breadth vertical ...	724cm.	710cm.	-1·9
Strip, breadth horizontal	724cm.	710cm.	-1·9

Thus, in spite of the extreme difference of the cross sections of the primaries the resonance lengths differ from the primaries less than 2 per cent., a deviation possible from mere experimental errors.

The foregoing experimental results admit of mathematical elucidation. Abraham's Paper "On the Electric Oscillations on a Rod-Shaped Conductor," *Annalen der Physik*, 1898, p. 435, treats this question rigorously on the basis of Maxwell's equations, and contains the explanation. A more elementary treatment will here suffice. The problem is: Two equal wires each length l are arranged in a straight line and connected with a source of high potential difference. Their nearer, rounded ends are approximated so that a spark occurs when the charging potential reaches its highest value. Before discharge the charge is uniformly distributed, all parts of a single conductor having the same potential. As soon as discharge sets in the current in the neighbourhood of the spark-gap rises to a maximum, since the spark may be regarded as a self-inductionless conductor. At greater distances along the wire the current is smaller on account of the self-induction of the wire. Denoting by i the instantaneous value of the current at a distance x from the outer end of one conductor, by R_1 the resistance, L_1 the inductance, C_1 the capacity of unit length of the wire, we get the ordinary cable equation

$$\frac{1}{C_1}\frac{d^2i}{dx^2} = R_1\frac{di}{dt} + L_1\frac{d^2i}{dt^2}.$$

The conditions of the problem lead to the equation

$$i = a \cdot e^{-\frac{R_1}{2L_1}t} \sin\frac{\pi}{2l}x \cos pt.$$

as a solution of the differential equation, a being a constant. Putting R, L and C for the resistance, inductance and capacity respectively of the whole length of wire, this becomes

$$i = ae^{-\frac{R}{2L}t} \sin\frac{\pi}{2l}x \cos\left(\pi\sqrt{\frac{1}{CL}}t\right) \text{ approximately.}$$

This shows that at each point of the wire the alternating current there has a different amplitude. The period T of the alternating current at each point is the same, and may be calculated from $T = \sqrt{CL}$ approximately.

Since the electrical disturbance travels along the wire with velocity $v = 3 \times 10^{10}$ cm. per sec., the wave-length is given by

$$\lambda = vT = 2v\sqrt{CL}.$$

Here C and L are in electromagnetic units. But

$$2v\sqrt{CL} = 2\sqrt{(Cv^2)L},$$

and Cv^2 is the magnitude of the capacity expressed in electrostatic units. Thus the simple relation $\lambda = 2\sqrt{CL}$ may be used for calculation, C and L being both in centimetres.

For the inductance of a straight wire, length $2l$, radius r, Hertz used the formula

$$L = 4l\left\{\log\frac{4l}{r} - 0{\cdot}75\right\},$$

which is deduced from Neumann's formula. Poincaré gives

$$L = 4l\left\{\log\frac{4l}{r} - 1\right\}$$

as more correct, as it allows for the "skin-effect." The difference is trifling in practice. Hertz's formula is preferred, since $0{\cdot}75 = \log_e 2$ approximately, and his formula then becomes

$$L = 4l\log\frac{2l}{r}.$$

The electrostatic capacity of a wire, length $2l$, radius r, neglecting the question of the proximity of the earth or other conducting masses, is

$$C = \frac{2l}{2\log\frac{2l}{r}}.$$

Employing these values, then,

$$\lambda = 2\sqrt{CL} = 4l.$$

The calculation thus confirms fully the experimental results. The mere length of the wire on which the oscillations exist determines their half wave-length.

The potential measured by the spark-micrometer is proportional to the maximum charge at the point to which it is applied. Let q_0 be the maximum charge per unit length of the wire at any point x, then

$$q_0 = a\frac{\pi}{2l}\cos\frac{\pi}{2l}x\int_0^{\pi} e^{-\frac{R}{2L}t}\cos\frac{\pi}{\sqrt{CL}}t \cdot dt.$$

The maximum charge thus follows the harmonic law, the highest value occurring at $x = 0$ and $x = 2l$, the least at $x = l$; that is, at the spark-gap. This is in complete accordance with the experimental result. Neglecting the damping, the equation reduces to

$$q_0 = a\frac{\sqrt{CL}}{2l}\cos\frac{\pi}{2l}x.$$

Hence the whole quantity of electricity on the wire is

$$Q = \frac{a}{\pi}\sqrt{CL}.$$

Further, still neglecting the damping,

$$i = a \sin\frac{\pi}{2l}x \cdot \cos\frac{\pi}{\sqrt{CL}}t,$$

whence the average current along the length of the wire is

$$J = a \cdot \frac{2}{\pi}.$$

Hence,

$$\frac{J^2}{4} = \frac{Q^2}{CL},$$

or, putting $L' = \frac{L}{2}$ and $C' = \frac{C}{2}$ for the half-wire,

$$\frac{Q^2}{2C'} = \frac{J^2L'}{2};$$

that is, the electrostatic energy stored on the wire in charging becomes wholly current or electromagnetic energy, the oscillation consisting of alternating conversions of the one form of energy into the other. The energy of the charge gives rise to the so-called electrostatic effects transmitted through the surrounding medium, which are, however, not very far-reaching; for, at considerable distances from the primary the effect is small, because the two halves of the wire system are at any moment oppositely charged. The current energy gives rise to effects which follow the known electromagnetic laws. The alternation from one form of energy to the other is accompanied by losses, spoken of as the damping of the oscillations. In the above formulæ the exponential term expresses this loss. From that term the ratio of the amplitudes of two consecutive swings is seen to depend on $R\sqrt{\frac{C}{L}}$. The loss of energy is, then, three-fold. First, heat is produced in the wire by its resistance, and also in the spark-gap; secondly, losses of charge occur, since the insulating power of the air is not infinite; and, thirdly, electromagnetic energy strays into space according to Poynting's law. This last amount represents the useful work of the process from the point of view of spark telegraphy.

The conditions which bear on the efficiency of the receiving wire are next to be studied. Since the laws of electromagnetic induction hold as seen above, a parallel disposition of the conductors, sender and receiver must be best. Also, the experiments already described show that the maximum effect occurs when the receiver has the same length as the sender. The following experiments were arranged to investigate the mode

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of oscillation in different arrangements and figures of the secondary.

The sender consisted of two polished solid brass rods, 3mm. in diameter and each 1 metre long. They were screwed into an ebonite vessel filled with petroleum in which the spark occurred. Their outer ends were insulated by glass supports. An induction coil of 15cm. (6in.) spark was used. A brass rod of equal thickness, resting insulated on glass supports, served as receiver.

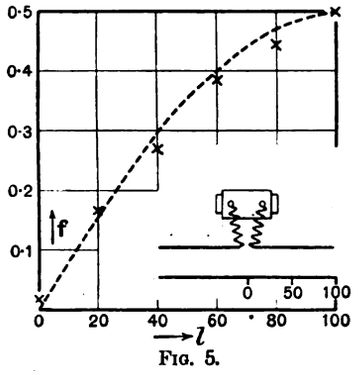

Fig. 5.

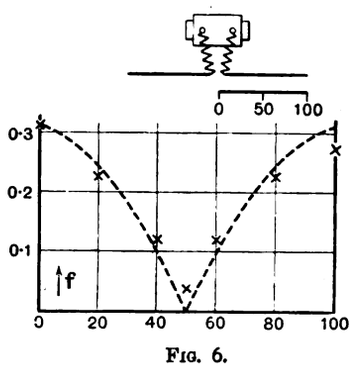

Fig. 6.

The receiver, 2 metres long, was placed 1 metre distant, parallel to the sender. Spark-micrometer measurements were made while the sender was in operation. Fig. 5 represents these measurements. The curve is a quadrant of a sine curve with a node of potential at the middle of the rod, the rod thus vibrating as a half wave-length.

The rod was shortened to one-half. The result is plotted in Fig. 6, which shows that the rod is the half wave-length of a vibration of double the frequency of that of the former arrangement, corresponding to the first overtone of the primary. It is noteworthy that the maximum potential at the ends reaches only about half the value indicated in Fig. 5.

Another metre of rod placed in line with, but not touching the rod in the last case assumed a similar state of vibration without disturbing the oscillation in the first metre.

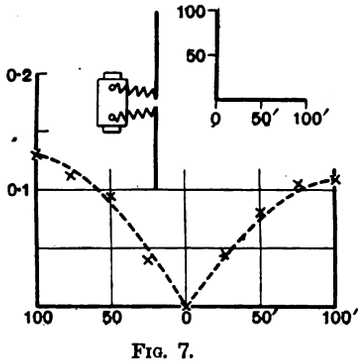

Fig. 7.

The second metre rod was arranged perpendicular to the first and in contact. Fig. 7 shows that the oscillation was now of the same frequency as that in the sender. In each limb was a quarter wave, the corner being a potential node. The potential loop at 100′ had always a slightly smaller value than that at 100.

A receiver with limbs 1 and 2 metres respectively was formed. The oscillations became more complicated. Fig. 8

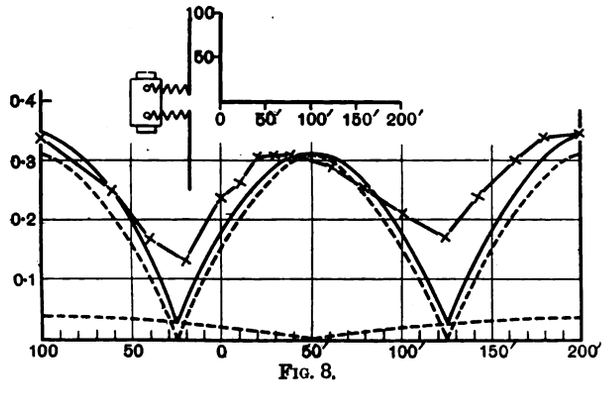

Fig. 8.

gives the experimental curve obtained and hints that the oscillation is built up of a vibration whose wave-length equals the whole length of the receiver, and has potential loops at the middle and the ends, and one whose half wave-length is the length of the receiver with its node in the middle.

A wire loop, formed by folding once a wire 2 metres long, oscillated as if each half were independent. Fig. 6 represents the state of affairs in each limb. Severing the loop at the bend made no difference.

With each limb of the loop a prolongation 1 metre long was connected and stretched separately perpendicular to the respective limb of the loop. Each limb oscillates as a half wave-length of the fundamental emitted by the receiver, the two corners being potential nodes. Then a wire 2 metres long was connected to the end of one prolongation. The end of this extension-wire gave a large micrometer reading. Other lengths than 2 metres gave smaller readings, which shows that in the extension-wire an oscillation of wave-length

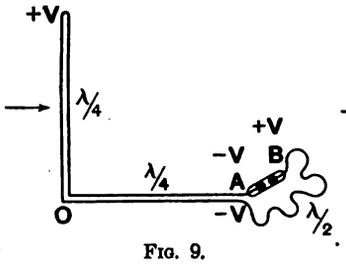

Fig. 9.

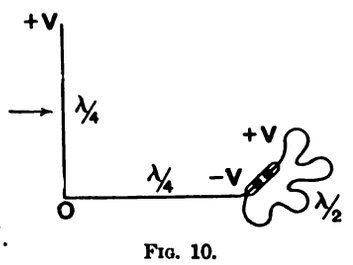

Fig. 10.

4 metres tended to establish itself. This arrangement is the disposition used in practical spark telegraphy (see *The Electrician*, p. 475, Vol. XLVI.), and is illustrated in Fig. 9 Since the potential at the ends, A, of both prolongations is the same, Count Arco gave the practical arrangement the simpler form of Fig. 10. These arrangements work without earth connection, and are, therefore, free from atmospheric disturbance. As the corner O is a node, that corner can, however, be earthed in practice.

To ascertain the law which connects the magnitude of the effect in the receiver with the distance between it and the sender, micrometer measurements were made on the receiver sketched in Fig. 11. The results are plotted in the figure,

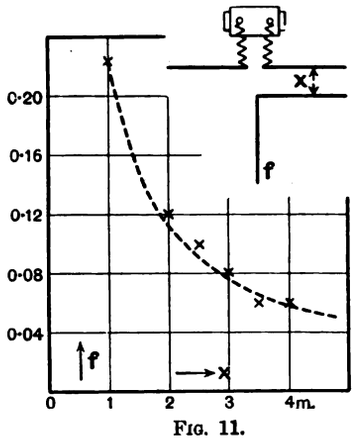

Fig. 11.

distances being abscissæ and the spark-lengths observed at the end of the prolongation wire being ordinates. The curve is hyperbolic, and indicates that within the limits of the experiments the effect on the secondary varies inversely as the first power of the distance.

(To be concluded.)

CARS FOR LONDON COUNTY COUNCIL TRAMWAYS.

On the recommendation of Prof. A. B. W. Kennedy, subsequently confirmed by the Highways committee, the London County Council on Tuesday last decided to place the order for the first rolling stock, comprising 100 cars, with Messrs. Dick, Kerr & Co. Nine firms tendered for the work and submitted altogether some 23 tenders. There was naturally keen competition, the prices ranging from £65,000 to something over £80,000, it being noteworthy that the German tenders were among the highest submitted. On account of the system being a conduit one, there are certain modifications in the car from the ordinary trolley type. Obviously, the chief difference arises in the introduction of a plough contact,

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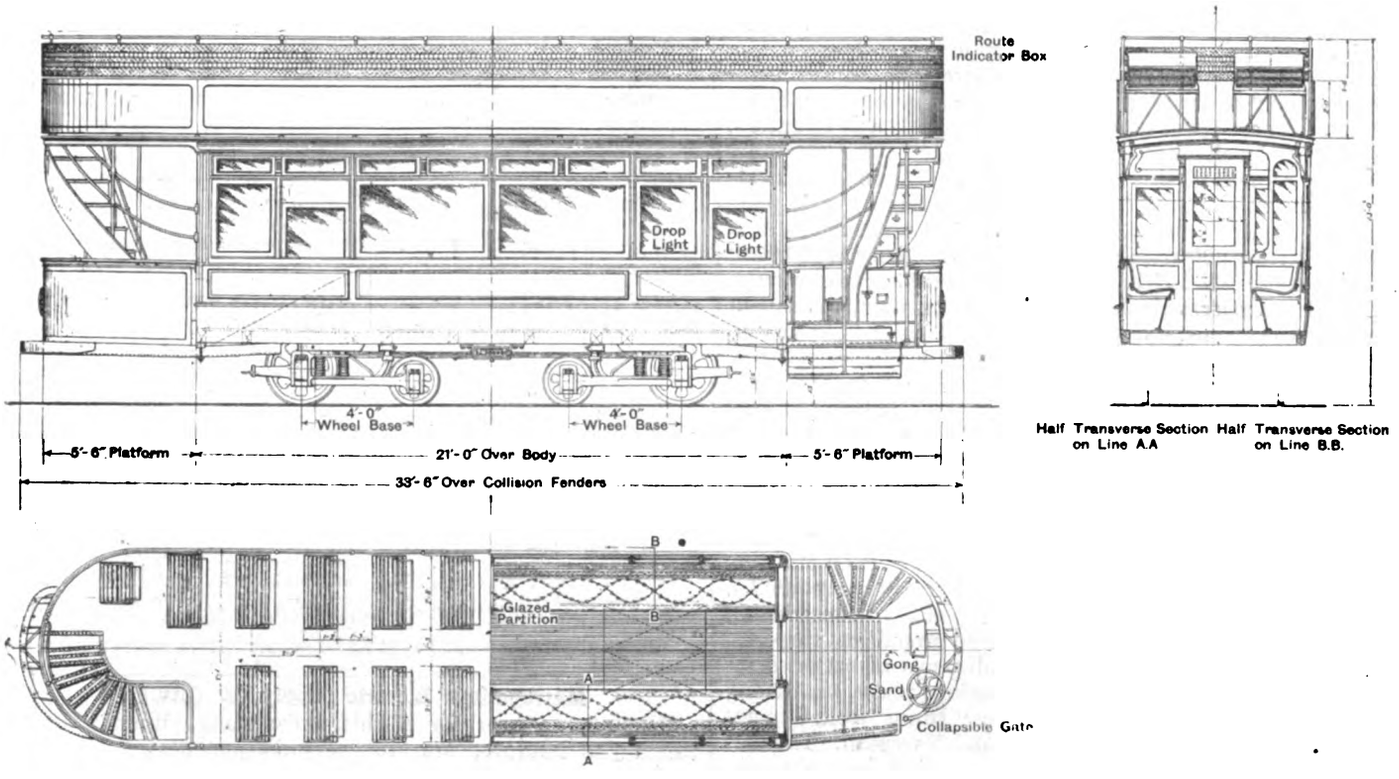
the one adopted being known as the J. G. White plough, which, we are informed, is identical with the form of plough designed by Mr. Connett for the Paris conduit system. The type of car will bear considerable resemblance to what is known as the "Preston" pattern, which has been supplied by Messrs. Dick, Kerr & Co. to many of the tramway systems in this country. It will be remembered that this design embraces new features in tramcar construction, giving greater space in the interior and slightly increasing the seating capacity on the outside. The reversed staircase, which was first employed in this type, has much to recommend it, and has become distinctly popular with tramway authorities. The seating capacity of the new London County Council cars will be 66 passengers, 28 inside and 38 outside; and the total length overall will be 33ft. 6in. The frame of the car will be so arranged as to accommodate on each side two large fixed windows in the centre, and four end windows arranged to lower in the manner shown in the drawing. Above these there will be a line of narrow, ornamental pivoted sashes to allow for ventition. At each end of the car will be route indicator boxes provided with revolving linen screens. A new feature in the interior of the car will be a glazed partition arranged in the manner shown in the illustration. The interior woodwork of the cars will be made up of quartered oak, and the end doors will slide in the usual way and will be fitted with the necessary handles, catches, &c. The roof seats, as already stated, will carry 38 passengers, and will be of the garden type with angle-iron legs. The cars will be mounted on maximum traction Brill bogies, each bogie carrying one motor. The electrical equipments will be in most respects similar to those usually supplied by Messrs. Dick, Kerr & Co., notable features claimed for the motor being freedom from sparking of the commutator under all conditions of load, and high efficiency. The temperature rise will be also well under the specified requirements. The cars will be fitted with the customary series-parallel controllers, and there will be the usual equipment of emergency switches, lightning arresters, hand brake, &c. It will be remembered that the order for the electrical generating plant for the London County Council tramway system was also placed with Messrs. Dick, Kerr & Co.



MOTOR-CAR EXHIBITION AT ISLINGTON.

The Automobile Club's exhibition of motor cars was opened on Saturday last at the Agricultural Hall, Islington, where the various exhibits will remain on view until to-morrow evening. As usual, steam and petrol cars are by far the most numerous, and among these there are vehicles capable of covering long distances at high speeds. The complications of the cars propelled by internal combustion engines, however, seem to increase with their size, and it becomes more and more apparent that unless radical improvements are effected, this class of car can only act as a "stop gap" until a more ideal method of propulsion is perfected. The electrically-driven vehicle certainly possesses in some respects ideal qualities, but the exhibits in this direction were not numerous, though an increase on former occasions.

The City and Suburban Electric Carriage Co. have a large exhibit of a variety of cars, ranging from an omnibus to carry 15 persons to a victoriette to seat two. The omnibus, which is well finished and upholstered, has a maximum speed of 10 miles an hour for 35 miles on one charge. The victoriette has a maximum mileage capacity of 40, with a "special battery," at about 12 miles an hour, and similar vehicles have been supplied to the Queen and other royal personages. A Tonneau phæton, with a body resembling a petrol car, looked very imposing, and this car is equal to 25 miles an hour over fair roads for about 100 miles on one charge of the cells. The motors of these vehicles gear directly on to the rear wheels, each motor running independently of its neighbour, thus dispensing with differential gearing. The batteries, made by the E.P.S. Co., are supplied in two forms: the "City," capable of propelling the loaded car for 35 to 40 miles, and the "Suburban" battery, which will do similar work, but for 50 to 55 miles. The company have a central depôt, at which they undertake to charge batteries and maintain cars for a quarterly or annual rental.

The Electric Carriage and Storage Co. showed three Krieger cars, a coupé, phæton and victoria. The motors of these vehicles are suspended under the driver's seat and gear directly on to the front wheels, the gear wheels being of a special form of vulcanite, which wears well, but does not cause any unpleasant noise. The controller allows for eight speeds, and arrangements are made for re-charging the cells when going down hill; 44 Fulmen cells are used and distributed at the front and rear of the vehicle. On the same stand was a landaulet of the Electric Motive Power Co. fitted

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with cells having Epstein-Planté positives and zinc negative plates. The motor was mounted under the front of the vehicle, and drove the rear wheels by a slanting shaft which extended to a worm gear at the base of the differential gear on the hind axle. A magnetic clutch was interposed between this gear and the motor, and a two-way switch energised the clutch in such a way that on one contact the parts of the clutch were drawn together as a solid piece, and on the other, the motor side revolved much faster, but the rear wheels slower. This enabled hills to be climbed at a more efficient motor speed, besides dispensing with noisy gearing. The vehicle in question carrying four persons is equal to 80 miles run, at about 12 miles an hour, on one charge. Arrangements are also fitted for re-charging the cells when going down hill.

The Canadian Electric Vehicle Co. have four cars on their stand, comprising a runabout for two persons, a landaulet for six persons, a dog-cart carrying four and a waggonette to hold six persons. These vehicles are fitted with "Ideal" batteries and motors constructed on the "Still" system. These latter have both revolving field and armature, one geared by chain to one of the rear wheels, and the other similarly connected to the other wheel. The cells are made in four sizes, 8-plate having 65 ampere-hours capacity, 12-plate with 95 ampere-hours, 16-plate for 135 ampere hours, and 24-plate having 200 ampere-hours capacity. The complete cell in each case weighs 12¼lb., 18¾lb., 24½lb. and 37lb. respectively.

Mr. Carl Oppermann had several cars on view, a runabout seating two persons, a victoriette, a brougham and a mail van. The victoriette has been run 100 miles on one battery charge, and the mail van, which has been constructed for the Postmaster-General, will shortly be tried on the London streets by the Post Office authorities. It is capable of running 40 miles on one charge, and will hold up to 4 cwt. of parcels and mails. All these cars are fitted with A.B.C. cells, which are of light construction and large capacity. The standard type of cell weighs 24lbs., and has a capacity of 230 amperes hours. The "Max" accumulator (see *The Electrician*, Vol. XLVII., page 985) was the only cell exhibited for all electrical purposes, traction, lighting and ignition, and being of light construction it should become much used for electric propulsion purposes.

A number of exhibits comprised displays of batteries for ignition purposes, coils, cell testers, sparking plugs, &c., among these being Peto and Radford with the "Dinin" cell, General Electric Battery Co., and Sutherland and Marcuson. The battery and coil for ignition in petrol motors is likely to give way to magneto-igniters, which are certainly more compact than the battery arrangement and dispense with straggling leads and high-pressure connections. The Simms Bosch magneto-igniter was on view, in various forms, for bicycle motors, single, double and four cylinder motors, and also for gas engines. The saving in weight over battery and coil in bicycles is about 7lb., and in cars about 10lb., the other advantages being certainty in action and longer life. The Lanchester Engine Co. have a magneto device attached to the motor flywheel. Permanent magnets are fitted to the wheel, and a fixed coil wound on a laminated core is fixed at the wheel hub. Revolutions of the wheel generate currents in the coil, which are led by stout conductors to the sparking device, consisting of a steel ribbon spring connected to a pin, passing into the interior of the plug through an insulating bush. The contact is here made and broken by the action of the spring, which is struck with a wiping trigger attached to the motor shaft. The slightest revolution of the motor causes a spark to pass at the plug.

ELECTRICITY WORKS ACCOUNTS.

The City of London Electric Lighting Co. (Ltd.).

A satisfactory feature of the 1901 accounts of this undertaking is the continued improvement shown in the costs. It may be remembered that the operations of the year 1900 marked a considerable advance in respect of economy of working on the preceding year. By the further reduction from 8d. to 2·47d. per unit the total costs of this undertaking compare very favourably with the average of other large metropolitan concerns. The improvement was effected through the generating costs, and it may be noticed that the fuel item shows a drop of 0·44d. per unit. The management costs have risen, as have the rates and taxes, legal charges for one thing, being tenfold what they were in 1900. The average receipts, more particularly of the private supply, were higher than in 1900, and the total revenue from all sources was 0·42d. per unit more. This movement, in conjunction with the lower costs, naturally changed the complexion of the financial results, and a dividend of 5 per cent. was made on the ordinary shares. Unfortunately, although the contributions to reserve were slightly more that in the preceding year, they are still very inadequate. Including interest, the charges on the net revenue account totalled no more than 2·76 per cent. on the mean capital expended.

The directors have opened a "debenture stock premium redemption account" by placing £47,361—the balance of premiums on stock issues—to this end.

The following are the details of the repairs and renewals expenditure included in our table under generating and distributing costs:—

Year	Total.	Repairs and renewals at station.						Maintenance, renewals, &c., of mains, posts, and transformers.
		Total at station	Buildings.	Boilers, heaters, &c.	Engines and condensers.	Dynamos & excitrs	Instruments & tools.	
	£	£	£	£	£	£	£	£
1900	23,486	18,736	1,969	7,459	3,418	888	5,002*	4,750
1901	17,959	12,759	1,247	5,311	2,125	427	3,649†	5,200

* Including £2,021 for coal conveyor, cranes, &c.
† „ 1,260 „ „ „

The most unsatisfactory side of the business last year was the small progress made in the expansion of the concern. The following table will afford an idea of the progress made in the past. The output last year was barely 2 per cent. above that of 1900, and the lamp connections were increased by only 5·8 per cent.:—

Dec. 31.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
No. of consumers	242	1,080	2,746	4,230	4,303	6,320	7,414	8,737	9,855	10,618
Equiv. 8 c.p. lamps con.	20,241	85,311	135,460	195,317	247,785	296,012	356,823	487,612	519,113	549,175

Metropolitan Electric Supply Co. (Ltd.).

The costs of working of this undertaking, although continuing to improve, are still very disappointing. All the generating costs are too high, the least unsatisfactory item being that of wages at the station. Probably owing to the recent re-assessment, the rates and taxes have been nearly doubled, otherwise the management and property charges remain practically stationary.

A slight reduction in the revenue is noticeable, but not sufficient to destroy the effect of the lower costs on the financial results. Unfortunately, here again, as with the City Company, the allocation to reserve was very small. In this case the interest and depreciation charges only amounted to 1·87 per cent. on the mean capital in total, yet it was thought justifiable to distribute a dividend of 6½ per cent. on the ordinary shares.

With the Metropolitan as well as with the City Company the load factor shows a decline in value. Both the output and the lamp connections show increases of between 12 to 13 per cent. on the values of 1900.

REMARKS.

CITY OF LONDON.—*a* Estimated. *b* Assuming the 503 arcs as equivalent to 8,000 8 c.p. lamps. *c* £27,456 out of premiums and reserve accounts. *d* £1,511 at credit of repairs and maintenance fund. *e* There is a balance of premiums of £17,361. *f* £24,106 on provisional order, mains and meters for Southwark lighting and £68,505 on conduits for telephonic purposes now largely used for lighting. *g* Includes repairs and renewals of lamp posts. *h* £3,417 proportion of salaries of engineer and assistants and wages of lamp trimmers. *i* £1,433 proportion of salaries of engineer and assistants. *j* Rates, taxes and lighting *k* Directors, salaries of manager and secretary, clerks, accountants, &c. *l* £2,122 insurance, £691 fires, £554 law and £277 professional charges. *m* 8d. per unit for first six units per lamp in winter and for first three units in summer, 2d. after. *n* Exclusive of £18,504 debenture stock premiums. *o* Includes £8,551 at credit of repairs and maintenance fund. *p* Proportion of salaries of engineer and assistants £5,660. *q* Proportion of salaries of engineer and assistants £1,407 and wages of lamp trimmers. *r* Law £1,549, insurances £2,590. *s* Covering attendance and renewals on public lamps.

LONDON.—*a* £21,871 premiums on stock. *b* £25 to purchase of current. *c* £8,383 salaries of engineers and officers. *d* Directors and trustees £3,650, salaries of management, secretary, engineers, clerks, &c., £8,002. *e* Auditing £242, law £175, insurance £1,415. *f* The capacity of generating plant at Willesden was 7,500kw. *g* £23,425 premiums on stock. *h* Over-expended. *i* £4,077 salaries of engineers and officers. *j* Directors and trustees £3,650, salaries of management, secretary, engineers, clerks, &c., £8,993. *k* Insurance £1,354, auditing £243, law £911.

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	CITY OF LONDON.		LONDON.	
Undertaking Worked by	The City of London Electric Lighting Co. (Ltd.)		The Metropolitan Electric Supply Co. (Ltd.)	
Date of Commencement of Supply	December, 1891.		1890.	
System of Supply	Alternate-current transformer sub-station feeding 3-wire network; also continuous current 3-wire system.		Alt.-curr. trans. in houses and sub-stations with 3-w. distribution, con.-curr. 3-wire; also extra h.p. 2-phase from [Willesden by rotaries.	
Chief Engineer	Frank Bailey.		R. R. Todd.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	—	—	—	19,002,892
„ SOLD (TOTAL)	12,472,900	12,719,872	9,855,175	11,122,022
„ sold to consumers	11,272,968	11,526,951	—	11,055,014
„ sold for public lighting, &c.	1,200,000[a]	1,192,921	—	67,008
„ sold for traction	nil	nil	—	—
„ used on works	—	—	—	618,605
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	27·6	24·7	—	—
Actual maximum supply demanded	11,230 kilowatts	12,583 kilowatts	8,905 kilowatts	10,842 kilowatts
Load factor	12·7%	11·5%	12·6%	11·7%
Number of public lamps	508 arc	508 arc	25 arc	20 arc
Number of consumers	9,855	10,618	8,000	10,500
Connections to mains in 8-c.p. lamps at end of year	519,113[b]	549,175	570,000	641,270
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	15,000	18,000	10,750	—[f]
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£2,000,000 / £133	£2,000,000 / £111	£2,000,000 / £186	£2,000,000 / —
Share	1,200,000 / 80·0	1,200,000 / 66 7	1,000,000 / 93	1,000,000 / —
Loan (including Debenture charges)	800,000 / 53·3	800,000 / 44·4	1,000,000 / 93	1,000,000 / —
RECEIVED (TOTAL)	1,693,909[c] / 113	1,805,950 / 100	1,419,056[a] / 132	1,493,425[g] / —
Share	1,105,950 / 73·7	1,105,950 / 61 5	927,185 / 86·3	1,000,000 / —
Loan (including Debenture charges)	560,503 / 37·4	700,000 / 38·9	470,000 / 43·7	470,000 / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	333 547 / 22·2	194,050 / 10·8	602,815 / 56·1	530 000 / —
Share (unissued)	94,050 / 6·27	94,050 / 5·22	12,310 / 1·15	nil / —
Share (uncalled)	nil / —	nil / —	60,505 / 5·63	nil / —
Loan (including Debentures)	239,497 / 16·0	100,000 / 5·55	530,000 / 49·3	530,000 / —
REPAID (TOTAL)	27,456 / 1·83	33,410 / 1·85	— / —	— / —
RESERVE OR SINKING FUND	nil[e] / —	48,410[n] / 2·69	} 78,422 / 73 0	88,447 / —
DEPRECIATION FUND	97,560[d] / 6·50	97,216[o] / 5·40		
EXPENDED (TOTAL)	1,756,431 / 117	1,910,435 / 106	1,417,805 / 132	1,619,731 / —
Lands and buildings	382,832 / 25·5	433,396 / 24·0	334,257 / 31·1	370,241 / —
Plant	744,984 / 49·6	817,435 / 45·4	596,504 / 55·5	667,059 / —
Mains	577,040[f] / 38·5	581,602 / 32·3	431,629 / 40·1	501,698 / —
Miscellaneous	51,575 / 3·44	78,002 / 4·33	55,416 / 5·15	80,733 / —
BALANCE OF CAPITAL ACCOUNT	− 62,521 / − 4·17	− 104,485 / − 5·81	1,250 / 0·116	− 126.306[h] / —
REVENUE—	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.
TOTAL	£213,474 / 4·109d.	£239,972 / 4·528d.	£209,013 / 5·090d.	£235,474 / 5·083d.
Revenue from supply	191,977 / 3·696d.	216,101 / 4·079d.	202,827 / 4·940d.	228,173 / 4·925d.
„ meters, &c.	7,394 / 0·142d.	8,232 / 0·155d.	6,144 / 0·150d.	7,249 / 0·156d.
„ public lighting	13,193 / 0·254d.	13,412 / 0·253d.	— / —	— / —
„ supply for traction	nil / —	nil / —	nil / —	nil / —
„ miscellaneous sources	910 / 0·017d.	2,227 / 0·042d.	42 / 0 001d.	52 / 0·001d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£156,146 / 3·004d.	£130,730 / 2·466d.	£130,513 / 3·178d.	£144,413 / 3·117d.
TOTAL WORKS COSTS	130,236 / 2·506d.	103,171 / 1·946d.	107,533 / 2·618d.	116,210 / 2·508d.
Generation of electricity	*119,149 / 2·291d.*	*91,429 / 1·724d.*	*106,099[b] / 2·581d.*	*112,610 / 2·429d.*
Fuel (including cartage, &c.)	78,128 / 1·503d.	56,150 / 1·059d.	69,065 / 1·681d.	72,867 / 1·573d.
Oil, waste, water, stores	5,520 / 0·106d.	4,189 / 0·079d.	6,172 / 0·151d.	7,341 / 0·158d.
Wages at station	15,844[h] / 0·305d.	17,194[p] / 0·324d.	15,275[c] / 0·372d.	16,950[i] / 0·366d.
Repairs and maintenance at station	18,736 / 0·361d.	12,759 / 0·242d.	15,472 / 0·377d.	15,452 / 0·334d.
Distribution of electricity	*10,057 / 0·194d.*	*10,733 / 0·202d.*	*1,524 / 0·037d.*	*3,600 / 0·078d.*
Wages, &c.	5,307[i] / 0 102d.	5,533[q] / 0·104d.	} 1,524 / 0·037d.	3,600 / 0·078d.
Repairs, renewals of mains, &c.	4,750[g] / 0·091d.	5,200[g] / 0·098d.		
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	1,030 / 0·020d.	1,009 / 0·019d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	25,910 / 0·499d.	27,558 / 0·520d.	22,980 / 0·560d.	28,203 / 0·609d.
Net rents	nil / —	nil / —	*1,370 / 0 033d.*	*1,654 / 0·036d.*
Rates and taxes	*10,727[j] / 0·206d.*	*11,027[j] / 0·208d.*	*3,604 / 0·088d.*	*7,009 / 0·151d.*
Management	*15,183 / 0·292d.*	*16,531 / 0·312d.*	*18,005 / 0·438d.*	*19,540 / 0·422d.*
Salaries	8,306[k] / 0·160d.	8,830[k] / 0·166d.	12,143[d] / 0·296d.	13,481[j] / 0·291d.
Stationery, &c.	1,195 / 0·023d.	961 / 0·018d.	901 / 0·022d.	1,082 / 0·023d.
Establishment charges	1,311 / 0·025d.	656 / 0·012d.	3,129 / 0·076d.	2,470 / 0·053d.
Law charges &c.	4,371[l] / 0·084d.	6,084[r] / 0·115d.	1,832[c] / 0·045d.	2,507[k] / 0·054d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£57,328 / 3 51%	£109,242 / 5·96%	£78,500 / 5·90%	£91,061 / 5·99%
Sum carried to Depreciation Fund	1,514 / 0·093%	} 22,041 / 1·20%	14,000 / 1 05%	10,000 / 0·653%
Sum carried to Reserve Fund	nil / —		— / —	— / —
Net interest on loans (incl. Debenture charges)	23,192 / 1·42%	28,520 / 1·56%	15,570 / 1·17%	18,364 / 1·21%
Net profit for the year	32,620 / 2·00%	58,681 / 3·20%	23,430 / 1·76%	62,698 / 4·13%
BALANCE FROM LAST ACCOUNT	1,623 / 0·099%	11,343 / 0 619%	4,410 / 0·331%	1,825 / 0·12%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	34,243 / 2·09%	70,025 / 3·82%	27,840 / 2·09%	64,522 / 4·24%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	nil / —	5% / —	6% / —	6½% / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	73·1%	54·5%	62·4%	61·3%
Expenditure per mean kilowatt capacity	£10. 16s. 2d.	£7. 18s. 5d.	—	—
REVENUE PER MEAN KILOWATT CAPACITY	**£14. 15s. 6d.**	**£14. 10s. 10d.**	—	—
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**8s. 11d.**	**9s. 0d.**	**7s. 10d.**	**7s. 9d.**
Price charged for lighting, per unit	8d. to 2d.[m]	8d. to 2d.[m]	6d. with discount	6d. to 5d.
Price charged for power, per unit	2½d.	2½d.	4d.	3d.
Price charged for public lighting	£26 per lamp per ann.	£26 per lamp per ann.	—	—
Receipts per unit for private supply	4·09d.	4·5d.	} 4·94d.	4·92d.
„ „ public lighting	2·64d.[s]	2·70d.[s]		
„ „ traction	—	—	—	—

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ELECTRIC TUBE RAILWAYS FOR LONDON.

Lord WINDSOR'S Committee has been actively engaged during the past week in pushing forward with the large batch of electric tube railway bills, the consideration of which was commenced on the 16th inst., as reported in our last issue. We give this week a lengthy report of the proceedings, and a map of the most important group in the 14 bills now before the Committee. Notwithstanding the amount of time which has been devoted to its programme, it may be said that the Committee has only just broken ground; and it may be expected that the multifarious questions and important issues which still remain to be considered will keep the noble Lords busy for some weeks to come. In the nature of things—the more especially because of the directly competitive character of many of these schemes—it is impossible for the various Bills to be despatched independently and seriatim. The Committee is compelled to consider them as a whole, postponing its decision upon each individual scheme until it has done so. Up to its last sitting, on Wednesday, evidence had been heard on (1) the Charing Cross, Hammersmith and District Electric Railway Bills, Nos. 1 and 2; (2) the Piccadilly and City Railway and the lines associated with it. Unusual interest attaches to this last-named batch of schemes, inasmuch as it is the intention of its promoters that it shall form an extensive system of underground railways, similar to and not less important than the group of railways recently brought into coalescence by the astute Mr. YERKES. Indeed, it is already becoming customary to speak of the "Yerkes group" and the "Morgan group" of these railways, the last-named being presided over by Mr. YERKES' millionaire compatriot, Mr. PIERPONT MORGAN. Besides the Piccadilly and City Railway, the Morgan group, if authorised in its entirety, will comprise the underground tubes forming the London Electric Railways, the North-East London and the City and North-East Suburban Railways. Further, by what is practically an amalgamation with the London United Tramways (Ltd.), the Morgan group will be worked in conjunction with the surface electric tramways of this company, and a system of through fares is to be introduced between the tramcars and the trains. Particulars of this arrangement are set forth in our report of the evidence before the Committee. Our readers will perceive that it is as yet early to forecast the decisions of the Committee, or to discuss the relative merits of this large and important batch of bills. Sufficient, however, has taken place already to show that the apparent chaos is evolving slowly, by a process of natural selection and coalescence, into something like order. There is good ground for hope that the action of the strong capitalists who have taken the problem of London's tube railways in hand, together with the judicious weeding out of superfluous schemes which we may expect from Lord WINDSOR'S Committee, will go far towards effecting that organisation of underground railways the necessity for which was insisted upon by the Joint Committee of Parliament last year.

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It was scarcely to be expected that any unified system of tube railways could be developed by private capital without its evoking protest from the socialist advocates of municipal trading. Both within and from without the Committee room this form of opposition is making its voice heard. The London County Council, as usual, of course, has been chattering. By no other term can we correctly describe its debate last Tuesday. Disappointed that Parliament has not seen fit to erect it into the central controlling authority over London's underground railways, it has aspired to erect itself into such an authority on its own sanction. Thus self-constituted, it has sat in judgment upon the 14 bills before Lord WINDSOR'S Committee and has been pleased to classify them under four heads, according to the measure of its disapproval of them. At one end of the category it places the schemes which, "subject to certain conditions," it will not object to; and at the other extremity is its Inferno for schemes which "should be opposed, for the most part, *in toto*." Considering that Lord WINDSOR'S Committee has been sitting for a week, the Council is rather behindhand with its decisions on this matter; but it is easy to discern from the tone of the speeches embodying these decisions that the Council has been holding back in expectation of being called in by Parliament to act as the appointed authority. Mr. BENN describes this inattentiveness of Parliament as an "unfortunate position," Mr. JOHN BURNS thinks that the "Morganising" ought to be stopped, Mr. BAKER is all for shallow tunnels, and affects to believe that Lieut.-Col. YORKE is on his side, Mr. SIDNEY LOW clamours for the appointment of a Royal Commission on the whole question—even at this late hour!—and Dr. NAPIER feels unhappy because the "Council itself has no powers such as a Royal Commission would have." Clearly, the London County Council progressive fraternity are very much upset at the idea of a system of underground railways, uncontrolled by themselves, springing into existence beneath the ground dedicated to their own tramways. We have said more than once before, and we again repeat, that the pecuniary interest which the possession of its tramways gives to the Council in all questions affecting London's railway systems is quite sufficient to disqualify the Council from acting as an authority in the matter. It cannot act impartially; therefore, it should persistently be refused power to act at all.

So much for the opposition of the London County Council outside the Committee rooms; it is also raising opposition, on quite other grounds, within them. The erection of railway buildings fronting upon public thoroughfares is no new thing in London; and it has hitherto been the law that such buildings—forming a necessary part, as they do, of undertakings authorised by special acts of Parliament—shall not be subject to the Metropolitan Buildings Acts. To bring them under these municipal acts would be superfluous, and would lead to unnecessarily irksome restrictions. The London County Council, acting on the authority vested in it by the Metropolitan Buildings Acts, has had control over the buildings for electricity supply works, and it professes inability to see the difference between these and the buildings for electric railway generating stations. To its mind a power station is a power station, wherever and for whatever purpose erected; and it is desirous of having power to enforce "uniformity" in its construction. This view of the matter was put forward on Tuesday by the Council, in connection with the Metropolitan and District Railway Bill. The power station for this railway will supply current for the Yerkes group of underground lines; and we regard it as a piece of purely vexatious opposition that the County Council, now that all the plans for the power station are prepared and lodged before Parliament, should have sought power to override them and insist on irksome and expensive modifications. No useful end would have been gained by granting such power to the Council; on the contrary, as we have said, the progress of individual electric railway schemes in London would be uselessly hindered. It is satisfactory to note, therefore, that the Committee has refused to sanction this extension of the Metropolitan Buildings Acts to he buildings connected with London's underground railways.

THE INSTITUTION AND ITS PROPOSED MODEL CONTRACTS.

At the meeting of the Institution of Electrical Engineers last night the proposed form of Model General Conditions for use in connection with contracts for plant, mains and apparatus for electricity works, was brought forward, as drafted by a committee appointed for the purpose, and presented to the Council for adoption as the "Model General Conditions" recommended by the Institution of Electrical Engineers. The committee was appointed by the Council on Dec. 20, 1900, and met first on Jan. 7, 1901; it was then arranged:—

1. To send copies of the original draft, for the purpose of eliciting criticisms and suggestions, to the Electrical Plant Manufacturers' Association, to the Cable Manufacturers' Association, and to the Municipal Electrical Association, as well as to certain engineers and manufacturers, and
2. To consider such replies as should be received when examining the draft conditions in detail.

At the request of the committee, the three associations above named, and also the Engineering Employers' Federation, appointed delegates to confer with the committee, and at a subsequent council meeting these delegates were formally added to the committee, which was much strengthened and greatly assisted by their co-operation. The meetings of the committee were well attended, and the draft General Conditions were considered individually in great detail, the views of all parties being carefully studied, and, as far as possible, harmonised. The General Conditions, with the emendations and additions made in the first survey, were re-examined in detail, and were then submitted to counsel. The form of General Conditions hereto subjoined is that agreed to as between counsel and the committee. By order of the Council of the Institution they have now been placed before a general meeting, in order that they might be discussed, and that any important criticisms thus elicited might be carefully weighed, and the committee and the Council assisted in their attempt to draft a set of General Conditions which may meet with general acceptance. In view of the importance of these "model conditions" and the necessity that they should be thoroughly discussed before they become crystallised, we herewith reproduce some of the main clauses in the draft. By this means we hope, through the medium of our Correspondence columns to elicit discussion from electrical engineers and others who may have been prevented from taking part in yesterday's discussion.

Our readers will clearly understand that the clauses quoted below are merely in their draft form, and are subject to subsequent revision.

The draft commences with definitions of terms, such as "purchasers," "contractor," "engineer," "work" or "works," &c. Passing over such matters as "drawings," "foundations and builders' work," "use of crane," "site," &c., we come to:—

Tenderer's Specification.—The tenderer is required to fill in the details of his tender in the spaces provided for the purpose at the end of each section of the specification. Such statement will be accepted in lieu of a detailed specification, but the tenderer is at liberty to add any further information that he may deem desirable, and in the event of his doing so shall print or type the same and annex it to the specification returned by him.

Drawings to accompany Tender.—The tenderer must submit with his tender the drawings enumerated in the section for which he is tendering, drawn to as large a scale as is convenient. Detailed drawings are not required to be submitted with the tender; but if the tenderer wishes to

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call special attention to any detail of construction, he may submit a drawing of the same with his tender. All drawings submitted by unsuccessful tenderers shall be returned within 14 days of the date of the adjudication of the purchasers upon the tenders.

Tenders.—The copy of the specification herewith supplied to each tenderer must be filled up, returned intact, together with the General Conditions and drawings, sealed and marked "Tender for Electricity Works," addressed to ——, and must be received by him before —— p.m. on ——. The purchasers reserve to themselves the right of accepting a separate tender or separate tenders for any one or more of the sections of the specification. The purchasers do not bind themselves to accept the lowest or any tender, nor will they be responsible for, or pay for, expenses or losses which may be incurred by any tenderer in the preparation of his tender, except as provided by condition 10. The sum deposited by the tenderer on application for the specification will be refunded to him within 14 days of the date of the adjudication upon the tenders, unless in any case the purchasers, on the advice of the engineer, shall determine that the tender was not made in good faith, in which case the deposit shall be forfeited. Extra copies of the specification and general conditions may be supplied by the engineer to tenderers on payment of 5s. per set, and extra copies of the drawings at a reasonable price. The engineer shall decide whether a tenderer should or should not be so supplied.

Contractor to inform Himself fully.—If the contractor shall have any doubt as to the meaning of any portion of these general conditions or of the specifiation, he shall, before signing the contract, set forth the particulars thereof, and submit them to the engineer in writing, in order that such doubt may be removed.

Contract and Bond.—The contractor shall, upon the acceptance of his tender, enter into a sealed agreement for the proper fulfilment of the contract, and provide and name two sureties, or grantors of an insurance or guarantee policy, whose names shall be set out in the tender and be subject to the approval of the purchasers, and who shall execute a joint and several bond or grant an insurance or guarantee policy to the extent of 10 per cent. of the value of the contract, by way of suretyship for the due and faithful performance of the contract, as defined by these conditions, such suretyship to be binding, notwithstanding any variations, alterations, directions, or extensions of time to be made, given, conceded or agreed under these conditions. The required agreement and instrument of suretyship shall be prepared or approved by or for the purchasers and executed by the contractor and his sureties, insurers or guarantors respectively within 30 days after the same shall be presented to them for that purpose, and the purchasers shall execute their portion of the contract, and forward the same to the contractor not less than one month from the date of acceptance of his tender.

Unless the contractor shall, within 14 days after being required in writing so to do, satisfy the foregoing provision, the purchasers may at their option withdraw their acceptance of the tender, and on such withdrawal being notified in writing the deposit shall be forfeited.

In case the contract and bond or security shall not be executed by the contractor or his sureties, insurers or guarantors respectively within 30 days after the same shall have been presented to them for that purpose, the purchasers shall not, unless they think fit, be bound by their acceptance of the tender, or by the contract, but the same shall, at the option of the purchasers, be absolutely void, and if the purchasers, by notice in writing to the intending contractor, declare the same to be void, the purchasers shall not be liable to or for any claim or demand from the contractor in respect of work then already done or materials furnished, or in respect of any other matter or thing whatsoever.

In case the contract shall not be executed by the purchasers within 30 days after the acceptance of the tender the tenderers shall not, unless he thinks fit, be bound by his tender, but the same shall, at his option, be absolutely void, and if the tenderer, having duly complied with these conditions, shall, by notice in writing to the purchasers, declare the same to be void, the tenderer shall not be liable to or for any claim or demand from the purchasers, but he shall be entitled to be repaid the proper expenses of his tender, together with any sum or sums in respect of work then already done or materials furnished, at the request in writing of the purchasers.

The expenses of completing and stamping the contract and bond or insurance or guarantee policy shall be paid as to one-half by the contractor, and the other half by the purchasers, and the contractor shall be furnished with an executed counterpart of the contract.

Local Government Board's Sanction.—The contract will be made subject to the sanction of the Local Government Board (London County Council) being given, on terms acceptable to the purchasers, to the borrowing by the purchasers of the necessary moneys for the purpose of carrying out the works. The contractor is to be notified on acceptance of his tender whether such sanction has been applied for or obtained. [NOTE.—*This clause will only be used in connection with municipal contracts.*]

We give the foregoing as a sample. The next batch of clauses in the draft deal with "drawings of completed works," "sub-letting of contract,"* "approved apparatus," "notices to the contractor," and "patent rights." This last-named is as follows:—

The contractor shall fully indemnify the purchasers against any action, claim or demand, costs or expenses arising from or incurred by reason of any infringement or alleged infringement of letters patent, trade mark or name, copyright or other protected rights, in respect of any plant, work, material or thing, system or method of using, fixing, working or arrangement used or fixed or supplied by the contractor. All payments and royalties payable in one sum or by instalments or otherwise shall be included by the contractor in the prices named in his tender, and shall be paid by him to those to whom they may be due or payable.

In the event of any claim being made or action brought against the purchasers in respect of any such matters as aforesaid, the contractor shall be immediately notified thereof, and he shall, with the assistance, if necessary, of the purchasers, but at his sole expense, conduct all negotiations for the settlement of the same, or any litigation that may arise therefrom.

An important general clause deals with "power to vary or omit work":—

The contractor shall not alter, in any way whatsoever, any of the work, except as directed in writing by the engineer; but the engineer shall have full power, from time to time during the execution of the contract, to alter, amend, omit or otherwise vary any of the work, without in any way affecting or vitiating the contract, and the contractor shall carry out such alterations, amendments, omissions, variations or directions, and be bound by the same conditions as far as applicable, as though the said alterations, amendments, omissions, variations or directions occurred in the contract. The differences of cost, if any, occasioned by any such alterations, amendments, omissions, variations or directions, shall be added to or deducted from the contract price as the case may require. The amount of such difference, if any, shall be ascertained and determined in accordance with the rates specified in the schedules of prices, so far as the same may be applicable, and where the rates are not contained in the said schedules, or are not applicable, they shall be settled with the engineer. But the purchasers shall not become liable for the payment of any charge in respect of any such alterations, amendments, variations or directions unless the instruction for the performance of the same shall have been given in writing by the engineer, nor unless such instruction shall state that the matter thereof is to be the subject of an extra or varied charge, nor unless the particulars of his claim shall be set forth in writing by the contractor, and furnished to the purchasers within one month after the execution of the same; but subject to these conditions being duly complied with, the purchasers shall be bound by such particulars unless they or the engineer object thereto in writing within two calendar months after delivery thereof.

In the event of the engineer requiring to dispense with or add to any part of the plant or works to be done under this contract such reasonable and proper notice shall be given to the contractors as will enable them to make their arrangements accordingly.

Unless the contractor shall otherwise agree in writing, the total sum of money set out in the contract shall not be affected by such alterations, amendments, omissions, variations or directions to the extent of more than 10 per cent. of the amount of the contract. Provided always that in cases where goods or materials are already prepared, a reasonable sum shall be allowed by the engineer for any work already done that requires to be altered.

Negligence.—If the contrator shall fail to execute the work with due diligence and expedition, or shall refuse or neglect to comply with any orders given him in writing by the engineer, or shall fail to execute any other matter stipulated in the contract, or shall contravene the provisions of the contract, the purchasers shall, after seven days' notice to the contractor in writing, be at liberty to employ other workmen, and forthwith perform such work as the contractor may have failed to do, or, if the purchasers shall think fit, it shall be lawful for them to take the works wholly or in part out of the contractor's hands, and re-contract with any other person or persons, or provide any other materials, tools, tackle or labour for the purpose of completing the works or any part thereof, and the purchasers shall, without being responsible to the contractor for loss or wear and tear of or injury to the same, have the free use of all the materials, tools, tackle or other things, the property of the contractor, which may be on the site, for use at any time in connection with the work, to the exclusion of any right of the contractor over the same.

If the cost of completing the works exceed the balance due to the contractor, the said materials, tools, tackle or other things may be sold by the purchasers, and the proceeds applied towards the payment of such difference. Any outstanding balance existing after crediting the proceeds of such sale shall be paid by the contractor on the certificate of the engineer, but when all expenses, costs and charges incurred in the completion of the work are paid by the contractor, all such materials, tools, tackle or other things shall be removed by the contractor.

After a clause or two on "death, bankruptcy, assignment and sub-contracting," we come to "inspection and testing at maker's works":—

The engineer, and his duly authorised representative, shall have at all reasonable times access to the contractor's works, and shall have the power at all reasonable times to inspect, examine and test the materials and workmanship of the plant during its manufacture there; and if part of the plant is being manufactured on other premises, the contractor shall obtain for the engineer and for his duly authorised representative permission to inspect as if the plant were manufactured on his own premises.

The engineer shall, on giving 14 days' notice in writing of his grounds of objection, have full liberty to reject all or any materials, plant or workmanship which, in his opinion, are not in accordance with the contract, or are defective for any reason whatever, and such rejection shall be operative and final at the expiration of such notice, provided that, if notice of any such rejection, setting forth the reason for such rejection, be not sent to the contractor within 14 days after the grounds upon which such rejection is based have come to the knowledge of the engineer, he shall not be entitled to reject the said materials, plant or workmanship on these grounds.

* The contractor shall not, without the consent in writing of the engineer, assign his contract, or any [substantial] part thereof, nor underlet the same or any [substantial] part thereof, nor make any sub-contract with any person or persons for the execution of any portion of the works other than for raw materials, for minor details or for any part of the work of which the makers are named in the contract.

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The contractor shall give the engineer not less than seven days' notice of any material being ready for testing, and the engineer, or his representative, shall proceed to the contractor's works within three days of the date on which the material is notified as being ready; failing which visit the contractor may proceed with the tests, and, in the absence of the engineer, the tests shall be taken as if they were made in his presence.

* * * * * *

Engineer's Supervision.—All the works are to be carried out under the direction, control and to the entire satisfaction in every respect of the engineer; but the contractor shall be responsible for the accuracy of his work, and no plea as to the acts, order or general supervision of the engineer otherwise than instructions given by him in writing will be admitted in justification of any errors of construction or fixing.

Engineer's Decisions.—In respect of all matters which are left to the decision or certificate of the engineer, the engineer shall, if required so to do by the contractor, give in writing a decision thereon, and his reasons for such decision, or if he shall withhold any certificate then his reasons for so doing. The decision of the engineer shall be final and binding, subject only to the right of arbitration reserved by these conditions.

Contractor's Superintendent and Workmen.—The contractor shall constantly employ at least one competent superintendent to superintend the erection of the plant and the carrying out of the works. The said superintendent shall be present on the site during working hours, and shall be prepared to receive from time to time orders and instructions from the engineer or his duly authorised representative.

The said superintendent, if objected to by the engineer, on account of incapacity, misconduct or negligence, shall be removed by the contractor, and the contractor shall, after receiving formal objection in writing, forthwith replace him by another superintendent, competent to fulfil his duties.

The engineer shall be at liberty to object to any person employed by the contractor in the execution of or otherwise about the works who shall, in his opinion, misconduct himself or be incompetent or negligent, and the contractor shall forthwith remove the person so objected to, and if necessary replace him by a satisfactory person who shall be the servant of and be renumerated by the contractor.

Liability for Accidents.—The contractor shall properly cover up and protect such of the work as may be liable to sustain injury by exposure. He shall also take every necessary, proper, timely and useful precaution against accident or injury to the plant, and shall be and remain answerable and liable for all losses, damages or injury which, during the progress of the work, and until it be taken over under clause 42, may arise or be occasioned to the plant, or any part thereof, whether proceeding from the effects of the weather, storms, fire, lightning, tempest, defective or careless work, or any accident not arising out of the act or neglect of the purchasers or their agents or of any other contractor, and for any losses, damages or injury through the execution of his work, to any property, persons, animals, sewers, drains, gas, water or other pipes, sheds, buildings, implements, articles or materials; and all such losses, damages or injuries if sustained by the purchasers, shall be made good in the most complete and substantial manner by, and at the sole cost of the contractor, and to the satisfaction of the engineer, and the contractor shall indemnify the purchasers against all claims and demands in respect of such losses, damages or injuries, if sustained by any other person or persons.

He shall likewise, until the plant shall have been taken over under clause 42, indemnify and save harmless the purchasers against actions, suits, claims, demands, costs or expenses arising in connection with the works under the Workmen's Compensation Act, 1897, and any other statute in force at the date of the contract dealing with the question of the liability of employers for injuries sustained by employés.

In the event of any claim being made, or action brought against the purchasers arising out of the matters referred to in this clause, the contractor shall be immediately notified thereof, and he shall, with the assistance if necessary of the purchasers, but at his sole expense, conduct all negotiations for the settlement of the same, or any litigation that may arise therefrom. The purchasers, will, at the expense of the contractor, afford all available assistance for any such purpose.

Replacement of Defective Work or Materials.—If during the progress of the work on site, the engineer shall decide and notify in writing to the contractor that the contractor has executed any unsound or imperfect work, or has supplied any plant or materials of inferior quality to those specified, the contractor shall at his own expense, within 24 hours of his receiving the notice, proceed to alter, re-construct or remove such work or supply fresh materials up to the standard of the specification, and in case the contractor shall fail to comply with such orders, the purchasers may, without further notice, remove the work or materials complained of, and, at the cost of the contractor, perform all such work or supply all such materials.

Deductions from Contract Price.—All costs, damages or expenses which the purchasers may have paid, or be liable to pay, or which shall have become forfeited to the purchasers as provided for by these conditions and by the specification, shall be paid by the contractor to the purchasers on the certificate of the engineer, or if not so paid may be deducted from any moneys in their hands due or becoming due to the contractor under the contract, or recovered by action at law or otherwise from the contractor.

Terms of Payment and Certificates of Engineer.—The contractor shall from time to time be entitled, upon the certificates of the engineer and within 28 days from the date of each certificate, to payments by the purchasers by instalments in accordance with the following provisions:—(I.) As the works progress, 80 per cent. upon the contract value of the work from time to time delivered or executed on the site to the satisfaction of the engineer. (II.) The remaining 20 per cent. (referred to herein as retention money) in respect of each distinct section or part of a section of the works as follows:—(*a*) 10 per cent. at the expiration of one month after the works shall have been taken over by the purchasers under clause 42 or alternately, at the option of the contractor, at the expiration of one month after the works shall have been put into beneficial use by the purchasers; (*b*) 10 per cent. at the expiration of nine months after the first 10 per cent. becomes due under (*a*). No part of the "retention money" will be payable at the time at which payment of the same ought otherwise to be made under the contract unless in the opinion of the engineer the works are then in good repair, condition and sound working order, fair wear and tear and accidental injury or damage by persons other than the contractor's servants and not due to faulty workmanship or material excepted. Provided, however, that where the defects are not of such importance as to affect the full beneficial use of the works, the retention of the whole instalment shall not be insisted on, but the purchasers shall be entitled to retain such less sum of money, as, in the opinion of the engineer, represents the damage to the purchasers arising out of incomplete or defective details. Any sum retained under this clause will become due upon the adjustment of such details to the satisfaction of the engineer. In the event of the purchasers failing to pay the contractor any amount certified by the engineer, within the specified period, and in accordance with the contract the contractor shall have the right, on giving 14 days' notice in writing to the purchasers or the engineer, to stop all operations, and the expenses incurred in resuming work shall be paid by the purchasers to the contractor as an extra over and above the amount payable under the contract. Every application to the engineer for a certificate must be accompanied by a detailed claim (in duplicate) setting forth in the order of the schedule of prices particulars of the work executed to the date of claim, and the certificate shall be issued within 14 days of the application for same. Not more than one certificate shall be issued in any one month in respect of the same section. The engineer shall not give his certificate in respect of any work which is in any respect defective or not according to the contract, or while the contractor is not using due diligence in the prosecution of the work, or is making default in the performance of his contract. The engineer may by any certificate make any correction or modification in any previous certificate which shall have been issued by him, and payments shall be regulated and adjusted accordingly.

Clause 40 deals with the important matter of "damages for delay in completion":—

If the contractor shall fail in the due performance of his contract by and at the time fixed under the contract, whether by way of extension or otherwise, the engineers shall, in writing, certify the fact of such failure, and in such case the contractor shall pay to the purchasers, as and for agreed liquidated damages, the following amounts, reckoned on the contract value of such portion only of the works as cannot, in consequence of the delay, be used beneficially—during the first four weeks of the delay, 5s. per £100; during the second four weeks, 10s. per £100; during the third four weeks, 15s. per £100; and during the fourth or any subsequent four weeks, 20s. per £100; for each and every week which may have elapsed between the appointed time and the actual time of completion.

With regard to "tests on completion," the clause provides, *inter alia*, that—

On the giving of such notice, the plant shall, for the purpose of the tests, be deemed to be complete, and no alterations or readjustments of the same shall be made within 48 hours before the time fixed for starting the tests, without the express permission of the engineer in writing. Should any alterations or readjustments be found necessary within 48 hours before the time fixed for starting the tests, the tests may, at the sole option of the engineer, be deferred for a period not exceeding 14 days, and all reasonable expenses to which the purchasers may be put by the deferring of the tests shall be borne by the contractor. The contractor shall find and provide all necessary superintendence and labour for the purposes of the tests, and during the tests shall have the full working control of the plant. If, at the time agreed upon between the contractor and the engineer for the starting of the tests, the engineer or his duly authorised representative shall fail to attend, the tests may proceed in his absence. As soon as the tests have proved that the plant has completely fulfilled the contract conditions the engineers shall forthwith so certify in writing to both the purchasers and the contractor, and *thereupon it shall be deemed that the purchasers have taken over the plant.* If the works fail under the tests to fulfil the contract conditions, complete new tests shall, if required by the engineer or by the contractor, be carried out upon the same terms and conditions, and upon payment to the purchasers of all reasonable expenses to which they may be put by the repeated tests.

If the tests, proving that the works fulfil the contract conditions, be not made by the contractor within one month after the date fixed under clause 39 for the completion and the readiness of the works for beneficial use or for testing, and if, in the opinion of the engineer, the tests are being unduly delayed, the engineer may, in writing, call upon the contractor, under seven days' notice, to make such tests, and on the expiry of such notice such tests shall forthwith be made by the contractor.

If, after the expiry of the notice from the engineer, the contractor neglects to make such tests, the engineer may proceed to make such tests himself at the contractor's risk and expense.

Rejection of Inefficient Work.—If any portion of the completed works fails to pass the specified "tests on completion," the engineer may totally reject such portion, and in the latter event the purchasers shall have the option of:—(*a*) Permitting the contractor to replace the defective work, or (*b*) themselves replacing the defective work by purchase from or contract with any other party or parties, or (*c*) returning the defective work and recovering the sum or sums paid or allowed on account of same. In the event of (*a*), the substituted works shall be in all respects deemed to be subject to all the terms and conditions of the contract. In the event of (*b*), no further sum

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beyond that already paid to the contractor in respect of the work in question shall be due or payable by the purchasers to the contractor in respect of such defective work, but the contractor shall repay to the purchasers any sum paid by them in respect of such work; and the contractor shall also pay to the purchasers any loss or damage to which they may be put by reason of the purchase or replacing of fresh work by them, it being agreed that if the contractor shall fail to execute works in strict accordance with the specification, it shall be lawful for the purchasers, at their discretion, to obtain, without additional cost to them, the work in question from any other party or parties, or so to arrange for the execution of the works, as they may deem desirable, and that the contractor shall be liable for any loss suffered, or expenditure beyond the contract prices incurred by the purchasers in consequencce of such failure. In the event of (*c*), if the defective work be required by the purchasers for beneficial use, they shall be entitled to make use of the same for a reasonable time sufficient to enable them to obtain other work to replace it, the contractors being allowed a reasonable sum for the use of the same.

Maintenance.—Until the final certificate shall have been issued the contractor shall be responsible for any defects that may develop under normal and proper use arising from bad materials, design or workmanship in the works. When called upon, in writing, by the engineer to remedy such defects, the contractor shall do so with due diligence, and unless such defects be remedied by the contractor within reasonable time, the contractor shall be responsible for all losses, damages, &c., sustained by the purchasers through such defects. If the defects be not remedied within a reasonable time, the purchasers may proceed to do the work at the contractor's risk and expense. Until the final certificate shall have been issued the contractor shall have the right of entry by himself or his duly authorised representatives, at all reasonable working hours, upon all parts of the works for the purpose of inspecting the working and the records of the works and taking notes therefrom, and, if necessary, making any tests at reasonable times at his own risk and expense.

Requirements of Local Authorities.—The contractor shall, throughout the continuance of the contract, and in respect of all matters arising in the performance thereof, promptly and effectually conform to all the requirements of any local or municipal authority in whose district the work may be executed, and provide for the safety and due convenience of the public.

Arbitration.—If at any time any question, dispute or difference shall arise between the purchasers or their engineer and the contractor as to any matter of construction, fact or otherwise, upon or in relation to or in connection with the contract, either party may forthwith give to the other notice in writing of the existence of such question, dispute or difference, and such question, dispute or difference shall be referred to the arbitration of a person to be mutually agreed upon, or, failing agreement, to some person appointed by the president for the time being of the Institution of Electrical Engineers. The award of the arbitrator shall be final and binding on the parties. Upon every or any such reference the costs of and incidental to the reference and award respectively shall be in the discretion of the arbitrator, who may determine the amount thereof, or direct the same to be taxed as between solicitor and client, or as between party and party, and shall direct by whom and to whom, and in what manner the same shall be borne and paid. This submission shall be deemed to be a submission to arbitration, within the meaning of the Arbitration Act, 1889.

The draft clauses, of which the foregoing gives but a selection of the more important, are followed by a "Form of Tender" and a "Form of Agreement" proposed for use in connection with these contracts. These are reproduced verbatim below:—

FORM OF TENDER.

SECTION.

To the .....

Gentlemen,

..... the undersigned, do hereby offer to contract for the above-named work, in accordance with the preceding general conditions and specification, at the prices which.....have submitted on the preceding page, and in case ..... tender be accepted .....do hereby undertake and agree to execute a contract in accordance with general conditions, clause 10, and ..... propose as sureties as required by that clause.....of.....and.....of.....

Dated..... .....day of .... 190 .

Signature .....

Address.....

List of drawings submitted by tenderer under section :—

.....

FORM OF AGREEMENT.

THIS AGREEMENT, made the ..... day of ....., 190..., between ..... (hereinafter referred to as the "contractor") of the first part, the (hereinafter called the "purchasers") of the second part and of ..... and ..... of ..... (hereinafter called the "sureties") of the third part. Whereas the purchasers are about to erect and maintain the....., hereinafter called the "works," mentioned, enumerated or referred to in certain general conditions, specification, drawings, form of tender and schedule of prices, which for the purpose of identification have been signed by ..... on behalf of the contractor and ..... (the engineer of the purchasers) on behalf of the purchasers. And Whereas the purchasers have accepted the tender of the contractor for the provision and exectiion of the said works for the sum of ..... upon the terms and subject to the conditions hereinafter mentioned. And Whereas the sureties have agreed, for the consideration hereinafter appearing to enter into the covenants hereinafter contained, and on their part to be performed. Now this Indenture witnesseth that in pursuance of the said agreement and in consideration of the payments to be made to the contractor by the purchasers as hereinafter mentioned, the contractor hereby covenants with the purchasers, their successors and assigns that he shall and will duly provide, erect and complete, uphold and maintain the works mentioned, enumerated or referred to in the contract, and shall do and perform all other works and things therein mentioned or described or which are implied therefrom or therein respectively or may be necessary for the completion of the said works within and at the times and in the manner and subject to the terms, conditions and stipulations in the contract mentioned and to the satisfaction of the engineer for the time being of the purchasers, and also will to the like satisfaction maintain the same in an efficient manner as mentioned in the contract, and shall and will observe and perform all the conditions and provisions set out in such contract and that all the powers, liberties, rights and privileges mentioned therein and conferred thereby in respect of such works shall and may be exercised according to the true intent and meaning thereof and in consideration of the due provision, erection, execution, construction and completion of the said works and the maintenance thereof as aforesaid and of the covenant of the sureties hereinafter contained, the purchasers do hereby for themselves, their successors and assigns covenant with the contractor that they, the purchasers, their successors and assigns will upon the certificates of the engineer for the time being of the purchasers, pay to the contractor the said sum of ....., or such other sum as may become payable to the contractor under the provisions of the contract, such payments to be made at such time and in such manner as is provided by the contract. And the sureties, at the request of the contractor and in consideration of the purchasers entering into this agreement, do hereby jointly and severally covenant and guarantee with and to the purchasers that the covenant on the part of the contractor in this contract contained shall be well, truly and faithfully performed by the contractor in every respect according to the true intent and meaning of this contract, and that, in the event of default on the part of the contractor in respect of the performance in any particular of the said contract, the sureties will pay to the purchasers all such losses, damages, costs, charges and expenses as the purchasers may sustain, incur or be put unto by or by reason or in consequence of any such default, but so nevertheless that the total amount to be demanded or recovered by the purchases of or from the sureties shall not exceed the sum of 10 per cent. of the total contract price.

Provided always and it is hereby covenanted, agreed and declared between and by the parties hereto that these presents are entered into and the said works are to be provided, erected, executed, constructed, completed and maintained upon and subject to the terms and conditions contained in the contract, and that the parties hereto respectively shall have such rights, powers and liabilities, and the said engineer shall have such powers and authorities in respect of the said plant and the tools and materials for the same and extension in respect of the contract and all matters connected therewith as are given and expressed by and in the same terms and provisions of the contract.

In witness whereof, &c.

LARGE GAS ENGINES FOR DRIVING ELECTRIC GENERATORS.*

BY A. R. BELLAMY, M.I.E.E., M.I.M.E.

(Concluded from page 1015, Vol. XLVIII.)

5. *Want of Reliability.*—The same cause—viz., the slide valve—that gave trouble at starting was also responsible for most of the difficulty in working. The introduction of tube ignition very materially simplified the gas engine and therefore made it more reliable. In a "Stockport" gas engine fitted with tube ignition there are, as a general rule, only four valves, which are of the mushroom type:—(1) The gas valve, which admits the gas to the mixing chamber, and in the "hit-and-miss" method of governing this valve is only opened every other revolution when the engine is working up to its maximum power. (2) The charge valve, which allows the explosive mixture to enter the cylinder. (3) The timing valve, which controls the time of ignition. (4) The exhaust valve, which permits the products of the explosion to escape into the atmosphere. All these valves are lifted by means of suitable levers actuated by cams fixed on the side-shaft, and they are closed by springs. The side-shaft is driven from the crank-shaft by means of worm gearing. It will thus be seen that the valves and gear are simple, and give little chance for anything going wrong. It is always desirable to have these valves working vertically. With electrical ignition the timing valve is dispensed with. The other moving parts of a gas engine, such as the piston, connecting rod, crank-shaft, &c., are common to steam engines; so there is no necessity to do more than mention them. It must, therefore, be admitted that the gas engine is now extremely simple and (in the writer's opinion) will work with less attention than any other reliable prime mover. The gas engine requires some attention which is special to itself, but any intelligent labourer will be able to

* Paper read before the Manchester Section of the Institution of Electrical Engineers, April 8th.

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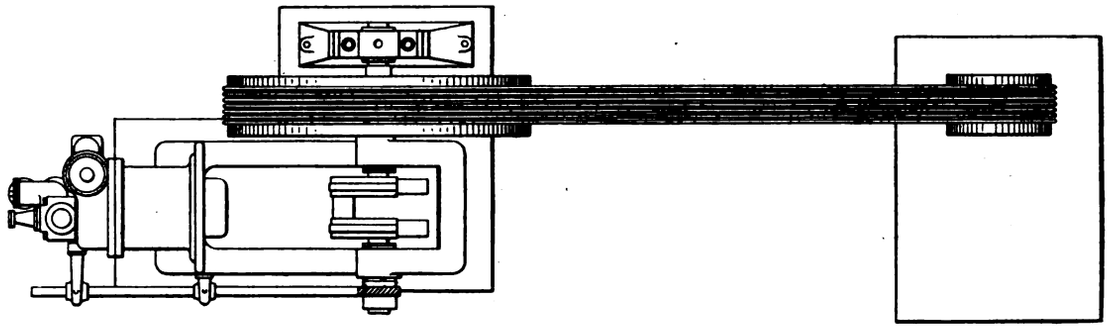
attend to the largest gas engines after a little instruction. As a rule, it is better to employ a man who has no preconceived ideas upon the subject, and will simply carry out the instructions given to him. When gas engines are worked with any form of poor gas it is sometimes found that there is trouble owing to tar being carried along with the gas and deposited on the gas valve, thus causing it to stick. This is not a fault of the engine, but in the gas plant, and the greatest care must be taken to have the gas perfectly free from tar.

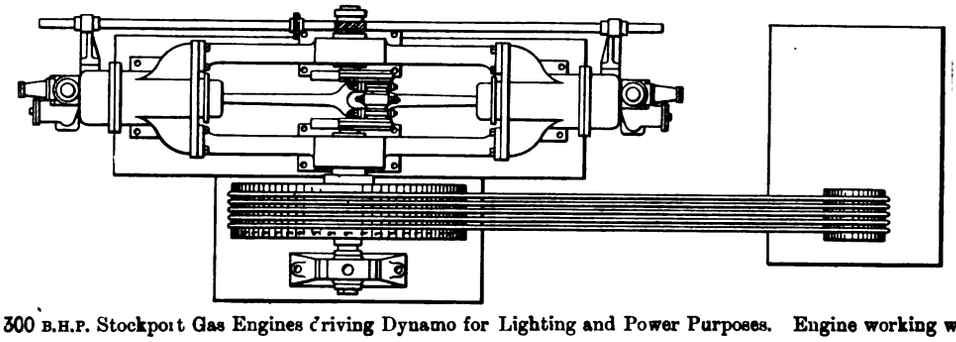


One of Two 150 B.H.P. Stockport Gas Engines driving Dynamo for Lighting and Power Purposes. Engine working with Dowson Gas.

As a test of reliability mention may be made that Messrs. Andrew, of Reddish, have supplied some large engines that work continuously for months, and at one installation the engines are worked by coke oven gas, which varies in quality to a considerable extent.

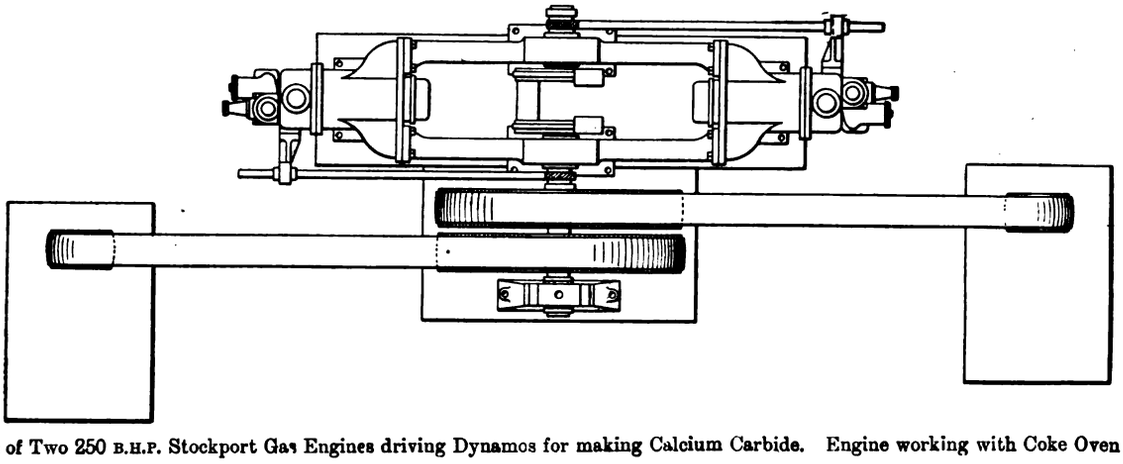
6. *Want of Automatic Lubrication, particularly on the Bearings of the Crank-shaft and Connecting-rod.*—It is unnecessary to point out to the members of this Institution the importance of lubrication. Some controversy might arise as to what constitutes automatic lubrication. It might be held by some that if there are a number of oil cups fitted to the engine which can be kept filled whilst the engine is in motion that the flow of oil would go on automatically, whilst others would hold that the flow would only be automatic so long as there was any oil in the oil cups, and unless the cups were self-filling the lubrication could not be considered to be automatic. The system adopted by Messrs. Andrew is to have one large oil tank, which is fixed on the splash guard directly over the centre line of the crank-shaft. From this tank the oil flows by gravitation through pipes to the various bearings. Careful provision is made for catching all the oil which escapes from the bearings; this is collected into a reservoir, and is pumped up again to the oil tank. The principle followed out for lubricating all journals is to introduce the oil at the point of least pressure, and provide no means of escape at the point of greatest pressure. It is found in practice that large engines lubricated as described give no trouble, and are economical in the amount of oil used.

7. *Insufficient Provision for Preventing Oil being thrown about.*—It will be readily understood that the system of lubrication just described is worthless unless every provision is made to prevent the oil being thrown about and wasted. If the oil is all collected, then a liberal supply can be given to the bearings. This necessitates the oil guards being constructed to cover in the crank and connecting rod. There is no difficulty about this, and the oil guard is designed so that it can be easily removed when required. Close to the outside edge of the main bearings a groove is cut to prevent the oil creeping on to the outside of the brass. This does not, however, prevent the oil finding its way along the shaft and on to the boss of the flywheel, thence on to the rim of the flywheel. This has been got over by a little ingenuity, and engines are made quite free from oil splash.



One of Two 300 B.H.P. Stockport Gas Engines driving Dynamo for Lighting and Power Purposes. Engine working with Town Gas.

8. *Difficulty of Working with "Poor Gas" (gaz pauvre).*—It is sometimes said that gas engines often work well with town's gas but give trouble when working with "poor gas." When this occurs it is not altogether the fault of the gas engine, which very often receives the blame when the cause of the difficulty is in the gas plant. It is certainly true that there is more need for care when the installation includes a gas plant, but if the gas engine be properly constructed to work with poor gas and the gas plant be designed to produce clean gas of about 140 B.T. units per cubic foot, then, with the attention of an intelligent labourer, there will be no trouble worth mentioning. Many such installations are in daily use and are working satisfactorily under the care of men who would be incapable of taking charge of a steam plant. The use of magneto-electric igni-



One of Two 250 B.H.P. Stockport Gas Engines driving Dynamos for making Calcium Carbide. Engine working with Coke Oven Gas.

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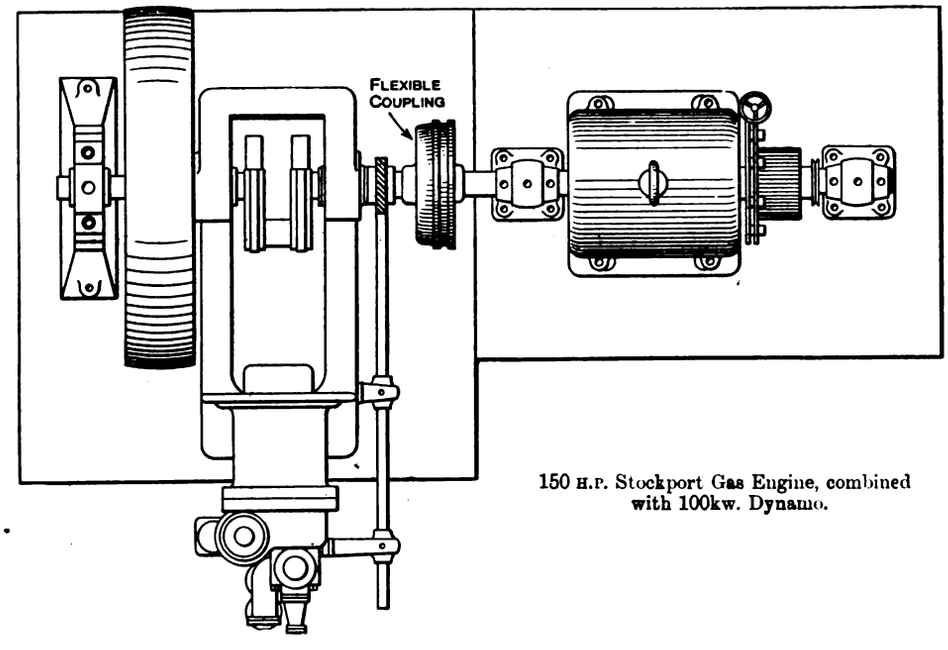
tion has simplified and improved the gas engine for working with poor gas, but this subject will be dealt with later.

9. *Want of Speed.*—The fashion of the present day is to extol the coupled plant, and electrical engineers express disappointment that the gas engine cannot be made to run quicker—*i.e.*, at a greater number of revolutions per minute. It is argued that the slow speed necessitates a very expensive generator. To a certain extent this statement is warranted, but if the coupled plant is to become the *sine quâ non*, then surely there should be no difficulty in designing a dynamo to meet the conditions. The reason why the cost of the generator is now so great is that most makers of dynamos do not make a suitable machine, but quote for the ordinary type of fast running machine, specifying for a larger machine to run at a slower speed. Where space is the principal consideration, there is no doubt the coupled plant is preferable, but apart from this it is a question of considerable debate. The point is one that has never yet been settled in steam engine practice, and in the opinion of the writer does not permit of any hard-and-fast rule. It is urged that with the coupled plant there must be an economy through dispensing with the driving belt or ropes. This may be true, but against this you have the question of the quick-revolution, short-stroke gas engine, as against the slower-revolution, long-stroke engine. The question of short stroke versus long stroke is one not easily settled. One of the chief arguments brought forward for the quick-revolution steam engine is that the loss of heat in the cylinder walls is reduced, but this does not apply to a gas engine, because the temperature of the cylinder is largely governed by the amount of water passed through the cylinder jacket, and it is a difficult problem to get rid of the excess of heat in the cylinder ends of large gas engines. Another important point is that the shape of the combustion chamber of a gas engine bears an important part in the economy of the engine, and the long-stroke engine gives the more favourable opportunity for designing the best form of cylinder end or combustion chamber. There are other considerations, but sufficient has been indicated to develop this subject when this Paper comes under discussion. Messrs. Andrew & Co. (Ltd.), adopt a piston speed of about 750ft. per minute in their large engines, and decide the number of revolutions according to the size of the engine. In no case do they go beyond 300 revs. per min., even for small units.

10. *The Want of more Powerful Engines.*—This is a matter that is improving itself every day. It may be said that English manufacturers are behind makers in other countries in this respect. It would be inadvisable and serve no useful purpose in this Paper to go into the reasons why this is so. The manufacture of gas engines is, comparatively speaking, a new industry, and electrical engineers will appreciate the fact that it takes time to make developments. The most satisfactory progress is the outcome of experience, and this cannot be obtained without time. The experience of a few weeks or months is insufficient to test the merits of any new development. Suffice it to say, that there are now several makers of gas engines producing units of 500 H.P. Engines of 150 to 200 B.H.P. manufactured by any of the well-known makers can be accepted by you with the same confidence that you would place in a steam engine of similar power. It may be said that even the 500 H.P. unit is paltry in size when compared with steam engines. This may be so, but it should not be forgotten that when the gas engine first claimed your attention, about 20 years ago, it was little better than a toy, and, therefore, the progress that has been made in the past augurs well for the future.

Having now dealt with the debit side of the gas engine account, it is only equitable to consider the credit side. Undoubtedly the first and most important item is economy in working. An appendix to this Paper gives some tests made of "Stockport" gas engines. All the tests were made by independent experts, and no attempt was made by the makers to emulate the example of "trial runs." In the case of the test made at Messrs. Harmsworth's the plant had only just been put to work. The engines were not working at more than three-quarter load, yet the consumption of fuel per B.H.P. per hour equals 1·37lb., or per kilowatt-hour 2·16lb. In the test made by Mr. Mathot of the engine erected near Brussels the total consumption of fuel per B.H.P. per hour equalled 1lb., and the thermal efficiency with the engine working at 85 per cent. of its full power came out to 18·5 per cent. In the second test, made by Mr. Mathot, of the "Stockport" gas engine working with town's gas, the consumption of gas at full load was 15·65 cubic ft. per E.H.P. per hour, the engine developing 50·2 B.H.P.; town's gas can be taken at an average price of 2s. 6d. per 1,000 cubic ft. There are a great many towns that supply gas at less than the above price. Assuming 2s. 6d. as an average price, then with an engine developing 50 B.H.P. the cost of gas would work out to one halfpenny per B.H.P. per hour. Allowing 1⅓ B.H.P. per kilowatt, the cost of gas per kilowatt would then work out to 0·7d. It will, therefore, be seen that gas engines working with town's gas can produce electric current at a cheaper rate than it is usually supplied even for motive power purposes.



150 H.P. Stockport Gas Engine, combined with 100kw. Dynamo.

It may be urged that the cost price of the fuel that is generally used in gas plants is considerably more than ordinary steam coal, but within the last few years a great advance has been made in the production of gas from bituminous coal, and at the present time gas engines are being successfully worked by gas manufactured from bituminous slack of such a poor quality that it would be considered almost unfit to be used for firing a boiler.

No mention has been made of the many other advantages that gas engines have over steam engines, such as no boiler, and therefore no difficulty with water; no chimney, and therefore no smoke, little or no stand-by loss, less coals to cart and ashes to remove.

Magneto-electric Ignition.—This form of ignition poesesses several important advantages over tube ignition, amongst which are: (1) it is safer, there being no outside flame; (2) there is less liability to early ignitions, because there is no timing valve to stick open; (3) ignition is more certain, as the electric spark will ignite weaker mixture; (4) it is less liable to get out of order, as there are no tubes to break; (5) it is more economical (*a*) because the ignitions are more regular and (*b*) it saves the gas that would be used to heat the tubes. Against this it must be stated that it adds a little to the first cost and it is not quite so easily understood by the attendant. In the tube ignition, if a tube breaks, the incident advertises itself and draws attention to the part requiring replacement, but with electrical ignition there is not the same outward manifestation to localise the trouble. Messrs. Andrew & Co. (Ltd.) adopt the magneto-electric igniter. The magneto machine is mounted on the side of the cylinder, over the side-shaft of the engine, and is operated by a cam fixed on the side-shaft. The same cam actuates a lever for breaking the contact of the terminals inside the combustion chamber.

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An important feature of this ignition gear is that the electric current is only produced at the moment it is required, and there is thus no possible chance of the charge becoming ignited excepting at the time at which the gear is set to make the spark. For the reasons given the writer is of opinion that the electric igniter is best suited for large gas engines, especially when the engines are working with "poor gas."

[This paper is accompanied by a number of illustrations, seven of which we have reproduced in our reprint. These figures, with their footnotes, are self-explanatory,—ED. *E.*]

CABLE COMMUNICATIONS.

The second and general report of the inter-Departmental Committee on Cable Communications has recently been issued, forming, with the first report as to the Telegraphs to India, a Blue Book of 84 pages. The contents are of great importance to all interested in the telegraphic connections of the Empire, and we therefore summarise them as fully as our limited space this week permits.

The Committee recognise that the only method of securing cable communication in time of war is that a variety of alternative routes should be provided, so that it would be practically impossible to interrupt all at the same time. Where these conditions obtain it is, we think, likely that none of the sections would be cut, since it would yield no advantage to a belligerent. They consider that "appreciable but not paramount value" attaches to all-British routes, that every important colony or naval base should be connected with this country by one cable landing only on British territory or that of a friendly neutral, and after this the more alternative cables following commercial routes the better.

To further secure communication with India, they recommend the laying of a cable between either Rodriguez and Ceylon (1,800 miles), Cocos and Ceylon (1,475 miles), or Cocos and Singapore (1,150 miles), and, so soon as circumstances permit, a cable touching only on British territory, for strategic reasons, to St. Lucia (West Indies). The Committee consider that while land lines cost less than cables to establish and maintain, it is in certain cases essential, on strategic grounds, that the latter should not be driven out of the field of competition. They define the power of the State to control cable companies as being the making of stipulations when granting a subsidy or guarantee; the employment of public funds in competing or encouraging competition with private enterprise; the granting or withholding of landing rights and general facilities, and the regulation of Government and unrouted messages. They recommend, as a rule, guarantees of minimum revenue instead of subsidies, and that no direct pecuniary return should be exacted for landing rights, which should be used as a check on any marked unreasonableness. In their view, the normal policy of this country and its dependencies should be to encourage free trade in cables, with exception only on the ground of national interests. They are "strongly opposed to the general purchase of cables by the State" and do not consider any of the present rates excessive, with the exception of those to the Gold Coast and Nigeria, which should be reviewed at the next renewal of landing rights of the cable starting from this country.

The Committee reject the suggestion of "urgent" rates but think in favourable cases deferred messages might be introduced with advantage. They regard large reductions in existing rates, such as Mr. Henniker Heaton's suggestion of a 1d. rate to America and Australia, which broke down altogether under cross-examination, as quite impossible on a commercial basis, and dissent from Sir Edward Sassoon's criteria in estimating the fairness of rates.

Certain portions are omitted from the report as published where it is held that the strategic considerations involved render it desirable that publicity should be avoided. The report has evidently been compiled with the utmost care, and will be found to contain the results of an exhaustive and fair-minded examination of a subject of the utmost importance to this country from the commercial, social, political and strategic points of view.

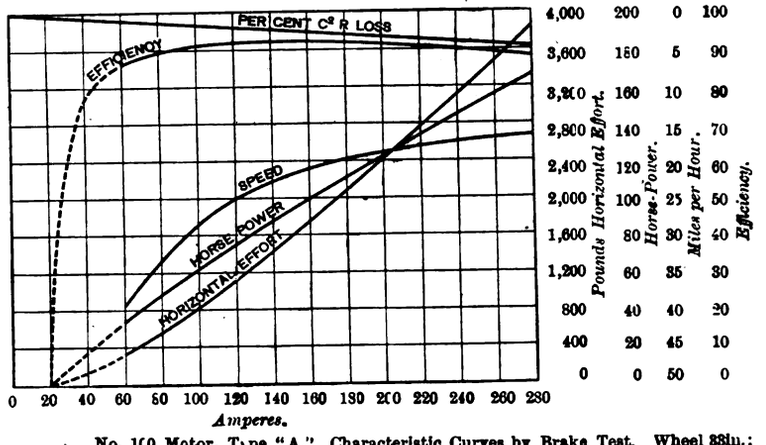
In regard to wireless telegraphy, while not wishing to pronounce a decided opinion, they anticipate it may soon become of considerable service for communication between different islands, or between islands and the mainland.

CORRESPONDENCE.

RAILWAY AND TRAMWAY MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to the remarks made by Prof. Carus-Wilson in the discussion of Messrs. Swinburne and Cooper's Paper on "Problems of Electric Railways," and which have been printed in your last issue. In what Prof. Carus-Wilson says of the motor used in the tests on the Liverpool Overhead he is not altogether correct. Herewith



No. 100 Motor, Type "A." Characteristic Curves by Brake Test. Wheel 33in.; Gear ratio 53/19=2·79 to 1. Temperature Rise, at end of 1 hour delivering 100 H.P. at Armature Shaft: Commutator Rise=60°C., Armature Rise=40°C., Field Rise=60°C: Bearings Rise=15°C., Air Temperature=29°C. Total Resistance at 20°C. of Motor=0·151 ohms, Fields=0·0792 ohms; Armature=0·0605 ohms.

is a copy of the characteristic curves of the motor in question. At 100 H.P. this motor requires 162 amperes and delivers a torque of 1,780lb. This is at the rate of 11lb. per ampere. At half load, or 50 H.P., the motor requires 83 amperes, and delivers a torque of 600lb., or 7·22lb. per ampere. The torque per ampere varies between half load and full load, in the ratio of 100 to 152, and not in the ratio of 100 to 110, as Prof. Carus-Wilson states. The value of this ratio increases as the rating of the motor is decreased. For example, under some conditions of rating, this motor might be styled a 50 H.P. motor. Under such conditions the value of torque per ampere varies about as 100 to 165.

The original motors built by the large electrical companies were very much under-rated. Consequently, for this reason alone it is only natural to find now a decrease in this ratio. Prof. Carus-Wilson's desire is to increase the value of the torques at full load and at over load—*i.e.*, to make more of a bend in the torque curve. Making this change will entail a diminution of speed for these loads. In other words, will make the speed curve straighter.

There are a number of objections to Prof. Carus-Wilson's idea. In order to insure sparkless commutation at full load and all overloads, it is necessary that the magnetic density must be brought to saturation in the pole face, the teeth, or the armature body. To make this effective it is necessary to cause a considerable bend in the speed curve.

One of the motors at present finding great favour in the United States, the type manufactured by the Steel Motor Co., has this carried to such an extent that practically the only point to be considered in connection with overload is their heating effect. Sparking at any overload seems unknown. This freedom from sparking is obtained at the expense of very heavy starting current, but tramway men seem willing to pay the price. The same effect of sparkless commutation might be obtained by winding the armature so that it will

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not be so heavily loaded. This means that the iron sections must be increased and that a motor of larger capacity must be bought. The dead weight carried by the cars must, therefore, be increased.

A further advantage of early saturation of some part of the magnetic circuit is that we thus obtain a more constant speed and have more of the advantages of a shunt-wound motor—namely, constant speed at varying loads. This is especially advantageous on roads operated under steam railroad conditions, where a schedule speed must be adhered to under all conditions of traffic. The Central London is a case especially in point. Here on account of the construction of the road heavy starting torque is not of so great consideration. According to the figures given by Prof. Carus-Wilson, nearly constant speed at all loads seems to have been rather a more important figure in the design.—Yours, &c., J. N. DODD.

London, April 22.

PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

Friday, April 18.

The House of Lords Committee, under the chairmanship of Lord Windsor, continued its hearing of the promoters' case for the **Charing Cross, Hammersmith and District Railway Bills, Nos. 1 and 2.** At the adjournment on Wednesday the Chairman asked for financial evidence.

Mr. HANSON, of the firm of stockbrokers, Messrs. Coates, Son & Co., said he had considered the possibilities of the scheme, and had sufficient confidence to recommend it to investors. Cross-examined by Mr. Littler, K.C., on behalf of various opponents of the bill, witness admitted that it was only within the last week that he had been consulted about the scheme, and that it was after the sitting of the Committee on Wednesday that he had been asked to attend to give evidence. It was a very serious matter for any public company to be over-capitalised.

By Mr. BALFOUR BROWNE, K.C.: A through line from Hammersmith to the City would be a good thing if it were in the hands of one concern, probably on account of facilities for through communication; but he did not think intimate relations with the London United Tramways Co. were necessary.

Viscount KNUTSFORD: You have made no inquiries as to the promoters of this bill?—No.

Mr. R. MARKHAM, M.P., was strongly of opinion that such railways as those should be constructed with British capital, and not American, as in the latter case all the orders for machinery went to that country, as was the case with a large proportion of the equipment of the Central London Railway.

Mr. MARK ROBINSON, one of the promoters of the bill, while acknowledging that he did not personally know several of the other members of the first board, said that in consenting to become a director he had directly stipulated that there should not be any inflated promoting profits. He certainly did hope to obtain an order for his firm for part of the equipment; and, indeed, a provisional agreement had been entered into for carrying out certain work. But the terms for this work were to be settled upon a reasonable basis, or else by arbitration. The question of the disposal by sale of certain rights of some earlier promoters of the previous bill who had now left the undertaking had never been suggested to him, and the *personnel* of the new syndicate which was promoting the Charing Cross, Hammersmith and District Electric Railway Co. was materially changed from that which had had last year's bill in hand.

Mr. C. S. MEIK, one of the joint engineers to the scheme, was then recalled, and said that the share capital of the company was £3,300,000. Of this, £2,432,960 was for works and lands, legal expenses £182,000, interest on loans £150,000, working capital £50,000, other expenses £50,000. The balance would have to meet the very important item of underpinning. He estimated there would be a margin in the borrowing powers of some £600,000, but the equipment, which would have to come out of the borrowing powers, was a very varying quantity, and his estimates for this portion of the work might be exceeded.

Mr. R. E. MIDDLETON, joint engineer to the scheme with Mr. Meik, said an endeavour had been made to meet the objections which Sir A. R. Binnie had made to the line before the Joint Committee last year. Numerous exchange stations with other lines were to be constructed allowing of passenger intercommunication. His opinion was that the whole of the tunnels should be constructed in brick, which would cause a considerable saving in expenditure and also tend to reduce vibration. Part of the tunnels on the Great Northern and City line was being constructed of brick. Brickwork would last longer, and such tunnels would allow of more frequent inspection. The difficulty of dust being given off from the gravel permanent way which was advocated for the line, could be obviated by the use of thin asbestos sheets laid over the gravel. The proposals of the Central London Railway Co., in their competition with the Charing Cross and Hammersmith line, would, in his opinion, be the ruin of the former company if carried out. Their circle was not wanted, and it would prevent them from making any future extensions.

Mr. A. A. CAMPBELL SWINTON gave technical evidence as to the site for the generating station and the method of generation, &c. The site was admirably chosen in respect to the line and as regards electrical losses in the conductors conveying the current to the system. The transmission would be on the same lines as that of the Central London Railway, and polyphase current would be generated at 5,000 volts or thereabouts, which would be fed into three or four sub-stations, converting it into continuous current for the motors on the trains. The third-rail system would be utilised. He thought it would be wrong for the Committee to sanction several systems of electrically-working tube railways, chiefly on account of the impossibility of intercommunication. The Piccadilly-City line were proposing to use a different system, and, indeed, had practically bound itself to use some different system, to that utilised on the Central London.

Mr. JOHN BRUNLEES said he had examined the plans for the line and considered them judiciously laid out. The sites for the stations were well chosen and the estimates were not excessive.

This closed the case for the promoters, and the Committee decided to proceed with the cases for the promoters of the competing lines over the Piccadilly route before coming to any decision.

PICCADILLY AND CITY, LONDON UNITED, NORTH-EAST LONDON, AND CITY AND NORTH-EAST SUBURBAN RAILWAYS.

Mr. BALFOUR BROWNE, who, with Mr. E. Moon, K.C., and Mr. Vesey Knox, appears for the Piccadilly and City Railway (Bills Nos. 1 and 2), then addressed the Committee on behalf of his clients. He said the bill still bore the name of last year's bill, but for obvious reasons it was now a longer line. In the case for the Charing Cross, Hammersmith and District Railway it had been claimed that that promotion was in the field first, which was quite true, and other things being equal they should have the preference. But other things were not equal. It was no breach of faith to say that the Piccadilly-City promoters were willing to have taken over all that the Charing Cross-Hammersmith promoters had done last year, and to have adequately compensated them, but, unfortunately, it was found that the latter were not financially strong enough to even negotiate, and under such circumstances he had no alternative but to promote this bill of his own, and the proposal now made was that he should be authorised to make this line, and to form a junction with the North-East London Electric Railway in the City.

Mr. WEDDERBURN, K.C., for the Charing Cross, Hammersmith and District Railway interposed that a considerable number of negotiations had taken place.

Mr BALFOUR BROWNE replied that no one could be found who could close a bargain with him. The line which he was promoting ran from Ludgate-circus, through Fleet-street, past the Law Courts to Charing-cross, Piccadilly-circus, Albermarle-street and so on in the same direction as the previous bill with a terminus close to the London United electric tramways. In deciding between the previous bill and his, the Committee would have to bear in mind the recommendation of last year's Joint Committee, that "block "lines were to be deprecated. The gentlemen who were promoting this Piccadilly to City line in conjunction with the promoters of the North-East London line were a very strong financial group. He had been twitted with the fact that it was American money, but Mr. Clinton Dawkin, one of the promoters, although a member of the Morgan house, was an Englishman, and among the same group were Messrs. Siemens Bros. & Co., and others not Americans. Further, along the same route the London United Tramways were promoting a similar bill, and it was obvious that one of the schemes would have to be rejected. Therefore, to make their financial position doubly strong, they had practically amalgamated with the tramway company, and were jointly promoting this line, and by the agreements with the latter body through tickets would be issued from Southall and such places in the west, right through to Tottenham in the north. Of course, this amalgamation did not apply to the other lines which the London United Tramways were promoting running in different directions. Dealing with the other competitors along this route, he reiterated his assertion made before last year's Committee, that the Brompton and Piccadilly-circus line was being promoted as a "block" line by the District Railway Co. Apropos of the Central London Railway, he said that this company's bill last year only provided for loops at either end of the line for the working convenience of the system, but this year they were proposing to make their system a closed circuit, and in this he recognised his most formidable rival. But he ventured to think the company were making a great mistake in their own interests, and in the interests of the public it would be a great mistake to let them have this route from Hammersmith to Charing Cross. What the public wanted was competition between two strong bodies of promoters—one on the north and one on the south. And in following the principle of a closed circuit, what was to become of the outside districts for communication? People wanted to get into and away from the centre of London. The public had a right to a through route from one end of London to the other through Piccadilly, and, what was more, they expected it. In consequence of this he admitted that the Metropolitan and District Railways must suffer because they were in the wrong place. Their line ran along by the river and was in a very susceptible position to be tapped, and they would be tapped by someone. The centre of London was becoming less and less populous as regards residents, and would probably in time become uninhabited except for those who came into it every day and left it every night. On the question of finance, he said there was an enormous difference between sanctioning these lines to weak financiers and strong financiers. Over-capitalisation was mentioned in the report of the Joint Committee last year. To get the lines constructed cheaply they should be entrusted to those who could put the money down for them, and in this matter his position, in conjunction with the London United Tramways, was undisputed.

Monday, April 21.

Lord WINDSOR, in connection with the proposed amalgamation between the London United Electric Railways and the Piccadilly-City line, asked what was proposed with regard to the fact that the tunnels in the two original bills were of a different size.

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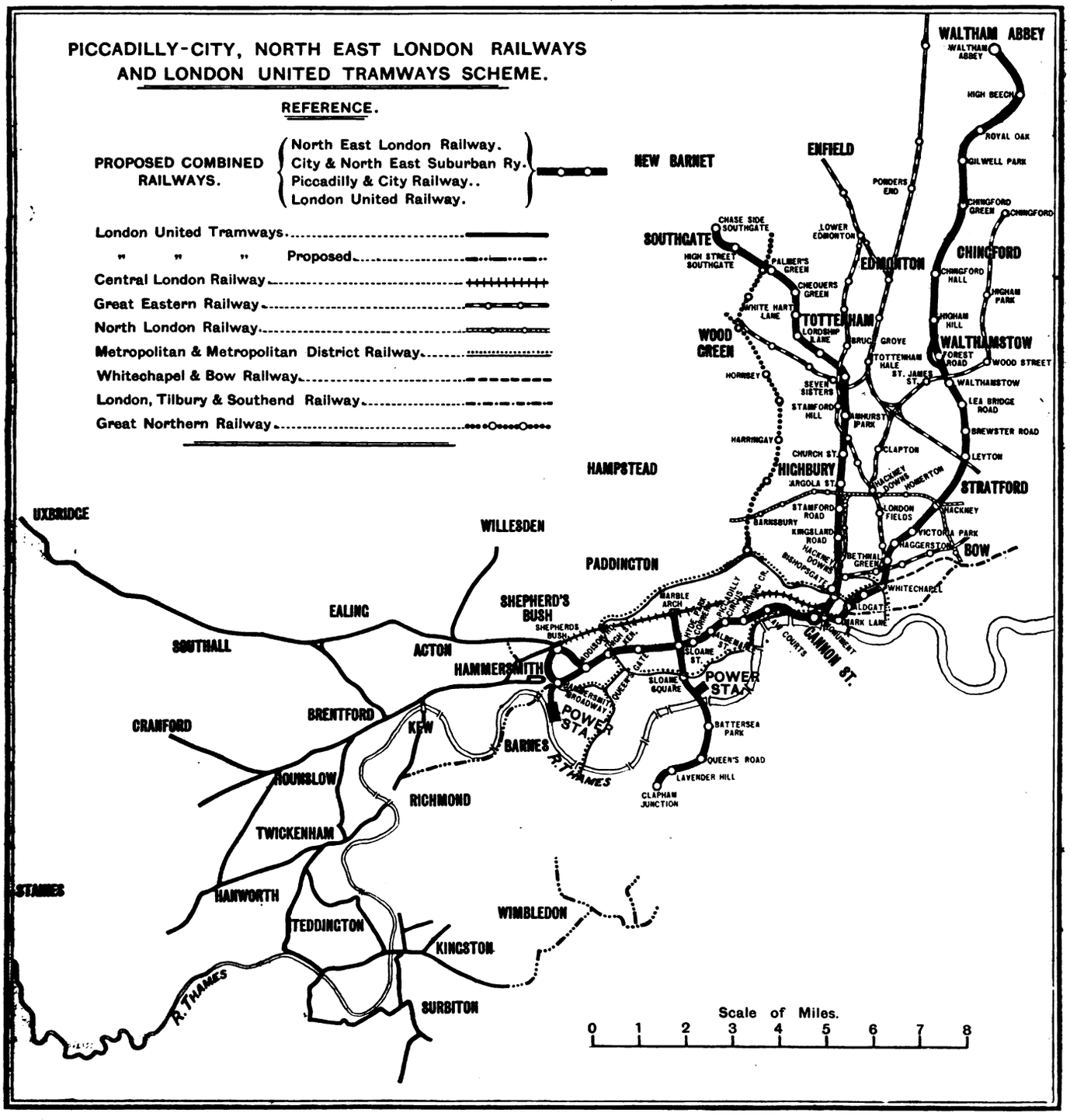
Mr. E. MOON, K.C., for the Piccadilly and City Railway Co., said that this difficulty had been recognised, and it had now been decided to increase the size of the tunnel of the London United Railways to fit in with the proposal of his clients. This, of course, would necessarily involve an increase in the estimates for that part of the scheme.

Mr. LEWIS COWARD, K.C., on behalf of the London United Electric Railways, concurred in this view.

Mr. E. MOON, continuing on the question of the relations between the companies promoting this through line from Hammersmith to the north-east of London, said that the branch of the North-East London Railway which constituted the branch to Walthamstow was not now proposed to be constructed. An arrangement had been made with the promoters of the London was a great mistake. Passengers should have the choice of as many stations as possible, and he was quite sure that a railway to the City should be one passing through it and not stopping in it. The further a circle, such as that proposed by the Central London Railway, approximated to an ellipse, the greater the disadvantage to the public. It was against public interest that through parallel routes should be in the same hands. The proposal for the whole of the railways for the through route for which he was the engineer—viz., the London United Electric Railways, the Piccadilly and City Railway, the North-East London and the City and North-East Suburban Railways, was that a 13ft. 6in. tunnel should be employed. At the same time he considered this was a matter which should be left to the discretion of the Board of Trade, and it was not at all unlikely that 13ft.



City and North-East Suburban Railway, and there would be now no opposition on the part of the North-East London promoters against the City and North-East Suburban line.

Sir DOUGLAS FOX, the engineer to the Piccadilly and City line, said that such a line as that proposed by the Central London Railway involved either exchange stations with other lines or else confluent junctions, which was specially mentioned as being undesirable in the report of the Joint Committee last year. The Central London Railway Co. would, in his opinion, have done far better had they taken the advice which was tendered them last year to extend their line eastwards to East Ham and Bow. He thoroughly agreed with Sir A. Binnie that a central terminal station in such a city as would be considered sufficient. The larger size tunnel allowed of better ventilation, permitted of the emergency platform in the tunnel, and allowed of the motors being carried under the trains. The through route from the west of London it was now proposed to start at Shepherds Bush, and by means of the loop, seen in the map, to run to Hammersmith Broadway and then away to the east. Alternate trains would run through Shepherds Bush from Hammersmith to the City. The line would then run under the main road, through Fulham, Kensington and under a portion of Hyde Park to Sloane-street. At this point the London United line would terminate and would join the Piccadilly-City line, which would continue from a station at Hyde Park Corner, under Piccadilly, Albermarle-street, Picca-

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dilly-circus (where there would be a joint station with the Baker Street and Waterloo Railway), on to Charing Cross (where there would be an exchange station with the Charing Cross and Euston line, and also with the South Eastern station); then through the Strand, where a very excellent site had been arranged for with the London County Council near the south side of the new thoroughfare, Ludgate-circus, and now, owing to considerable opposition, to the south of St. Paul's, running into a station adjoining the Mansion House station of the District Railway. From that point the line would run under the City lines of the Metropolitan and District Railway Companies to the Monument, where it was hoped to have an exchange station with the City and South London Railway, and also with the City and North-East Suburban line. Turning sharp up Gracechurch-street the line would run to a station at Liverpool-street, where he hoped the Central London would join up with them. From here the journey was continued by the North-East London Railway, which, briefly put, runs through Shoreditch, Hackney, and on to the London County Council estate at Tottenham. Beyond this there was a district which would be served by some 4 miles of line on the surface. The City and North-East Suburban line, which would form an interchange station at the Monument, would run through Bethnal Green, Victoria Park, Leyton, Walthamstow, Chingford and away to the north. The junctions in connection with the loop at the Hammersmith end of the line would be ordinary open junctions, and not tube junctions.

Lord WINDSOR: I understand that the Office of Works agrees to your running under Hyde Park?

Mr. LEWIS COWARD: Yes, and the price has been fixed.

Sir DOUGLAS FOX, continuing, said that any junction with the Brompton and Piccadilly Circus line was rendered impossible by the smallness of the tunnels of the latter. The North-East London line would run into the City as far as Ludgate-circus. At the Law Courts it was proposed to have a connection with the Great Northern and Strand line, and at Cannon-street an interchange station with the proposed Crystal Palace and District line. His estimates for the original proposals had naturally, by reason of this amalgamation, been very much altered, but his revised estimate for the construction of the line from Hyde Park Corner to Southgate, with which part of the through line the London United Company would have nothing to do, was as follows:—This section of the line totalled 13½ miles—*i.e.*, 9½ miles of tunnel and 4 miles of open. For the tunnelling he estimated a cost of £4,512,715 and for the open work £337,000. To arrive at anything like a total figure, the cost of the London United and North-East Suburban lines would have to be added. The former consisted of 10 miles 3 furlongs, and the cost was estimated at £3,677,000. The City and North-East Suburban was 4 miles 1 furlong in length of tube and 11 miles 3 furlongs of open work. These figures were all exclusive of cost of works and electrical equipment.

Cross-examined by Mr. G. M. FREEMAN, K.C., for the Central London Railway, Witness said the amalgamation of these lines was effected only a few days ago. Exactly the same arrangements would hold good for dealing with the traffic at Hammersmith from the tramways as was the case at Liverpool between the Corporation electric tramways and the Overhead Railway.

Where is the inconvenience of having an exchange station at Liverpool-street between the Central London and the North-East Suburban?—Passengers would have to change carriages.

Other things being equal, do you not think that the Central London line being there, and also having in view the fact that it is the pioneer line and has borne all the brunt of the work, should have the benefit of this extension?—No.

What has become of your Barnes extension?—The London United Electric Tramways come over Hammersmith Bridge and will feed the Hammersmith Broadway station.

Will you tell me anything that we cannot do on the Central London line that is recommended by the Joint Committee?—The 12ft. tunnel which you propose will not enable you to adopt the safety platform at the side of the tunnel, and you cannot properly use the multiple-unit system.

But we are using this system now?—You are only adopting the multiple-unit system at the ends of the trains. We propose to make our trains dividable into two halves which would be done in the slack hours of the day.

By Mr. E. H. PEMBER, K.C.: Originally the North-East Suburban line was laid out for connection with the low level electric line which the District Company had powers to construct from Earl's Court to Cannon-street, and this arrangement would still hold good as a very excellent one. In his estimate of cost many things had been duplicated as such a number of lines were concerned, and this duplication would probably allow of £1,200,000 being knocked off. As to certain cracks which had appeared in buildings along the route of the Great Northern and City line, for which he was also engineer, it was impossible to determine exactly what had caused these. At Old-street, where such an occurrence had taken place, the City and South London line had been there first, and as to the Finsbury Barracks, the City and South London line was closer to them than the Great Northern and City. He was prepared to guarantee that no station should be put anywhere near the St. George's Hospital, although there would have to be an opening to one of the subways quite near to it.

By Mr. T. W. WHEELER, K.C., for the City Corporation: If arrangements could be made with the Chatham and South Eastern Railway Company there would be intercommunication with the two lines at Ludgate-hill station.

In answer to Mr. A. WEDDERBURN, for the Charing Cross, Hammersmith and District line, Sir Douglas Fox did not consider that this line and the Central London extension fulfilled all the suggestions made by last year's Joint Committee. He did not see the advantage of having two emergency platforms, as the Charing Cross and Hammersmith Company proposed, and he proposed to utilise the other side of the tunnel for the two running conductors, which he considered a safer place to have them than between the running rails. On the question of the foundations for the permanent way, he preferred concrete, as the use of ballast, besides giving off so much dust, would necessitate the use of some backing underneath, which would be impossible on account of the height of the tube. As to the remarks upon the large loan capital of the Charing Cross, Hammersmith Company, it was quite true that this was one-third of the share capital, which was the usual practice; but the question was rather one as to whether the share capital was properly fixed.

Lord WINDSOR: I think the criticism was, that if the share capital was very large, the borrowing powers were a very much greater proportion.

Mr. WEDDERBURN: As a matter of fact, I think our share capital is the smallest of all the lines.

Continuing under cross-examination by various counsel for numerous petitioners against the bill, Witness quite agreed that a private owner ought to be compensated for any damage during construction, but not afterwards. It was now proposed to have one generating station for the Piccadilly-City line, which would be the one selected at Fulham for the London United Electric Railways. He regarded it as of great importance that his scheme promised greater speed, which it would be impossible for the Central London line to give with their present-sized wheels without the motors projecting into the floor of the carriages. The statement of the opposition counsel as to the cost per mile of this line was altogether erroneous.

Mr. C. JENKIN, of Messrs. Siemens Bros. & Co., said that this firm had worked out a provisional scheme for working this combination of lines, but did not wish to pledge themselves to it absolutely. It was quite probable that during the carrying out of the work several improvements would be effected, and they wished to take full advantage of all such improvements. They had provided for multiple driving, and there would be a 2½-minute service over the whole line from Hammersmith to Tottenham. It was proposed to have seven-coach trains carrying about 400 passengers, and each train could be divided into two sections of three or four coaches so as to lighten the train during the less busy hours of the day. There would be eight motors on the long trains instead of the four used by the Central London, and there would be no more difficulty in the matter of control. The motors proposed would give 20 miles an hour where the stations were fairly widely spaced on the North-East London line, and the average speed would be 17 miles an hour on the Piccadilly-City line. Over the whole line the average would be 18 miles per hour. About 1¾ tons of the motor would be spring-borne. The total power required at the generating station for this service would be 40,000kw., which would be distributed as follows:—In the Fulham generating station 12,000kw.; in the Kingsland-road generating station 12,000kw. and in a generating station on the North-East Suburban line about 16,000kw. There would also, of course, be the usual auxiliary machinery for lighting and other purposes. Three-phase transmission at 10,000 volts would be utilised, and he saw no difficulty in complying with Col. Yorke's recommendations as to separate lighting circuits. In fact, the tunnels would have electric lamps distributed along them with a switch at every station, so that in the event of a train not arriving to time the lights could be turned on. A completely insulated system was proposed to obviate any possibility of electrolysis. The cost of electrically equipping this service would be £3,650,000, but as the amalgamation had only been arrived at within the last few days his estimates also were liable to correction. They were approximately correct, however. All three of the companies concerned had not been able to come to an exact agreement upon some of the items. Since the above estimate was prepared, also, he had heard that the North-East Suburban line proposed to run a five-minute service, which would reduce the total cost to £2,980,000. In this provisional scheme, they were proposing nothing which had not been actually accomplished in practice, although he was not quite certain as to the measure of success which had attended the use of the completely insulated system. With the smaller tunnels and the multiple-unit system it was absolutely necessary to raise the floor of the carriage under which the motors were placed, and the consequences of this might be serious in case of accident.

Lord ZOUCHE: Is there any danger from shock?—This matter is entirely independent of the electrical side. It is a physical difficulty likely to bear serious consequences in a rush.

Supposing the passengers touched the conductor on the side of the tunnel, would they receive a shock with the insulated system?—If the insulation was good there would be comparatively little shock from one conductor, but if the two were touched the shock might be severe.

Cross-examined by the Hon. J. D. FITZGERALD, K.C., on behalf of the Charing Cross and Hammersmith line, Witness said the average distance between the stations on the North-East London line was 3,780ft., and on the Piccadilly-City line 2,530ft. He had calculated on an average stop of 20 seconds at stations. The cost of the electrical equipment of the North-East Suburban line alone was £806,000, and for the London United, Piccadilly-City, and North-East London £2,174,000, making a total of £2,980,000. The coaches were 50ft. long.

Tuesday, April 22.

Mr. JENKIN, continuing his evidence, made some corrections to his figures given yesterday, consequent on further consultations between the various promoters of the combined routes. The power stations were to be reduced to two, and the total estimate for the whole system was now reduced to £2,700,000, split up as follows:—Power station equipment, £720,000; buildings for power stations, £200,000; line equipment, £232,000; sub-station equipment, £340,000; rolling stock, £1,208,000. Of the total amount the Piccadilly-City line would cost £220,000, the North-East London £850,000, City and North-East Suburban line £900,000, and the London United £730,000. It was now decided to have eight-coach trains instead of seven coaches—*i.e.*, four motor cars and four trailers, and this size train would fit in with the 400ft. platforms. The

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aggregate capacity of the power houses would be reduced from 40,000kw. to 36,000kw. There would probably be 22 sub-stations, but at present this was an immaterial point.

Under cross-examination, Witness said it was proposed to run a 2½-minute service all day, except at times on the City and North-East Suburban line, which would run a five-minute service when a quicker service was not needed. These calculations were based on having 102 trains running all the time. It was quite true that two of the promoters of this line were directors in Messrs. Siemens Bros. & Co., but no agreement had been entered into by this firm for carrying out the scheme which he had outlined.

Major PHILIP CARDEW, R.E., corroborated the previous evidence in favour of the engineering side of this scheme.

Cross-examined by Mr. PEMBER for the District Railway Co. as to his evidence in favour of the Ganz polyphase system for working the Inner Circle, Witness did not agree that any fair comparison could be made between a tube line such as this and the Metropolitan and District Railway problem. This latter was a question of adapting an existing equipment which must necessarily have connection with the main line railways of the country.

By Mr. ROSKILL, K.C., for the Brompton and Piccadilly Circus Railway: He would not accept the proposition that a 13ft. tunnel was better than a smaller tunnel for operating the line, and worse for the safety of the passengers. One platform for emergency purposes in the tunnel was better than none, but it was impossible for him to say what a train full of passengers would do in a state of panic as to pushing one another off on to the track.

By Mr. HUTCHINSON, K.C., for the Charing Cross, Hammersmith and District Railway: He agreed that two platforms were preferable to one, and that the third rail conductor on the Charing Cross, Hammersmith and District line could be covered in and worked similarly to a conduit tramway system. The use of a ballast foundation, assuming the difficulties of construction of this were overcome, would probably tend to reduce vibration. It was quite possible to get a higher speed on any railway with the smaller sized tube by using smaller and more numerous motors on the multiple-unit system. Of course, this did not necessarily mean any less electrical efficiency, but there would be extra complication in working and connections.

By The Hon. J. D. FITZGERALD, for the Central London: On the question of immunity from shock in case of contact with the third rail, it was hardly correct to say that this would always happen; it all depended upon the insulating properties of the skin at the time. Personally he would rather not test it.

Re-examined: There could be three means of exit from the tunnels of the through line of the combined companies—viz., one emergency platform, the covered permanent way, and another platform could be provided which would cover over the conductors on the other side of the tunnel.

Lord WINDSOR: Are the arrangements for fixing the conductors at the side of the tunnel ample?—There is a safeguard in having the conductors one above the other and so close together.

Mr. R. ELLIOTT COOPER said the essential point of all tube railways was to get good station sites from the point of view of the public convenience. Closed circles were a mistake, as they entailed either confluent junctions or precluded extensions. He had examined the estimates of these lines and considered them satisfactory. They included the amount for compensation to landowners.

Mr. CLINTON DAWKIN who is, in the absence of Mr. Pierpont Morgan, senior partner in Messrs. Morgan's firm, said he was perfectly prepared to guarantee to find the capital for the whole of these lines without any assistance from the London United Electric Railways Co., but at the same time he regarded the latter as a valuable partner in the co-operation. There was no doubt that the whole capital could be provided in England, but there was an additional source of capital in the United States, where money might be cheaper at the moment, and it could be obtained in this way if desired. As regards orders for materials, it was quite true that hitherto practically all these in connection with tube railways had been sent to America, but in financing such firms as Messrs. Siemens Bros. & Co. and the British Thomson-Houston Co., the Morgan house did so with the object of enabling all the machinery to be made in England. The City and North-East Suburban line had approached him in the matter of amalgamation. Negotiations had also been opened with the Central London with a view to friendly relations existing between the two promotions, but the latter would only consent on the condition that the Hammersmith-City project was dropped, and a similar proposition was made by the District Company. His estimate of the capital required for the four sets of lines was 12½ millions and the borrowing powers four millions. The construction and equipment would cost £13,759,801, and the interest on capital for two years at 3 per cent. would be £825,584, making a total of £14,585,385 for 38 miles of line, as against a total capital of £16,000,000. He did not think it possible that any of the other companies could go direct to the public and obtain such an amount. Experience was all against it. Not a single tube project had done so, with the exception of the City and Waterloo line, which had only been able to do it by means of its intimate relations with the London and South-Western Railway, which had guaranteed a return on the capital. The Brompton and Piccadilly Company had made an appeal to the public without any satisfactory response, and the Great Northern and City made two such appeals, and were finally forced to call in the aid of financing houses. A similar thing happened in connection with the Central London line.

Under cross-examination: He considered the profits would be about 4 or 5 per cent. His estimates were based on the whole system, and he could not give any figures as to the estimated traffic over certain portions of the system, such as between Hammersmith and Charing Cross.

Mr. LITTLER, K.C., for the Brompton and Piccadilly line: This is a very important point, and I hope to show the Committee that there is no traffic over this portion which would justify the construction of the railway.

Continuing, Mr. CLINTON DAWKINS said that if any of Mr. Yerkes' schemes were carried into effect it would have no influence upon the raising of his capital. He had heard that five millions of money had already been actually subscribed towards Mr. Yerkes' schemes. The terms of the agreement between the London United and the other lines were that he had agreed to find half the capital for the former's line from Shepherds Bush to Charing Cross. From this point he had no connection financially with the London United Company, and the whole of the capital for the line from that point right through to Tottenham and Southgate would be found by his firm. As regards the City and North-East Suburban line, he was to find two-thirds of the capital. He should certainly call it an amalgamation, in spite of the fact that the three bills were to be presented to Parliament by separate promoters, who would each bear their own expenses. But after that there would be joint control in the working.

Re-examined on behalf of the combined railways, he said that Mr. Clifton Robinson and Mr. George White were promoting the London United Electric Railway, and a condition of this arrangement would be low fares and through tickets from the tramways to the tubes. It was not really the London United Tramways Co. which was promoting the tube railways. The whole system of the London United Tramways would be in the company's hands for about 25 years before the purchase clause under the Tramways Act of 1870 could be put into effect. The exception to this were a few short lengths of lines which the London County Council could purchase in a few years time, but which it was not at all reasonable to suppose would interfere with any of the working arrangements between the trams and tubes. With regard to Mr. Littler's statement that there was not sufficient traffic to justify the line from Hammersmith to Piccadilly, he said the fact that the Brompton and Piccadilly Circus line ran practically over the same route refuted this suggestion. As to the Yerkes' millions which had already been subscribed, it must be remembered that a private syndicate was at the back of this, and no one knew the terms upon which the money had been raised.

Mr. GEORGE WHITE gave further evidence as to the financial stability of the promoters of the London United Electric Railways. As a matter of fact, under its articles of association the tramway company did have power to construct tube railways. The market value of the shares of the Imperial Tramways Co., which promoted the London United Tramways Co., was between six and seven millions. The pieces of line which the London County Council could purchase in a few years' time amounted to about 4 miles. It was really owing to the opposition of the London County Council against surface tramways that they had been obliged to seek powers to promote tubes. It would have been perfection to have been able to carry their passengers straight through to the north of London without any changing whatever. The main consideration in view in entering into this combination with Messrs. Morgan was the through traffic which would thus be secured. The question of division of profits from the through traffic had not yet been discussed in detail, but it had been decided to leave it to Mr. Balfour Browne, if any difficulty arose. No arrangements had yet been entered into with any contractor, neither did the arrangement with Mr. Morgan include any such condition.

Viscount KNUTSFORD: What about the management of this through line. We are still somewhat in the dark as to how this is to be managed.

Mr. WHITE replied that there would be one joint board of directors, consisting, probably, of two from each company interested. He quite admitted that the London United Tramways hoped to benefit by this arrangement. On the other hand, it was an arrangement which would benefit both parties. The loop at Hammersmith and Shepherds Bush he regarded as a most important one. If the Central London Railway Co.'s proposal was sanctioned, a passenger coming by the electric tramway to Shepherds Bush and wanting to get to Piccadilly would have to find his way to Hammersmith before he could take the tube. Under the proposal now before the Committee such a passenger would get into the tube at Shepherds Bush without any further trouble.

Mr. J. CLIFTON ROBINSON went into the question of through fares in detail. From Acton on the tramways to Charing Cross on the tube the fare would be 2d.

Lord WINDSOR? What will the fare be from Acton to the City?

Mr. ROBINSON said it would be another penny, which would amount to the same as the fare if the passenger went by the Central London from Shepherds Bush. But he would only have to take one ticket. He hoped to arrange the fares in penny sections collectable on the train. The through fare from Hammersmith to Southgate would be 4d. divided into five or six penny sections. From Cannon-street to the limit of the Chingford and Waltham Abbey line the fare would be 3d. Workmen would be carried at single fares for the double journey. Thus, from Southgate to the City would be 1d. It would be possible for a traveller to come from Clapham Junction to Sloane-street, exchange there with the same ticket and ride on to Charing Cross for 2d. He considered it would be a very remunerative investment in time, having in veiw the densely populated districts through which the lines passed. From 5 o'clock in the morning until 7:30 there would be a five-minute service of workmen's trains. From 7:30 a.m. until 9:30 p.m. there would be a 2½-minute service everywhere with the exception of the farther end of the City and North-East Suburban line, which would be served with a five-minute service. From 9:30 p.m. till 1 a.m. on all lines there would be a five-minute service, and from 1 in the morning until 5 o'clock there would be a service on all the lines at half-hour intervals; and the fares during the night would be the same as during the day. He had estimated the passengers likely to be carried with eight-coach trains which had a capacity of 384 passengers. On the Hammersmith-Southgate section, 345 millions per annum; Cannon Street-Waltham Cross, 231 millions; Marble Arch-Clapham, 89 millions—a total of 665 millions per annum. These figures gave the total carrying capacity of the whole lines. But the estimated traffic likely to be carried was worked out on a basis of 40 per cent. of the total possible, which would be 222¾ millions per annum. This was a liberal figure, as the

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average for the Central London was something like 60 per cent. of the total capacity of the trains. The estimated earning capacities were :—Hammersmith-Southgate, £790,629 ; Cannon Street-Waltham Cross, £529,947 ; Marble Arch-Clapham Junction, £185,416—a grand total of £1,505,992. Taking the working expenses at 50 per cent.—which was probably too high—there was an estimated profit of £752,994, or 4·7 per cent. on the total capital of 16 millions. The figures for receipts were worked out on a basis of an average fare of 1½d., and the trains filling up once in every 6 miles.

Cross-examined by Mr. LITTLER for the Brompton and Piccadilly line, Witness said he estimated the carrying capacity of the Hammersmith-Piccadilly section of the line at 132 millions, which gave a working figure on the 40 per cent. basis of 53 millions. In making all his estimates he had allowed for all possible competition on all the sections. Should any of the existing companies deem it advisable to adopt electric traction, the competition would be greater, and this would tend to increase the traffic.

Under further cross-examination, Mr. Robinson stated that the opposition which was encountered last year to the tramway which it was proposed to run over Hammersmith Bridge was now overcome, so that this line would in all probability be sanctioned in this year's bill and would thus form a valuable feeder to the railways. He admitted that he had never had any practical experience as the manager of a tube railway, but, inasmuch as the Central London in its early days selected a tramway traffic manager for this post, he presumed there was nothing of a special character in the duties.

Wednesday, April 23.

Mr. J. CLIFTON ROBINSON (cross-examined) said that he did not consider this amalgamation would be a violent protection or monopoly for his group over the whole of these tubes in their relation with the tramways. If the Metropolitan and District Railways and Central London Railway Co. made their fares harmonious with those which it was proposed to introduce on his tubes, this could not be so. An idea of the possible traffic on this Hammersmith-City line of route was evidenced by the fact that over 150,000 per day were carried on the tramways, and of this he estimated something like 100,000 came to Shepherds Bush. The proportion of these which went on to the lines of the Central London Railway was very large, but the exact figure was better known by the railway company itself. Between Hammersmith and the City the omnibus companies carried 50 millions of passengers per year. Over 30 omnibus routes converged on to the Strand, 700 omnibuses depositing their passengers there. At Hyde Park-corner, which was another very important point, there were 20 routes for the 'buses, which brought to that point, approximately, some 30 millions of passengers per year. At High-street, Kensington, the 'bus traffic approximated to nine millions per annum. Directly carried by 'bus from Hammersmith to Charing Cross he should say there were quite 10 millions per annum. With reference to Col. Yorke's evidence before the Joint Committee last year, that all-night services were undesirable and even impossible on tube railways, owing to the necessity for nightly inspection, which would be prevented if the trains were running, he pointed out that the trains were only proposed to be run at half-hour intervals. Further, it was quite probable that Col. Yorke had in his mind, at the time of giving this evidence, the only tube railways then constructed, which, of course, afforded no facilities for inspection when the trains were running. The use of 13ft. tunnels put a different aspect upon the question. In these larger tunnels, with the platforms on either side, there was plenty of room for repairs to be executed when only the half-hour service was on. On the question of fares he would hesitate to follow Col. Yorke's evidence. His calculations on the earning capacity of the lines were based on the assumption that the trains would carry their full capacity once every 6 miles, and that the average fare per passenger was 1½d. He was surprised to hear that the average fare on the Metropolitan Railway was as low as 1·49d. and on the North London Railway 1·34d. He did not know that the North London Railway Co. were carrying workman 12 miles for 2d., and that, in spite of such a low fare and automatic machines for taking tickets, only nine million workmen were carried.

Re-examined : Witness considered that if this scheme was carried into effect London would be on a par with other great towns in America and Europe. London's means of communication would then be capable of carrying 300 times its population, or some 1,800 millions per annum.

Dr. JAMES EDMUNDS, late medical officer of health to the district of St. James, said he had given great attention to social economic problems, and looked with great favour upon all tube railways as an important factor in the housing of the working classes. The west-end of London was gradually becoming more and more a business neighbourhood, and it was only by means of rapid communication that the population could be accommodated further out from the centre of the City. So long as this communication was cheap, rapid and convenient it did not matter who constructed the lines.

Dr. CAWFIELD, late medical officer to St. George's, Hanover Square, gave similar evidence.

Dr. MANSFIELD ROBINSON, town clerk to the borough of Shoreditch, viewed the amalgamated scheme with favour, as it afforded a means for carrying the working population of his district out into the country at cheap rates, at the same time opening up what was not now in existence—viz., a rapid communication with the City and West-end.

Mr. BUCKLAND, of Messrs. Buckland and Jarrow, valued the cost of acquiring the necessary lands and buildings for station sites, &c., along the route from Southgate to Hyde Park Corner at £1,810,000. There was no serious inconvenience with any property. Replying to a question on behalf of Coutts' Bank at Charing Cross, he said the amount of space required for a station near the Lowther Arcade was 6,000ft.

Mr. A. R. STENNING, who had surveyed the extension to London of the Great Central Railway Co., thought the proposed sites for the stations satisfactory.

Mr. CHARLES STEEL, who has just retired from the position of general manager of the Great Northern Railway Co., corroborated Mr. Clifton Robinson's evidence as to the working of a tube railway. There was no complexity in managing such a line. It was simply a question of having sufficient rolling stock, there being no diversity of traffic. The great feature of London suburban traffic was its numbers, and the service ought to be varied according to the hours of the day. His experience was that the greatest crush was from 8 to 10 a.m. and 5 to 8 p.m. This combined tube scheme proposed to do that which to a very large extent the Central London had failed—viz., to develop the intermediate or short distance traffic, and it was proposed to do this by means of a differential system of fares.

This concluded the case for the Piccadilly and City Railway, and further evidence was then given for the London United Electric Railways.

Mr. S. G. FRAZER, engineer to that portion of the amalgamated lines from Hammersmith to Hyde Park-Corner, enumerated the proposed stations on the section of the railway as seen in the map. It was possible to make the line from Clapham Junction to Marble Arch form a continuous line to Cricklewood, by forming an end-on junction with the North-West London Railway, which was authorised to run from Marble Arch to Cricklewood, and by this means intercommunication would be given between the south and north main railway lines of the country. Land had been scheduled at Battersea Bridge for a generating station, in case it was thought desirable to have another site in addition to the one at Hammersmith. On their loop at Hammersmith they avoided confluent junctions, and none of the crossings were in the tube.

Cross-examined by Mr. SHIRESS WILL, K.C., for the Albert Hall and other petitioners, Witness objected to having what was called "The Bank of England clause" inserted in the bill, because, in his opinion, it tended to retard the raising of the capital, by having an effect on the public. This clause, which was inserted in the Central London Railway Co.'s bill for the protection of the Bank of England, provided that the authorities should appoint someone to inspect the construction work while it was in progress, and refer any points at issue to the Board of Trade. He granted that the inclusion of this clause in the Central London Company's bill did not prevent their finding their capital, but they had had great difficulty in doing so. His margin for contingencies was 10 per cent., and while Sir Douglas Fox allowed 15 per cent. for this item in respect of the other portions of the combined scheme, the latter's estimate for tube construction was less.

Mr. W. J. BULL, M.P. for the Borough of Hammersmith, said the London United Electric Railways Co. had offered the Borough Council very much better terms than the Central London Railway, and this was the reason why the borough supported this scheme.

Mr. HUGH MAIR, surveyor to the Hammersmith Borough Council, confirmed this.

Mr. WILLIAM THOMPSON, a Richmond town councillor, gave evidence of the poor and expensive railway travelling from the Thames Valley to the City. The District and Metropolitan Companies had both refused cheaper fares, and at present it was 3d. cheaper to split the journey up and book three times in order to get from Richmond to Charing Cross than to book right through by one of the above-mentioned railways. The essential point in the problem of housing the working classes was cheap travel into the open country. The present fare from Acton Green to Charing Cross was 1s. return, but it would only be 4d. return if this combined system were sanctioned.

Mr. EDWIN FOX, of Messrs. Fox and Bousfield, valued the necessary land for the London United Electric Railways at £467,719.

This disposed of the case for the London United Electric Railways.

Mr. BALFOUR BROWNE then briefly sketched the proposal of the North-East London Electric Railway, which is also seen in the map, and repeated the figures given in Sir Douglas Fox's evidence on Monday.

The Committee then adjourned until to-day (Friday).

THE METROPOLITAN DISTRICT RAILWAY BILL.

This bill came before a Select Committee, presided over by Mr. H. Hobhouse on Tuesday last, the other members of the Committee being Mr. G. White, Mr. Carlile and Mr. Hammond.

Tuesday, April 22.

Mr. PEMBER, K.C., in opening the case for the promoters, said that Part I. of the bill dealt with the laying down of certain cables for the purpose of supplying electricity to the Metropolitan District Railway system. The cables would run from a generating station on the banks of the Thames, near the Chelsea Basin, down Edith-grove, Redcliffe-gardens, and Earl's Court-road, to the nearest point on the Metropolitan District Railway. Part II. of the bill would give power to acquire land from the Chelsea Vestry for the construction of a generating station. Part III. would give power to work railways by means of electric power, and that section of the measure was opposed. It meant that, inasmuch as the Metropolitan District trains in the ordinary course of working would run on certain parts of the South-Western and the Hounslow and Metropolitan railways, therefore it was necessary to lay down the necessary apparatus for electricity. The promoters had entered into an agreement with the South-Western and Hounslow and Metropolitan Railways. Part IV. of the bill, which dealt with raising capital and making capital arrangements as to powers the company already possessed, the Committee would not be troubled with, these being matters of a domestic kind, of interest only to the promoters. An attempt had been made before the referees to obtain the right to go into these matters, but the referees had disallowed the application. Part V. of the bill dealt also with a matter which was domestic to the promoters—viz., power to make certain railways authorised by the Act of 1897 a separate undertaking. An attempt had also been made to oppose this part of the bill, but the referees had refused to allow it. The line was one which would run underneath the existing railway, and

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serve as a sort of relief or duplicate line, and would be known as "the low level line." Part VI. dealt with extension of time and contained two items—the extension of time for the completion of the railway, and the purchase of land authorised by the Act of 1897. To this, opposition had been sanctioned by the referees. The power to deal with superfluous lands would be extended. The bill would confirm certain agreements with the Great Central and the Great Central and South Western Railways; it would incorporate certain sections of the Act of 1897, make provision for running powers over the Tilbury and Southend Railway, confirm an agreement with an electric traction company and certain other matters. The only parts of the bill opposed were those relating to electrical equipment, cables and extension of time for works.

Mr. PERKS, M.P., chairman of the Metropolitan District Co., gave evidence for the bill. He said the position of the company to proceed with the work now was, financially, better than it was formerly. They had had £1,000,000 subscribed when they came to Parliament last July. The same combination had now got £5,000,000 subscribed. They were applying also for an extension of time for the construction of the deep-level railway, authorised in 1897. The deep-level railway would start from Earl's Court, and proceed under the Metropolitan Railway, stopping at the Mansion House. This was authorised in 1897. But since that, so far as the supply of electricity was concerned, they had added the Hounslow and Metropolitan Railway, they had agreed with the South-Western Railway Co. to supply current from Gunnersbury to Richmond, and to supply the South-Western from Putney Bridge to Wimbledon. They would supply current to Sudbury Hill over their Ealing branch, and to Turnham Green; they had also offered to the Metropolitan Railway Co. to sell them current for their portion of the Circle Railway, but they had not accepted the offer. The current would be supplied to the company's western extension, and then, going eastward, to the Mansion House, and away to Whitechapel. Current would be supplied to the railway from Whitechapel to Bow when it was opened in June, and the current would be carried not only to Bow, but to the Tilbury Railway and East Ham, where they had arranged to run on June 1 eastward. The whole of the current would be supplied from the power house to these districts as well as to the Brompton and Piccadilly undertaking; and they were amalgamating so as to carry the current to Finsbury Park. With regard to the acquisition of land for the power station, they had had a series of arbitrations, and the promoters had found that they would have to pay about twice as much as they had been told they would have to pay.

Cross-examined by Mr. FREEMAN, K.C., on behalf of the London County Council: Do not you think it desirable that the London County Council should have a voice as to the form and construction of the power house?—No. I do not think the London County Council should have the right to interfere with railway buildings. Railway companies are not under the Metropolitan Building Acts.

Is it not desirable that you should have uniformity in metropolitan generating stations?—No; you cannot have uniformity. You would not, for instance, put up the same sort of building at Neasden as you would put by the river. A building to produce 8,000kw. of electricity would not be like a building such as we propose—to produce 50,000kw. I do not think it would be possible to construct two generating stations alike in London.

In further cross-examination, Witness said it would take 12 months to build the power house contemplated.

Mr. JAMES RUSSELL CHAPMAN, the next witness for the promoters, said that he had been engaged in connection with electrical undertakings in Chicago for nine years, during which time he had laid down 900 miles of tramways in the town and neighbourhood, and 40 miles of elevated railways. Of the 900 miles, 200 were of the same character as was proposed in the bill. He was engineer to the Metropolitan District Electric Co., who had the bill in hand, and the works now proposed, if carried out, would be carried out under his supervision and control. It was proposed, on the site at Lots-road, Chelsea, to construct a generating station of the capacity of 50,000kw. The ducts for the electric cables would be laid down on the well-known principle of embedding them in blocks of concrete with manholes about 400ft. apart. There would be inspection chambers, and from these it would be possible to work the cables without interfering again with the roads. The top of the concrete would be 2ft. to 2ft. 6in. below the surface of the pavement. They saw no reason why they should not be able to lay these cables without undue interference with the pipes of the local authority. In all cases where such extensive work was done it was necessary to interfere with pipes and mains, but wherever this was done it was proposed to defray the cost of re-arrangement. To his mind the question would only be one of meeting the engineer of the local authority and working amicably with him.

Cross-examined by Mr. TALBOT, on behalf of the Metropolitan Borough of Chelsea, witness said the ducts should take about three months to construct, but the cable would not be ready by that time. The generating station would not be finished for a year or two after the completion of the ducts.

So that if you get power to construct the ducts next year that will be time enough?—No. We have to make measurements for the manholes, and three months after that, having got the factory to make the cables, they will begin to deliver. The delivery of the cables would extend over a period of from six to nine months.

By Mr. FREEMAN: The works authorised now were much larger than those contemplated in 1900. The generating station would be five times the size of that proposed in the former year. Of course, a larger number of tubes for the cables would be required in the ducts. The conduits would carry 60 tubes, 30 in each, the tubes being 3½in. in diameter. That would necessitate the use of continuous blocks of concrete 6ft. 4in. high by 4ft. 6in. wide. The inspection chambers would be 13ft. square by 9ft. high. There was an alternative route for the cables down less frequented streets, but it would as easily afford the facilities required, besides, which it would be necessary to tear up the road from kerb to kerb to do the work. There were some nurseries which the cables could be taken through, but that was public property. It would be easier to go through Brompton cemetery.

That would be a large order?—No doubt. The route through the nursery would be better than either routes through the streets.

Witness, in reply to further questions, declared that it would be highly inexpedient to require the railway company to submit its plans to the London County Council. The London County Council might oppose the plans or require them to be modified, in which case the promoters would not be able to construct a 50,000kw. power house.

Do you object to your building being compelled to do that which all other electrical buildings in London have to do—viz., keep the building line?—I do.

Re-examined by Mr. CLODE: The ducts should be finished before the winter, and the cables should be got in and everything should be in working order before the next summer. That was the best way to do the work from the standpoint of all concerned.

By the CHAIRMAN: Their system of cables was a duplicate one. Thirty cables would suffice for the power needed, but there would be another 30 for use in the case of a breakdown.

Sir JOHN WOLFE BARRY, K.C.B., also gave evidence for the bill. He explained that smaller ducts had been originally proposed along another route, but that was when arrangements were only in contemplation for the provision of electricity for the Inner Circle Railway. He thought Mr. Chapman had under-estimated the time it would take to make the ducts. It would take nearer nine months than three. He had great objection to the local authorities regulating railway buildings. Power houses in the future would be as common in connection with railways as goods stations. Parliament had always allowed railway companies to design their own works.

By Mr. MOORE, K.C., for the Middlesex County Council: He knew of no structural damage being done to buildings by vibration.

Sir ALEX. BINNIE, formerly engineer to the London County Council, also gave evidence for the bill. He submitted that, as the promoters had already designed their machinery, it would be a great hardship to alter the general law and require them to submit their plans for a power house to the judgment of the London County Council. All railway companies were specifically exempted from the London Building Act.

The CHAIRMAN asked whether, in view of the development of electric enterprises, witness would limit the size of the ducts for carrying cables.

Witness said they had been limited in the past, but that had been a mistake, as Lord Windsor's Committee had found. Enterprise would be curbed if severe limitations were laid down.

This concluded the case of the promoters as to works.

Mr. COURTHOPE MUNROE then opened the case for the Borough of Kensington, calling

Mr. WILLIAM WEAVER, surveyor to the borough, who stated that the ducts proposed by the company would form two solid masses of concrete 6ft. high by 3ft. broad under the road. It would practically give the company the monopoly of the user of the road. He suggested an alternative route through by-streets.

Mr. LIVINGSTONE gave similar evidence.

Wednesday, April 23.

Mr. FREEMAN addressed the Committee on behalf of the London County Council. He said there were only two simple points on which he desired to obtain the decision of the Committee. Both arose under the provisions of the London Building Act, 1894. The first was in respect of the generating station which was going to be enlarged, and it was that, in the public interest, the promoters should be required to submit plans to the County Council. The main object of this was to secure that the building should be so constructed as not to be a danger to the inhabitants. In other cases, companies concerned in the construction of generating stations had proposed plans which, if carried out, would have resulted in danger, and the London County Council had used their power to control the plans. In one instance it had been proposed to build a generating station of wood, which, of course, was ridiculous. But the promoters said that by sec. 201 of the London Building Act, railway companies were exempted from the operation of the measure. It was a matter of doubt whether that section applied to generating stations a long way from the railway. The London County Council asked the Committee to say that in this case the railway company should come under the general law which applied to all other generating stations.

The CHAIRMAN: Did your counsel ask for this power when the bill of 1900 was under consideration?—No, they did not.

The CHAIRMAN: You are aware that the works are already commenced—that the contract has been issued for them?—The machinery is ordered, but the actual building which is to go over it is not constructed.

Mr. CLODE: The chimneys are commenced, and the steel girders which are to fit into the building.

Mr. WM. RILEY, superintending architect to the London County Council, then gave evidence in support of Mr. Freeman's statement.

Mr. PEMBER replied for the promoters, declaring that the thoroughfare was one of no importance, and that no harm would result from a slight divergence from the line of buildings. The London County Council's demand should have been put forward in 1900, when the railway company obtained their original powers. All that was sought now was power to take an additional site. Since 1900 contracts had been let for the work, and girders had been ordered. Moreover, he relied upon the exemption given in the London Building Act. As to the route for the cables, the promoters would be prepared to put half the cables on one side of the road and half on the other.

Some conversation then passed between counsel. Mr. Pember undertook that the Metropolitan District Railway would insert a clause applicable to vibration similar to that imposed in the promoters' bill now before Lord Windsor's Committee.

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The room was then cleared while the Committee deliberated in private. On the re-admission of the public,

The CHAIRMAN said that the Committee were prepared to pass the preamble of this bill, subject to certain conditions. With regard to the question of carrying this mass of cables under the public streets, the Committee were of opinion that the works ought to be subject to the supervision of the Board of Trade. They therefore proposed to insert words to the effect that as regards the works authorised in clause 5, the detailed plans, including the mode of construction and the position in the street, should be subject to the approval, before actual construction, of the Board of Trade, and that future enlargements and alterations should also be subject to such approval, and that in giving such approval the Board of Trade should have regard not only to the safety of the public, but to the convenience of the road authorities. In regard to the other points, the Committee did not propose to give the London County Council any power to approve the plan of the generating station or to regulate its building line, but they proposed to insert some words carrying out the proposal made by the promoters as to the kind of materials to be used in the building.

Mr. R. W. PERKS, M.P., then gave formal proof of the unopposed parts of the bill.

Consideration of the clauses was postponed till to-day (Friday).

THE POST OFFICE TELEGRAPHS.

On the vote to complete the sum of £4,211,255 in connection with the Post Office telegraph service, Mr. A. CROSS, one of the Glasgow members, referred to the frequent breakdowns in telegraphic communication between England and Scotland in winter, and said that the Post Office authorities should devise a means to obviate similar occurrences in the future, by the use of underground cables or otherwise.

Sir J. LENG, an Edinburgh member, said that the admitted loss of revenue caused by recent breakdowns was £2,500 in November last and £5,500 in December, and that the cost of repairs in these two months was £2,500 and £27,000 respectively. It was also stated, he said, that the cost of the underground wire to Birmingham was £165,000, and that an underground wire to Glasgow would cost £700,000. The loss in the two months cited above represented far more than the interest on a million pounds. The hon. member also asked what the Post Office was doing to encourage the adoption of wireless telegraphy; it had already been adopted on the great Atlantic liners and 130 of His Majesty's ships. He feared that some of the permanent officials were inclined to be obstructive in the matter.

Mr. BRYCE (Aberdeen) also called attention to the interruption of telegraphic communication in Scotland, and said that no part of the United Kingdom was more liable to snow storms than the country between Fife and Aberdeen. He also urged the importance of establishing wireless telegraphic communication with Iceland.

Mr. AUSTEN CHAMBERLAIN said that the occurrences of the last two years had been quite exceptional, for during the 10 years previous the total expenditure required for repairs had only slightly exceeded £3,000,000. The country between London and Birmingham was taken first for the experiment of underground wires because this district was very liable to be interrupted by winds sweeping across the Midlands. The Post Office department was devoting £30,000 to underground work this year, and the money would be spent for the advantage of northern communication generally, and not in favour of any particular district on the way to Scotland. Even when cables were put underground, overhead wires could not be dispensed with. He was informed that there were several classes of telegraphy which could not be conducted through underground wires. Moreover, the latter wires were still very costly, and less satisfactory in working than overhead ones. It had been said that as large profits were made, the money should be spent to guard the revenue and to protect customers. But the difficulty was that the telegraph service had made no profit, but a loss.

Mr. BRYCE here interposed the remark that the loss was probably due to these interruptions.

Mr. AUSTEN CHAMBERLAIN, continuing, said that if the right hon. gentleman meant to imply that the loss would be recovered if they spent this money, that was not so. In reality the amount of traffic stopped was very small; during the worst week of last year the reduction was only 6 per cent. of the total figure. At the same time, he shared the desire of the Postmaster-General to push the work on as rapidly as possible, but it must be recognised that the present financial year was not a promising one for making a great increase in telegraphic expenditure without any corresponding increase in revenue. The amount asked for in the present year would be a quite inadequate figure if it were taken as a measure of the normal rate of progress. Concluding, he said that he did not underrate the importance of the matter, and would remember it in framing next year's estimates.

Mr. MUNRO-FERGUSON (Leith Burghs) said that the amounts had been still smaller in the two previous years.

Sir A. AGNEW (Edinburgh) and Mr. BLACK (Banff) also complained of the interruptions of the telegraphic communication to Scotland.

Mr. GIBSON BOWLES asked whether the Secretary of the Treasury could not arrange to have the telegraph and the telephone charges accounted for separately in the estimates in order that it might be seen what profits arose on the telephone service. He also called attention to the report of the Inter-Departmental Committee on Cable Communications, in which it was stated that the Board of Trade granted landing rights in this country, and in which also a suggestion was made that the powers of the Cable Landing Rights Committee should be enlarged, that it should be called the Cables Committee, and that the Board of Trade should be relieved of its present responsibility in regard to cable landing rights. He wished to know if this course had been taken?

Mr. NORMAN asked how much money had been spent by the Post Office on experiments on wireless telegraphy, and what return the country was getting for it?

Mr. GIBSON BOWLES asked if the Post Office had satisfied themselves as to their position in subsidising the Marconi system supposing it should turn out that the Lodge patent was really the master patent, as had been alleged?

Mr. AUSTEN CHAMBERLAIN said that it was intended to continue underground cables to Scotland. The cable would run northwards to Lanark, and then branches would be taken to Glasgow and Edinburgh. Every endeavour would be made to give Stornaway the best telegraphic service possible in the circumstances of the case. He would suggest to the Postmaster-General that the revenue of the department be increased by means of increased fees for registered telegraphic addresses. Unfortunately, it was not possible to distinguish the past expenditure on telephones from that on telegraphs, but such a distinction would be observed in the future with regard to the London system. The recommendations contained in the Cable Committee's report would be sent to the various departments concerned. Referring to the facilities given to Mr. Marconi by the Post Office, he said that at that time Mr. Marconi had already secured the master patent. The amount spent on these experiments was £?,000 or £3,000, and this was not only for the benefit of Mr. Marconi, but of the Post Office electricians, who were at that time (as well as Dr. Lodge and other scientific men) devoting attention to the problem of wireless telegraphy. The Post Office had made no payments to Mr. Marconi. Wireless telegraphy within this country, and within the 3-mile limit, could only be undertaken under the Postmaster-General's licence. The Postmaster-General was well aware that there were rival claims on the question of validity of Mr. Marconi's patent. He had taken advice on the subject, and was giving it serious consideration.

Mr. ALLAN said that wireless telegraphy was invented by Beaumont Lindsey in 1837, and Mr. NORMAN again asked what sum had been expended by the Post Office in connection with wireless telegraphy.

Mr. AUSTEN CHAMBERLAIN replied that the Post Office were already conducting a series of experiments themselves when Mr. Marconi asked for facilities. He might possibly be able to find the whole sum expended, but could not ear-mark the expenditure in regard to the experiments suggested by Mr. Marconi.

PROPOSED TRAMWAY ALONG THE EMBANKMENT.

On the order for the second reading of the London County Council (Tramways and Improvements) Bill in the House of Commons on Monday,

Mr. BOULNOIS said that he did not intend to proceed with his amendment for the rejection of the bill, because a number of its tramway schemes, including one for running an omnibus service, had been pronounced illegal and had been withdrawn.

The bill having been read a second time,

Mr. BOULNOIS moved that it be an instruction to the Committee to omit the clause providing for the construction of a tramway along the Embankment from Westminster Bridge to Blackfriars Bridge. This route was under the sole control of the London County Council, and no local authority in the metropolis nor, he believed, the people of London, would have *locus standi* before a committee if they objected to the scheme. This tramway scheme had been rejected nine times. He did not believe that the project was desirable or necessary. One of the few things which Londoners had reason to be proud of was the Thames Embankment.

Sir J. PEASE seconded the instruction.

Mr. BARTLEY said that, on account of its width, the Embankment was more suitable for a tramway than any other London thoroughfare. He did not understand how a tramway would ruin the Embankment, which at present was very little occupied, and a good service of trams would relieve the congestion in the Strand.

Mr. BURNS said the Embankment was the best road he knew of anywhere for a tramway owing to its width, and the London County Council wished to connect it with their 48 miles of tramways on the north side of London, whose electrical equipment was in progress. The scheme was one on which the London County Council—Progressives and Moderates—were practically unanimous. There would be 40ft. between the rails on either side, and in that space there would be ample room for motor cars, carriages and other traffic to and from the City.

Mr. BANBURY supported the instruction.

Sir J. DICKSON-POYNDER said that no less than 476 'buses on an average and 5,348 people crossed the three bridges per hour. These people would appreciate improved facilities.

Mr. MACDONA supported the scheme, and Sir F. DIXON-HARTLAND and Mr. MOON did not think that the scheme would appreciably conduce to the settlement of the housing problem. Mr. BURDETT-COUTTS and Col. PILKINGTON supported the instruction.

The House divided—for the instruction, 159; against, 178; majority against, 19.

REPAYMENT OF LOCAL LOANS.

The Select Committee of the House of Commons considering the matter of local loans sat again on Tuesday and Friday last week, and on Tuesday this week, Mr. Grant Lawson, Parliamentary Secretary of the Local Government Board, presiding on both days.

On Tuesday, April 15, Mr. G. A. STEVENSON, of the Public Works Commissioners for Ireland, who was the first witness, said that loans to local authorities in Ireland were made from the Local Loans Fund by the Commissioners. The period for repayment of such loans was settled by the Local Government Board, the money being lent by his department for the period fixed, subject to its not exceeding the probable duration of the works as required by statute. There was a growing tendency in Ireland to borrow for a long period, but the Commissioners never lent money for more than 50 years.

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Sir H. ROBINSON, permanent vice-president of the Irish Local Government Board, explained the method of procedure, saying that the Board decided the terms of the loan on the evidence of an inspector sent into the district in question, deciding from this what they considered the probable duration and continuing utility of the works. They knew of few cases of the utility of works ceasing before the loan had been repaid, paving works being among the few instances.

Sir A. ROLLIT asked if he did not think there might be an extension of the term, in view of there being few instances of cessation of durability of works. Witness replied that encouragement should be given the people to spend money on improvements, and a longer term might be granted for the repayment of loans for acquiring land.

Mr. J. M. DODDS, senior clerk in the office of the Secretary for Scotland, replying to the chairman, said there was less Government control in Scotland in this matter. Scottish acts specified the maximum period for the repayment of loans, the local authority proceeding as it pleased within that limit. The Scottish Education Department sanctioned and fixed the repayment period of all School Board loans, the Local Government Board sanctioning all loans to minor parish councils. The local debt of Scotland was £20,162,330 in 1881, and in 1900 it totalled £47,700,000, of this £15,000,000 was due to productive and remunerative undertakings. The maximum period for repayment was usually 30 years, though longer periods were sometimes given; Glasgow, for instance, had 60 years granted for certain improvements.

At the sitting on Friday, April 18, the LORD MAYOR OF MANCHESTER (Mr. Alderman Hoy) said that he was specially struck with, what he thought, the inadequate period of 55 years allowed for the repayment of the town hall land purchase and erection. The land value had now reached a high figure, and in another generation the ratepayers would possess that valuable property free from debt. He thought 100 years would not have been unreasonable for the repayment of such a debt. Seventy years was the longest period granted the Corporation, this being for the Thirlmere waterworks, an undertaking which would be of greater value a century hence than now. He thought that no hard-and-fast lines should be laid down for the term of a loan, but the circumstances of each case should be considered—as land value, buildings maintenance, and the purpose of the loan. Manchester had borrowed about five times its assessable value, and had made good profits on certain of its undertakings. He thought that facilities should be afforded the local authorities to make application for an adjustment of the loan period on existing loans.

Mr. Ald. J. P. SMITH, mayor of Barrow-in-Furness and Member of Council of the Incorporated Municipal Electrical Association, concurred generally with the views of the Lord Mayor of Manchester, and he thought that electric lighting works had been retarded in their development by the shortness of the loan period. Local authorities had refrained from exercising the provisional orders they already had, and 155 who had provisional orders had not cared to put them into operation.

Mr. J. E. ELLIS, town clerk of Plymouth, also gave evidence.

On Tuesday last Mr. G. T. LEE, town clerk of Dewsbury, who had been asked by the Association of Municipal Corporations to give evidence, said that non-county boroughs having a smaller rateable value than county boroughs, felt more intensely that there should be some alteration of the present practice. Of 212 non-county boroughs interrogated on the subject, 88 desired that the periods fixed by Government Departments should be made uniform with the longer periods allowed by Parliamentary Committees, and 16 of the number expressed satisfaction with existing arrangements. For leasehold land he thought the period should not exceed the term of lease; land for street widenings might reasonably be paid for in 60 years, and remunerative works might have a basis of repayment equal to the probable life of the works. Non-productive undertakings might be dealt with in the same manner, but with a maximum of 40 years. Their electricity works had not yet paid, and there was a loss on the waterworks due to the manufacturers' demand being met at a loss. The electric lighting deficit was made up out of the gas profits, but their undertakings as a whole were substantially profitable.

Mr. BUTTERWORTH, Wimbledon District Council, and Mr. BAKER, of Baker, Ellis & Co., parliamentary agents, also gave evidence advocating uniformity between the Local Government Board and Parliamentary Committees.

CROYDON AND DISTRICT ELECTRIC TRAMWAYS BILL.

On the order for the second reading of this bill in the House of Commons on Tuesday, Mr. H. W. FORSTER, member for the Sevenoaks division of Kent, said that he had put down a notice of a motion to reject this bill. The bill was for the purpose of authorising three continuous lines of tramways originating in Croydon and passing through Penge into Beckenham. Standing Order 22 of the House provided that when it was proposed that a tramway should run through more than one administrative area, the consent of the authorities having jurisdiction over at least two-thirds of the route should be obtained. Penge assented, Beckenham objected, and Croydon assented subject to an understanding from the promoters that no tramways should be laid within the Croydon area. Croydon, therefore, assented to the bill, but objected to a part of the tramways proposed, which was contrary to the spirit of the standing order in question. There should be an expression of opinion by the House that this was a course which local authorities ought not to take in such matters. The promoters had now agreed to strike Beckenham out of the bill, and he would therefore withdraw his opposition to it.

Mr. JEFFREYS, deputy-chairman of Committees, in whose name a motion stood on the paper to refer the bill back to the examiners to report whether Standing Order 22 had been complied with, said that when the parties came before him he believed that there had been no collusion nor an intention to evade the standing order. As Penge was now the only authority concerned, and their consent had been given, there was no need to move his motion.

Sir J. BRUNNER said there had been something very like an attempt to evade the standing order. He looked upon this as a serious matter, and therefore he desired to move the motion which stood in the name of the deputy-chairman.

After some discussion, during which Mr. RITCHIE (member for Croydon) said that, so far as Croydon was concerned, there had been no collusion whatever, and Sir W. HART DYKE (Dartford division of Kent) characterised the proceedings connected with the bill as "shady,"

Sir J. BRUNNER asked leave to withdraw his amendment, and the bill was then read a second time.

TELEGRAPH AND TELEPHONE POLES.

In the House of Commons, on Friday last, Mr. BOSCAWEN inquired of the Secretary to the Treasury, regarding the increase of the poles on country roads, whether he knew that in some places two sets of poles of the Post Office telegraphs and a telephone authority respectively were erected, each carrying a few wires, and whether in such cases rental terms might not be offered the various telephone authorities for the use of the Post Office poles.

Mr. AUSTEN CHAMBERLAIN replied that the Postmaster-General did not think the cases referred to numerous, or that poles impeded the traffic. Should occasion arise, however, the Postmaster-General, who was desirous of meeting the wishes of local authorities, would consider the matter of renting wires on Post Office poles. He did not think it desirable that telephone authorities should be allowed to place their own wires on Post Office poles.

LONDON COUNTY COUNCIL (SUBWAYS AND TRAMWAYS) BILL.

On Wednesday the Select Committee of the House of Commons, of which Mr. Hy. Hobhouse is chairman, commenced consideration of the London County Council (Subways and Tramways) Bill. Mr. Erskine Pollock, K.C., Mr. G. M. Freeman, K.C., and Mr. Bernard Wilkinson appeared for the promoters. The other petitioners in opposition were represented as follows:—Metropolitan District Railway, Mr. Reader Harris, K.C.; Metropolitan Borough of Holborn, Mr. Bellews; Great Northern and Strand Railway Co., Mr. Balfour Browne, K.C., and Mr. E. H. Lloyd; and the Westmins'er City Council, Mr. Blennerhassett, K.C., and Mr. R. Berkeley.

Mr. ERSKINE POLLOCK, K.C., in opening, said the Committee were asked to sanction a tramway to be placed in a shallow subway which would commence at Theobald's-road, where it would form a junction with existing tramway owned by the London County Council, though not worked by them. It would then gradually fall in level until in Southampton-row it would be below the level of the street. From there, in a shallow subway about 3ft. deep, it would pass along the site of the proposed new street from Southampton-row to the Strand until it met the crescent to be constructed in or near the Strand, where it would turn towards the Thames Embankment, the level of which it would reach near Waterloo Bridge. The tramway was to be worked by electricity, and so far as it went it would meet the pressing problems which the London County Council had to face connected with the congestion of the streets, the annoyance caused by the constant breaking up of the streets to lay pipes, wires, cables, &c., and the connection of the London County Council system of tramways in North London with their tramway lines south of the Thames. The London County Council were the owners of 74 miles out of the total of 115 miles of tramways which existed within the County of London. Of the remainder the Council had given notice to acquire 16 miles more; and at the proper time the Council would give notice to acquire the remaining 25 miles. Parliament had already sanctioned a bill enabling the County Council to apply electricity to their tramways, so that at no distant date they would have power to work the whole of the lines in London by electricity. The tramway could be constructed simultaneously with the construction of the new street. The landowners did not oppose. The scheme was quite novel, the idea having been borrowed from Boston, where there was a tramway in a shallow subway carrying over a course of 5 miles 27½ million passengers a year. Only single cars would be run, carrying about 50 passengers each, and this would obviate the inconvenience of having an enormous number of passengers discharged at certain stations at one time, as was the case with trains composed of many carriages. The London County Council had also had the benefit of the experience of New York and of Paris with tramways of a kind similar to that at Boston. On the subway in Paris in 10 months there had been 40½ million passengers carried—a phenomenal number. Col. Yorke, of the Board of Trade, had reported on the advantages of the proposed scheme.* The cost of the tramway would be about £250,000 and £70,000 in addition would be taken for land to be used in connection with the undertaking. The length of the tramway would be about three-quarters of a mile.

The CHAIRMAN: What will the streets cost?

Mr. POLLOCK said they would cost £6,000,000. The £250,000 would include the cost of the subway. The opponents of the measure were local authorities and railway companies, the authorities asking for protection so far as their streets were concerned, and the railway companies complaining of competition and interference with their undertakings. The Great Northern and Strand Railway Co. said that the proposed subway would hamper the petitioners and increase the cost of their tube railway, but he denied that in this respect the present bill, if passed, would in any way alter the position of the petitioners, for when they obtained their powers it was subject to the carrying out of the new street works by the London County Council, who were authorised to construct a

* See *The Electrician*, Vol. XLVIII., p. 965.

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subway and who, moreover, were allowed seven years in which to carry out their act. Then the petitioners complained of prospective competition, but he failed to see ground for the complaint. The tube of the petitioners ended at the Strand, and its object was to connect the Strand with Finsbury Park, whereas the bill was to connect the North London system of tramways with the Thames Embankment, along which it was hoped to run a tramway connecting with the South. In conclusion the learned counsel went through the petition of the Metropolitan District Railway Co., which was somewhat similar in effect to that of the other railway company.

Mr. FITZMAURICE, chief engineer to the London County Council, who had had charge of the Blackwall Tunnel operations and the works at Assouan, on the Nile, gave evidence in support of the bill, supporting Mr. Pollock's opening statement. He added that in addition to the tramway subway there would be subways under the new street to take all the sewers, drains, pipes and cables. He attached great importance to these subways, which would save the expense and inconvenience of breaking up the streets.

Cross-examined by Mr. BLENNERHASSETT: The subway now proposed would be much more important and extensive than the one originally proposed. When making three structures over one another he did not think it was right to commence with the lower.

By Mr. READER HARRIS, K.C.: The tramway would pass at one place on the Embankment some 5ft. above the Metropolitan Railway. It would be an electrically-worked line with cables below it, and therefore when electricity was adopted on the Metropolitan Railway they would cross a railway using electricity. As far, however, as he could see, there was no chance that the tramway would interfere with the railway company's works. He agreed that the expense of constructing the Metropolitan line along the Embankment was £900,000, £200,000 of which was paid to the Metropolitan Board of Works for the right of way along the Embankment.

Re-examined: It was only for a few feet that the tramway would pass over the District Railway.

Mr. ALFRED BAKER, manager of the tramways worked by the L.C.C., said he and a member of the L.C.C. went to America in 1901 to investigate the shallow tramways there, and visited, among other places, Boston, where the congestion of traffic was such as almost to prevent the working of surface tramways. A shallow system of tramways was adopted there, many features of which were common to the present proposal. It was the desire there, as here, to take the tramways on the surface where it could be done, and when that could not be done, to put them underground. In Boston the subway was lighted by electricity, but there was a good deal of natural light used at the stations. There was no stuffiness or bad air in the subway. The service of tramways was very frequent, single cars running at about half-minute intervals, and that struck him as particularly advantageous, because instead of people arriving in great crowds they arrived in a steady stream. He made very careful inquiries in Boston as to vibration, but could not discover that any complaint had been made with regard to it. In America, as on the Continent, they had single-deck cars, not top seat cars. Such cars would be used here, and that would be an advantage, because whenever a single-deck car was seen on the lines away from the subway it would show that it was going to the subway. Generally, only 20 steps would have to be descended to reach the trams. The success of the Boston shallow tramway had been quite phenomenal, 28,000,000 passengers having been carried in the first year it was open from one (the principal) station alone. The result was that in the street where the station was there never seemed now to be any congestion. Witness also visited New York, where they had a scheme for making about 21 miles of shallow underground tramways on a rather more extensive scale than in Boston, inasmuch as there were to be four tracks, the two inner for the express traffic and the two outer for the local traffic. Except as to the number of tracks, that system was practically the same as the London County Council proposed. He anticipated that when all the cars in North London were run by electricity a half-minute service of cars in the subway would be required, and he estimated that the number of passengers carried would be 30 millions yearly.

Cross-examined by Mr. READER HARRIS: The terminus of the tramway would be on the Embankment, and shunting would be done there.

By the CHAIRMAN: He did not think the use of cars in the way proposed would cause any risk or danger to the public. The line would be fenced, and there would be men to direct the public, and the police would exercise control over the traffic.

Mr. JOSEPH A. BAKER, vice-chairman of the Highways committee of the London County Council, said that the Highways committee and the Council itself were unanimous in advocating this scheme. The tunnel entering on the Embankment would be lighted, and precautions would be taken to safeguard the traffic on the Embankment. The London County Council proposed to electrify all the tramways in the north of London.

Mr. J. H. RIDER, electrical engineer to the London County Council, who had accompanied Mr. Baker on his visit to America, and who had inspected electric works on the Continent, said he had found that there was no vibration resulting from the tramways in Boston, Paris and Budapest. The system of traction in the subway would be similar to that adopted on the surface tramways. It would be on the conduit system. The cars would be single decked, the motors would be encased in steel and would be absolutely fireproof. The tunnel would be lighted throughout with incandescent lamps.

Cross-examined by Mr. READER HARRIS, for the Metropolitan District Railway Co., witness said the electric power used in the proposed subway would be of similar voltage to that of the Metropolitan District Railway when it was electrified. The cars would weigh from 8 to 10 tons, and would be run singly.

This concluded the case for the promoters.

The inquiry was resumed yesterday (Thursday).

Mr. READER HARRIS, opened the case for the Metropolitan District Railway Co. He asked the Committee not to pass the preamble. The petitioners asked that in this case, if there was to be a tramway station, it should be on the County Council's own property before it debouched on to Victoria Embankment. The congestion of traffic at the foot of Savoy-street would be very serious if the bill were carried. But more than this, the measure would do the Metropolitan District Railway an injury. That railway was constructed many years ago with cast-iron girders and arches overhead, which were strong enough to carry the roadway, but that was all. There was only a space of 12in. between the top of the girders and the roadway. The new tramway would interfere with the railway, which had not been constructed to bear overhead heavy electric cars weighing from 8 to 10 tons. Even if the bill were passed, it should be with the idea that the tramway should stop before it debouched on to the Embankment.

Sir J. WOLFE BARRY, consulting engineer to the Metropolitan District Railway Co., gave evidence in support of the petitioners. He said the girders were designed to bear the ordinary roadway before the days of steam rollers. Already the girders were overstrained, and he should look with alarm at heavy tramcars being allowed to run over them. The tramway would be an intolerable nuisance to the Savoy Hotel and the public using the roadway at the end of Savoy-street.

Cross-examined by Mr. E. POLLOCK, Witness said that a road roller might give a pressure of 8 tons on each girder. About 50 per cent. more weight would be got from a tramcar than from a road roller, and then road rollers did not run at 8 or 10 miles an hour and would not cause so much vibration as electric cars. If only one-storey cars were used the weight would be less than 11½ tons, no doubt.

Re-examined: Steam rollers were not used under statute, and if they did damage those who used them could be required to pay compensation but that would not be the case with a tramcar running under an Act of Parliament.

The CHAIRMAN: Could not the girders be strengthened?—Yes; but it would be a costly process.

Mr. POLLOCK said that the London County Council would be prepared to agree to abide by the decision of an arbitrator as to the desirability of strengthening the Metropolitan District Railway at the point at which the tramway would come upon the Embankment. If the arbitrator decided that the railway should be strengthened, the London County Council would bear the cost.

Mr. READER HARRIS: That would not satisfy us. There is a shorter way of doing it, and that is by stopping the tramcars before they reach the railway.

Mr. BLENNERHASSET then addressed the Committee on behalf of the Great Northern and Strand Railway Co., who asked for a clause to express in the clearest way that no further burden should be placed upon the petitioners by the passing of the act. Otherwise, they might be left at the mercy of the London County Council as to the time at which they should commence their construction?

Mr. BELLEWES, for the Borough of Holborn, contended that his clients should be allowed protective clauses, having reference to subsoil, subsidence of drains, sewers, underground wires, and other conveniences. There should also be a clause providing that the borough should not suffer in respect of rates, and another requiring plans of the entrance to the tunnel in Southampton-row to be submitted to the Borough Council for their approval.

Major ISAACS, formerly M.P., surveyor, gave evidence in support of Mr. Bellewes' statement.

Mr. POLLOCK then replied. He pointed out that the local authority having control over the streets leading to the Embankment, such as Savoy-street, were not here to make complaint against the bill. As to the other point of the District Railway, their real opposition was on account of the competition of the tramway which later on it would be proposed to construct along the Embankment. As to danger to the girders of the District Railway, the test of themerit of the opposition of the Metropolitan District Railway was to be found in their rejection of the offer of arbitration. As to the contention of Mr. Blennerhasset, he denied that that gentleman's clients would be put in any worse position under the present bill than that they formerly occupied, and it was not possible to give an absolute veto to Holborn.

The CHAIRMAN, in announcing the decision of the Committee, said: The Committee pass the preamble of this bill. They think that the District Railway ought, if they desire it, to have a proper protective clause as regards the superstructure of their railway where the tramway crosses it, such as was suggested by the promoters. I do not say the exact terms; it will be for the Committee to settle that clause if it is submitted to them. With regard to the Strand Railway, they are willing to put in a simple saving clause, something to this effect:—"Nothing in this act contained shall affect the exercise of the powers conferred on the company by the Great Northern and Strand Railway Act, 1899." We are not prepared to give Holborn the clauses they ask for.

The Committee then adjourned, consideration of the clauses being postponed.

STAND-BY SUPPLY

The Belfast Corporation Bill, which is an "omnibus" bill seeking general powers, came before a Select Committee of the House of Commons on Monday. It contains an important clause relating to the much-debated question of the liability of an electricity supply undertaking to furnish a "stand-by" supply to a consumer who has his own electrical installation.

Mr. J. D. FITZGERALD, K.C., appearing for the Corporation, explained that many persons who sent in a demand for electricity already had electricity installations of their own, which would give them all the electricity they required in ordinary circumstances, but included no provision to meet the case of a breakdown. The Corporation were bound, not merely to lay the wires, but to increase their plant for the purpose of

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meeting the possible demand. The consumer was thus relieved from expenditure on reserve plant, and the Corporation bore this for him. This condition of affairs prevailed in some other places than Belfast, but the Belfast Corporation had thought it desirable that some remedy should be found. They proposed that such person should pay to the Corporation as a minimum annual sum an amount which would give the Corporation a reasonable return on the capital expenditure and other standing charges which they incurred in order to meet his maximum demand. In the case of non-agreement between the parties the amount should be fixed by the arbitration of an electrical engineer.

The CHAIRMAN (Sir Francis Evans): Was such a clause ever put into a bill before?—Yes, it was passed last year in the Devon case.

Sir SAMUEL BLACK, town clerk of Belfast, then gave evidence in support of the Bill.

Mr. BUSHE, who appeared for the Belfast Hotel Co., said that the Devon Bill was unopposed and the clause never discussed. He contended that the clause proposed would entail a hardship, as the consumers would be unable to get electricity to be used for purposes to which they never applied their own supplies unless they signed an agreement imposing conditions to which no other consumers were liable.

Mr. V. A. H. McCOWEN, the electrical engineer to the Corporation, also gave evidence in support of the clause. In cross-examination he explained that what was required was a guarantee that users of the Corporation supply should be in reality users.

Mr. BUSHE complained that the proposed agreement would compel the consumer to be responsible for a certain consumption.

Mr. FITZGERALD replied that the Hotel Company limited its demand to the electricity for working a lift. The Corporation said that before they put up the additional plant to supply it they should have a guarantee as to the minimum to be taken.

The CHAIRMAN: I cannot see that there is very much difference between you. You are prepared to give way, I understand, on the question of the permanent charge?

Mr. FITZGERALD: Yes; but I think a minimum amount ought to be guaranteed for a certain number of years.

The CHAIRMAN: It seems to me that the difference between you is so small that it might be settled without much trouble. Your idea of the protection asked for by the Corporation, Mr. Fitzgerald, seems to be reasonable, and the protection Mr. Bushe asks for on the other side seems to be reasonable also.

A consultation then took place between counsel, and the following clause was agreed upon:—

"Notwithstanding anything contained in the Electric Lighting Acts, 1872 and 1888, a person shall be entitled to demand from the Corporation a supply of electrical energy to any circuit, cable, or current-consuming device while the same are supplied from private sources, and unless such person shall have previously agreed to pay to the Corporation such minimum annual sum in respect of current consumed through such circuit, or cable, or current-consuming device, and for such number of years as will give to the Corporation a reasonable return on the capital expenditure and other standing charges incurred by the Corporation to meet the possible maximum demands of such persons. In case the Corporation and the person demanding such supply of electrical energy shall fail to agree, the amount of such minimum annual charge to be paid by such person and the period for which the sum shall be paid shall be fixed by an electrical engineer to be appointed as arbitrator by the President of the Institution of Civil Engineers."

The CHAIRMAN then declared the preamble of the bill proved, the clauses were adjusted, and the bill will be reported to the House for third reading.

OTHER ELECTRICAL BILLS.

The Brighton and Rottingdean Seashore Electric Tramroad Bill was read a second time in the House of Lords on Thursday last week. In the House of Commons on the same day the Manchester and Liverpool Express Railway Bill was read the third time.

In the House of Lords on Monday the Middlesex County Council Tramways Bill and the Newcastle-upon-Tyne Electric Supply Bill were read the second time, and on Tuesday the Gloucester Electric Power Bill and Manchester Corporation Tramways were also read the second time.

The Derbyshire and Nottinghamshire Electric Power Bill has passed through the committee stage of the House of Lords as an unopposed measure, and will be reported to the House for third reading.

The bill of the South Wales Electrical Power Distribution Co., by which the company is enabled to acquire additional lands, and also to absorb electric lighting undertakings within their area of supply, has been reported to the House for third reading, having passed through the committee stage as an unopposed measure.

The Birkenhead Corporation Bill, which contains provisions relating to the supply of electricity to neighbouring districts, came before a House of Commons Committee on Wednesday. The preamble was proved and the bill has been reported for third reading.

On Wednesday the preamble of the Preston Corporation Bill was proved by a House of Commons Committee, and the bill is to be reported for third reading. One section of the measure relates to the conversion of the horse tramways to electric traction. The total length to be so reconstructed is some 13½ miles, and this necessitates the alteration of the gauge to 4ft. 8½in. The estimated cost of the new lines, inside and outside the borough, is £170,000, exclusive of cars and car depôts, &c., which is put at £23,320.

On Friday last the Court of Referees, presided over by Mr. Parkin Smith, considered the objection of the North Metropolitan Electric Power Supply to the *locus standi* of the Middlesex County Council, who had petitioned against their bill, except as against the provisions of the bill which authorised interference with main roads and county bridges vested in them.

On Monday the petition for an additional provision by the Islington and Euston Railway Co. came before the examiner of the House of Lords. He will report a non-compliance with the standing orders, and this will be considered by Lord Morley's Committee on Friday.

On Tuesday Mr. Campion found the standing orders duly complied with in the case of the London United Tramways Bill, and the bill proceeded to its next stage in the Lower House.

The North Metropolitan Electric Power Supply Bill and the Electric Supply Provisional Orders Bill (No. 4) have been grouped into a new group J, the members of which are not yet nominated.

The Scarborough Tramways Bill.—This bill came yesterday before the Committee on unopposed bills in the House of Commons. This bill seeks power to incorporate a tramways company to make and maintain tramways in Scarborough, and to enable the Corporation of that town to subscribe towards and to hold shares in the capital in the company, which is to be called the Scarborough Tramways Co. The capital of the company is to be £96,000 in 9,600 shares of £10 each. Provision is taken in the bill to use electrical power. Formal evidence having been given the preamble was passed, and the bill ordered to be reported to the House.

The Norwich Corporation Electricity Bill, which seeks powers to have transferred to them the undertaking of the Norwich Electric Co., was also passed by the House of Commons Committee on unopposed bills yesterday, and was reported to the House in the usual way.

LEGAL INTELLIGENCE.

Eastern & South African Telegraph Co. (Ltd.) (Appellants) v. Capetown Tramways Co. (Ltd) (Respondents).

Judgment was given on Friday last in the appeal action brought by the Eastern and South African Telegraph Co. (Ltd.), from a judgment of the Supreme Court of the Cape of Good Hope. (The previous proceedings, both at Capetown and in London in this action have been fully reported in *The Electrician*.)

Lord ROBERTSON now delivered judgment as follows:—The question raised by this appeal is whether the respondents are liable in damages for certain disturbances in the working of the appellants' submarine telegraph cable at Cape Town. That such disturbances did take place; that they were caused by electricity which had been stored by the respondents and used in propelling their tramcars in Cape Town and its suburbs but from time to time had left the tramway system and found its way to the appellants' cable in the sea near Cape Town; and that pecuniary losses resulted; are matters beyond dispute. In order to the adequate understanding of the question thus raised, it is not necessary to enter into minute or highly technical descriptions. It may conduce to clearness in the discussion of the legal questions which result if, leaving over in the meantime the mode in which the electricity left the respondents' system, it be in the first place stated how the electricity injured the appellants. At some point, then, in Table Bay this electricity, having escaped and being at large, was attracted by the appellants' cable entered the sheathing of the cable, and by sheathing as a conductor, found its way back to the tramway, central station whence it had started, and thus completed its circuit. While travelling along the sheathing of the appellants' cable, the current varied very frequently, and at irregular intervals, in accordance with the starting and stopping of the tramway cars. It was this irregularity and jerking which did the mischief; and, but for this, the current might have used the sheathing as a conductor without any injury. As things were, the current in the sheathing induced similar irregular currents in the conducting wire of the cable, with the result that the signals were interfered with and as recorded were confused and unreadable. None of the apparatus was damaged; but the working of the apparatus was so interfered with as to take away its utility for the time of the interruption. In order to complete the description of the nature of the injury it is necessary to add that the difficulty has now been completely got over by laying what is called a twin-core cable for several miles out, the two wires rectifying one another's action. Now that this has been done, the electricity from the tramways can pass along the sheathing without any harm being done. The cost of this remedial measure forms a large part of the claim in the suit, much of the rest representing experimental and tentative measures. Into this, however, it is unnecessary further to enter, as the *quantum* of damage is not raised this in appeal, but only the question of liability. Turning now to the mode of escape of the electricity from the tramways, there is again no controversy; and for present purposes a succint statement is sufficient. The respondents' tramway runs along the shore of the sea, and their tramcars are run by the tolerably familiar system of overhead trolley. All that is necessary to take note of is that the electricity which is used is generated at a power station erected by the respondents for that purpose, and that the conductor which is provided for the return of the current, after driving the tramcars, consists of the tramway rails. Now, when uninsulated (and safety requires that this should be their condition) the rails are so far from being (even comparatively speaking) a perfect conductor that necessarily, and as matter of course, a considerable proportion of the electricity, instead of going directly back to the station, leaves the rails; and some portion of the escaped current it was which reached the appellants' cable. Upon these facts the appellants' main contention is that on the principle of Fletcher *v.* Rylands, L.R., 3 E. and I. App., 330, the respondents are liable for the interruption of the appellants' business, and must recoup them for the protective measures necessarily taken to prevent a recurrence of such interruption. To this the respondents have a twofold answer: (1) they say that they are protected as regards all but a small portion of their tramway system by

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certain provisions which occur in each of the series of colonial statutes incorporating their constituent companies; and (2) as regards the part of their line not so protected by statute they maintain that Fletcher *v.* Rylands does not apply to the facts. Two other contentions have been advanced on the latter branch of the case (the first of which received more countenance in the Supreme Court than support at their lordships' bar)—viz., (1) that the law of Fletcher *v.* Rylands has no place in the Roman-Dutch law, and (2) that it was not established that any escape of electricity injurious to the appellants took place from that section of the tramway to which none of the statutes apply. Before proceeding to discuss the interesting and important questions thus raised, a few facts and dates may conveniently be noted. The appellants' cable had been in operation for years before the respondents' tramways were made. The tramcars began to be worked in August, 1896, and the disturbances on the appellants' apparatus were felt at once and continuously thereafter during the days and hours when the tramcars were running. Communications took place between the parties, and both seem to have frankly co-operated in ascertaining the cause of injury and devising remedies. After this had been done, with the result already stated, the present suit was instituted, on April 15, 1899, in order to determine the question of liability. On March 13, 1900, the Supreme Court of the colony gave judgment for the respondents, and the present appeal is against that judgment. In considering the merits of the appeal, it is best, first, to take the question of common law. That the facts about the section of tramway line not constructed under statutory authority—viz, that from the city boundary to Mowbray, do raise this question is in their lordships' judgment sufficiently clear. It is true that the crucial test of this particular section being worked alone is awanting; although at one time during the disturbances of the cable this section and the short section home to the station house were worked alone. But no effective answer was made to the record of journeys which was commented on by Mr. Bousfield; and this record attests that the disturbances on this section were at least as great as on any other. Now Mr. Jacob, the respondents' principal witness, is very emphatic in stating (and indeed this is of the essence of the respondents' case), that the disturbances on the cable are not dependent on the quantity of the current escaping, but on the rate of alteration and the rate of variation, and Mr. Jacob's evidence, when directly applied to the separate influence of one section, entirely supports the appellants' case. The question of common law is thus raised directly (as well as indirectly in relation to the just construction of the statutory provisions). Now, if regard be had solely to the action of the respondents in storing electricity on their lands, it must be allowed that the analogy is very close to the illustrations given in Fletcher *v.* Rylands of the kind of things which a proprietor can only do at his own peril. Electricity (in the quantity which we are now dealing with) is capable when uncontrolled of producing injury to life and limb and to property; and in the present instance it was artificially generated in such quantity, and it escaped from the respondents' premises and control. So far as the respondents are concerned, it appears to their lordships that, given resulting injury such as is postulated in Fletcher *v.* Rylands, and the principle would apply. But this is only one half of the question, and it remains to be seen if the injury postulated is present. Was there such resulting injury as to found a claim on the principle of Fletcher *v.* Rylands? Now, in the present case neither person nor property was injured (unless the ingenious suggestion of Mr. Bousfield could be entertained, that physical injury was done to the paper which was smudged by the eccentric action of the recording apparatus). Certainly, there is here no injury of the same genus or species with the tangible and sensible injuries which have hitherto founded liability on the principle in question, and which have always constituted some interference with the ordinary use of property. Now, the kind and degree of interference with the respondents' property is pretty well illustrated by the fact that it can only take place if the cable is constructed without certain precautions, for, given the cable as it now is, there is no injury. This is referred to, not because their lordships consider that the respondents have made out that the twin cable had the general use and recognition which they ascribed to it, but as showing that it cannot be predicated of the electric escape in question that it is destructive of telegraphic communication generally, but only that it affects instruments made in a certain way. Now, if the instrument be taken as it was when the injury occurred, its nature is such that to insure its immunity from disturbance is a somewhat serious liability to cast on neighbours. To describe this as a delicate instrument might be inaccurate if the term were used in relation to other electrical instruments of extreme sensibility. But in the present discussionthis is not the true comparison at all. The true comparison is with thingsused in the ordinary enjoyment of property, and this instrument differs from such things in its peculiar liability to be affected by even minute currents of electricity. Now, having regard to the assumptions of the appellants' argument, it seems necessary to point out that the appellants, as licensees to lay their cable in the sea and as owners of the premises in Cape Town, where the signals are received, cannot claim higher privileges than other owners of land, and cannot create for themselves, by reason of the peculiarity of their trade apparatus, a higher right to limit the operations of their neighbours than belongs to ordinary owners of land who do not trade with telegraphic cables. If the apparatus of such concerns requires special protection against the operations of their neighbours, that must be found in legislation; the remedy at present invoked is an appeal to a common law principle which applies to much more usual and less special conditions. A man cannot increase the liabilities of his neighbour by applying his own property to special uses, whether for business or pleasure. The principle of Fletcher *v.* Rylands, which subjects to a high liability the owner who uses his property for purposes other than those which are natural, would become doubly penal if it implied a liability created and measured by the non-natural uses of his neighbour's property. Nor need the law be regarded as showing any want of adaptability to modern circumstances if this be the true view, for the liability, thus limited, is of insurance and not for negligence, and all the remedies for negligence remain. While agreeing in the result with the Supreme Court on the common law branch of this case, their lordships are not prepared to accede to some of the comments made on Fletcher *v.* Rylands. The learned judges of the Supreme Court have indicated considerable reluctance to accept the doctrine of that case, and seemed to regard it as more or less inconsistent with the principles of the Roman law, upon which the law of the colony is based. Their lordships are unable to find adequate grounds for this view, and it was not maintained at the bar. It is not supported by the texts or decisions which illustrate the full recognition of the right of an owner freely to use his property for natural purposes, even although loss to his neighbour may result. Nor, on the other hand, does the prominence given to *culpa* in Roman law preclude the reception of the doctrine now under consideration into legal systems founded on the civil law. The learned judges, and also Mr. Justice Kekewich in the National Telephone Companies, seem to have been inaccurately informed on this point; for, as matter of fact, not only is the principle of Fletcher *v.* Rylands fully accepted in Scotland, but it had formed part of the law of Scotland bef re Fletcher *v.* Rylands was decided, and Fletcher *v.* Rylands has been treated by the Scotch Courts as an authoritative exposition of law common to both countries. So far, then, as the respondents' liability is governed by the common law, their lordships on the grounds already stated, do not consider the appellants' claim to be maintainable. It remains to consider the liabilities of the respondents for the escape of electricity on those sections of their line which have been constructed under statutes. The provisions of the several statutes authorising the several sections are identical; and sec. 4 sub-sec. D of Act 22 of 1895 has been taken as the text of the argument. The statutes have, of course, direct and express relation to electricity as the motive power. The company under those statutes have right to maintain and work all necessary power and stations, subject to the approval and in accordance with any resolution or standing order of the Council of the City of Cape Town, "Provided that . . . the company specially undertakes that in the event of any electric leak taking place and damage being thereby caused at any time by electrolysis or otherwise, it will reimburse and make good to the Council or other body or person all costs, damages and expenses to which the Council or other body or person may be put by reason thereof; and provided further that nothing in this act contained shall entitle the company to use the rails of any of the said lines of tramway as a part of its system of conductors for the return electrical current without the consent of the Council first had and obtained." The consent of the Council to the use of the rails for the return current was had and obtained under certain conditions, of which the fourth is as follows:—"(4) If, at any time and at any place, a test be made by connecting a galvanometer or other current indicator to the insulated return and to any pipes in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells, connected in series if the direction of the current is from the return to the pipe, and by interposing one Leclanché cell if the direction of the current is from the pipe to the return. If at any time a greater leakage is discovered than would render it possible for the current to be reversed in the manner above indicated, the same shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is so localised and removed within 24 hours." The first question, then, is, was it a leak, either in the sense of the statutory undertaking or of this condition, that sent out this electricity which reached the cable? For if so, the stipulated liability has been incurred. Their lordships are unable to think that it was. The language of both the statutory undertaking and of the condition seems to point to some defect in apparatus, not contemplated as a condition of the working of the system. But the departure of the electricity from the rails arose from no defect but from the necessary condition of things, if the tramcars were to run and the rails to be used as a return. The evidence shows clearly that, if uninsulated (as was the case here), the rails of necessity conduct home to the central station only some of the electricity, the rest leaving the rails and going afield. Giving to the word "leak" whatever expansion may be appropriate to its extension to electricity, their lordships do not consider the event which has occurred to fall within the undertaking and condition. The escape was, on the contrary, a natural incident of the operation legalised under the statutes. The argument of the respondents on the words "or otherwise," as limited by the preceding word "electrolysis," did not command their lordships' assent; but it is superseded by the other grounds of judgment. Their lordships will humbly advise His Majesty that the appeal ought to be dismissed and the judgment of the Supreme Court affirmed. The appellants will pay the costs of the appeal.

Reason Manufacturing Co. (Ltd.) v. Ernest F. Moy (Ltd.).

In this action, which was heard by Mr. Justice Byrne in the Chancery Division on Monday, plaintiffs claimed an injunction to restrain an alleged infringement of patent, and also damages.

Mr. FLETCHER MOULTON, K.C., for plaintiffs, said the patent was of a simple character, and would not entail a long investigation as to priorities. It was a patent for boxes for covering electric fuses in a manner in which the danger of two fuses being got at was completely avoided. In 1894 the patentee of the boxes on which plaintiffs were suing devised a method of protecting fuses in such a way that although it in no way prevented their being reached readily, there was no inconvenience or danger. Prior to this time the fuses were usually put in the same box, and sometimes the box was divided by a partition, so that if you touched one fuse you would not be liable to touch the two. Sometimes they were put in two boxes—boxes being made deep to obviate danger. The patentee abandoned all that, and made his fuse box so that instead of having high

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sides it practically had no sides at all. He made the top very deep, and put the fuse boxes back to back, so that each of them automatically prevented one being opened when the other was open. By putting the two in that position—by arranging and constructing them so—the patentee solved the difficulty, and since 1894 these fuse boxes had been in large request, over 100,000 of them having been sold. He could see no difference between the invention and the alleged infringement.

His LORDSHIP: What is the defence?

Mr. THOS. TERRELL, K.C., for the defence: I say there is no subject matter, and if they want to make out their subject matter then there would be no infringement.

Mr. MOULTON said he should not trouble his lordship any more about infringement or utility—that would be proved by the evidence. With regard to subject matter the patentee had accomplished something which had never been accomplished before, partly by arrangement and partly by construction. Defendant had raised in the pleadings that there were interlocking arrangements in railway signals; of course there were. But because you had made one interlocking arrangement which was successful for a particular type of machinery, was it to be said that there was no subject matter in any other interlocking arrangement of a different kind? If the patentee, without adding to the expense—without bringing in one single extra piece—had by this ingenious modification of construction and arrangement been able to give in this particular case—in these particulars circumstances—safety and security very cheaply, why in the world did it militate against that being a good invention because other people in dealing with the much more complex case of railway signalling had interlocking rods, ledges and boats and all that sort of thing? What had that got to do with the presence or absence of subject matter? He claimed that there was here utility, novelty, invention and infringement of the most palpable kind.

Mr. J. G. LORRAIN explained to his lordship the object of fuses. It was quite a common thing, he said, for them to give way, and new ones had to be put in frequently. In opening the fuse-box, if both fuses were exposed, there was great danger of short-circuiting. Fuses were mainly put in by people who were unskilled or careless, and short circuits were more or less common. The purpose of the invention was to obviate such accidents, and down to 1894 there was no cheap or efficient device for preventing short-circuiting. He knew that that was something which had been looked for for some time by electrical engineers. The invention claimed in plaintiffs' specification was the construction and arrangement of fuse-boxes. The construction consisted of having a particularly deep lid and a very shallow box or body. The shallow box or body allowed the operator to get ready access to the fuse. He had never seen a fuse-box of that particular construction before the date of the specification. In the alleged infringement the construction and arrangement was the same as that contrived by the patentee. In his opinion plaintiffs' invention was new, useful and largely used. It might or might not be that by adjusting the distance apart two shallow lids would produce the same result as two deep lids. So far as arrangement was concerned, the essence of the invention was putting the boxes so close together back to back that when the lid of one was opened it interfered with part of the other—it intruded itself as an obstacle.

Mr. JAMES SWINBURNE said that he regarded the invention as of very great utility, and, in his opinion, it was sufficient to protect against the consequences of negligence and carelessness in short-circuiting apart from wilfulness. He thought the apparatus involved invention and ingenuity. He did not know of anything like it before.

Mr. TERRELL contended that there was no subject matter in plaintiffs' letters patent. All that the patentee seemed to have done was to select the sort of fuse-boxes which would do, and placed them back to back so close together that one could not be opened when the other was opened. That was all the invention claimed, and that, he submitted, was not sufficient to support a patent.

Mr. E. F. Moy, managing director of the defendant company, and Mr. W. W. Beaumont gave evidence to the effect that there was no novelty in the patentee's idea.

On Wednesday Mr. Justice BYRNE delivered judgment. He said the main objection taken by the defendants to plaintiffs' claim was want of subject matter. In reference to the boxes themselves, there was no novelty about them, but that what had been done was novel he thought was proved, and also that it was useful. There had been a large sale of the patented boxes, and the question that remained was whether there was sufficient invention to support a patent. Though the invention was not a great one, in his opinion there was invention in the construction and arrangement of boxes as the present boxes were arranged. Fairly used this invention did, to his mind, obviate what it was desirable to obviate, was useful, novel and contained some invention. Under these circumstances he must grant the injunction.

Counsel for plaintiffs asked his lordship to certify that the patents came in question, and that the particulars of breaches were reasonable and proper. He added that the plaintiffs would take an inquiry as to damages and delivery up of the infringing articles.

Mr. Justice BYRNE agreed.

Mr. TERRELL asked for a stay of execution, which was allowed, defendants undertaking to give notice of appeal within a week. An application for the stay of the injunction was refused.

Islington Borough Council v. Gas Light and Coke Co.

The hearing of this action for the recovery of £13. 18s. 6d. compensation for damage done to their electrical boxes and mains in Highbury-park, London, N., caused through an explosion of gas on Oct. 8 last, was resumed last week. The proceedings at the first hearing were reported in our issue of April 4.

Mr. G. F. FOULGER, distributing engineer, of the defendant company, was recalled and examined as to the explosion in Regent's Park in 1898. Shortly after that explosion he inspected the electric lighting conduit, which was made of concrete and found it had been disturbed for a considerable distance, and the covers of three manholes, which ran into it, had been blown into the air. That explosion was, no doubt, caused by gas. Examination showed that a new surface gas pipe, running across the top of the conduit, had been completely eaten away by electrolytic action, a hole some 2in. in length being discovered. Consequently the gas, blowing at pressure on the conduit had penetrated the substance, and found its way into the conduit, thereby causing the explosion. Even if there had been no crack in the concrete—and cracks were bound to appear in long conduit lengths of the type in use in Regent's Park—the masonry of the conduit would not be absolutely proof against a gas escape if it were blowing under pressure, because ordinary bricks were not impervious to gas if blown under pressure.

In cross-examination by Mr. BRAMALL, as to whether or not on that occasion a naked torch was used by the company's men in searching for the leakage, witness was unable to state definitely, but with a pipe exposed such as that one was there was no means of discovering a leak other than by a naked light. It would not be right to use a naked light where the leak was known to be a big one, and their men had instructions to that effect.

In re-examination he said there was no Board of Trade inquiry as to the Regent's Park explosion; neither was there any claim on the part of the lighting authority against the company for damages.

For the defence, Mr. NEILSON said his main contention would be that if there had been no bottomless boxes there would have been no explosion. He proceeded to quote the Board of Trade regulations in force between 1892 and 1896.

Mr. BRAMALL: This particular conduit was not laid till two years ago.

Mr. NEILSON: I want to show that at the time the Council obtained its provisional order there were Board of Trade regulations which said that street boxes shall be efficiently protected against accumulations of gas. The regulations of the Board which superseded the ones he had referred to stipulated that all street boxes should be constructed of durable material, and all reasonable means should be taken by electric lighting undertakers to prevent accumulations of gas in such receptacles.

The JUDGE: "All reasonable means" is a modification of rule 15 of the previous regulations, which stated that the boxes "shall be" efficiently protected. You say that the boxes ought to have been more efficiently ventilated?

Mr. NEILSON: Yes.

Mr. BRAMALL tendered evidence to show that the Gas Company, having gained experience of the serious consequences resulting from the use of a naked light at Regent's Park, should have been warned against using a naked light on the occasion complained of.

The JUDGE: I shall find that, if it is proved beyond question that defendants' workmen applied a naked light, I shall take it as proved that it set fire to the accumulation of gas in the boxes and blew them up. That was admitted by the first witness of defendants.

Mr. ALBERT R. WEBB, defendants' senior inspector for Islington, said that up to the present time, although repeated efforts had been made, the leakage which the Gas Company's men were sent to find had not been discovered. He denied the statement that he went down on his hands and knees at one of the electric boxes and said there was live gas pouring out, but he told the men not to use a naked light. When the lid of the box was removed he noticed a peculiar smell, but he was in doubt as to whether it was gas or not. Since the explosion the electric inspection box had been rebuilt and a ventilator added. For discovering leakages, they first used an indicator, and if that showed no escape of gas they then opened up the ground. As there was not the slightest trace of escaped gas in the neighbourhood, he should not have had any hesitation in using a naked light in the trench. The explosion might have been caused by sewer gas, inasmuch as no escape from the mains could be located.

Mr. HENRY S. REESON, assistant engineer to the Gas Company, said there would be no harm in endeavouring to find an escape when a trench was opened with a lighted piece of yarn. If the boxes had been constructed with bottoms no explosion would have taken place.

Further evidence of a similar nature having been given,

His HONOUR, held that, had it not been for the negligence of the defendant company's servants in applying a naked light no accident would have happened, and, therefore, the fact of defendants' servants using that naked light, and setting the gas on fire, it seemed to him that that was an act of negligence which caused the explosion, and which ought to have been avoided if defendants' servants had used reasonable and proper care. Under the circumstances he gave judgment for plaintiffs for the amount claimed with costs on Scale B.

Stay of execution was granted for 21 days to enable defendants to appeal.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Board of Management of the East London Hospital for Children and Dispensary for Women, Shadwell, require an officer for the electrical department. Candidates must be capable of organising and superintending a new department for electrotherapeutics and radiography. An advertisement contains further particulars. Applications to the secretary, Mr. Thomas Hayes, by 17th May.

Falkirk Town Council invite applications for the position of resident electrical engineer. Forms of application from the town clerk (Mr. A. Balfour Gray), Municipal Buildings, Falkirk. See advertisement.

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Ilkeston Corporation require an electrical engineer and general manager of their tramways. Applications to the town clerk (Mr. Wright Lissett) by May 8. See advertisement.

York Corporation require a junior assistant engineer and a managing clerk for the electricity department. Further particulars are set out in advertisements. Applications to the city electrical engineer (Mr. C. A. Midgley), Electricity Works, Foss Islands-road, York, by May 12.

Marconi's Wireless Telegraph Co. (Ltd.) require junior electricians to train at their private school for staff appointments. Applications to the secretary, 18, Finch-lane, London, E.C. See advertisement.

The Marconi International Marine Communications Co. (Ltd) require a number of first-class operators for service on board ship and at shore stations. Applications to the secretary, 18, Finch-lane, E.C. See advertisement.

An assistant meter inspector is required by the Newcastle-upon-Tyne Electric Supply Co. (Ltd.), 50, New Bridge-street, Newcastle-upon-Tyne. See advertisement.

Manchester Electricity committee require a shift engineer. Applications to chairman of Electricity committee by noon May 3. See advertisement.

Electricians are wanted for the Royal Navy. Applications to Lieut. South, R.N., Recruiting Office, Devonport. See advertisement.

A specification clerk is required by a large patent agency in London. See advertisement.

A London traveller and provincial agents are required by the Davies Electric Lamp Co., 16, Morwell-street, London, W.C. See advertisements.

Canterbury Electric Lighting committee require a shift engineer. Applications to the chief engineer, Mr. C. A. Blascheck, by May 5. See advertisement.

Devonport Corporation require an assistant electrical engineer. Applications by noon April 30.

Mr. A. P. Rutherford has been appointed burgh electrical engineer at Leith in succession to Mr. J. G. Scott, recently appointed to Croydon. Mr. Rutherford has been assistant at Leith since the start of the electricity works.

Mr. J. W. Donnet, superintendent of the Pinkston power station, Glasgow, has been appointed electrical engineer to the Trafford Power and Light Supply (Ltd.).

Mr. Walter F. Long, assistant engineer at the Manchester Corporation electricity works, has been appointed city electrical engineer at Cape Town at a salary of £650, with a residence. Mr. Long leaves England to take up his new duties in June.

Mr. C. M. Shaw, of Leeds, has been appointed city electrical engineer at Wakefield at £300 per annum, in succession to Mr. R. Blackmore.

Mr. R. Blackmore, late city electrical engineer at Wakefield, has accepted a position on the staff of the Hyde, Stalybridge, Mossley and Dukinfield Joint Electricity and Tramways Board.

Mr. R. S. Draycott has been appointed resident engineer at Coatbridge of the Scottish House-to-House Electricity Co., in succession to Mr. J. B. McIndoe resigned.

Mr. Arthur H. Blagden has been appointed assistant electrical engineer to the Shanghai Municipality.

Mr. F. T. Hall has been appointed shift engineer at the City-road station of the County of London and Brush Provincial Co.

Mr. Forbes Waddell, engineer and manager of the Broughty Ferry gasworks, has also been appointed manager of the electricity works.

Barnsley.—The second annual report of the Electricity and Lighting committee states that steady progress had been made in all departments during the year to March 31. New plant had been added and considerable extensions of the mains carried out. The equivalent in 8 c.p. lamps connected was 22,193 against 14,825 in 1901, consumers having increased from 209 to 280. There were 41 motors, totalling 190 H.P., connected. Capital expenditure during the year was £9,747. 17s. 9d. Of the borrowing powers of £48,500, £4,536. 19s. 7d. remains to be raised. In sale of current there was an increase of 52 per cent. compared with the previous year, the total revenue showing an increase of £812. 5s. 11½d., notwithstanding that the average price per unit sold was only 3·54d., against 4·48d. last year. Works costs showed a noticeable decrease, coal alone being less by £127. 0s. 6d. than in 1901. The total generating cost for 1902 was £2,072. 16s. 7d., or 1·62d. per unit, against £1,489. 6s. 7d., or 1·73d. per unit in 1901. Total receipts were £4,638. 7s. 3d., and gross profit £2,557. 8s. 10d., an increase of £306. 13s. 4d. After setting aside £2,397. 0s. 5d. for interest and sinking fund, and taking into account £8. 1s. 10d. from 1901, the net profit for the year was £168. 10s. 3d., which has been carried forward. In view of the satisfactory results, the Council has decided, on the recommendation of the borough electrical engineer (Mr. S. E. Bastow), to reduce the flat rate for current for lighting from 4½d. to 4d. per unit.

Bath.—The Corporation have already received two tenders for the purchase of their electricity works, one from the promoters of the local electric tramways, and in both cases the tenderers undertake to assume the liability of the Urban Sanitary Authority, and pay interest and sinking fund on the capital expended on the works, which amounts to about £100,000.

Sir F. Bramwell has been appointed arbitrator to fix the price to be paid by the local authority for the tramways of the Road Car and Tram Co.

Battersea (London).—The Borough Council have suggested to the London School Board that all board schools in the district should be lighted electrically.

Bermondsey (London).—The Council have approved a scheme for wiring consumers' premises on the easy payment system. The chairman of the Electric Lighting committee (Mr. Cox) explained that in each case the applicant would be required to pay down one-tenth of the cost of the installation on completion and the Council's fee for inspection and estimating. The balance, at the applicant's option, could be spread over three, five or seven years, and be paid by 12, 20 or 28 quarterly instalments, including interest at 4 per cent. on the amount for the time being remaining unpaid.

Boston.—Tenders submitted by several firms for the supply and erection of electricity generating plant have been submitted to the consulting engineer (Mr. Adrian Collins) for analysis and report.

Blackpool.—An inquiry will be held on May 1 into the application of the Corporation to borrow £14,000 for electric lighting extensions.

Bradford.—The electric tramway routes between Forster-square, and Frizinghall and between Westgate and Sunbridge-road were officially inspected on Tuesday.

Bray.—An inquiry into the engineering details of the proposed electric tramways was held last week. The promoters (General Electric Co. of Ireland) were represented by Mr. A. Lane Joynt, who supplied particulars of the various routes, which would be about 4 miles in length. The total estimated cost, including power station, was put at £77,397. The track would be constructed to a 5ft. 3in. gauge.

Bridgwater.—A company has notified the Council of intention to apply for a provisional electric lighting order. The Council obtained an order in 1898, but nothing has been done to comply with its provisions.

Brighton.—The Council's application for authority to construct several extensions of the electric tramways has been granted.

British Electrical Superannuation Fund.—This fund was established on July 1, 1900, by the management of the British Electric Traction Co. on the basis, so far as the conditions apply, of the Railway Clearing System Superannuation Fund Corporation, which enables companies other than the original founders to participate in the benefits of the fund. The desire of the founders was to adopt a superannuation scheme capable of extension to the electrical industry generally. The affairs of the fund are managed by 12 managing trustees, six being elected by contributing companies and six by contributing members. The voting power of this board of management is regulated by the amount of the annual contributions to the fund. One-half of the managing trustees retire every year, and are ineligible for re-election for the ensuing year. The funds are safely invested in gilt-edged securities, which are divided into five sections, the last of which is debenture stock of electrical undertakings of the United Kingdom concerns only. Members contributions are based on a salary percentage, and the contributions from the companies is a sum based on a percentage of the monthly salary of the member. The benefits are clearly set out in a pamphlet recently issued, which in addition gives instructions to both companies and members as to the method of joining the fund, and gives other information which should prove of interest to intending contributors. We may add that the first general meeting of the fund was held in March under the presidency of Sir C. Rivers Wilson, G.C.M.G., C.B., one of the managing trustees. At this meeting the report of the managing trustees was read, and showed the funds to be in a flourishing condition. There are already a large number of contributing companies, but these so far naturally chiefly represent the affiliated companies of the British Electric Traction Co. Mr. W. G. Bond, Donington House, Norfolk-street, London, W.C., is secretary of the fund, and will supply all further information.

Camberwell (London).—The Borough Council have received a communication from the Board of Trade as to their application for a provisional order. The order has been so amended that the Council will have to purchase the undertakings of all companies supplying electricity in the district.

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Cardiff.—Sanction to a further loan of £20,910 for electric lighting has been obtained by the Council.

The first section of the electric tramways were officially inspected by Major Druitt, R.E., and Mr. A. P. Trotter on Tuesday.

Creswell.—An inquiry was held here last week into the application of the Council to borrow £650 for public lighting by electricity. The Bolsover Colliery Co. will supply electric current to 68 32 c.p. incandescent electric lamps.

Dartmouth.—The Council have entered into a contract with the Urban Electric Supply Co. for public lighting for 10 years, at £364 per annum. There are to be 10 arc lamps of 750 c.p. each and 100 incandescents of 25 c p. each. The arrangement takes effect from Aug. 15, the date of the expiry of the present gas contract.

Electric Traction in India.—The *Financial News* of the 22nd inst. contains particulars of an interesting interview with Lieut-Col. R. E. Crompton on the subject of electric traction in India. Col. Crompton refers to a scheme which is before the Government of India for a railway 200 miles in length in the area watered by the rivers Ravi, Sutlej, Chenab and Jhelum, tributaries of the Indus, and Col. Crompton is sanguine of securing for his firm the contract for building the first long range electric line in the world. Within the district of the proposed line there is available water-power of no less than 5,000,000 H P. A rough survey has already been made of the proposed route.

Electric Traction in Spain.—A Royal Order appears in the *Madrid Gazette* of 16th inst. granting the Tramways Company of Seville permission to adopt electric traction on an extension of one of their lines.

A concession has also been granted to the Tramways Company of San Sebastian for the extension of the electric tramways in that city.

Señor Don José B. y Hernandez has applied for a concession for an electric tramway service from Seville to San Juan de Azualfarache, for another line from Castille to Cuesta y Sines, and for another line from Camas to San Teponce. More favourable terms than those offered by Señor Hernandez may be submitted until May 16.

[Copies of the *Madrid Gazette*, containing the conditions and other particulars of the above matters, may be seen, by appointment, at (but are not obtainable from) the offices of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London.]

Gillingham (Kent).—An inquiry is to be held here into the District Council's application to borrow moneys for the purchase of so much of the electric lighting undertaking of the Chatham, Rochester and District Electric Lighting Co. as lies within the district.

Light Railways.—A scheme for the construction of a light railway between Colchester and Southend is projected.

An inquiry will shortly be heard into the application to construct a light electric railway from Clacton to St. Osyth.

The Board of Trade have, after modification, confirmed the Deanhead (Yorks.) Light Railway order.

The Light Railway Commissioners held an inquiry last week into the application of Sir William Crundall and others to construct a light electric railway from the terminus of the Dover electric tramways to Kearsney Abbey, along the East Cliff to St. Margarets. The scheme is estimated to cost over £60,000 and has the support of nearly all the interested local authorities. The Commissioners decided to grant the order.

Liverpool.—An interesting report has been issued by the general manager of the tramways (Mr. C. R. Bellamy). During the first complete year of electric traction 101,000,000 passengers were carried, compared with 82,000,000 in the previous years. There are no ½d. fares, and of the total number of passengers just over 90 per cent., took 1d. tickets. Of the total population of Liverpool all but 14·6 per cent. live within the radius of the 1d. stage, which extends to 2¼ miles. 10·7 per cent. of the passengers paid 2d., and only about two passengers per 1,000 paid more than 2d. The average fare was 1·11d. whereas in the last year of the company's management with horse traction it was 1·82d. In the past year there were nine fatal accidents—seven to pedestrians and two to passengers—giving a proportion of one to 11,250,000 passengers, compared with one to 7,000,000 passengers in the previous year. The average receipts per car-mile travelled were 10·32d. for the past year, compared with 12·24d. The working expenses per car-mile worked out at 8·87d., of which 2d. was due to interest and sinking fund, and 1·6d. for electrical energy. The gross profit for the year was £147,057, and the credit balance £52.822, out of which there was to be provided depreciation and renewal. It is proposed to obtain powers to enable the Corporation, after setting aside annually £30,000 for renewal and reserve fund, to carry the surplus to credit of general rate, provided that in no year up to Jan. 1, 1912, shall more than one-third of the total surplus be so carried to credit of rates. The total length of tramways is about 114 miles, and the power plant provides 15 000 H P.

Llangollen.—The Council have entered into an agreement with Messrs. Bremner Smith & Co. for the transfer of their provisional electric lighting order. The firm undertake to erect electricity works and supply current for public and private lighting, the Council retaining the option of purchase at the end of 10 years.

London County Council.—At Tuesday's meeting nine tenders for the supply of 100 double-decked double-bogie electrically equipped cars were considered, and that of Messrs. Dick, Kerr & Co. was accepted at £71,754. They will be allowed to sublet as follows :—(*a*) to the J. G. Brill Co., Philadelphia, U.S.A., the manufacture of the car-trucks ; (*b*) to the Electrical Railway and Tramway Carriage Works, the manufacture of the car bodies ; (*c*) to Messrs. J. G. White & Co., the manufacture of the car ploughs ; and (*d*) to the English Electric Manufacturing Co., the manufacture of the electrical equipment and motors for the cars specified in the contract. Below are set out particulars of the tenders considered.

The report of the Highways committee on the subject of these tenders stated that the cars are to be used on portions of the Council's tramways, (*a*) Westminster and Tooting, (*b*) Elephant and Castle and Kennington, (*c*) St. George's-circus and Waterloo-road, when these routes have been reconstructed for electric traction. Tenders were invited for 50 cars, and for a further 50 if required. The above list does not include a number of tenders sent in, but which were not considered, the total number received being 25. One incomplete tender was received (from Gottfried Lindner, of Halle, Germany). Dr. A. B. W. Kennedy, who carefully examined the tenders, expresses the opinion (the report continues) that the best make of truck included in the tenders is that of the J. G. Brill Co. ; that the best makers of car bodies are Messrs. Milnes and the Electric Railway and Tramway Carriage Works ; that the plough should be that of Messrs. J. G. White & Co. (the contractors for the conduits), which is practically in accordance with the specification on which the tenders were based, and if this be adopted no question can hereafter be raised by Messrs. White & Co. as to its suitability for its purpose ; that as regards wheels and axles there is no special difference between those specified in the different tenders ; and that for the electrical equipment and motors those of Messrs. Dick, Kerr & Co. are the best, as their motors are the most powerful and give better acceleration than any others. Dr. Kennedy's opinion with regard to these matters is shared by the tramways manager and the Council's electrical engineer. The two lowest tenders which provide for (*a*) Brill trucks, (*b*) approved car-bodies and (*c*) White's ploughs (which, in the opinion of Dr. Kennedy, are essential to the efficiency of the service), are those of the British Thomson-Houston Co., £70,330, and of Messrs. Dick, Kerr & Co., £71,754. Messrs. Dick, Kerr & Co.'s motors are, however, so much the more effective that Dr. Kennedy considers them worth more than the difference in price, which amounts to about £7 per motor. Moreover, that firm is prepared to deliver the whole of the 100 cars within 24 weeks from the date of the order, and the difference in time for delivery is somewhat important, having regard to the desirability of the tramways being worked by electric traction at the earliest possible time. The committee then recommend that the tender of Messrs. Dick, Kerr & Co. be accepted, and further mention that the whole of the works, with the exception of the trucks, will be of British manufacture.

At Tuesday's meeting electric lighting loans were granted to Battersea (£2,285) and Woolwich (£5,600).

Tube Railway Bills.—The Parliamentary committee submitted a voluminous report detailing the steps they intended to take with regard to the underground electric railway bills now before Parliament.

—	Amount.	Period for deliv'ry after date of order.	Names of proposed sub-contractors for various parts of the cars.			
			Truck.	Body.	Plough.	Equipment and motors.
Brit. Thomson-Houston Co.	£65,880	36 weeks	Brush Co., or European McGuire Mfg. Co.	British Elec. Car Co.	None.....	None.
Do. (alternative) ...	70,330	36 ,,	J. G. Brill Co.	G. F. Milnes & Co.	J. G. White & Co.	None.
British Electric Car Co.	69,994	36 ,,	None.....	None.....	Do.	B. T.-H. Co.
Dick, Kerr & Co.	71,754	24 ,,	J. G. Brill Co.	Elec. Railway & Tramway Carriage Works	Do.	English Elec. Mfg. Co.
Witting Bros.	71,862	32 ,,	Brush Co.	G. F. Milnes & Co.	Electricite et Hydraulique.	Electricite et Hydraulique & B. T.-H. Co.
Do. (alternative) ...	71,102	32 ,,	Do.	Do.	Do.	Electricite et Hydraulique
Siemens and Halske ...	73,704	32 ,,	Do.	Do.	None.....	None.
Brit. Westinghouse Co.	77,252	33 ,,	Do.	G. F. Milnes & Co., or Brush Co., or Brit. Elec. Car Co.	J. G. White & Co.	None.
Brush Co.	78,390	39 ,,	None.....	None.....	None.....	None.
British Schuckert Co...	81.506	70 ,,	J. G. Brill Co.....	G. F. Milnes & Co.	J. G. White & Co.	None.

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The committee first deal with the recommendations of the Joint Committee which sat last session to consider the whole question of underground railways, and refer particularly to recommendation No. 20, which suggests that a Board of Trade model clause should be inserted in each bill based on that in the Light Railways Act, 1896, giving power for the Council or the City Corporation to either construct or aid in the construction of lines. The committee point out that Earl Morley, Chairman of Committees in the House of Lords, refuses to allow such a clause without the general question having been considered in Parliament in the ordinary way. While accepting the decision of Lord Morley, as it affects the bills now before Parliament, the Finance and the Highways committee are carefully considering the matter with a view to the Council deciding what further steps shall be taken. Continuing, the committees, after considering in detail the various schemes submitted to Parliament, set out a number of conclusions which they think are conditions applicable more or less to all the schemes. The most important of these conditions shortly stated are as follows:—

1. Confluent junctions not to be allowed.
2. Construction of stations to avoid discharge of passengers into crowded thoroughfares.
3. Model workmen's train clause to be inserted requiring the issue of tickets at all stations for trains timed to arrive up to 8 a.m. at 1d. single fare and 2d. return.
4. No interference or damage to Council's parks.
5. That statutory powers shall cease unless undertakers substantially commence to carry out work within 18 months, unless extension of time is sanctioned by Board of Trade.
6. All tunnels to be properly ventilated.
7. Proper accommodation to be provided in the way of entrances, exits, &c.
8. Tunnels to be lighted and foot-plate provided for the use of the public in case of accident.
9. No inflammable material to be used if possible in construction.
10. The fact of Parliamentary powers being given to promoters of a tube railway not to prejudice Council's interests when seeking to construct tramways or shallow tramways along same routes.
11. The promoters shall undertake to facilitate the construction of interchange stations with existing or future tube stations.

The schemes which, subject to certain conditions, the committee think the Council should not object to are:—(1) Baker Street and Waterloo Railway Bill, (2) Central London Railway (new lines) Bill, (3) Edgware and Hampstead Railway Bill, (4) the Great Northern and City Railway Bill, (5) Great Northern Railway Bill, No. 2, (6) Great Northern and Strand Railway Bill, (7) Islington and Euston Railway Bill, (8) North-West London Railway Bill.

The schemes which, subject to certain conditions, and to the attention of the Select Committee being drawn to the financial proposals contained therein, should not be objected to by the Council, are:—(1) City and Crystal Palace Railway Bill; (2) City and North-East Suburban Electric Railway Bill; (3) North-East London Railway Bill.

The other bills the committee consider might, subject to certain conditions, prove satisfactory, but on account of the financial proposals require to be strenuously opposed by the Council, are: (1) the King's Road Railway; (2) the West and South London Junction Bill; (3) the Brompton and Piccadilly Extension Bill; (4) the Charing Cross, Euston and Hampstead Railway Bills; (5) the Charing Cross, Hammersmith and District Electric Railway Bills; (6) the City and Brixton Railway Bill; (7) the London United Electric Railway Bill, and (8) the Piccadilly and City Railway.

Considerable discussion ensued on this report. Mr. SIDNEY LOW suggested that the Council might approach the Government and ask for the appointment of a Royal Commission to inquire into the whole matter of underground locomotion for London. Sir J. DICKSON POYNDER, M.P., said that as one who served on the Joint Committee of last year he could be no party to such a proposal. He thought, however, the Council might appear before the Committee and ask for the appointment of some central body which should have for its object the co-ordinating of these railways in the interests of the public generally.—Eventually the report was adopted.

Tramways.—A number of references were made to the tramways of the Council. It was agreed to petition for the insertion of an additional clause in the Council's Tramway Bill extending the time for the reconstruction for electrical traction of the tramways between Westminster Bridge and Tooting. The clerk was authorised to call proper statutory meetings of the Council to consider whether it should exercise its right to acquire the undertaking authorised by the Southwark and Deptford Tramways Act, 1881, from the South London Tramways Co.

Manchester.—In the estimates of the receipts and expenditure of the tramways department for the year ending March, 1903, the traffic receipts are put at £250,000, and miscellaneous receipts from tramway rental, &c., will bring this up to £260,306. The expenditure is estimated at £206,052, leaving a profit of £56,984, out of which it is proposed to contribute £30,000 to relief of rates and to transfer £26,984 to reserve, renewals and depreciation. Last year the approximate income was £113,830, and there was a profit of £30,600, out of which £20,000 was devoted to relief of rates and £10,600 transferred to reserve. It is estimated that the capital outlay during the year will amount to £600,000. Of this sum £120,000 is for land and buildings, the balance being for tramcars and equipment.

The estimates of the electric lighting department for the current year have been issued and show probable expenditure £175,459, against receipts £166,447, leaving an estimated loss of £9,012, which it is proposed to meet out of reserve. Last year's working showed a surplus balance of £6,300, which has been carried to reserve. During 1903, it is estimated that £875,799 will be expended, including £21,000 at Dickinson-street, £55,394 at Bloom-street, £463,705 at Stuart-street, £211,295 upon distributing stations and £119,400 on mains.

The electric tramway route from Albert-square to High-street was opened for traffic on Saturday.

Motor-Car Exhibition.—We refer elsewhere to the larger electrical exhibits at the imposing exhibition of motor vehicles and accessories at the Agricultural Hall, London, which will be open till to-morrow (Saturday) evening. In addition to the exhibits dealt with elsewhere, a number of firms show electrical accessories, sundries, &c., used in the motor vehicle industry. These firms include Messrs. Crossley Bros. (stand No. 6) who show oil and gas engines; Messrs Gianoli and Lacoste (No. 14) exhibiting accumulators, induction coils, measuring instruments, sparking plugs, radiators, &c.; the Société des Accumulateurs Electriques "Max" (No. 24), showing special types of accumulators for traction work; the Meyra Electric Co. (No. 26), ignition batteries, &c.; the Brush Electrical Engineering Co. (No. 29), whose automobile department, 66, Great Russell-street, London, W.C., exhibits a Brush petrol car, a working model of the Brush-Dawson magneto as applied to the Brush motor, &c.; the Electric Carriage and Garage Co. (No. 49) show an electric landaulette, a victoria and other vehicles; the Electric Ignition Co. (No. 50) display a variety of ignition specialities; Mr. H. W. Van Raden (No. 71) shows electric ignition appliances, woven glass accumulators, induction coils, electric wires, measuring instruments, &c; Messrs. Shippey Bros. (No. 80), in addition to a display of motor cars, engines, &c., show two sets of Gordon's patent primary batteries for charging 4-volt accumulators; Messrs. Th. Botiaux & Co. (No. 88) show an electric victoria on the Cantal system with Botiaux body; Garages Limited (No. 104) show a "Baker" electric stanhope for speeds of 6, 11 and 16 miles per hour, to travel 40 miles on one charge, weighing complete with battery 900lb. This vehicle has aluminium wheels. Le Carbone (No. 108) has a good display of "Sans Pareil" dry cells, "Paris" cells and funnels which can be charged en route; the Auto-Machinery Co. (No. 3, minor hall) have a good display of nuts, studs, ball bearings, and a special roller-bearing arrangement. The Dowsing Radiant Heat Co. (No. 3 arcade) show a new system of warming and lighting automobiles and the Dowsing luminous electric radiator for heating; Messrs. Stern Bros. have an extensive show of dust-proof lubricators, lubricants, &c.; Messrs. W. H. Willcox & Co. (No. 3, gallery) make an excellent display of oils and greases for motor vehicles, and general engineering accessories and supplies. Messrs. J. C. Meredith (Ltd.) (No. 5, gallery) display electrical appliances for ignition, including accumulators, coils, switches, &c. At No. 29, gallery, Messrs. Ransomes, Sims and Jefferies show a new motor lawn mower with Sims-Bosch magneto-ignition. M. Alfred Wydts (No. 36, gallery) shows the Allumeur electro-catalytique, the new electro-catalytical ignition for petrol motors. We have only space here for this brief mention of the immense number of articles which go to make up the display at the 1902 exhibition of horseless vehicles. This show is a great advance upon any of its predecessors, and gives evidence that the motor car exhibition is likely in the near future to become one of the principal exhibitions of the metropolis. The public has accorded a full measure of patronage to the show, and has evinced much interest in the exhibits.

Municipal Telephony.—The first complete set of accounts relating to municipal telephone enterprise is to hand. This is the balance-sheet, revenue account and statistics of the Guernsey States Telephone Department for the year ended Dec. 31, 1901. The statistics show that the number of lines working at this date, exclusive of junction lines, was 881. There were in addition about 100 spare or partially completed lines of an estimated value of about £800. The capital expenditure on construction has been £15,332. 3s. 5d. (making the inclusive cost of construction per line £17. 8s.), or including cost of land and buildings £17,574. 2s. 4d. Allowing for the 100 spares the cost per working line is thus reduced to £16. 9s. 11d. The total revenue for 1901 was £2,630. 6s. 9d., giving an average per line for the year of £2. 19s. 8d. £1,752 8s. 1d. has been set aside out of revenue for depreciation and sinking fund, after paying interest, Post Office royalty and all working expenses, the sum so set aside representing nearly 10 per cent. of the total capital outlay to date. The profit remaining on the working of the service for 1901 is £117. 11s. 2d. The total number of subscribers and public telephone calls in the year increased from 257,138 in 1900 to 379,342 in 1901, and the number of telegrams, &c., telephoned to the Post Office increased from 363 (from Aug. 10 to Dec. 31, 1900) to 2,373 (for the full year 1901). The number of subscribers on No. 1 tariff (£1. 10s. per annum and 1d. per call) increased from 559 to 678, on No. 2 tariff (£5 per annum and 3,200 calls without further payment) from 24 to 39, and on No. 3 tariff (£2 5s. per annum and ½d. per call) from 23 to 53.

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Owing to adverse polls of ratepayers, some of the promoters of the bill for the constitution of a joint telephone board for the Manchester area have been obliged to withdraw their support, and it is understood that the bill will now be dropped, especially as at a recent Manchester ratepayers' meeting a poll was demanded.

Cardiff Corporation have abandoned their scheme for a municipal telephone exchange.

Municipal Trading.—At a meeting of the Northern Section of the National Electrical Contractors Association, on Saturday, the president (Mr. Hy. Bland) gave an address on "Municipal Trading."

He pointed to the unfair competition of local authorities in the electrical trades. Whilst admitting that water, gas and electric supply, drainage, trams, and even telephones (the whole of which necessitated the taking up of roads, streets and pavements) were perhaps better in the hands of municipal authorities, he protested against the unfair competition with tradesmen who were ratepayers, at prices at which no commercial firm could sell and make a livelihood. Taking Liverpool, for example, the Corporation were advertising and selling Ediswan electric lamps at 14s. per dozen. No tradesman could do that, allowing for trade expenses, rent, rates, office expenses, carriage and breakage. The Corporation should be asked to give returns including the above expenses. They also competed with their own ratepayers in quoting for electric lighting installation work, and, not satisfied with drawing on rates for any deficit in that work, they submitted the electrical trade to a further unfair condition by charging contractors and their customers, who were ratepayers with equal rights, a higher price for connections to their mains than that charged to their own customers. It had been decided to refer these cases to the Board of Trade. He advocated giving full information to the public, who were always willing to support a just cause, and required some enlightening on technical matters. Several Corporations were letting out motors on hire. Should these motors be superseded by some more efficient type this would naturally leave a stock on the hands of the Corporation and result in loss to the ratepayers. In 18 years the local taxation had increased by 105 per cent., and the local debt of municipalities by 171 per cent. Besides debiting the taxpayer with enormous sums from the national exchequer, the last three years has increased this debt by 120 millions sterling.

It was resolved to ally with all kindred associations suffering from unfair trading by municipal authorities with a view to combined action. The association also decided to become members of the National Electrical Contractors' Association of Great Britain and Ireland.

Newington (London).—The Council have received notification that the Board of Trade decline to grant their application for a provisional order to supply electricity in the portions of the borough outside the parish of Newington. The Board consider that Parliament was not likely to grant an order allowing a local authority to compete with a company already giving a sufficient supply of electric current in a district. In St. George's and St. Saviour's there were two companies supplying, and a third had a right of way through a portion of the latter district. The matter is before the General Purposes committee.

Portsmouth.—The Tramways committee have decided to retain Mr. E. Rotter as consulting engineer after the completion of the reconstruction of the tramways, the engagement to be subject to six months' notice.

Stretford.—An inquiry was held last Friday into the Council's application to borrow £54,000 for electricity works. The chairman of the Electric Lighting committee (Mr. T. Johnston) stated that there was a great demand for electricity. They would supply current for lighting and traction, and did not expect to derive all their profits from traction. Replying to Mr. Langdon, who represented a number of ratepayers and landowners in Trafford Park (including the British Westinghouse Company, W. T. Glover & Co., the Electrical Manufacturing Co., &c.), witness said that there was no doubt the largest manufacturing establishments were in Trafford Park, but the largest number were outside the Park. The clerk to the Council (Mr. Abraham) gave particulars of the population, rateable value, &c, and said industrial development had taken place to a great extent in Trafford Park. There were 8½ miles of tramway; the trams were at present worked by the Manchester Carriage and Tramways Co. The Council had given notice to the company to purchase the tramways. The arbitration on the purchase price had been held, and they were now awaiting the award. The consulting engineer (Mr. C. H. Wordingham) supplied technical details. He said there was a great demand for electricity in the district. For the opposition, Mr. S. V. Clirehugh, consulting engineer, said the demand for electricity did not warrant so large an expenditure, and the undertaking would not for some years be profitable, but would necessitate a charge being made on the rates. The growth of the demand for electric current for lighting must necessarily be slow, and if the Council must establish their own works instead of taking a supply from either Manchester Corporation or the Trafford Power Co., they ought not to embark on so large a scheme until satisfactory evidence was produced that the necessary demand existed to warrant the expenditure. Mr. Matthew Ingram, engineer, and chairman of the Trafford Park Ratepayers' Association, also opposed the application. Other evidence was given and the inquiry closed.

Theft.—At Bow-street (London) Police Court, on Monday, Herbert Bowser, cashier, was sentenced to six months' hard labour for stealing about £200 from his employers, the British Electric Traction Co.

E. de Behr was indicted at Bournemouth last week for having abstracted and used, between Dec. 11 and 28 last, electric current of the value of 10s., the property of the Bournemouth and Poole Electricity Supply Co. The facts were given in our issue of Jan. 24. The jury found prisoner guilty, and the Recorder, in view of the jury's recommendation to mercy, ordered that he should enter into his own recognisances in £50 to come up for judgment if called upon.

Warrington.—The electric tramway service from Rylands street to Latchford swing bridge was commenced on Monday.

Will.—The will of the late Mr. Matthew Gray, who died on Dec. 16 last, aged 80 years, has just been proved, the estate being valued at £282,428. 16s. 10d. gross, and net £274,854. 2s. In addition to family bequests, Mr. Gray has bequeathed £100 a year for 20 years for the benefit of poor persons employed by or formerly in the employ of the India Rubber, Gutta Percha and Telegraph Works Co.

TRADE NOTES AND NOTICES.

[*These Notices for insertion must reach us by first post Thursday morning; New Catalogues, Price Lists and similar matter early in the week*]

TENDERS INVITED.

Extension of Time.—*London County Council* invite tenders for wiring and fittings for the electric lighting of the Euston-road fire station. Further particulars are set out in an advertisement. Tenderers may inspect drawings and obtain specifications, &c., at the Chief Engineer's Department, County Hall, Spring-gardens, S.W. Tenders to the clerk (Mr. G. L. Gomme), County Hall, by 10 a.m. of Thursday, May 8 (instead of May 1 as previously announced).

The Establishment committee of the *Fulham* (London) Borough Council invite tenders for the supply, delivery and erection of a 600kw. two-phase steam alternator (with Willans, Belliss or Allen engine) or one 600kw. Parsons' turbo-alternator. Specifications, &c., from the consulting engineer, Mr. F. Hastings Medhurst, 13, Victoria-street, London, S.W., after 21st inst. Further particulars are given in an advertisement. Tenders to the town clerk (Mr. R. M Prescott), Town Hall, Walham Green, London, S.W., by 7 p.m. on May 5.

Fulham (London) Guardians invite tenders for the supply and erection of a switchboard. Specifications, &c., of the consulting engineer, Mr. F. Hastings Medhurst, 13, Victoria street, London, S.W. Tenders to the clerk (Mr. Edward J. Mott), 75, Fulham Palace-road, London, W., by 10 a.m. April 29. See advertisement.

West Ham Corporation invite tenders for two steel chimneys, four fans and engines for induced draught, brickwork in connection with the flues and economisers. Specifications, &c., from the borough electrical engineer (Mr. Jas. K. Bock) after Monday, and tenders to the town clerk (Mr. Fred. E. Hilleary) by 4 p.m. of May 13. An advertisement contains additional particulars.

Sudbury Corporation invite tenders for water tube boiler with fittings, feed-water heater, feed pumps, &c, pipe-work, two steam dynamos and motor boosters, storage batteries, main switchboard and connections, underground mains, conduit and roadwork, and station lighting. Tenders to chairman of Electric Lighting committee, Town Hall, Sudbury, by noon May 1.

Walsall Corporation invite tenders for a battery of accumulators. Specifications, &c., from the borough electrical engineer (Mr. Alex. J. Wyllie), Wolverhampton-street, Walsall. Tenders to the town clerk (Mr. J. R. Cooper) by April 30. See advertisement.

Grimsby Corporation invite tenders for the supply and delivery of continuous-current arc lamps, arc lamp-posts, stoneware pipes, cables, &c. Specifications, &c., from the borough electrical engineer (Mr. W. A. Vignoles), electricity works, Grimsby, where tenders must be in by May 5. See advertisement.

Bedford Electricity committee invite tenders for supply and delivery of economisers. An advertisement contains further particulars. Specifications, &c., from the borough electrical engineer (Mr. R. W. L. Phillips), Cauldwell-road, Bedford. Tenders to chairman of Electricity committee by May 19.

Dartford Urban District Council advertise for tenders for the supply and erection of a 300kw. steam dynamo, with steam and exhaust pipes, switchboard instruments, &c.; one Lancashire boiler with feed pump, additional feed pipes and extension to economiser. Specifications, &c., after 28th inst. Tenders to the clerk (Mr. J. C. Hayward), Sessions House, Dartford, by noon May 10.

The *War Office* invite tenders for the manufacture of a self-propelled lorry for military purposes. Further particulars are given in an advertisement. Specifications, &c., can be obtained on application to the Director of Army Contracts (Mr. A. Major), War Office, Pall Mall, London, S.W., to whom tenders must be sent by noon of July 31.

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Glasgow Corporation invite tenders for the supply, delivery and erection of material for extension to switchboard at Coplawhill sub-station. Specifications, &c., may be obtained from the general manager (Mr. John Young), 88, Renfield-street, Glasgow. Tenders to town clerk (Sir J. D. Marwick) by 5 p.m, May 7. See advertisement.

Glasgow Corporation also invite tenders for the supply of electricity meters for one year from June 1. Specifications, &c., from the chief electrical engineer (Mr. W. A. Chamen), 75, Waterloo-street. Tenders to the town clerk (Sir J. D. Marwick) by 3rd prox. See advertisement.

Glasgow Corporation invite tenders for the supply of motor-driven boosters and relative switching apparatus. Specifications, &c., from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow, and tenders to the town clerk (Sir J. D. Marwick) by 5th prox. See advertisement.

Sheffield Tramways committee invite tenders for boilers, &c., for their Kelham island power station. Tenders to general manager of tramways by 28th inst.

Erith District Council invite offers from firms willing to take up free wiring in the district. Communications to the clerk (Mr. Charles H. Fry) by noon May 5. See advertisement.

Oldham Electricity committee invite tenders for lighting and traction switchboards and instruments. Tenders to Mr. Andrew, Gas and Water Offices, Oldham, by May 6.

Stepney (London) Borough Council invite tenders for meters and demand indicators. Tenders to chairman of Electrical committee by noon May 1.

Barnsley Corporation require tenders for wiring and fittings for electric lighting of Kendray hospital. Tenders to borough engineer by 10 a.m. 29th inst.

Southwark (London) Borough Council require 1,000 incandescent electric lamps (of Ediswan, Robertson or Zurich type) of 8, 16, 25 and 32 c.p., for 200-volt circuit. Tenders to town clerk by noon April 30.

Harrogate Corporation invite tenders for material for laying about 600 yds. of light railway for electric or steam traction. Tenders to engineer (Mr. E. W. Dixon), 14, Albert-street, Harrogate, by May 12.

Aberdeen Electric Lighting committee invite tenders for a 20-ton electrically-driven overhead crane for their Dee Village electricity works. Tenders to city electrical engineer by mid-day May 7.

West Hartlepool Corporation invite tenders for a 200kw. to 250kw. steam dynamo, switchboard extension, &c. Tenders by mid-day April 30.

West Hartlepool Corporation also require six additional cells for destructor works. Tenders to chairman of Health committee by 4 p.m. 30th inst.

Manchester Tramways committee invite tenders for special track work, cross-over roads and points and crossings. Tenders by 1 p m. May 3.

Dublin Lighting committee invite tenders for the construction of a cast-iron subway under the Grand Canal Dock. Tenders to chairman by noon of May 13.

Mansfield Corporation invite tenders for pipe-work, valves and tanks. Tenders by 4 p.m. May 1.

Trowbridge District Council invite proposals for a lease of their electric lighting order. Applications to clerk by April 30.

Barrow Corporation require arc lamps, columns, switchboard, pillars, &c. Tenders by noon May 7.

Poplar (London) Electricity committee invite tenders for coal-conveying plant. Tenders to clerk (Mr. Leonard Potts) by 29th inst.

Bury Corporation invite tenders for tramway feeder and pilot cables, conduits and accessories. Tenders to town clerk by May 8.

Cleckheaton District Council require continuous-current motors. Tenders to clerk by May 3.

Tenders will shortly be invited for electrical and mechanical tools for the new Royal Stores, *Antwerp*. Tenders to Hotel de Ville, Antwerp.

It is announced that tenders are invited for a service of automobile omnibuses for Shanghai. Tenders have to be sent in to the Municipality of Shanghai by June 30.

The *Norwegian* State Telegraph Department will receive, up to noon of May 7, tenders for the supply of post-hooks, insulators, top covers, top plates and telegraph wire. Specifications and conditions can be seen at the Technical Department of Telegraphs, Christiania, from which address tender forms can also be obtained.

TENDERS RECEIVED AND ACCEPTED.

Sunderland Corporation have accepted the tender of W. T. Glover & Co. for indiarubber-covered cables (13 tenders received); that of Watson, Gow & Co. for cast-iron piping, &c. (3 tenders); Messrs. Doulton & Co. for stoneware casings (without competition); Mr. Thomas Lumsden, machine tools, &c. (24 tenders); and the Vacuum Oil Co. for oil for ensuing 12 months (without competition).

The contracts for arc lighting at Islington (London) and for the trolley lighting at Dudley have been placed with the Improved Electric Glow Lamp Co.

Oban Town Council have accepted the following tenders:—

Babcock and Wilcox, steam, exhaust, drain and other pipes, pumps, condensing plant, &c.

Bertram Thomas, balancing transformers, motor-generators and switchboard.

British Power, Traction and Lighting Co., storage batteries.

Oliver & Co., arc and incandescent lamps and fittings.

St. Helens Cable Co., cables.

James Carrick & Sons, travelling crane.

The Corporation have themselves undertaken the road work, conduits, manhole covers, arc lamp posts, &c.

The tender of Messrs. Babcock and Wilcox has been accepted by the Llandudno District Council for the supply of two water-tube boilers, steam and exhaust pipes, drain pipes, lagging, &c, and a feed pump for £1,951. 10s.

Messrs. D. Bruce Peebles & Co. have obtained an order for the electrical power equipment of the new workshops of the Bengal-Nagpur railway at Khargpur. The order includes 80 motors of an average of 15 B.H.P.

Messrs. Ashmore, Benson, Pease & Co. have received an order from the Blackpool Winter Gardens for two storage batteries, each consisting of 60 cells.

Southampton Town Council have accepted the tender of Messrs. Douglas and Richards for constructing the permanent way of tramways in St. Denis-road at £4 666. Seven tenders, varying from £4,666 to £7,178. 4s., were received.

The St. Helens Cable Co. have obtained the annual contract for cables, jointing material, &c., at Shoreditch, and the contract for cables at Oban, the latter insulated with dialite bitumen without lead covering. The company have also received orders for 6½ miles of the same class of cable similarly insulated for the Liverpool Overhead Railway, and for the extensions of mains at the works of Lever Bros., Port Sunlight.

BUSINESS NOTICES.

An agreement has been entered into between Messrs. D. Bruce Peebles & Co. and Messrs. Ganz & Co, of Budapest, under which the former acquire the sole manufacturing licence for Great Britain and the Colonies for all Messrs. Ganz and Co.'s three-phase manufactures. Messrs. Bruce Peebles & Co. have also taken up the Ganz system of electric traction, and it is stated that the working application of this will be shown in this country as soon as possible. Already the firm have acquired a large tract of land for works premises, which will enable them to turn out machines up to 10,000 H.P.

Mr. John F. C. Snell, borough electrical and tramways engineer, intimates that communications for the electric lighting and tramways departments of the Sunderland Corporation should in future be addressed to the Central Offices, Town Hall, Sunderland.

Mr. J. Pullar Phibbs, M.I.E.E, is taking up a position with Messrs. J. Pullar & Sons, dye works, Perth, and is relinquishing his connection with Messrs. Geoffroy and Delore, Bergmann's Electrical Works, Carels Frères and the High Speed Engine Co. Mr. Pullar Phibbs address is now Muirton Bank, Perth, N.B.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the Walsall County Court last week, in the examination of Lewis Bayliss, electrical accessories manufacturer, lately trading at Wednesbury, London and elsewhere:—

The statement of affairs showed liabilities expected to rank £2,225.16s.11d., deficiency £1,786. 6s. 8d. In cross-examination by the Official Receiver (Mr. S. W. Page) bankrupt stated that he was formerly an electrical engineer in the employ of Veritys Limited, but in October, 1897, he started business in Wednesbury as a cycle maker and electrical accessories manufacturer, with a capital of about £100. About twelve months later he was joined by a brother, a clothier, who also found £100, but who withdrew a year afterwards. A Mr. Sanders then bought the business for £300, and it was arranged that bankrupt should enter into partnership with Miss Sanders, the business being known as Lewis Bayliss & Co. About October, 1899, the business was removed to Wednesbury, Mr. Sanders providing about £840 for the purchase of land and erection of premises. Bankrupt believed that business to be still solvent after providing for £3,600 found by Mr. Sanders and for liabilities. Soon after entering into the fresh partnership, bankrupt entered into business with a Mr. F. Terrill, cabinetmaker for electrical accessories, of Birmingham, whom he agreed to supply with cash at intervals to pay for his plant, and in return was to have a share of the profit. He found from £160 to £180, but had not had more than £10 out of the business. The business was afterwards removed to Wednesbury, and was carried on as Terrill & Co. He had no money out of Lewis Bayliss & Co. to pay Terrill & Co., though the latter firm became indebted to the former to the extent of £260. About twelve months ago bankrupt purchased a clothier's business carried on in London. In January, 1902, he purchased the business of the Thames Electrical Co., at Bucklesbury, London. An account was prepared showing a deficiency of about £50, and bankrupt undertook to discharge liabilities amounting to about £900. He paid debts amounting to £395, and then took over the business, which he continued until he found he was being swindled. In respect of the latter

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business he was liable for £700 or £800. The inability of the Thames Company to discharge its liabilities was responsible for the crisis in the affairs of Terrill & Co., as the former owed the latter £300. Bankrupt attributed his failure to the mismanagement of the clothier's business and the taking over the business of the Thames Company. Examination adjourned to May 7.

Mr. Registrar Brougham on Friday suspended for two years the order of discharge in the case of L. J. Lawrence, electrical engineer, lately trading as Lawrence and Butcher, at 5A, Stafford-street, London, W. Failure was attributed to illness and loss by underestimating on contracts. Liabilities were £334, assets £5.

In the bankruptcy of J. A. M. Collier, electrical engineer, Claremont-grove, Gateshead, the trustee has been released.

The Reno Electric Stairways and Conveyors (Ltd.) is to be wound up voluntarily. Mr. G. H. Hewlett, 3, Crown-court, London, E.C., is liquidator. A new company with a similar title has been registered.

Plant for Sale.—Electric light generating plant (comprising two 16 H P. Crossley engines, two 9 unit shunt-wound dynamos, belting and accumulator, switchboards, &c.) is for sale. Applications to Messrs. R. Creese Harrison & Son, 103, Cannon-street, London, E.C. See advertisement.

Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Factory Sites.—Messrs. Humbert and Flint, Watford, Herts., and 11, Serle-street, Lincoln's Inn, London, W.C., announce in another column some convenient factory sites in the Watford district for disposal.

Mr. J. H. Osborne, 15, Charterhouse-street, London, E.C., has for disposal convenient freehold sites for factories, under 11 miles from City, and adjoining railway and navigable river.

Power and Lighting Contracts.—Among recent contracts for power and lighting plants which Messrs. Ellis and Ward, of Birmingham, have carried out is a complete installation at Messrs. Nelson, Dale & Co.'s works at Warwick, the plant including two steam engines, two Lancashire boilers, condensing plant, &c., and electrical equipment. For 32 engines, 50 electric motors, ranging from 40 H.P. downwards, will be substituted, and the lighting will consist of about 1,000 incandescents. The same firm have supplied a number of motors to Elliott's Metal Co. for their South Wales works, to Whitmore's printing works, and to several other important works and business premises.

Insulating Compounds.—Mr. F. J. Down, M.I.E.E., F.C.S., A M Inst.C.E, of Harpenden, Herts, is issuing a circular treating fully of the merits of Armalac as an insulating compound for all electrical purposes. The circular deals also with some other insulating materials, and can be obtained on application. A small booklet accompanies the circular, describing the method of application of Armalac.

Catalogues, Price Lists, &c.—The General Electric Co. have ready a sheet of new patterns in glass shades for electric lighting.

The Electric and Ordnance Accessories Co., of Stellite Works, Birmingham, have ready a leaflet showing a five-way distribution board, built up with their patent bow bridge type distribution segments. In these segments the effective fuse-break is over 2½in., and all the fuse-wires are visible from the front. The fuses on the board are arranged so that they will not blow in sympathy, and any one can be replaced without interfering with the remainder, and this while the board is "alive." The makers claim that this is essentially a high-voltage board in a small compass. The boards are stocked in quantities, and can be delivered, we understand, with promptitude. Stocks are kept by Messrs. Baxter and Caunter, 5, Macclesfield-street, Shaftesbury-avenue, London, W.C., who are agents for the company.

Pamphlet No. 121 issued by the British Thomson-Houston Co. illustrates and describes small direct-current motors, type C.A. The illustrations show motors mounted on various classes of machinery.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 16 to April 22, with the ports of destination :—

Africa—Alexandria, £176; Cape Town, £748 (including £693 telegraph material); Durban, £681; East London, £323; Port Elizabeth, £518. *Australasia*—Fremantle, £42; Melbourne, £1,075; Perth, £45; Sydney, £184; Wellington, £256 (telegraph material). *Burma*—Rangoon, £35. *Ceylon*—Colombo, £23. *Channel Islands*, £60. *Denmark*—Copenhagen, £93 (telegraph cable). *Germany*—Hamburg, £217. *Holland*—Amsterdam, £130. *India*—Bombay, £190 (including £103 telegraph wire); Calcutta, £2,261. *Japan*—Osaka, £130. *Malta*, £105. *Mexico*—Vera Cruz, £6,101. *Russia*—Odessa, £280. *West Indies*—Trinidad, £102 (telegraph material). Total, £13,775, against £24,323 in the corresponding week last year (April 17 to 23).

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 23⅞d. per oz. (April 24). Consols (2¾ per cent.) 94⅛—94⅜ for money, 94 9/16—94 11/16 for account; 2½ per cent. 94¾—95¼ (May 24). Consols Pay Day, May 2; Stocks and Shares Continuation Days, May 13 and 27; Ticket Day, May 14; Pay Days, April 25 and May 15; Mining Share Carry-over Days, May 12 and 26.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The eleventh drawing for payment of 152 of this company's 4 per cent. mortgage debentures will take place on May 1 at the offices, Electra House, Moorgate, E.C.

BAKER STREET AND WATERLOO RAILWAY CO.—At the meeting yesterday (Thursday) the half-yearly report presented by the directors stated that, owing to the limited funds at their disposal, they were not able to proceed with the works as rapidly as could be wished, but a contract has been entered into with the Metropolitan District Electric Traction Co., and the works were now being pushed on rapidly. Under the agreement with the Traction Company, it was arranged for that company to pay 3 per cent. interest during construction. The engineers report that since the last half-yearly report the western station tunnel at Waterloo has been completed; the eastern running tunnel under the river has reached a point on the south side of the river where it is clear of the water-bearing strata, and safely situated in the London clay. Northwards the eastern tunnel has been continued from Regent-street, near the junction of Conduit-street, to the north side of Oxford-circus, where it will join the large station tunnel. At the station works at Waterloo considerable progress has been made with the lift chamber, which will shortly be completely covered in and the surface restored. The underground passages from the shafts to the tunnels are well advanced. At Piccadilly it is intended to start the underground passages round the shafts as soon as necessary arrangements can be made. At Oxford-street the 18ft. shaft has been sunk to the full depth, and the underground passage connecting it with the eastern tunnel has been constructed.

BRITISH INSULATED WIRE CO. (LTD.)—At the annual meeting on Wednesday the chairman (Mr. E. K. Muspratt) moved the adoption of the report given in our last issue. He explained that the decrease in the dividend compared with the previous year (when 15 per cent. was paid) was owing to the business of the company in the autumn having considerably declined, but the directors having put forward special efforts large orders subsequently were secured, and were now being well maintained. A considerable sum had been devoted to the acquisition of two concessions in Australia for electric lighting and traction in order to secure markets for their goods. Up to the present those enterprises had not arrived at a profit-earning stage, but the directors regarded them as of a highly valuable nature, and had no doubt that very shortly they would yield handsome returns. For some time past negotiations had been in progress with the Telegraph Manufacturing Co., of Helsby, near Warrington, for an amalgamation, and he was glad to say that since the issue of the report the negotiations had been carried through and the amalgamation was now completed. The amalgamation would do away with some competition, and would enable their company to tender for electrical installations from beginning to end instead of as hitherto for the cable portion only. The report was amended as to compensation to retiring directors and was then carried unanimously.

BUENOS AYRES AND BELGRANO TRAMWAYS CO. (LTD.)—The chairman (Mr. J. B. Concanon) at the meeting last week said the year under review was their first complete year of working electrically, and he thought that they had good cause for congratulation on the results. The total receipts exceeded those of 1900 by £20,115, whilst expenditure was £1,425 less—a net increase of profit of £21,540. The other tramway companies showed decreases due, he believed, to a great extent to the commercial depression that had prevailed at Buenos Ayres for some time past. There was hardly a street in Buenos Ayres without a tramway; there were numerous companies and therefore tramway competition had been more or less active always, but they suffered, and were likely to suffer, less from competition than any other company.

CLAYTON AND SHUTTLEWORTH (LTD.)—At the meeting on Wednesday, the chairman (Mr. F. S. E. Drury) regretted that at the termination of the first year in the history of the company he had to put before them a statement of an unwelcome character. He commented on the fluctuating and world-wide nature of their business, and pointed out that the reasons which had combined to produce that result, viz., the acute commercial depression in Germany, Austria and Hungary, the bad harvest in various districts on the Continent, the sudden fall in prices of raw materials in Jan., 1901, and the loss of South African trade, consequent upon the war. He did not think that matters had turned the corner on the Continent, to which they looked for so large a portion of their trade. He could only say that they would study and practice every economy consistent with effective maintenance of business, and which would not in any way lower the quality of their goods.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—A dividend has been declared on the ordinary shares at the rate of 4 per cent. per annum for the half-year ended Dec. 31.

DUDLEY, STOURBRIDGE AND DISTRICT ELECTRIC TRACTION CO. (LTD.)—At the meeting on Monday the chairman (Mr. C. S. B. Hilton) announced that the year's traffic receipts amounted to £34,500, an increase of over £16,000. The net profit was £11,743, against £6,900. The passengers carried numbered 6,141,572, an increase of 2,947,600. The average receipt per passenger remained practically the same as last year. The directors were extending the line to Lye, and increasing the power output. They had erected a battery sub-station near the junction of the

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Kinver line and the main line, and proposed to purchase more rolling stock to cope with the increasing traffic. They proposed to set aside £2,050 to provide against any depreciation in value of their line. £2,050 was placed to reserve, £1,500 to depreciation, 4½ per cent. dividend on ordinary shares absorbed £4,500, and £6,000 was carried forward.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—A dividend for the quarter ended Dec. 31 of 2s. 6d. and a bonus of 4s. per share (or 2 per cent.) has been declared, making a total of 7 per cent. for the year 1901. The dividend and bonus is payable on 8th prox., the share register being closed from 30th inst. to May 7 inclusive.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—The accounts for 1901 have been i sued and show total receipts (less £35,222. 4s. 6d. loss on exchange) of £502,608. 12s. 5d., and expenses £113,594. 8s. 9d. Interim dividends already paid absorbed £75,000, and a final dividend of £1 per share, absorbing £150,000, is now recommended. £150,000 is placed to reserve and renewal fund, £27,777. 15s. 7d. to renewal fund for cable steamers, £5,555. 11s. 1d. to pension fund of staff, and £2,500 as directors' remuneration, leaving £64,871. 10s. 8d. to be carried forward.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LTD.).—The report for 1901 states that the total expenditure to Dec. 31, on account of buildings and plant, amounted to £29,435. 3s. 4d. The gross receipts, including amount receivable from Kidderminster and Stourport Electric Tramway Co. for dividend on shares held by the company, amount to £5,181. 16s. 8d., which, added to £708. 3s. 3d. from last account, makes £5,889. 19s. 11d. After deducting expenses (including interest on loans), amounting to £3,550. 12s. 5d., there is a net profit of £2,339. 7s. 6d. The directors propose that £1,500 of this be applied in payment of preference dividend for 1901, £100 to depreciation, £613. 19s. 3d. to dividend on ordinary shares at the rate of 2 per cent. per annum, and £125. 8s. 1d. to be carried forward.

The profit and loss account of the Kidderminster and Stourport Electric Tramways Co. is attached, and states that the net profits for the year in respect of the tramways were £2,863. 11s. 8d., which, added to £128. 9s. 9d. from last account, makes £2,992. 1s. 5d. This has been applied in payment of dividend at the rate of 4 per cent. (£2,288), £500 has been placed to depreciation and reserve, and £204. 1s. 5d. carried forward.

In electricity supply the private consumers now connected with the mains represent an equivalent of 7,628 8 c.p., and this department continues to make satisfactory progress. During the year new generating machinery has been fixed at the power station, increasing the capacity by 600kw.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)—The directors' report for the year to Dec. 31 last states that revenue shows a credit balance of £14,591. 10s. 1d., including £2,673. 16s. 6d. brought forward, and after deducting £4,287. 12s. interim dividend, there is £12,977. 14s. 7d. for distribution. It is proposed to pay a final dividend of 3½ per cent., tax free, absorbing £6,002. 12s. 9d. (making 6 per cent. for the year), to transfer £4,000 to reserve, and to carry forward £2,975. 1s. 10d. The Indian subsidiary companies have both maintained their dividends of 6 per cent. The adoption of metallic telephone circuits has for some time back been under consideration, and as the installation of cables would involve large expenditure, negotiations have been entered with the Government of India for an extension of the licences of the companies interested. These negotiations it is believed will soon be brought to a conclusion.

The Telephone Company of Egypt (Ltd.) has again declared the full preferred dividend of 7½ per cent. During the past year a contract was entered into for the underground cabling of Cairo and Alexandria, which it is hoped will be completed during the current year. The Egyptian Government are erecting trunk telephone circuits between the two cities, and when the Company's reconstruction is completed facilities will be afforded to its subscribers for telephonic intercommunication.

The China and Japan Telephone and Electric Co. (Ltd.) has paid its debenture interest, but the accounts have not yet been audited. The business at Hong Kong continues to make progress.

At this company's own stations the increase of business has been steady, and a licence has been granted by the Government of India for an exchange at Bangalore. The company's electric lighting branch has made satisfactory progress, but more capital is required.

OSWESTRY ELECTRIC LIGHTING AND POWER CO. (LTD.)—At the annual meeting last week the report presented by the directors stated that the sale of current continued to increase steadily. The profit for the year amounted to £262. 3s. 2d., and a dividend at the rate of 4 per cent. was recommended. On the motion of the chairman (Mr. A. Wynne Corrie) the report was adopted.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—The amount of electricity sold by this company during the Lady Day quarter is returned at 1,989,972 units, estimated to produce £33,995, against 1,778,340 units, which produced £30,899, for the corresponding period of last year.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed May 7 as a special settling day in 51,501 £10 fully-paid 5 per cent. cumulative preference shares, 30,999 £10 (£5 paid) 5 per cent. cumulative preference shares, £655,341 4 per cent. first mortgage debenture stock, and provisional certificates (£50 per cent. paid) for £169,659 4 per cent. first mortgage debenture stock of the *London United Tramways (Ltd.)*, and the further issue of 2,200 £10 fully-paid ordinary shares of the *Notting Hill Electric Lighting Co. (Ltd.)*, and the securities have been ordered to be quoted. The Committee has been asked to appoint a special settling day in 65,000 £1 shares (15s. paid) of the *W. R. Sykes Interlocking Signal Co. (Ltd.)*

URBAN ELECTRIC SUPPLY CO. (LTD.)—The report for 1901 presented at the meeting yesterday (Thursday) stated that the necessary Parliamentary powers for electric lighting and traction having been obtained, an issue of 30,000 £5 preference and 30,000 £5 ordinary shares was made in June, and fully subscribed. The guaranteed dividends upon both classes of shares were paid on Oct. 1 and April 1 under agreement with Edmundson's Electricity Corporation. Substantial progress has been made with the business of the company. At Stamford and Hawick the electric lighting works have commenced to supply current, and at Twickenham, Weybridge, Godalming, Dartmouth, Camborne and Redruth supply will be commenced within the next few months, and before the end of the year lighting works will be in operation at Glossop and Newton Abbot. The tramways between Camborne and Redruth are expected to be open for traffic in August, and those in Glossop before the end of the year. This report was, on the motion of the chairman (Mr. F. E. Gripper), adopted.

WOOLWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)—The report for 1901, which was presented at the meeting last week, stated that, owing to the difficulty in obtaining fresh consumers while the negotiations were pending for the sale of the undertaking to Woolwich Corporation, the equivalent 8 c.p. lamp connections had only increased from 19,425 to 22,986, and the receipts from sale of current from £6,109 to £7,858. A contract for the sale of the undertaking to the Corporation as from Jan. 1, 1901, for £80,000, was signed on Oct. 4, the Corporation repaying all additional capital expenditure incurred after Jan. 1, 1901. It is expected the completion of the agreement will be carried out about the end of the year. Interest at 4 per cent. per annum on the purchase money and on additional capital expenditure from Jan. 1, 1901, up to actual date of completion of purchase, will be paid by the Corporation. The company is working the undertaking on behalf of the Corporation until completion of the contract, the Corporation taking the profit and paying the company interest, as already stated. The profit on the year's trading was £3,170. 6s. 9d. After paying debenture interest, &c., amounting to £1,223. 9s. 4d., this would leave £2,351. 4s. 1d. available for dividend. The directors recommend payment of a dividend of 6 per cent. which will absorb £1,500. The report was adopted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Apl. 12	569	− 66	45	31,951	+ 2,031
*Birmingham Tramways.	„ 19	4,792	+ 536	15	68,813	+27,138
*Blackburn Corporation.	„ 18	718	+ 143	16	10,036	+ 1,457
Blackpool Corporation...	„ 17	440	+ 150	3	1,215	− 318
Blackpool and Fleetwood	„ 19	278	+ 9	16	3,601	+ 359
Bolton Corporation	„ 20	1,539	+ 12	3	4,187	− 509
Bradford Corporation ...	„ 13	2,635	+1,631	2	7,099	+ 4,983
Brisbane Tramways.....	Mar. 5	2,322	+ 184	10	22,945	+ 1,894
*Bristol Trams & Carriage	Apl. 18	4,314	+ 258	15	61,438	+ 5,127
Burnley Corporation ...	„ 19	661	+ 247	‡3	1,911	+ 526
*Buenos Ayres & Belgrano	Mar. 23	2,722	− 49	12	32,383	− 458
Calcutta Tramways Co...	Apl. 19	R22,035	+R2,067	16	R354,219	+R28,900
Carlisle Tramways Co....	„ 19	146	− 6	†16	2,043	+ 79
Central London Railway	„ 19	6,757	+ 314	16	105,952	+ 7,968
City & South London Ry.	„ 20	2,810	+ 874	16	47,543	+15,417
Cork Elec. Tramways Co.	„ 17	433	+ 13	§15	5,688	+ 203
Devonport & Dist. Trams	„ 11	379	...	14½	5,530	...
Dover Corporation	„ 19	194	− 1	3	541	+ 128
Dublin & Lucan Railway	„ 20	100	− 4	16	1,439	+ 143
Dublin Southern Dist....	„ 18	978	+ 221	¶15	11,232	+ 3,406
Dublin United	„ 18	3,543	+ 98	¶15	52,173	
Dudley—Stourbridge ...	„ 11	595	− 268	14½	9,360	+ 1,819
*Dundee Corporation ...	„ 16	761	+ 179	...	...	...
Gateshead & Dist. Trams	„ 11	619	...	14½	9,125	...
*Glasgow Corporation ...	„ 19	11,530	+2,236	19	203,798	+78,408
Greenock & Port Glasgow	„ 11	454	+ 263	14½	5,518	+ 3,058
Hartlepool Tramways ..	„ 11	229	− 25	14½	2,711	+ 146
*Huddersfield Corpn. ...	...	...	...	...	...	...
Hull Corporation	„ 19	1,626	+ 102	3	4,955	− 33
Isle of Thanet Co.	„ 19	490	+ 101	...	...	...
Kidderminster & Dist....	„ 11	93	− 77	14½	1,408	+ 137
*Liverpool Corporation...	„ 12	8,893	− 255	15	132,806	+13,319
Liverpool Overhead Rly.	„ 20	1,445	− 199	‡16	22,441	− 1,887
Manchester Corporation	„ 19	2,327	...	§45	91,673	...
Merthyr.....	„ 11	169	− 185	14½	2,813	− 185
Middleton	„ 11	244	...	2½	769	...
Newcastle-on-Tyne Corp	„ 19	2,356	...	...	...	...
Oldham, Ashton & Hyde.	„ 11	447	− 165	14½	6,731	− 18
Perth (W.A.) Elec. Trams	„ 18	609	+ 104	‡42	40,798	+13,692
Poole & Dist.....	„ 11	227	− 31	14½	2,858	− 31
Portsmouth Corporation	„ 19	1,415	+ 846	...	...	...
Potteries	„ 11	1,331	− 251	14½	19,675	+ 669
*Salford Corporation ...	„ 21	2,212	...	‡51	94,155	...
*Sheffield Corporation ..	„ 20	3,762	+ 302	16	58,556	+12,697
Southampton Corporat'n	„ 17	825	+ 154	15	12,052	+ 2,506
Southport Tramways ...	„ 11	199	− 39	14½	2,177	+ 535
*S. Staffordshire Trams...	„ 11	656	− 406	14½	10,484	+ 540
Swansea Trams.....	„ 11	409	− 89	14½	5,938	+ 566
Taunton Trams.....	„ 11	53	...	14½	790	...
Tynemouth & Dist.	„ 11	207	− 104	14½	2,836	+ 118
Wolverhampton District	„ 11	119	+ 42	14½	1,897	+ 1,216

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶Plus 3 days

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 16.	Price Wednesday, Apr. 23.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 23. Highest	Lowest
			ELECTRICITY SUPPLY.			£ s. d.			
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞ ⅞	1 1			...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100 101	100 104	4 6 9	...	...	...
£7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11 12	11 12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103 106	103 106	6 5 2	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9 9½	9 9½	4 4 8	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9⅝	9 9½	3 13 8	March and September	...	...
20,000	5	2/6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8½ 9⅛	8⅛ 9¼	2 7 4	...	...	...
10,000	5	...	Do (Nos. 20,001-30,000)	8 9	8 9		...	8¼	...
£250,000	Stock	...	Central Electric Supply Co. 4% Guar. Deb. Stock	106 108	106 108	3 14 9	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. Corp.	9 10	9 10	5 0 0	February and August	9 7/16	9 5/16
50,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6¾	5½ 6¾	3 18 3	" "	5⅞	...
£250,000	Stock	4/0	Do. 4% Deb. Stock Red.	105 107	105 107	3 15 6	...	...	...
44,426	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	6½ 6¾	5½ 5¾	3 9 7	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 113	110 113	4 0 2	June and December	...	...
70,879	10	10/0	City of London Electric Lighting Ord.	8 9	8 9	5 5 7	February and August	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12⅛	12⅜
£100,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 123	123 128	3 18 10	June and December	...	...
£200,000	Stock	4½%	Do, 4½% 2nd Deb. Stock Certs. (all pd.)	103 106	103 106	4 6 0	...	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8 9	8 9	4 8 11	...	8 5/16	8
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	12⅜	12⅛
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	107 110	107 110	4 3 0	...	109⅛	108⅜
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	6⅜ 6½	6⅜ 6½	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½ 6¾	6½ 6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...	...
£100,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	103 106	104 107	3 14 11	...	...	...
110,000	3	...	London Electric Supply Ordinary	1⅛ 2	1½ 1⅝		...	105	...
42,340	5	3/0	Do. 6 per Cent. Preference	4½ 4⅝	4½ 4⅝	6 6 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95 100	95 100	4 0 0	...	4 1/16	4⅛
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	14½ 15½	15 16	4 1 3	Mar., June, Sept., Dec.	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 115	111 115	3 18 2	April and October	1 ⅛	1 1/16
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 100	97 100	3 10 8	June and December	...	...
8,652	10	6/0	Notting Hill Electric Ordinary	14 15	14 15	4 0 0	...	...	...
10,000	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	March	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	98 101	93 101	3 19 3	"	...	...
300,000	1	...	Rand Electric	1/16 1/16	1/16 1/16	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	65 70	65 70	...	...	...	...
£107,800	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	102 104	102 104	4 3 4	January and July	...	...
40,000	5	9 6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	April and October	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8 9	8⅞ 9⅜	3 13 8	February and August	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98 101	98 101	3 9 6	" "	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝ 2½	1⅝ 2¼	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2½ 3½	2½ 3½	...	...	...	...
109,518	5	5 6	Westminster Electric Supply Ordinary	11⅝ 12⅛	11 12	4 7 6	March and September	12	11 15/16
28,141	5	...	Do. 5 per Cent. Cumulative Preference	...	3¾ 4	...	...	3¾	3 15/16
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	3⅞ 4⅛	3⅞ 4⅛	4 17 0	April and October	4⅛	4 1/16
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125 130	115 130	4 13 9	...	124⅜	126⅛
20,000	10	...	Barcelona Tramways Ordinary	7⅛ 8⅛	7⅛ 8⅛	...	...	7⅛	...
10,000	10	5/0	Do. 5% Cumulative Preference	8 9	8 9	5 11 1	...	...	...
£49,800	100	5%	Do. 5% Debentures	96 100	98 102	4 18 9	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	92 97	92 97	4 12 9	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13 14	13 14	4 12 10	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	2⅝ 3⅛	3 3⅛	...	...	3⅛	...
75,000	5	2/8	Do. 5% Cum. Pref.	4½ 5	4½ 5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	103 106	103 106	4 5 9	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	110 112	09 111	3 12 1	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	6⅜ 7⅛	6⅜ 7⅛	2 15 2	...	...	...
20,000	10	5/0	Do. 5% Preference	9⅛ 9⅜	9¼ 9⅜	5 2 7	May and November	9⅜	...
£25,000	40	4½%	Do. 4½% 1st Mort. Debs.	100% 102%	100% 102%	4 8 0	...	...	...
100,000	10	6/0	British Electric Traction Ordinary	13⅛ 14⅛	13½ 14½	6 4 2	...	14	12 15/16
100,000	10	6/0	Do. 6% Cum. Pref.	12½ 12¾	12½ 12¾	4 14 1	February and August	13⅝	13 1/16
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126⅛	124⅛
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝ 1⅞	1⅝ 1⅞	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	5 5⅛	5 5⅛	5 9 1	...	5 5/16	...
27,500	5	3/0	Do. "B"	5⅛ 5⅜	5⅛ 5⅜	4 15 8	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 4	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 0	...	97½	...
34,440	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	13⅛ 14	13½ 14½	2 1 5	...	14¼	14
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	106 108	106 108	4 4 0	...	108	10 ½
440,000	1	1/2⅜	Cape Electric Tramways Shares	2⅜ 2⅝	2⅜ 2⅝	4 4 2	...	...	...
£1,969,800	Stock	4%	Central London Ordinary Stock	103 106	103 105	3 15 11	June and December	106	105
£440,100	Stock	4%	Do. 4% Preferred Stock	103 106	103 106	3 15 11	...	106	105
£440,100	Stock	4%	Do. Deferred Stock	99 102	100 103	3 17 1	...	103	...
£698,201	100	4%	Do. 4% Deb. Prov. Scrip. Certs	116 118	116 118	3 8 0	...	...	...
40,000	5	2/6	City of Birmingham Trams, Co. 5% Cum. Pref.	5 5⅛	5 5⅛	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...	...
£855,000	Stock	2½%	City and South London Railway Con. Ordinary	65 68	65 68	2 18 10	February and August	68	67
37,500	10	1/0⅛	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	" "	...	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	... ...	... ...	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 15 5	" "	...	...
£200,000	Stock	5%	Do. (1896)	123 126	123 126	3 19 4	...	125½	...
£150,000	Stock	...	Do. (1901)	120 124	120 124	...	...	124	123½
£13,913	Stock	4%	Do. 4 per Cent. Perpetual Debenture	112 116	112 116	3 9 0	May and November	116½	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11½ 12⅛	11⅛ 12⅛	4 0 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½ 15⅛	14½ 15⅛	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...	...
20,000	5	6,0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4 4½	4 4½	6 13 4	...	...	...
78,600	10	3,0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	...	1⅛	8⅝
30,000	10	8%	†Imperial Tramways Ordinary	26½ 27⅛	26½ 27½	3 18 6	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14 14½	14 14½	4 0 0	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110 112	110 112	4 0 6	January and July	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4⅞ 5	4⅞ 5	3 0 0	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅜ 11	10½ 11	4 11 1	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98 99	98 99	4 0 0	January and July	...	...
£350,000	Stock	4%	Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd)	102 104	102 104	3 16 11	...	103⅝	103
$6,103,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	111 115	111 115	4 6 11	...	...	...
£50,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	103 105	103 105	4 15 3	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	102 104	102 104	4 6 7	...	...	...
24,000	5	4/0	New General Traction Ordinary	2½ 3⅛	2⅜ 3⅛	5 14 4	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4 5	4 5	6 0 0	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96 100	96 100	5 0 0	...	...	...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stock	99 102	99 102	4 13 2	...	101	...
40,334	10	8/0	Potteries Electric Traction Ordinary	9½ 10⅛	9½ 10⅛	3 16 2	...	...	...
20,000	10	5,0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	10⅝	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	106 109	106 109	4 2 9	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	... ...	... ...	...	...	...	...
51,132	1	...	Do. 6% Preference (10/0 paid)	... ...	... ...	...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	... ...	... ...	...	" "	...	...
£500,000	Stock	...	Do. 4½% Debenture Stock (50% paid)	... ...	... ...	...	January and July	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	91 94	91 94	3 4 0	June and December	94	92½

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 16.		Price Wednesday, Apr. 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 23.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅜	4⅜	3⅜	4⅜	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...		...	...
£804,720	Stock	12/6	Anglo-American	44	47	44	47	5 19 5	Feb., May, Aug., Nov.	45½	...
£3,097,640	Stock	25/0	Do. Preferred	86	88	87	89	6 10 8	" "	89	87
£3,097,640	Stock	2/0	Do. Deferred	6⅞	7⅛	7	7⅛	1 6 8	" "	7⅜	7⅛
$13,333,300	$100	$1⅓	Commercial Cable Capital Stock	159	161	159	160	5 0 0	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	93	96	93	96	4 3 4	" "	94⅜	94
16,000	10	4/0	Cuba Submarine Ordinary	4⅛	5⅛	4	5	8 0 0	February and August	4⅛	...
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 10	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	3	4	3	4	5 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8⅜	9⅛	8⅜	9⅛	5 5 3	" "	9⅜	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	98⅞	102⅞	98⅞	102⅞	4 8 3	January and July	...	...
60,710	20	3/0	Direct United States Cable	9⅛	10⅛	9⅛	10⅛	6 3 10	Jan., Apr., July, Oct.	10⅛	9⅜
£101,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200) (red.)	124	132	122	134	5 5 3	Jan., Apr., July, Oct.	127	122
£1,930,507	Stock	17/6	Do. 3½ per Cent. Preference Stock	83	86	83	86	4 1 5	" "	85½	84½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	105	109	105	109	3 14 3	May and November	107⅜	106½
300,000	10	2/6	Eastern Extension	12⅛	13⅛	12⅛	13⅛	5 3 8	Jan., Apr., July, Oct.	13 3/16	12⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	108	113	108	113	3 11 6	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	98	101	98	101	3 17 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞	103⅞	100⅞	103⅞	3 17 8	May and November	102½	101
150,000	10	5/0	Great Northern of Copenhagen	27	29	27	29	5 3 5	January and July	...	...
£75,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos	99	103	99	103	4 8 3	June and December	...	...
17,000	25	12/6	Indo-European [1 to 1,200) (red.	35	39	35	39	6 8 2	May and November	37½	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	6%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 7	June and December	...	...
15,609	...	...	*West African Telegraph Shares	1½	2½	1½	2½	...		...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99	101	99	101	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	⅜	⅝	⅜	⅝	...		...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅜	⅝	⅜	⅝		May and November	...	...
34,563	10	£/0	Do. 6 per Cent. 1st Preference	5	5½	5	5½	5 9 1	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3	4½	3½	4½	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	12	13	12	13	5 12 0	Mar., June, Oct., Dec.	12	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 3	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 18 5	...	...	...
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3½	4	3½	4	6 5 0	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	¾	½	¾	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	96½	95½
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	3⅛	3⅜	3⅛	3⅜	6 4 6	...	3 5/16	...
£1,966,667	Stock	4½%	Do. Deferred Stock	58	61	57	61	7 7 7	...	58½	57
15,000	10	0/0	Do. 6 per Cent. Cumulative 1st Preference	13	15	12	14	4 5 9	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	12	14	4 5 9	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅛	5⅛	4⅛	5⅛	4 17 7	" "	4⅜	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	93	96	93	96	3 13 0	June and December	...	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	101	105	101	105	3 16 2	...	103	...
171,504	1	0/6	Oriental	1/16	1	1/16	1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	4½	5½	4½	5½	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	5 0 0	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	105	102	105	4 15 3	June and December	...	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛	¼	⅛	¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛	¼	1/16	⅛	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜	½	⅜	½	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	8⅜	9⅛	8	9	8 6 8	July and February	8⅜	...
70,000	5	5/0	Do. 6 per Cent. Preference	5⅝	6⅛	5⅝	6	5 0 0	January and July	...	...
£250,000	Stock	50/3	Do. 4½% 1st Mort. Deb. Red.	102	105	102	105	4 5 11	...	103	...
150,000	5	3/0	British Westinghouse 6% Preference	5⅜	6	5⅜	6	5 0 0	...	6	5⅞
105,731	2	...	Brush Electrical Engineering	¾	1	¾	1		March	¾	⅞
150,000	2	1/3½	Do. 6 per Cent. Pref. Non-Cum.	1⅛	1⅜	1⅛	2	3 0 0	March and September	1 1/16	1 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	101	104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	97	100	95	100	4 10 0	January and July	...	...
80,000	5	5/0	Callender's Cable Construction Ord.	17	18	17	18	4 3 4	" "	17⅜	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	6	5⅛	6	4 3 4	" "	5 15/16	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111	115	111	115	3 18 4	November and May	...	...
£150,000	1	0/4½	Castner-Kellner Alkali Co. (fully paid)	⅜	½	¾	1	3 0 0	...	⅞	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	87	92	87	92	4 17 10	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅛	⅜	⅛	⅜	7 2 3	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	½	1	½	1	6 0 0	...	...	...
135,000	3	1/9	Crompton and Co. (Nos. 1 to 54,000)	3	3½	3	3½	6 8 6	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103⅝	105⅝	103⅝	105⅝	4 16 2	" "	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅜	1	⅜	1	6 0 0	...	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜	⅝	⅜	⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	2	3	2	3		" "	...	...
£344,022	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	78	83	78	83	4 15 3	June and December	...	...
£100,000	Stock	5%	Do. 5% 2nd Deb. Standing Prv. Cts. (all pd)	82	87	82	87	5 14 11	...	...	...
25,500	5	2/6	Edmundson's Electricity Corporation Ord.	6⅛	6⅜	6⅛	6⅜	5 3 3	Half-yearly	6 1/16	6⅛
20,000	5	3/0	Do. 6% Cumulative Preference	6	6⅛	6	6⅛	4 12 4	...	6⅛	...
£120,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	106	109	107	110	4 2 7	...	...	...
112,100	2	1/2½	Electric Construction Co.	1	1⅛	1⅛	1⅛	6 17 2	January and July	1 1/16	1 1/16
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅛	3	2⅛	3	4 13 4	July	...	...
£132,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97	101	97	101	3 19 3	January and July	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	9⅜	10⅛	9⅜	10⅛	4 17 7	...	...	...
£210,000	Stock	4%	Do. 4% 1st Mortgage Debentures	93	101	98	101	3 19 3	...	...	...
35,000	5	10.0	Henley's Telegraph Works Ordinary	17	18	17	18	4 3 4	February and August	...	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	6	5⅛	6	3 15 0	" "	...	...
£49,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	115	111	115	3 18 3	" "	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
£7,350	12	36/0	Telegraph Construction and Maintnce.	34	37	34	37	6 9 8	March and July	37	33½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 5	January and July	...	...
25,000	5	4/0	Do. Manufacturing Ordinary	10⅜	11⅛	10½	11½	5 4 4	...	10⅜	...
10,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅜	6	5⅜	6	4 3 4	...	...	...
66,666	5	5/0	Willans and Robinson Ordinary	8⅜	9⅛	8⅜	9½	5 5 3	April and October	...	...
66,666	5	3/0	Do. 6 per Cent. Cumulative Pref.	6⅛	6⅜	6⅛	6⅜	4 8 1	" "	6⅜	6⅛
£ 67,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105	107	105	107	4 0 2	May and November	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	5⅜	5⅛	5⅜	5 9 1	...	...	...
180,527	10	1/9	Globe Telegraph and Trust	8⅛	9⅛	8½	9⅝	5 10 6	Jan., Apr., July, Oct.	⅝	⅝
190,042	10	3/0	Do. 6 per Cent. Preference	12½	13⅛	12½	13⅛	4 8 11	" "	13⅛	12⅝
11,889	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	7⅛	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	110	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

CONSIDERABLE satisfaction is felt with the Institution Council nominations for next session, published in our last issue. Mr. JAMES SWINBURNE, the Pre sident-elect, enjoys considerable popularity, so much so, that it was almost anticipated he would have been put up last year by a section of the Institution as a candidate for the presidential chair. The other new nominations are also viewed with general approval, and it is evident that the Council, including as it now does a large proportion of practical engineers eminent in their profession, may be considered as well representative of the Institution of Electrical Engineers.

REPORTS of the proceedings before Parliamentary Committees occupy a large amount of our space again this week. Considerable interest will doubtless be taken in the technical details of the competing tube railway schemes, the enormous "combines," financed by Mr. MORGAN and Mr. YERKES respectively, quite throwing the more modest schemes into the shade, both as regards millions of pounds and millions of watts. We published a map of the Morgan group of railways in our last issue, and propose to present our readers with a plan of the Yerkes lines in our next. The modification of the Metropolitan-District deep-level scheme to fit in with the latter has now been reported to the House of Commons for third reading, as has also the remarkable Bill of the London County Council for its shallow conduit tramways. Among others we may call attention to our report on the committee stage of the Cavehill and Whitewell Tramways Bill, which throws an interesting sidelight on the law appertaining to tramways in Ireland; and of the London County Council (Electric Supply) Bill, which seeks to enlarge its own powers and those of the Metropolitan Borough Councils for purchasing company electricity supply undertakings. The latter may be regarded as a sort of counter-move to the establishment by companies of "bulk" supply works outside their own districts.

ELSTER and GEITEL'S latest researches, of which a summary appears in this week's "Contemporary Electrical Science" column, place the production of radio-active substances within the reach of the humblest physical laboratory. All that is required is an influence machine or induction coil for maintaining a thin wire, some 30ft. in length, at a potential of about 8,000 volts for three or four hours. At the end of that time the wire—preferably of aluminium or copper—has acquired a radio-active surface layer capable of discharging an electroscope or producing a photographic impression through black paper or aluminium foil. It is true that the activity is only temporary, but it lasts for several hours at all events, and suffices to produce two of the most characteristic effects. We have here, therefore, a popular and easily workable method of producing free ions—most probably positive electrons joined to atoms, the negative ones having been split off by the prolonged negative charge. The step so accomplished is, in many respects, similar to the production of magnetism without magnetic iron ore and electricity without amber, and may well have similarly far-reaching effects.

IT is not easy to sympathise with the difficulties of those who are unable to decide in their own minds whether electrolytic conduction is possible without electrodes. The fact that, in order actually to detect any current in the liquid, it appears necessary to introduce electrodes seems to obscure the real issue, and to set up a frame of mind which insists on denying the existence of a current because some of the ordinary evidences of it cannot be brought to bear. Mr. CARL HERING has discussed the question in a Paper before the American Institute of Electrical Engineers, a reprint of which appears in our issue this week. A novel method of proving that electrodeless conduction can take place is proposed by Mr. HERING, and, although he has not actually experimented with this method, it is quite easy to see that it must work. But there

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is a simpler experimental proof than Mr. HERING'S—viz., in the electromagnetic reaction between a varying current and a mass of electrolyte in its neighbourhood. For example, if a glass tube in the shape of a circular ring be filled with electrolyte, and be then placed in a plane parallel with and close to a primary coil, the coefficient of self-induction of the latter will be decreased by the mutual induction of the secondary current set up in the ring. This is incontestable evidence of electrolytic induction, nor is the evidence really weakened if the effect is produced by an alternating current. Moreover, an alternating primary current is by no means essential to success of the experiment, for it is equally successful if a steadily-growing primary current, lasting several seconds before attaining its maximum, is employed, the electrodeless current in that case being steady and uni-directional.

AN interesting Paper by Mr. B. E. F. RHODIN was read before the newly-formed Canadian Section of the Society of Chemical Industry on March 6th, giving details of the plant erected by the Canadian Electro-Chemical Co. for production of alkalies and chlorine compounds at Sault Sainte Marie, Ontario. A number of works have been built at this spot, which seems likely to become of considerable industrial importance as a result of its water-power developments. The works of the Canadian Electro-Chemical Co. are supplied with power from the St. Mary's river, and have generating plant installed equivalent to 660kw. The generators are 220kw. machines, and are each driven by a separate turbine working under a head of 19ft. The decomposing plant consists of 120 cells of the Rhodin type, and is designed to produce 4¼ tons of caustic soda and 9⅛ tons of bleach per day. At present, owing to the unfavourable commercial conditions, only one-half the plant is operating, but it is hoped in time to supply the whole of the Canadian demand for caustic alkali and bleaching powder from these works. The bleach and caustic produced are said to be of good quality and strength.

THE Rhodin cell is of the mercury type, and differs from the Castner cell chiefly in the method adopted for obtaining circulation of the fluid mercury cathode. From the figures given by RHODIN in his recent Paper, it appears that each cell takes a current of from 800 to 1,000 amperes, and that the average E.M.F. required per cell is 5 volts. Under these conditions each cell is said to yield 79·4lb. 75 per cent. caustic soda per 24 hours, with the equivalent amount of chlorine. Taking an average current of 1,000 amperes per cell per 24 hours, this yield represents 76lb. NaOH per 24,000 ampere-hours, or 1·434 grammes NaOH per ampere-hour. The theoretical yield is 1·495 grammes NaOH per ampere-hour, and the above figure, therefore, represents a current efficiency of 95·9 per cent. This is an unusually high efficiency even for a mercury cell, and until confirmatory figures are published we are disposed to regard it as one based on estimates, rather than on actual working results. The only figures published for the Castner cell, work out to a current efficiency of 91 per cent., and it would seem to be unlikely that the Rhodin cell will improve upon this result. The greater complication of the cell construction, and the higher E.M.F. required to work the Rhodin cell, are two features which will probably render the cost of the bleach and alkali produced rather higher than with the Castner cell—other conditions being equal. Our readers are probably aware that litigation between the Commercial Development Corporation, the owners of the Rhodin patents for this country, and the Castner-Kellner Company, has hitherto prevented the industrial operation of the Rhodin cell in the United Kingdom. Legal proceedings in connection with this case have been going on since 1899, and the fight over patents validity is not yet concluded.

IN this issue we conclude our abstract of Dr. SLABY'S Paper on the scientific basis of wireless telegraphy. In this, his latest essay, the author has, by concordant, deductive and experimental methods, abundantly succeeded in demonstrating the type of oscillation which occurs on the sending and receiving air-wires of a communicating system. Many doubtful points seem settled and further inquiries suggested by its appearance. It will come as a surprise to most that the oscillation set up on a wire by an induction coil is so nearly a pure tone, as Dr. SLABY'S micrometer experiments indicate. For it has, up to the present, been continually stated that the air-wire gives off waves of many frequencies—a whole spectrum, in fact—capable of inducing oscillations in receiving wires of any length, within certain limits, on which the waves may fall. And this very supposition has repeatedly been used to explain the non-success of attempts at tuning in, say, the original Marconi system. Hitherto, perhaps, the existence of a complex vibration on the sender has been assumed because of the wide latitude permissible in the length of the receiving wire rather than demonstrated by actual measurements on the sending wire itself. At any rate, the science of the air-wire is now taking a shape so definite that its principles should be helpful to the practical worker and inspiring to the inventor.

BUT while such satisfactory progress may be chronicled for the theory of the air-wire, no great advance is evident in that of the coherer. This all-important instrument is, for its action, dependent ultimately on principles so elusive and, apparently, complex and variable, that statements by different authorities are often contradictory, while observations of fact are not uncommonly paradoxical. As an example of this inconsistency on the part, let us say, of the coherer, some experiments on auto-decoherers by M. ROCHEFORT, which are described among our notes on contemporary science in this number, are aptly illustrative. It has, up to the present, been thought, not unreasonably, that the non-cohering contact, the auto-decohering contact, and the contact affording a coherence needing violence to annul it, formed successive stages in the closeness together of, or in the degree of pressure between, the the cohering surfaces. M. ROCHEFORT would alter the order just mentioned, however; for he has found that auto-decoherers become coherers which require tapping if the pressure between the particles be relaxed. This is just the reverse of what has been believed—or what would be expected. And while it furnishes, of course, merely one more instance of the playfulness of this baffling instrument, it adds considerably to the call for systematic investigation of the whole subject by patient, skilled observers.

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National Physical Laboratory.—It is announced that an anonymous donor has contributed the sum of £1,000 to the funds of the National Physical Laboratory.

South Wales Electrical Power Distribution.—The laying of the foundation stone of the first large generating station of the South Wales Electrical Power Distribution Co. took place on Wednesday at Pontypridd, the ceremony being performed by Sir Frederick Bramwell, Bart.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinheiro	Mar. 8, 1902 ...	April 24, 1902
Suakim—Jeddah	April 16, 1902 ...	April 25, 1902
Bolama	April 19, 1902 ...	—

Devonport Electricity Works.—The official inauguration of the Devonport Corporation electricity works took place last Monday, energy being now available for both public and private lighting. The works have been running temporarily since June last, during which time current has been supplied to two tramway companies.

Beware of Pickpockets!—A writer in a local paper at Sheffield, where there is a municipal electricity works, complains that the local authority, by not suppressing the gas company, is "letting another company take the bread out of the ratepayers' pockets."

Wireless Telegraphy.—Prof. R. A. Fessenden has been experimenting with a new system of wireless telegraphy which he has perfected, messages having been transmitted between stations 50 miles apart. According to the New York correspondent of the *Daily Telegraph*, the results were satisfactory, and Prof. Fessenden claims to dispense with the coherer in his apparatus.

Electricity Supply in Marylebone.—In connection with the purchase of the Metropolitan Electric Supply Co.'s Marylebone undertaking by the local Borough Council, an arbitration under the Lands Clauses Act will take place at the Royal Courts of Justice on May 12th to determine the price to be paid by the Marylebone Borough Council. The umpire is Mr. C. A. Russell, K.C., and the arbitrators Mr. Robert Vigers and Mr. Ryde for the Company and Council respectively.

The Royal Society.—The following were among the Papers down for reading yesterday: "The Conditions Determinative of Chemical Change and of Electrical Conduction in Gases, and of the Phenomena of Luminosity," by Prof. H. E. Armstrong, F.R.S.; "Contributions to a Theory of the Capillary Electrometer: I. The Insulation-Resistance of the Capillary Electrometer and the Minimum Quantity of Electricity Required to Produce a Visible Excursion," by G. J. Burch, F.R.S.

Conference of the Electrical Industry on the Factory Act of 1901.—We are informed that the Council of the Institution of Electrical Engineers has decided to call together representatives of branches of the electrical industry which are affected by the last Factory Act, which includes in its definition of a factory, electrical stations.

20. Electrical stations—that is to say, any premises or that part of any premises in which electrical energy is generated or transformed for the purpose of supply by way of trade, or for the lighting of any street, public place, or public building, or of any hotel, or of any railway, mine, or other industrial undertaking.

The meeting of the conference will be on Monday, May 12th, at 8:30 p.m. The place of meeting will be notified later on.

Electric Drill for Stoping.—An electric drill for use on mining stopes is employed in one of the mines of the Lancaster Gold Mining Co, South Africa, and, according to the *Johannesburg Star*, it is found to be very satisfactory in working. It is operated by a motor attached to the side of the drill, and the action is maintained by means of a cam, tappit and spring. The total weight is almost 200lb., and the motor is detachable, so that the entire apparatus can be moved from place to place easily. A hole 22½in. deep, commencing at 1⅜in. diameter, reducing to 1¼in. diameter was drilled in 20 minutes, with the exertion of ½ H.P., the motor speed being 1,400 revolutions, and the strokes delivered 850 per minute.

Storage Battery Traction.—The Brooklyn Rapid Transit Co. is making experiments with a view to adopting a storage battery system for its large network of lines, popular agitation having reached such a point that the removal of the trolley wires from the streets by the municipal authority may shortly be expected. The conversion to an open slot system, similar to the Manhattan Metropolitan Street Railway Co., would cost nearly $25,000,000, and the instalment of storage battery cars could, it is thought, be done for less. The *Electrical Review* of New York, in commenting on the prospect of the conversion, refers to the attempts at a successful operation of battery cars in the United States, the only practical outcome of these being the single line of cars doing cross-town service along Thirty-fourth Street, Manhattan.

Development of Plates Exposed to X-Rays.—The evening discourse on "X-Rays and Localisation," delivered at the Royal Institution last Friday by Mr. J. Mackenzie Davidson, commenced with a historical survey of the subject and gradually led up to the practical methods of employing X-rays at the present day. He explained the necessity of covering up the X-ray tube with red lead or a similar substance, leaving only one point transparent for the rays to pass out; and he surprised many of his hearers by pointing out that the plate impressed by the X-ray image could be developed by daylight, as the X-rays had a different effect on the sensitive film to that of light rays. The concluding part of the discourse was devoted to the methods employed for localisation after the X-ray picture had been taken from two points.

The Institution of Civil Engineers.—At the annual meeting of the Institution of Civil Engineers, held on Tuesday evening, Mr. Charles Hawksley, President, in the chair, the result of the ballot for the election of officers was declared as follows:—

President, Mr. J. C. Hawkshaw, M.A.; Vice-Presidents, Sir William White, K.C.B., Mr. F. W. Webb, Sir Guilford Molesworth, K.C.I.E., and Sir Alexander Binnie; other Members of Council, Mr. James Barton (Dundalk), Mr. Horace Bell, Mr. B. Hall Blyth (Edinburgh), Mr. Cuthbert A. Brereton, Mr. John Brown (Cape Town), Mr. R. Elliott Cooper, Col. R. E. B. Crompton, Mr. Cecil West Darley, Mr. George F. Deacon, Mr. W. R. Galbraith, Mr. E. P. Hannaford (Montreal), Mr. G. H. Hill, Mr. J. C. Inglis, Mr. G. R. Jebb (Birmingham), Dr. Alex. B. W. Kennedy, Sir William Thomas Lewis (Cardiff), Mr. J. A. McDonald (Derby), Mr. William Matthews, C.M.G., Mr. William Shelford, C.M.G., Mr. Alexander Siemens, Mr. Henry C. Stanley (Brisbane), Mr. John Strain (Glasgow), Mr. John I. Thornycroft, Prof. W. C. Unwin, B.Sc., Mr. F. R. Upcott, C.S.I., Sir Leader Williams (Manchester).

Tramways and Light Railways Association.—From the official circular of this Association we learn that the following arrangements have been made for the Tramway and Light Railway Congress, subject to alteration:—

The formal opening of the Congress to take place on Monday afternoon, June 30, at the Berners Hall, Agricultural Hall, Islington. The opening of the Tramway Exhibition to follow immediately after.

In the evening a réunion or conversazione to be held, when those invited will be the joint guests of the Union Internationale Permanente de Tramways and of the Association.

On the three following days, July 1st, 2nd and 3rd, Congress meetings will be held at the Berners Hall in the forenoon, and excursions will be made in the afternoon.

On Friday, the 4th, the Congress will sit until they complete their labours, and in the evening a banquet will be given by the Association at De Keyser's Hotel.

On July 5th, and possibly on the 6th, it is hoped that lengthy excursions may be arranged.

The headquarters of the Congress will be at the Agricultural Hall.

Cardiff Corporation Tramways.—The Cardiff Corporation purchased 9¼ miles of tramways from the local company, and took over the lines on January 1st last. This portion has been converted to electric driving, and was opened yesterday. The combined lighting and power station of the Corporation furnishes the necessary current to the rolling stock, which will comprise at the outset 120 single and double deck cars. These each have two motors of 30 H.P., a seating capacity of about 60 people, and both hand and electric brakes. The gauge of the track is 4ft. 8½in., and the trolley wire is supported from centre and side poles, the latter predominating. Lead-covered feeders of B.I.W. Co.'s make, laid in Doulton conduits, supply energy to the line. Current for the tramways is generated by five Musgrave-Westinghouse units, totalling 3,500 H.P. The maximum gradient of the route is 1 in 17, and the sharpest curve has a radius of 40ft. The Board of Trade inspection of the route took place on April 22nd.

Institution of Civil Engineers' Premiums.—The Council of the Institution of Civil Engineers have made the following awards for Papers read and discussed before the Institution

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during the past session :—A Telford medal (in standard gold) to Mr. W. M. Mordey, and a George Stephenson medal (in standard gold) to Mr. B. M. Jenkin, M.Inst.C.E., a Watt medal (in standard gold) to Mr. J. A. F. Aspinall, M.Inst.C.E., and Telford premiums to Messrs. W. C. Copperthwaite, A. H. Haigh, B.Sc., and J. Davis, MM.Inst.C.E. The Council have also awarded the Howard Quinquennial Prize of the Institution to Mr. R. A. Hadfield, M.Inst.C.E. (of Sheffield) for his scientific work in investigating methods of treatment and new alloys of steel, and on account of the importance, in industry, of some of the new products introduced by him. The presentation of these awards, together with those for Papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

Incorporated Municipal Electrical Association.—The seventh annual Convention of the Incorporated Municipal Electrical Association will be held in London on July 2, 3, 4 and 5, 1902. The following is a list of the Papers to be read and discussed, and preliminary information as to other matters in connection with the meeting :—

Wednesday, July 2nd.—(1) Presidential address, J. H. Rider ;[1] (2) "Double-current Generators and their Application," E. T. Ruthven-Murray ; (3) "H. T. Continuous-current Systems," A. S. Barnard.

Thursday, July 3rd.—(1) "Steam Turbines," S. E. Fedden ; (2) "The Correct Type of Engine for large Generating Stations," A. A. Day.

Friday, July 4th.—(1) "Some Notes *re* Earthing," H. Faraday Proctor ; (2) "Two *versus* Three-Wire Distribution," J. F. C. Snell.

Visits to Works, &c.—Arrangements are in hand for visits to be made to various works and other places of interest.

Social Functions.—It has been arranged to hold either the usual annual dinner or to substitute a smoking concert, as the majority of the members may decide. It has been thought that a smoking concert would afford a better opportunity for members to meet one another, and especially for enabling the newer members, whether councillors or engineers, to become known to each other.

Further details and full programme will be issued in due course.

The Automobile Club Trials of Electric Vehicles.—The date of these trials has been fixed for July 7–12, 1902. The trials will last five days, and cars may be entered in either of the following classes :—

1. Town carriages.
2. Country carriages weighing *over* 30 cwt., including accumulators.
3. Country carriages weighing *under* 30 cwt., including accumulators.

The following routes have been selected :—

(*a*) London to Brighton.
(*b*) Brighton to London.
(*c*) London to Sandown and back.
(*d*) London to Windsor and back.
(*e*) London to Ascot and back.
(*f*) Special route for observations.

Special optional routes will be selected for town carriages.

In order to enable the trials committee to make efficient arrangements for the charging of cars, manufacturers of electric carriages are requested to inform the club secretary how many cars they propose to enter in the trials, and to state in respect to each car :

(*a*) The charging voltage at the beginning and end of charge.
(*b*) The average current during charge.
(*c*) The approximate time required for charging.

Official entry forms will be forwarded in due course, together with full programme of the trials. Statements of the particulars now asked for do not bind manufacturers to enter the cars for the trials.

Electric Automobiles.—The *Centralblatt für Accumulatoren- und Elementen-kunde* for March 1st contains an abstract of the lecture recently delivered by H. P. Maxim before the Automobile Club of New York. Referring to the progress made in the design of accumulators for electric cars, the lecturer stated that three years ago the best type of cells had only a capacity of 5·6 ampere-hours per kilogramme of cell weight. To-day the best cells have a capacity of 10 to 11 ampere-hours per kilogramme of cell weight, and, consequently, the range of distance which can be run by electric cars on one battery charge has been doubled. The life of such accumulators has also been increased 25 per cent. by the improvements in the design of the plates, and the best accumulator cells can now be utilised for running 8,000km. before renewal of the battery plates is required. The improvements which have brought about this advance, relate chiefly to the use of more active material for the plates, and to the method of attaching this to the conducting medium, so that no loss occurs by accidental shocks or by continued use. The cell divisions in the latest designs of accumulators are formed of thin plates of wood. This material is cheap, porous, only slowly attacked by the acid, and, when provided with vertical ribs, it can be pressed against the carriers holding the active material without interfering with the flow of acid to all parts of the cell. Although the accumulator cell for traction purposes is still far from perfect, no other automobile, in the lecturer's opinion, approaches the convenience or comfort of the electric automobile for general use. This type of machine is only likely to be supplanted by the light spirit or petroleum type of automobile, where the cost per car-mile is the chief consideration, or where the distances to be covered are beyond the range o the electrically-propelled vehicle.

The Mains Department of a Continuous Current Electricity Works.—Mr. G. F. Moore made the above the subject of a Paper before the Newcastle Local Section of the Institution of Electrical Engineers on April 7th last. The type of mains to be adopted was first discussed, the points raised being : The liability to short-circuit or earth, repairs, alteration to any section, first cost and life. The various systems were criticised under these heads, no one of them, it appears, filling all the author's requirements. Short circuits in distributors of large sections might be burned out by reason of the energy available, but the feeders presented a vulnerable point in the system. The taking of positive, middle and negative feeders to one point was debated, it being possible to obtain better pressure distribution by separating the poles by a distance of some hundred yards. Methods of insulation testing and localisation were dealt with briefly, Mr. F. C. Raphael's book and Mr. A. Russell's Papers being referred to for details. Meters, Mr. Moore remarks, are preferably tested from some steady source of energy, such as a special battery, rather than from the supply mains. He considers that the maximum demand and discount systems should not be used on the same system of supply, and that meter rents would become more acceptable to the consumer, if a nominal charge were made. Tables comparing electric and gas lighting costs were also given, as well as a list of the books necessary to a mains department. The cost of mains and their laying was illustrated by three curves, following a straight-line law, representing two cables laid with three-way Doulton casing (A), two cables laid solid, or in cast-iron pipes, or in two-way Doulton casing (B), and armoured concentric cable laid direct in the ground (C). Under A, 1 sq. in. cable cost about 14s. a yard, 0·75 cable 38s. per yard, B, for the same sectional areas, was 13s. 6d. and 37s. per yard, while C was 11s. and 31s. per yard, the intermediate sizes 0·15, 0·25, 0·5 being on straight lines connecting these extreme points in the three cases.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 2nd.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Ordinary Meeting at Westminster Palace Hotel. Paper to be read : "Some Factors in Colonial Railway Construction," by Lewis H. Rugg.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by A. E. Tutton, F.R.S., on "Experimental Researches on the Constitution of Crystals."

SATURDAY, May 3rd.

INSTITUTION OF ELECTRICAL ENGINEERS : STUDENTS' SECTION.

2 p.m. Visit to the Deptford Generating Station of the London Electric Supply Corporation.

MONDAY, May 5th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture IV. : "Glass for Optical Instruments," by Dr. R. T. Glazebrook, F.R.S.

WEDNESDAY, May 7th.

INSTITUTION OF ELECTRICAL ENGINEERS : STUDENTS' SECTION.

7:30 p.m. Meeting at 28, Victoria-street, S.W. Paper to be read : "Electric Light and Power Cables," by F. H. Langford.

THURSDAY, May 8th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Society of Arts, John-street, Adelphi, when the discussion on the "Form of Model General Conditions," &c., will be concluded.

SATURDAY, May 10th.

INSTITUTION OF JUNIOR ENGINEERS.

10 a.m. Visit to the Great Eastern Railway Co.'s Stratford Works.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Diffusion of Electrolytes.—If an acid containing an electrolyte is made to diffuse into a solution of the same electrolyte, the latter undergoes changes of concentration which at first sight appear somewhat surprising, but which are easily explained by the theory of dissociation. J. Thovert fills a test tube to one-third with a 0·4 solution of HCl, and the rest with a 0·39 solution of NaCl. After 16 hours the concentration of NaCl at the top of the test tube has fallen to 0·384, and after 47 hours to 0·378, whereas it is increased in the lower portions. The same applies to KCl, and to a solution of nitric acid diffusing into a solution of silver nitrate. But when the lower solution consists of sulphuric acid and the upper of HCl, the latter is driven up instead of down, and its concentration increases at the top instead of at the bottom. According to the osmotic theory, if an electrolyte is split up into ions, osmotic pressure, working against different ionic frictions, would cause a separation of the components if the solution has layers of different concentration. Hence, electric forces are brought into play, leading, in the first case quoted, to an increase in the velocity of the H ions, and a retardation of the Na ions, so that the latter are crowded out at the upper surface.

[J. THOVERT, *Comptes Rendus*, April 14, 1902]

Faraday Effect.—The effects of rotatory magnetic polarisation have lately received increased attention in view of the light which they throw upon the motions and distribution of ions in dielectrics and electrolytes. Siertsema recently extended the magneto-optic dispersion curve of potassium ferricyanide till close upon the limit of absorption. H. du Bois maintains that the Faraday effect is either positive or negative for the compounds of the different metals of the erbium series. The salts of cerium, praseodymium, neodymium, samarium, gadolinium, erbium and ytterbium are strongly paramagnetic, and the absorption spectra of cerium, gadolinium and ytterbium show peculiar lines and bands, concerning which we have an extensive literature. H. du Bois believes that researches made upon these three metals in connection with the magneto-optic properties are bound to yield valuable data for theoretical progress. He has not yet succeeded in finding any effect of a magnetic field upon the very characteristic absorption spectrum of the strongly magnetic erbium chloride solution. Experiments should be made, if possible, upon the absorption bands themselves.

[H. DU BOIS, *Ann. der Physik.*, No. 4, 1902.]

Validity of Ohm's Law.—The law enunciating the proportionality of a current to the ratio of the E.M.F. and the resistance in the circuit must now be expressed in terms of the known properties of the ions whose motions constitute the current. J. Stark formulates the equation

$$J_n = n_n \epsilon v_n X,$$

where J_n is the current density of the negative ions, ϵ their charge, v_n their specific velocity and X the force moving them. The same author now shows that the limit of the validity of Ohm's law is reached as soon as the difference between the driving forces at the beginning and at the end of the mean free path ceases to be small in comparison with the driving force itself. This may happen whenever, owing to some sudden change of medium, there is a surface accumulation of ions producing a strong electric field, or where, owing to exhaustion, the mean free path of the electrons is of visible length. It is well known that in the vacuum glow discharge the electric force is very great immediately at the cathode, whereas in the negative glow light it is little more than zero. The distance between the cathode and the negative glow light is smaller than the mean free path of the negative ions. There is, therefore, a steep slope of electric force just in that locality, and hence, also, the well-known invalidity of Ohm's law in the same place.

[J. STARK, *Ann. der Physik.*, No. 4, 1902.]

Spark Spectra.—When the poles between which electric sparks play consist of different metals, variations of the inductance of the circuit produce profound differences in the composition of the light of the sparks. B. Eginitis describes an experiment in which two aluminium wires about 1mm. thick are covered with a very small quantity of sodium up to a distance of 2mm. from the end. Sparks are made to play between the poles for a few seconds. They show the spectra of aluminium and of sodium. When the inductance is increased, the aluminium rays rapidly become feeble, whereas the intensity of the yellow sodium rays increases. A small coil 6cm. in diameter, and with a few turns of wire, suffices to shorten most of the aluminium lines. On further increasing the inductance, the aluminium rays gradually disappear, whereas the sodium rays become still brighter, and eventually become reversed. When the poles are only 1mm. apart, an inductance of 0·05 henrys suffices to eliminate the aluminium spectrum. At larger distances between the poles the inductance required is also larger. Similar results are obtained when platinum, iron, tin and other metals are substituted for aluminium, or when potassium is substituted for sodium. In the case of iron, however, the spectrum re-appears at very high inductances. The spectra which persist are those of the more volatile metals.

[B. EGINITIS, *Comptes Rendus*, April 14, 1902.]

Preparation of Radio-Active Substances.—J. Elster and H. Geitel give a detailed description of the preparation of radio-active surfaces by exposure to the air. The apparatus is comparatively very simple, and includes a wire which is to be made radio-active, a source of electricity capable of maintaining it at a negative potential of a few thousand volts, and, finally, an apparatus suitable for testing the acquired radio-activity, either by ionisation or by photographic effects. The best form of conductor to be made radio-active is that of a wire, since the electric density on its surface is comparatively high even at low potentials. Besides, the active surface of a wire may, as Rutherford showed in the case of thorium rays, be rubbed off and so transferred to leather, and obtained in a concentrated form for photographic purposes. The material of the wire should be either copper or aluminium. The active surface of the former may be rubbed off with the aid of a little ammonia, whereas that of aluminium may be detached by simple friction. The wire should be about 0·5mm. thick, and not shorter than 10 metres. The charged wire should be carefully insulated, as the induced activity increases with the potential to which it is charged. The charging is done by a water dropper or by an induction coil. The authors have succeeded in preparing active surfaces on leather in the manner indicated, whose activity equals that of uranium ore.

[ELSTER and GEITEL, *Physikal Zeitschr.*, April 15, 1902.]

Auto-Decoherers.—O. Rochefort discusses self-righting coherers with a view to dispose of what he considers a fallacy. It is often stated that the difficulty of regulating auto-decoherers is due to the fact that the limits between the imperfect contact which does not yet make up a coherer, and the imperfect contact producing a coherer which requires tapping, are too close together to allow of an imperfect contact producing a self-righting coherer. The author, on the other hand, shows that every self-righting coherer may be converted into an ordinary coherer by diminishing the pressure of the filings. His experimental results do not as yet enable him to say whether the converse also holds good. The practical importance of self-righting coherers is greatly increased by their successful employment for wireless telephony. By a slight modification of the soft-iron coherer the author has succeeded in using it both for wireless telegraphy and for telephony, accordingly as to whether it was used as an ordinary coherer or as an auto-decoherer. The soft-iron tube in question is derived from Tissot's tube. Such a tube, when "cohered" by a preliminary wave-train, shows a diminution of resistance which brings it exactly into the state of a highly sensitive auto-decoherer. This way of obtaining the required pressure is easier, more constant, and more certain than any mechanical means, which requires a too delicate manipulation.

[O. ROCHEFORT, *Comptes Rendus*, April 14, 1902.]

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REPORT OF THE COMMITTEE OF THE INSTITUTION OF ELECTRICAL ENGINEERS ON ELECTRICAL LEGISLATION.

The following report was adopted at the Council meeting on Thursday, April 10, 1902:—

Reference of Committee.

At the meeting of Council on March 14, 1901, the following were appointed members of the committee on electrical legislation to determine whether they can recommend the Council to take any action, and, if so, what action, that would assist the industry in connection with the matters dealt with in Mr. Madgen's Paper.*

Prof. W. E. Ayrton, F.R.S.	Mr. W. M. Mordey.
Major P. Cardew, R.E.	Prof. J. Perry, F.R.S. (*President*).
Lieut.-Col. R. E. Crompton, C.B.	Mr. R. P. Sellon.
Mr. S. Z. de Ferranti.	Mr. A. Siemens.
Mr. Robert Hammond.	Mr. C. P. Sparks.
Mr. H. Hirst.	Mr. J. Swinburne.
Mr. J. E. Kingsbury.	Mr. A. A. Campbell Swinton.
Mr. W. L. Madgen.	Prof. Silvanus P. Thompson, F.R.S.

Note.—On May 30, 1901, Mr. W. Langdon succeeded Prof. Perry as president, and became *ex-officio* a member and chairman of, but did not displace Prof. Perry on, the committee.

In the course of its inquiry the committee has met on 11 occasions. A number of gentlemen representing various shades of opinion upon the subject under consideration were invited to express their views The evidence of those who responded accompanies this report.

It will be seen from the evidence that, while taking divers views of subsidiary questions, the witnesses were practically unanimous in their conviction that electrical enterprise has not attained that stage of industrial development in this country which might fairly have been expected, having regard to the many favourable natural conditions, and having regard also to the achievements of British capital, labour and inventive genius in so many other branches of the mechanical arts. In considering the comparative development which might have been reached in this country, the committee has had in view, not only the extent of the plant employed, but also the source of its design and manufacture. As leading indicative cases, the committee may draw attention to the foreign equipment of the Central London Railway, the undisputed competition of American and Continental firms for the electrification of the Metropolitan District Railway, and the large orders executed abroad for the Dublin, Glasgow, Manchester, and numerous other corporations. The committee finds that the essential difference between the electrical industry as it exists in the United Kingdom and as it exists abroad is largely due to the exceptional legislative enactments, official regulations and powers of local authorities existing in this country. Thus British electrical engineers, capitalists and others concerned have been hampered by enactments and rules which other Governments have regarded as either unnecessary or opposed to public interests.

Under these conditions it has been possible for numerous local authorities to prevent any electrical supply whatever being provided within the area of their jurisdiction; and comprehensive traction schemes have been blocked, or only carried out at great unnecessary expense, owing to the opposition of one or two of the local authorities concerned.

A Joint Select Committee of the two Houses of Parliament, appointed so long ago as in 1898, reported that the law should be amended in so far as it gives local authorities the power of veto; but no steps have been taken to give effect to this recommendation. The committee considers that the acts restricting the electrical industry should be revised in order that there may be that development which is necessary to the commercial progress of the nation.

Besides the legislative enactments governing the projection, duration, expropriation, &c., of electrical undertakings, the committee considers that the Government departments should be put into such a position financially as would enable them to keep more in touch with the progress of science, so as to prevent them from continuing to enforce regulations which unduly impede engineering development.

The following resolutions embody the views and recommendations of the committee in respect to the matters covered by the reference of the Council:—

Resolutions passed by the Committee at its meeting on Tuesday, March 25, 1902.

1. That, notwithstanding that our countrymen have been among the first in inventive genius in electrical science, its development in the United Kingdom is in a backward condition, as compared with other countries, in respect of practical application to the industrial and social requirements of the nation.
2. That the cause of such backwardness is largely due to the conditions under which the electrical industry has been carried on in this country, and especially to the restrictive character of the legislation governing the initiation and development of electric power and traction undertakings, and the powers of obstruction granted to local authorities.
3. That local boundaries have usually no reference whatever to the needs of the community in regard to electric supply and traction; that the selection of suitable areas should be dealt with on the basis of economic principles and industrial demands; and that this has been found to apply also to gas, water and sanitary engineering.
4. That the development of electric power and traction undertakings offers the most favourable means of relieving congested centres, and of thus contributing towards the settlement of the housing question.
5. That it is expedient in the national interests that the Electric Lighting Acts, 1882–8, the Tramways Act, 1870, and the standing orders relating to special acts for tramways should be amended in so far as they enable local authorities to veto or delay the carrying out of electric supply and traction projects of which the utility can be shown; and that effect should be given to the recommendations of the Joint Select Committee of Parliament, 1898, on Electrical Energy—Generating Stations and Supply.
6. That excessive time is occupied and expense incurred in obtaining authority to carry out electrical undertakings, and that important and growing industries are thereby checked.
7. That while this committee fully recognises the ability of the technical officials of the Government departments concerned, it is of opinion that the staffs of those departments, as at present existing, are wholly inadequate, having regard to the great industrial interests involved; that it is essential that these departments should be put into a position enabling them to keep in touch with all developments in engineering matters, both in this country and abroad, and that a sufficient sum should be provided annually by Government to enable them to employ and pay a proper staff for such purposes.
8. That the adjustment of departmental regulations to engineering development should not be delayed until the industrial interests concerned are seriously hampered, and that, with a view to preventing any such delay, the Institution of Electrical Engineers should be willing to take part in revising such regulations from time to time.
9. That this committee recommends that the Institution should memorialise the Prime Minister to receive a deputation for the purpose of urging the removal of the present disabilities and restrictions which prevent electrical engineering from making the progress that the national interests demand, and attaining at least the same level as in America, Germany and other industrial countries.

* "The Electrical Power Bills of 1900: Before and After," by W. L. Magden, member. Published in the *Journal* of the Institution of Electrical Engineers, 1900, Vol. XXX. [Part 149], pp. 475-497, and *The Electrician*, Vol. XLVI., pp. 703, 740.

A MODIFIED FORM OF THE MOISSAN ELECTRIC FURNACE FOR LABORATORY USE.

The *Zeitschrift für Elektrochemie* for February 27th contains an illustrated description by Dr. L. Liebmann, of a laboratory

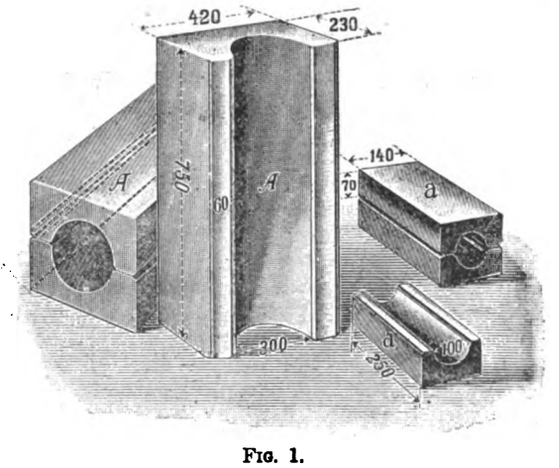

FIG. 1.

electric furnace which he has used for some months with most satisfactory results, for all kinds of electric furnace work. The furnace body is built up of the two types of moulded blocks

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shown in Fig. 1. The larger blocks, marked A, are made of the best fire clay, and in Germany are sold for about 9s. the couple. It is advisable to obtain them with a slight dip towards the centre of the hollowed-out portion, in order to retain any molten matter that may escape from the inner furnace. When the heating is carried out in these larger blocks, they should be lined with magnesia to protect them from the direct effects of the arc or molten mass. The smaller blocks, *a*, are obtained by splitting with a chisel the

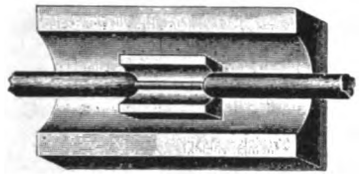

Fig. 2.

ordinary stoneware ducts, sold for enclosing electric cables. In Germany these are known as "Normalkabelsteine." They can be easily split into two equal halves, and are very cheap. These smaller blocks are not manufactured of specially heat-resisting materials, but their solidity is sufficient to resist one heating in the electric furnace, and they are so cheap and so easily obtained, that new ones can be used for every experiment. It is advisable to warm these blocks, and to coat the interior with magnesia before using in the furnace. Figs. 2, 3 and 4, show various methods of arranging the carbons in these channelled blocks, and Fig. 5 shows the complete furnace arrange-

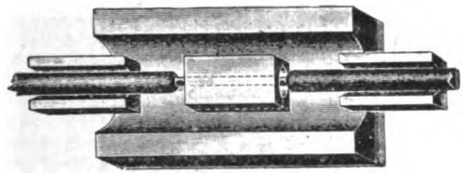

Fig. 3.

ment, with the leads and the water resistance for varying the current used. The author states that he has used this type of resistance since 1894, with the best results, and that both continuous and alternating current can be regulated by it with the greatest ease. In his experimental work the town supply of alternating current at 120 volts has been employed, and it has been necessary to reduce this to 60 volts for use in the furnace. This reduction has been effected by the resistance shown in Fig. 5, without difficulty, and currents up to 250 amperes have been passed through it.

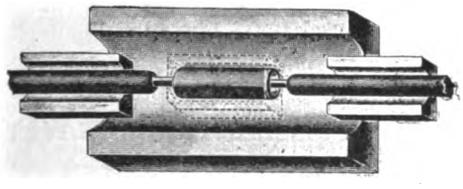

Fig. 4.

The following are the advantages claimed for this type of laboratory furnace:—

1. The furnace is always ready for use, either for arc or resistance heating.

2. The furnace can be used without difficulty or delay, either for heating small or large amounts of material; 20 grammes or 15kg. are the extremes of weight dealt with by the author.

3. The furnace is remarkably cheap to construct, and in this respect compares most favourably with the original types of electric furnace designed for laboratory work by Moissan and Borchers.

4. The furnace permits the heating of the substance to be carried out in any desired atmosphere, by the use or non-use of the channelled blocks, for covering the carbons and heated substance.

5. The furnace allows close observation of the progress of the heat reactions.

6. The furnace permits the use of currents varying from 20 to 1,000 amperes in intensity.

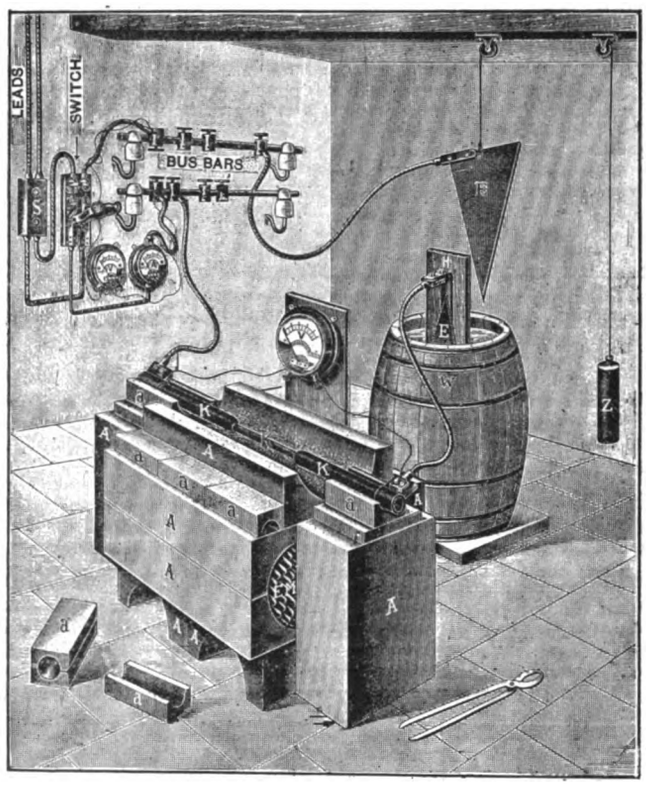

Fig. 5.

Dr. Liebmann has used this type of furnace for the laboratory production of calcium carbide, ferro-silicon, chromium, chrome-copper, molybdenum, and of phosphor-copper alloys with most satisfactory results.

THE SCIENTIFIC BASIS OF SPARK TELEGRAPHY.*

(*Concluded from page 8.*)

Oscillations in Closed Circuits.

The theory of electrical discharge in closed circuits possessing capacity and inductance was given by Lord Kelvin in 1853. His solution is based on the supposition that the current had the same value in all parts of the circuit at a particular moment. This supposition is equivalent to the assumption that the capacity of the conducting wire is negligible. It was desirable to determine whether this is near enough for practical purposes. The formula Lord Kelvin gave reduces to $T = 2\pi\sqrt{CL}$

whence $\lambda = vT = 2\pi\sqrt{Cv^2}.L = 2\pi\sqrt{CL}$

where in the last expression C and L are both in centimetres. This formula was experimentally tested. A series of Leyden jars of known capacity was formed into a circuit, closed, but for a spark-gap, by a measured length of wire, different lengths being used in different experiments. The half wave-length of the oscillation was measured by finding the resonance length of an insulated wire acted on inductively. The measured wave-lengths were found to be considerably smaller than those calculated by Kelvin's formula. That this is likely may be seen by noticing that in the limiting case when

* Abstract of a Paper by Dr. A. Slaby, *Elektrotechnische Zeitschrift*, No. 9, 1902.

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the condenser has no capacity, the formula used above for straight wires gives

$$\frac{\lambda}{2} = 2\sqrt{CL},$$

where C is the capacity of the wire; while, if the capacity of the wire is negligible, we have Kelvin's formula, which yields results about 36 per cent. larger than the other.

Kirchhoff has given the solution of the problem when the capacity of the wire is taken into account. Putting C′ for the capacity of the wire, and keeping C for the capacity of the condenser, as in Kelvin's formula, Kirchhoff's formula becomes

$$\frac{\pi l}{\lambda}\tan\left(\frac{\pi l}{\lambda}\right) = \frac{C'}{4C},$$

where l is the length of wire.

This equation reduces to the straight wire formula if C be infinitesimal, and to Kelvin's formula if C′ be negligible. To test this formula fresh experiments were made. An emitter of the Hertz form, consisting of two spheres at the extremities of a long straight wire broken at its middle to form a spark-gap, was used. It was suspended by insulating threads, and each half connected to a pole of an induction coil. The wave-length of the oscillations produced in this system was measured by finding the resonance-length of a parallel straight wire. Different spheres and different lengths of wire were used in the emitter and the results used to evaluate the capacity of the wire. The capacity of the spheres and the inductance of the wire were calculated from the ordinary formula. The results for the capacity of the wire tallied remarkably well with the same quantity calculated directly, and thus was demonstrated that Kirchhoff's formula can be absolutely relied upon.

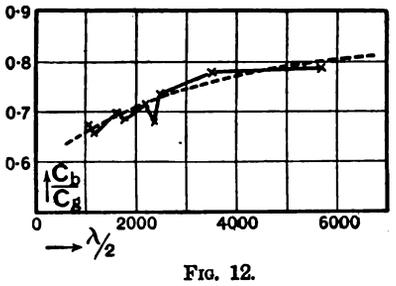

FIG. 12.

Another set of experiments performed on an emitter, consisting of a circle of fine wire including large condensers and a spark-gap, led to the conclusion that Kelvin's formula may be used for the calculation of the wave-length when the quantities are of such relative magnitude that $\tan\frac{\pi l}{\lambda}$ and $\frac{\pi l}{\lambda}$ differ by not more than 2 per cent.

The measurement of the capacity of the glass jars used in some of these experiments led to difficulties. When measured by the ballistic method differences amounting to 10 per cent. were found in the value of the same jar according to the time it had rested discharged. This fact led to the institution of a series of experiments by which the capacity calculated from the measured wave-length and the known dimensions of the emitter could be compared with the value of the capacity as measured directly by the ballistic method. Experiments were made when the wave-length of the emitter was varied, with the results shown in Fig. 12. Here C_b is the capacity of a jar computed from the experiments, C_g its capacity measured directly. With the frequencies employed the value obtained by computation was, on the average, 25 per cent. less than that obtained by measurement, and the figure shows that the effective capacity of a jar is dependent on the wave-length of the oscillations traversing it. This is, perhaps, due to the glass used as the dielectric.

The mode of sparking had no effect on the wave-length emitted by the sender. In most of the above experiments the spark passed in air across a gap of 1cm. A spark of 1mm. in petroleum gave, with the same apparatus, a wave-length measured to be exactly the same. The potential at the end of the resonating wire was much greater in this latter case, however, the spark in the micrometer being nearly 90 per cent. greater.

In 1898 an assistant of Dr. Slaby's while sending messages noticed that a condenser placed in parallel with the spark-gap greatly strengthened the signals. This observation led to further experiments. A large Leyden jar placed in parallel with the spark-gap was found not to increase, but to diminish

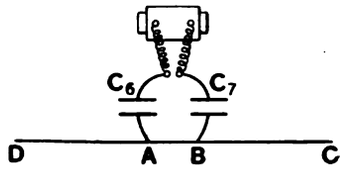

FIG. 13.

the effect, however. Quantitative experiments were, therefore, commenced. The arrangement in Fig. 13 was at length adopted where the wire DC was at first 39 metres (130ft.) long. From each of the ends C and D equal lengths were cut, and on each occasion a potential measurement made at those ends by the spark-micrometer. Fig. 14 gives the results, and shows that a wire length of 35 metres gave the highest

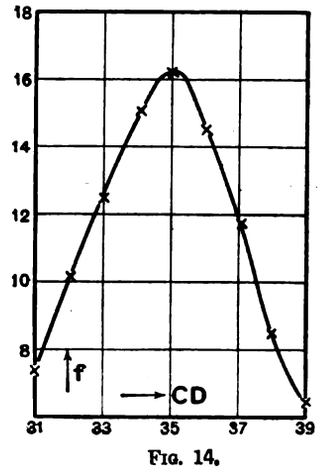

FIG. 14.

potential measurement. Previous experimeuts had shown that 35·1 metres was the half wave-length emitted by the condenser circuit oscillating without wire wings. Thus the addition of wire wings made no difference to the proper period of the closed circuit. Moreover, for the greatest efficiency of the compound system it is necessary that the proper periods of the condenser circuit and the straight wire respectively should be the same. A potential node is formed at the mid-point of the straight wire, so it is essential that the wire be arranged symmetrically with the capacity circuit.

PROBLEMS OF ELECTRIC RAILWAYS.

The following is the conclusion of our abstract of the discussion on Messrs. Swinburne and Cooper's Paper on this subject, which was read before the Institution of Electrical Engineers. The Paper and previous portion of the discussion will be found in *The Electrician* for April 4th, 11th and 18th:

Thursday, April 10 (continued).

Mr. W. GEIPEL said he was not one of those who believed that the application of electricity to the working of long railways was in the dim and distant future. He thought the time was very near at hand when it would be very seriously considered for the large railways running long distances. A point that struck him was that the authors recommended three different systems for operating railways. For suburban lines they recommended constant current; for shunting purposes they recommended storage batteries or the present system of steam locomotives; and for long main lines they recommended the parallel system. He differed with the authors entirely in this respect. The system to be adopted for working the suburban traffic should be the system which should be adopted for working the main line traffic and the shunting; and it was of very great importance, not only to the railway companies, but also to the electrical engi-

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neering profession, that the system which is adopted should be a common system to the whole of the railways of the kingdom. If each railway company adopted the same system, trains would be interchangeable, and the advantages generally would be enormous. For that reason he did not think too much discussion and attention could be devoted to this important subject, and with that in view he would point out that there were two paramount considerations to be borne in mind. The first had been referred to by the authors—viz., frequency—and the second was high pressure and working pressure. With regard to the question of frequency it had been suggested in Messrs. Mordey and Jenkin's Paper that a frequency of 40 ∿ should be adopted, having regard to the consideration of the lighting of the railway carriages. His own view was that a periodicity of 40 ∿ was very much too high for the working of railways, and that the recommendations of the Institution of Electrical Engineers as to frequency for power purposes—viz, 25 ∿—was nearer the requirements of the case. After all, the lighting of the carriages was a mere iota of the total power required to be used, and the lighting could be arranged whether the frequency be high or low in many obvious ways. With regard to the pressure, he thought it was also important that there should be one extra high pressure—10,000, 15,000 or 24,000 volts, or some even number at any rate. In one scheme recently 11,000 volts were decided upon. The authors had pointed out in the Paper that the steam locomotive gave a great torque at starting. He always thought that one great advantage of electric working over all steam working was the enormous increase in the torque of starting up and accelerating the trains. The torque of a steam locomotive was, on the contrary, bad. It was always the same. It was impossible to get a large torque because it was limited by the pressure of steam on to the area of the piston. Further, it was also controlled by the position of the crank, and, further than that, the turning moment resulted in a tendency to skid which did not happen with an electric motor. He did not quite agree with the authors that motors would give any torque required by great expense of power. That did not follow at all. The motor would give any torque required provided that the power was supplied at such a voltage as was suitable to its speed. Of course, if a source of power was used in which the voltage was reduced by needless resistances, then that particular motor was working under uneconomical circumstances, but not necessarily so if other arrangements were made. With regard to acceleration, he had been much struck by the fact that so many of the speakers in the discussion and the authors seemed to consider that the acceleration should be a constant one, and that there should be a constant torque for that reason. He was under the impression that it was very important that the comfort of the passengers should be considered when dealing with high rates of acceleration. For low acceleration it was not a great question. In the curve in Fig. 2 there was a constant acceleration from nothing up to full speed. The passengers were suddenly jerked into motion and suddenly jerked into continuous speed, which was most uncomfortable, to say the least of it. Those who had ridden in high-power motor cars would find this very much accentuated. One important disadvantage omitted from the Paper was the danger to the attendants on the locomotives. The double conductors were also spoken of as not being a vital objection, but he would suggest that, more particularly at high speed, this was a very vital objection, and he quite agreed with Mr. Mordey that the overhead wire should be simple and single. The difficulty with the generators and the general want of flexibility in the generating plant had already been dealt with by Mr. Mordey, with whom he entirely agreed. Then, again, current was not easily diverted for other purposes, such as auxiliary engines, cranes, lifts, and so forth, and, further, it was not easy to call in the aid of local power stations. It was not at all improbable that long railways might find it convenient at times to buy their power from the local power stations, in which case it was important that some system should be adopted which would admit of this. As to the advantages claimed by the authors, he had referred to one—the advantage of constant torque—which appeared a disadvantage. Then there was the collection of current, which the authors said was simpler with parallel systems, but they had still the difficulty of the two wires for collecting. With regard to the Ward-Leonard system and the curve drawn on the board by Prof. Carus-Wilson, the waste of energy at one particular point in the curve during acceleration had been referred to, but Prof. Carus-Wilson had entirely neglected the other points where the energy had been wasted in controlling resistances. This curve showed a sudden jump in the amperes from nothing up to half, and then a rest and another sudden jump up to full, when he presumed the motors were switched from series to parallel and vice versâ. But this could not be done without using resistances which Prof. Carus-Wilson had neglected altogether; and he would also point out that, in the use of this system, the energy was converted into a current at a voltage exactly suited to the voltage of the back E.M.F. of the motors at the speed at which they are running at the moment. The advantages of the system had been appreciated in the high-speed lifts in America, although the system had not been applied to high-speed railway work yet.

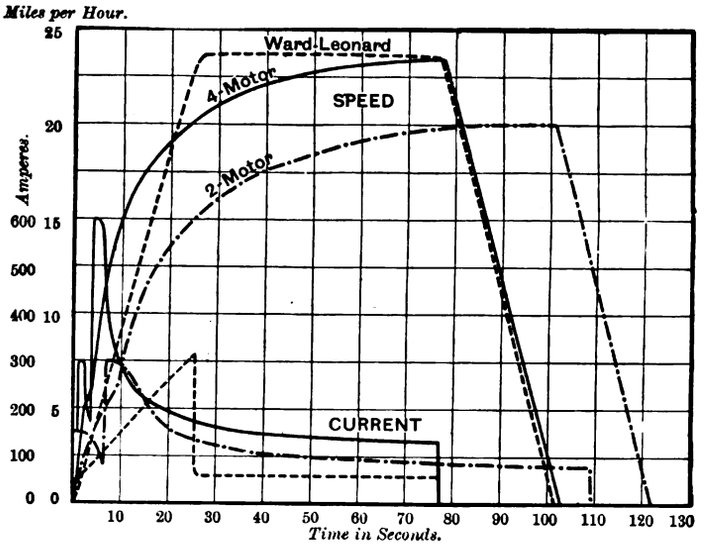
The discussion was adjourned.

Thursday, April 24.

Mr. J. N. SHOOLBRED agreed with previous speakers that indirectly we were not yet ready for the adaptation of main lines to electrical working, but at the same time there were a great many matters of detail bearing upon the question of electric traction generally which must be considered, and which would help towards a solution of this problem. For instance, there was the gauge of the vehicles. Some tramway promoters, for instance, seemed to be actuated more by a spirit of spite than anything else in adopting 4ft. gauges and even less. There should also be uniformity of pressure.

Mr. W. P. DIGBY did not agree with this tendency towards standardisation. The only heritages from steam railways in England to-day which would come to us in electrical working were gauge and height above rail level. The authors acknowledged that main line traffic was not ripe for electrical working, and therefore it was only the suburban traffic with which they need trouble themselves at present, and this would have to be solved according to the individual requirements of the locality and in accordance with the prevailing methods of supply in each particular town. Each line was really a problem to itself. So long as an electric locomotive was employed, what need was there to have them all standardised? Too much emphasis was being laid on this universal standardisation. In regard to the series continuous-current system proposed, he thought the authors had rather hurriedly assumed that a pressure of 2,000 volts would be adopted. With regard to distribution, the question would come in whether the leakage would not be materially greater from the third rail to earth in an open railway and in all conditions of climate than it was at present in a tube. The probability was that there would be appreciable leakage under these conditions.

Mr. McMAHON, referring to Prof. Carus-Wilson's diagram (*The Electrician*, Vol. XLVIII., p. 1,013), showing the difference between the series-parallel and the Ward-Leonard systems, said that it might be right as far as the current curve was concerned, but with the Ward-Leonard system the shape of the speed curve was considerably altered, and the advantage of the Ward-Leonard system was shown by the diagram below. The first curve in this represented the acceleration of a two-motor equipment with the series-parallel system of control, and, in fact, it was a diagram of one of the City and South London locomotives. He had taken these motors as he was more familiar with them than with any others, and had assumed the Ward-Leonard system applied to one of them. To do this he had assumed that the motors instead of being series were shunt-wound with the same ampere turns on the armature, and had allowed an efficiency of 93 per cent. for the transformation in the motor-generator. This might appear to some to be a high efficiency, but when it was remembered that only half the total energy was transformed, 93 per cent. was, if anything, low. On the same diagram were also plotted the curves for a train with the same total weight but with a four-motor equipment arranged in connection with the series-parallel controller. The four motors might be arranged in one locomotive or distributed through the train without effecting the curves. In the case of the two-motor equipment the maximum



current with the motors in series was limited to 150 and 300 amperes in parallel. In the Ward-Leonard system he had also limited the maximum current taken from the line to 300 amperes, but in this case, as a matter of fact, it rose to 318, and had been allowed to do so for the sake of simplicity in the calculations. It would be seen that the speed curves until about 5 miles an hour was reached were practically the same for the Ward-Leonard and the two-motor equipments, but that the acceleration in the case of the former arrangement continued uniform until 24 miles an hour was reached, when the necessary alteration was made in the field of the generator, and the current dropped from 318 to 59 amperes. The length of the section was taken as 2,700ft.; the two-motor equipment accomplished it in 122 seconds, and the Ward-Leonard did the same trip in 102 seconds. The watt-hours taken from the line in the case of the two-motor equipment was 105, and in the Ward-Leonard system exactly the same. Turning to the four-motor equipment, the motors were started four in series, with the current limited to 150 amperes, then placed two in parallel, two in series, and finally the four motors in parallel, and the current reached the high figure of 600 amperes. The speed curve in this case showed a very much higher acceleration than either of the other two, but at about 15 miles an hour the rate of acceleration commenced to diminish considerably, and, as a result, the trip was made in the same time as the Ward-Leonard system; but the watt-hours were somewhat low, being only 98·6. As far as the relative weights were concerned, taking the motors alone, in the two-motor equipment the weight was 8 tons and in the four-motor equipment 16 tons. These were rather heavy motors, being gearless, and, of course, the motor-generator in the Ward-Leonard system on board a locomotive could be run at a very much higher speed and consequently lighter, so that it seemed as if the weight for the motor-generator should not exceed about 4 tons. It would thus be seen that the weight of a locomotive and two motors with the Ward-Leonard arrangement was only 75 per cent. of a four-motor equipment, and that practically the same results were obtained.

Mr. A. A. CAMPBELL SWINTON, speaking on the question of uniformity, mentioned that he had been attending the Lords Committee on

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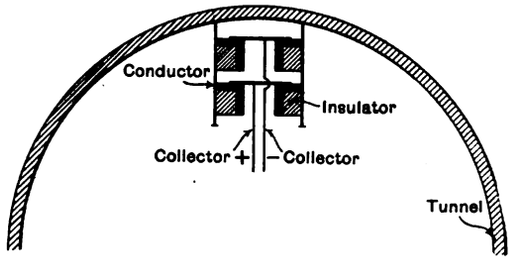
tube railways now sitting, and this led him to make a few remarks. As was well known, the Central London Railway worked with an insulated conductor between the running rails, using the rails as the return. But on one of the lines now before the Parliamentary Committee to which he had referred, and which had begun as a very small railway, but which had now a capital of 15 millions sterling, and had been acquired by some sort of an American combination, it was proposed to use an insulated return with the two conductors at the side of the tunnel. Of course, it was quite obvious that if this system were adopted there would be great difficulties in the future of intercommunication between this line and other tubes using a system like the Central London Railway. Further than this, as there were a large number of other tube bills yet to come before the Committee which might probably all have a system of their own, this was really an important matter, although at present, perhaps, it did not affect us very much. The whole traffic of London appeared to be the pawns with which American millionaires played their game.

Mr. M. HOLROYD-SMITH, taking up this matter of the collection of current, suggested a simple solution of this difficulty. Curiously enough, in England and in America overhead wires were erected in the streets, where they were dangerous for other traffic, but when dealing with railways, in which they had the whole of a tunnel to themselves, where such things could be put up without any danger, they persisted in putting down a third rail in such a way as if they were purposely designing something which should be dangerous. The accompanying sketch, which Mr. Holroyd-



Smith drew upon the board, shows an arrangement which he said was 15 years old, and which probably one of these days would be brought over from America as something new. All difficulties of points and crossings were easily got over by this method, and no complication of conductors would be too difficult to be met by it.

Mr. W. R. COOPER, replying to the discussion, said the very points which the Paper had been intended to bring out had been misunderstood. The object had been not to advocate the series system or any other system not in use at the expense of a system which was in use. It was rather to bring it forward for consideration. They scarcely thought it was necessary to go into detail, because when dealing with a system not in use, the first thing to consider were the possible advantages, if they were worth considering. After this matters of detail could be worked out. They did not mean to say there were no difficulties, because reference had not been made to many, but on the other hand there was no reason why they should be exaggerated. Unfortunately, in dealing with problems of electric traction it was impossible to solve them by laboratory experiments. If a system had to be proved it was an expensive matter and really could only be undertaken by a manufacturer, in the same manner as three-phase traction had been on the Continent. In the discussion certain difficulties had been brought forward, but they had rather been of one type. A good many things had been said about blue spectacles. But it was often still found necessary to have blue spectacles, and he wished he could have used a pair a few days back when witnessing the testing of a steam set. At the same time he should be sorry to say that shunt machines could not be made even if he did not know they were made. Improvements were very often made in old apparatus—*i.e.*, in apparatus which had been discarded. There were a great many instances of machines which had been discarded at one time or another and then taken up again. For instance, there was the steam turbine that had been proposed at the end of the eighteenth century, but he did not think that even Mr. Dow would have dissuaded Mr. Parsons from attempting to do something more in that direction. Then incandescent lamps were proposed in 1836, but in spite of this, Edison and Swan had tackled the subject again. Bicycles were not a success at first, nor pneumatic tyres, nor steam traction on roads, and he believed that breech-loading guns were tried as early as 1673, but it was only quite recently that the Admiralty had adopted them. It had practically been said that the series system was an old system. In a sense it might be so, but not to railways. It had been used for tramways, but the conditions of tramways in those days were quite different to railways in these days. In those days acceleration was not important, but now it was very important indeed. Then, again, in those old examples which had been quoted the sections were very short, and there was a very great deal of complication one way and another, and naturally the system would not work. Nobody could expect it to. The authors suggested that it might be workable for railways. Mr. Dow had suggested that there might be difficulties at the dynamos. Probably that gentleman had been working with something of the old arc lighter type of machine running at constant speed, and these conditions were quite different to those on a railway system. It must not be forgotten that the series system had been developed to a considerable extent by Thury in Switzerland, who had dynamos running to 1,000 H.P. and motors to something of the same size. Mr. Mordey said there would be a difficulty in increasing the system indefinitely, and that there would not be the same difficulty in increasing the parallel system. Well, of course, the difference was that in the series system the voltage was increased, and in the other the current was increased. Certainly it was more easy to increase the current indefinitely than the voltage, and perhaps there was that much to be said for the parallel system. Mr. Mordey also said that there would be an impossibility of transforming. There was no need to transform. The same speaker stated that series machines could not be run in parallel—but he did not think anybody would want to. Even if they did there would be no difficulty. The series machine as proposed would not be run at constant speed, and it was a different problem altogether. The authors had no doubt main lines could be worked electrically, but at the same time they wished to direct attention to the fact that the problem of working main lines was quite different to that of suburban lines. In the case of the latter, acceleration was very important indeed, and, further, it did not so much matter whether more or less power was used on suburban lines. The great thing was to get a good dividend paid for the shareholders—in other words, to use the capacity of the line to its fullest extent. The cost of the power station in relation to the whole cost of a railway was a comparatively small amount, and, therefore, they could well afford to have a larger power station and use larger power. On main lines acceleration was not important, but on the other hand the running costs were, and it was, therefore, important to keep down the cost of the installation. An electrical method had to compete with a steam method. With an electrical method, as Mr. Langdon had pointed out, there was the advantage of a constant load, but if this benefit was to be taken advantage of, then there must be an efficient means of distribution. For this reason the author considered the series system of importance. Mr. Langdon had also pointed out the great importance of variable speed on main lines, and this was undoubtedly so. For this reason there was a great difficulty with the three-phase system, because it would only run economically at one speed. Also, as Mr. Langdon pointed out, there were certain indirect economies which might be expected in the way of the save in pumping stations, possibly in the reduction of repairs, and, by having no tenders, a diminution in the weight. Mr. Mordey had mentioned the question of the subdivision of main lines, and this was important from the point of view of the convenience of the passenger, but from the point of view of the traffic expenses, it was important in the opposite direction. The traffic expenses would be run up a good deal, where they ought to be kept down as much as possible. Mr. McMahon had made some remarks upon the increase in the power station, but he had already mentioned that this is not necessarily important. Economy was less important on suburban lines, and the peaks obtained from a high acceleration were not really important if the service was very frequent. If it were not the peaks were important. But if the service was very frequent, then large peaks did not matter, because they came so often that a more or less constant load was obtained, and so the station increased in capacity practically as the watts per ton-mile.

The PRESIDENT said the problems set forth by Messrs. Swinburne and Cooper were bound to be of great use in considering this very important question. There were one or two points in the discussion which he should like to refer to. It had been stated that uniformity of gauge and pressure were of very great importance. With a railway traffic conducted by steam locomotives there was always the locomotive to deal with its own work, and each company had its own stock for the purpose. Vehicles of one company passed over the lines of another company, and were always drawn by the vehicles belonging to the company possessing the lines. When the time came for this traffic to be dealt with electrically, standardisation was all-important, for the reason that each vehicle did not carry its own propelling power. It had also been suggested that the means of conducting the current to the vehicles was the fundamental question, and although he did not wish at all to speak against overhead systems, yet he would like to recommend that the series system should receive as much attention on the part of inventors and engineers as the overhead system. There could be no question that the two conductors might readily be placed on the sides of the tunnel, but it meant that the collectors must be established at sufficient distance apart on the vehicles so as to provide for the break that must take place where lines intersect one another.

A hearty vote of thanks concluded the discussion.

THE KNEWE ARC LAMP.

The list of enclosed arc lamps on the market has been increased by yet another competitor, which, however, has the advantage of some novel features likely to bring it into favour for shop lighting. The amount of light lost by the employment of double globes of an enclosed arc lamp has reduced its efficiency considerably, and in the "Knewe" enclosed lamp only one globe is used, a circumstance which reduces the life of the carbons, but brings with it other advantages, such as the simplification of parts, greater light, and a less number of globe breakages. The adjoining figure is a section of the lamp, from which it will be gathered that the moving parts have been reduced to a minimum. The upper carbon holder A is a drilled casting with milled slots to ensure sufficient spring to grip the carbon, the holder sliding in a tube from which current is collected by a laminated contact above the holder. Copper gauze washers, mounted on the holder shank, form this contact, and side pressure on the tube is obtained by the action of a clutch when the lamp is burning. This clutch is shown at B, the carbon being gripped by the ball-shaped fitting, which exactly fits the tube, so that alignment is guaranteed and the carbon also guided and regulated in its descent from the main coil fixed to the top plate of the lamp. The globe C is securely clamped to an extension of the top tube, the joint being

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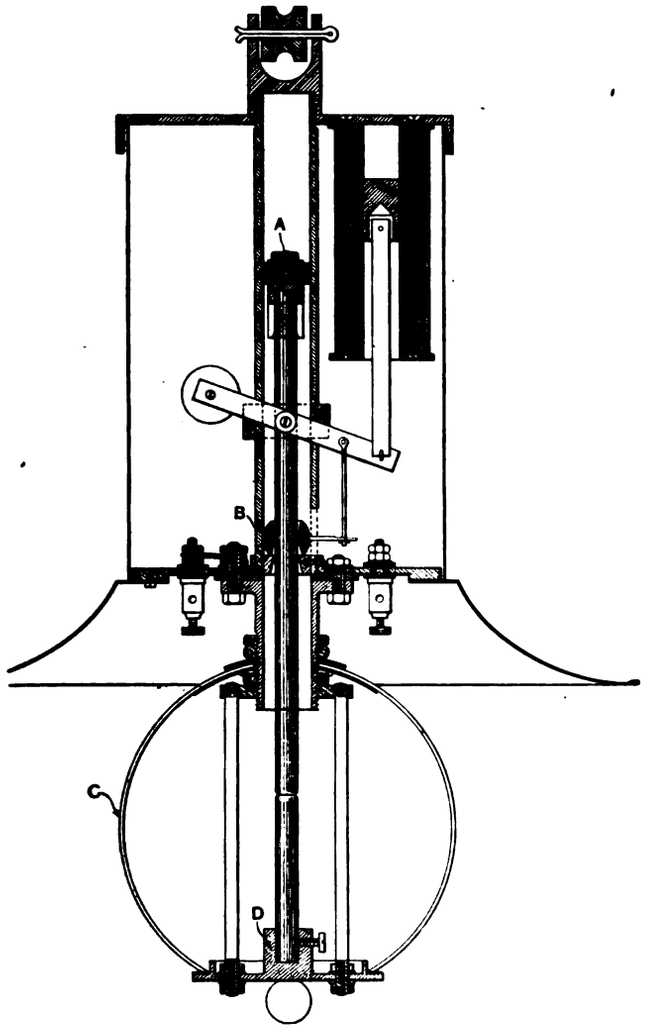
made by asbestos insertions. A 3½in. hole allows for trimming and cleaning, there being no occasion to remove the globe. The lower carbon holder D is a substantial fitting, comprising a base plate for the lower carbon and a top plate connected with the holder by two rods. This upper plate is screwed to fasten to the main tube at the top of the globe, this operation sealing the handhole and making connection to the bottom carbon. The extension of the main tube is in the negative circuit, the positive pole (in continuous current lamps) being connected to the lamp case. The action of the lamp is exceedingly simple; the upper carbon is gripped and raised by the main coil which gradually allows the clutch to loosen its hold, as the arc lengthens, thus maintaining the distance between the carbons as long as current passes. The plunger in the solenoid is fitted to form a dashpot for steadying the movements of the working parts. An enamelled reflector concentrates the rays of light beneath the lamp, and trimming can be easily performed without fear of damage to any of the parts. The average life is 60 hours and at



Scale: Quarter Actual Size.

the end of this time the top carbon only needs renewal, as sufficient is left of the upper carbon to transfer it to the negative holder. The 5-ampere size only is made, as this meets the greatest demand, and the lamps may be supplied for parallel working on 100-120 volt circuits, or two can be placed in series on double these pressures, alternating or direct current. Care has been taken to so construct the lamp that it may be confidently placed in unskilled hands, the end in view being met by the introduction of solid castings and substantial fittings.

Trolley Omnibus.—A concession is likely to be granted for the construction and operation of a trolley omnibus line on the Lake of Lucerne, between Brunnen, Gersau, Vitznau and Weggis. The cost of the undertaking is to be about £13,000. The omnibus is free to traverse the entire width of the road, but derives its driving power from overhead lines, against which two trolley arms press for the collection of current.

THE WOLVERHAMPTON EXHIBITION.

The Art and Industrial Exhibition at Wolverhampton was opened by H.R.H. the Duke of Connaught yesterday. Although not on so large a scale as last year's exhibition at Glasgow, it promises to be a success. The holding of an exhibition at Wolverhampton this year was suggested two years ago, and the idea was taken up at once by the local magnates. Support was promised on all sides, an executive committee was formed, with Mr. Thomas Grahame, J.P. (the originator of the movement) chairman, and a guarantee fund was opened, towards which a sum of £4,000 was subscribed within a few months. Mr. H. A. Hedley, manager of the Glasgow Exhibition, was appointed managing director, and Mr. J. H. Cundall general manager.

The exhibition lies less than a mile from the centre of the town. Part of the West Park has been appropriated for its purpose and also a piece of waste land which adjoined the park and was placed at the disposal of the committee by Lord Barnard. The grounds extend 32 acres, of which 127,215 sq. ft. is occupied by the main buildings. The latter include an Industrial Hall, the Canadian Pavilion and the Machinery Hall, in which the majority of the electrical exhibits are placed. We were invited to a private view of the exhibition last Friday, and found everything in a very advanced state, the majority of the exhibits promising to be in a complete state by the opening day, although much remained to be done in connection with the electrical generating plant.

The following are among the electrical and allied firms exhibiting:—

Electric Construction Co., Dick, Kerr & Co., D. Bruce Peebles & Co., Lancashire Dynamo and Motor Co., Phœnix Dynamo Co., Mavor and Coulson, Crompton & Co., Ferranti Limited, D. Selby Bigge & Co., Edison and Swan Co., Willans and Robinson, Belliss and Morcom, Robey & Co., Brownett, Lindley & Co., Crossley Bros., National Gas Engine Co., Bumsted and Chandler, Tangyes Limited, Mirrlees-Watson Co., Babcock and Wilcox, Danks & Co., John Thompson, Stirling Boiler Co., Galloways Limited, Green & Son, Arthur Lowcock (Ltd.), Smoke Preventer Co., Lloyd and Lloyd (Ltd.), New Brotherton Tube Co., Holden and Brooke, Metallic Jointing and Packing Co., British Insulated Wire Co., Isidor Frankenburg (Ltd.), National Telephone Co., McGeoch & Co., Brockie-Pell Arc Lamp (Ltd.), Sir Hiram Maxim Electric and Engineering Co., Wüst & Co., George Fletcher & Co.

We most necessarily defer any detailed account of the exhibits at present, but we can now give a sketch of the arrangements for supplying current to the exhibition and lighting it. The system adopted is a three-wire continuous-current one at 2 × 250 volts. There will be eight generators and a balancing transformer available for this supply, all erected in the Machinery Hall. The following is a list of these:—

Belliss-E.C.C., 500 volts, 500kw.
Belliss-E.C.C., 500 volts, 250kw.
E.C.C. 200-ampere balancing transformer.
Robey-Mavor and Coulson, 500 volts, 400kw.
Robey-Ernest Scott and Mountain, 250 volts, 75kw.
Robey-Ernest Scott and Mountain, 250 volts, 65kw.
Sisson-Lancashire Dynamo and Motor Co., 250 volts, 60kw.
Willans-Bruce Peebles, 500 volts, 250kw.
Browett Lindley-Dick, Kerr & Co., 500 volts, 325kw.

There are five boilers with a total H.P. of about 5,000. Two of these are a new type of vertical water-tube boiler by Messrs. Danks & Co. One is a Babcock and Wilcox boiler, and the remaining two are Dürr water-tube boilers supplied by the firm of John Thompson.

The main switchboard is of Messrs. Ferranti's make, and embodies some new features in its details. From this B.I.W. cables are led under the floors (or in wooden troughing when underground) to distributing points, and each exhibitor who employs a motor has to run service mains to his own double-pole switch and fuse.

The buildings are lighted with Brockie-Pell arcs and Ediswan incandescents; in the grounds the new Welsbach incandescent gas lanterns are largely employed, but there are a few incandescents; 30 Bremer lamps of the last mentioned being on the spiral water chute, &c., and "Rex" lamps, made by the Hiram Maxim Co., are employed for the band stand and concert hall. For the outside lighting, aluminium wire, made by the British Aluminium Co., is employed to a considerable extent.

There are in all 360 arcs and 8,000 16 c.p. incandescent lamps, and a further load of 30,000 white, red and green lamps is expected for outlining the buildings at night. The erection of these has not been commenced yet, however.

A practical arrangement is made with the firm supplying plant and material for the above-mentioned purposes. The makers loan it free of charge, the exhibition authorities doing the pipe work, laying the foundations, and arranging for the necessary attendance, it being understood that each machine shall be run at least once a day if possible.

Before closing this article we may call attention to the fine collection of pictures (including some famous paintings by early and modern English masters) which has been got together for the occasion. These are on view at the Art Gallery in the town, which will be open free during the exhibition, and is lighted at night by Nernst lamps.

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METALLURGY AND ENGINEERING.

At a special meeting of the Institution of Civil Engineers, on Wednesday, Mr. Charles Hawksley (president) in the chair, the tenth "James Forrest" lecture was delivered by Sir William Roberts-Austen, K.C.B., F.R.S., Hon.M.Inst.C.E., the subject being "The Relations between Metallurgy and Engineering." The lecturer stated that this was the subject with which the council had requested him to deal in his lecture; but it must not for a moment be imagined that the metallurgic art was not included in the wide range covered by the Institution, which had, from its earliest days, given prominence to the work of metallurgists. He quoted Mr. G. P. Bidder, who, in his presidential address to the Institution, delivered in 1860, said "that if he were called upon to define the object and scope of the profession of civil engineer, he would say that it was 'to take up the results discovered by the abstract men of science and to apply them practically for the commercial advantage of the world at large, and to diffuse their beneficent influence among all classes of his fellow-citizens.'" He hoped to be able to show that metallurgists practising an industrial art had helped the engineer to do this, and in evidence that such was the case he quoted from the presidential address of Sir John Fowler words to the effect that engineers had been more assisted by members of the Institution and by distinguished men of science generally in relation to iron and steel than as regarded any other material. It was in connection with iron and steel that the illustrations of the lecture would be mainly given. It might at first be thought that the relations between metallurgists and engineers, which had become so close and enduring, arose quite simply from common interest. The case was, however, far from being so simple; communication between those who extracted metals from their ores and adapted them for the use of the engineers, who actually employed metals in construction, was seldom, at the outset, quite direct. The relations with which the lecture dealt had been strangely stimulated by the intervention of men who, in many cases, were neither engineers nor metallurgists, but were men whose lives had been devoted to abstract science. Such men recognised the value of certain metals and alloys for definite uses; they investigated their mechanical properties and proclaimed their merits to engineers. The intervener then disappeared, leaving behind some coefficient or constant bearing his name by which he was gratefully remembered. As an instance, Galileo's estimation of the tensile strength of copper cylinders and Young's determination of the rigidity of steel (which had resulted in Young's modulus) were cited.

It was not easy to fix the period in industrial history at which the metallurgist began to give the engineer material assistance. If in this country Stonehenge were taken as a starting-point, the architect-engineer who designed that crowning example of neolithic art could not have received any assistance from the metallurgist. That stately structure arose from the plain at a time when bronze tools were known but were not in general use, and this period had recently been fixed by Mr. Gowland at about 2,000 B.C. In another phase of engineering work it was known that Rome, in the days of her occupation of this country, trusted to the metallurgists of our island to supply the lead which was so extensively used in the Eternal City. The fourth-century wrought-iron column, discovered in India, and the girders and beams of the Orissa temples rendered it necessary to exercise great caution as to the period at which iron was used in construction. Such magnificent efforts as those given were, however, not maintained, and no widespread or continuous records of the metallurgists' contributions to early constructive work could be presented. On the other hand the civil engineer had, to quote the charter of the Institution, "advanced mechanical science and directed the great sources of power in Nature for the use and convenience of man" for ages before the metallurgists rendered more than incidental service. As examples of great engineering works into the construction of which no metal entered, the lecturer referred to and gave illustrations of the primitive cantilever bridges of pine trees used to cross mountain torrents in Savoy. The interesting thirteenth century cantilever bridge, made up of 20ft. beams, given in the note-book of Villars de Honnecourt, was also shown, as was a bascule bridge of the middle ages. The dome of Milan cathedral, as designed by Leonardo di Vinci, the great Tuscan painter, engineer and architect, was also referred to as an example of a structure in which metal was not used. The employment of cast iron from the time of Queen Elizabeth to the present day was then dealt with, and the proposed cast-iron bridge of 600ft. single span, by Telford and Douglas, was referred to, and it was pointed out that in the nineteenth century metallurgists, by creating the age of steel, more than atoned for their somewhat tardy and intermittent efforts to supply engineers with suitable materials.

As regarded the use of cast iron and malleable iron, the influence of Watt in developing the steam engine was traced, and it was admitted that the necessity for pumping water out of mines was the main factor in the evolution of the steam engine, and, in turn, the development of British metallurgy of iron and steel dated from the time when the steam engine of Watt enabled air to be readily pumped into the blast furnace employed for the production of cast iron. It was then pointed out that more than half of the last century had elapsed before the "age of steel" began, and that towards the end of the century great attention was devoted to considerations connected with the molecular structure and properties of steel, and to enforcing the action of carbon, the element which gave steel its properties, by the addition of other elements than carbon in very small proportions. With regard to the slow growth of confidence in the qualities of steel, the opinion of successive presidents of the institution, as expressed in their addresses, was quoted; Sir John Hawkshaw, Sir John Fowler, Sir Frederick Bramwell, Mr. W. H. Barlow, Lord Armstrong and Sir George Bruce being specially alluded to. In 1887, when Sir George Bruce delivered his address, the merits of steel had at last received recognition, and, as regards the crowning triumph of the age of steel, the Forth Bridge, Sir George exultingly exclaimed:—"At the Menai Bridge the total quantity of iron was 11,468 tons; at the Forth Bridge there will be 50,000 tons of steel and iron." No one had done more than Sir Benjamin Baker to insist on the importance of phenomena which engineers used to consider "mysterious" in connection with the behaviour of steel, and his warnings and example were at last being regarded and followed. The lecturer pointed out that when metallurgists gave engineers mild steel they provided a cinder-free *solid solution* of iron and carbon. All subsequent advance had been due to the recognition of this fact and to the gradual study of the properties of metallic *solid* solutions. Sir John Hawkshaw, in his presidential address to the Institution, delivered in 1862, had said that if the strength of iron could be doubled, the advantages might be equal to the discovery of a new metal more valuable than iron had ever been. The lecturer contended that this was exactly what metallurgists had done with regard to steel. By suitable thermal treatment, and by suitable additions of comparatively rare metals, they had doubled the strength of steel as it was known in its early days. The nature of solid solutions was then explained, and the importance of allotropic modifications of iron was dwelt upon, this portion of the subject being illustrated by some difficult experiments. The question was then asked, Could the past molecular history of a mass of steel be traced by microscopic examination of the solid metal? Some very beautiful experiments by M. Osmond, Mr. Stead and others, were appealed to in evidence of the possibility of this. It was then demonstrated that solid metals might even reveal, by their structure, the vibrations to which they had been subjected, and Sir Benjamin Baker had constantly insisted on the importance of such vibrations. In making this clear, Vincent's experiments on the beautiful wave-structure that might be imparted to the surface of mercury by the aid of a vibrating tuning fork were then exhibited, and it was demonstrated that the surface of *solid* lead which had been subjected to similar vibrations, possessed a similar structure to the vibrating surface of mercury.

Finally, with regard to the efforts metallurgists were making to study the influence of rare metals on iron and other metals, the reducing power of aluminium on metallic oxides was shown. Very high temperatures of 3,000°C. and over were attained, and brilliant light was produced during the reduction of chromium, cobalt, nickel and other metals from their oxides.

In conclusion, the lecturer appealed to the new Alexander III. Bridge at Paris as showing the need for the careful measurement of high temperatures in connection with the treatment of large masses of steel. In the construction of the bridge 2,200 tons of *cast* steel had been employed, and a peculiar molecular structure was imparted to the steel by rapidly cooling it in air from a temperature of 1,000°C. to 600°C.; this gave the metal certain mechanical properties which it would not otherwise have possessed. With reference to the aid given by metallurgists to engineers in connection with ordnance, reference was made to the address delivered by Mr. T. Hawksley, the father of the president, in 1872. He said that "In no way" other than by the study of such questions "could the Institution [of Civil Engineers] serve its country better, or better promote, in the interests of peace, the advancement of practical science, and its application, if events should order, to the purposes of protective warfare." The use of copper, aluminium and other metals in electrical engineering was referred to, and the lecture ended with an appeal for the more extended study of the physical properties of metals.

Wireless Telephony.—Experiments with wireless telephonic apparatus have recently been made on the Potomac River, by Mr. N. Stubblefield, says *Electricity* of New York, and fairly satisfactory results were obtained. Messages were sent between two stations on land, and also between the shore and a steamer lying out in the stream, complete sentences and music being distinctly audible by those at the receiving stations. The apparatus comprised ordinary transmitters and receivers, a buzzer, an induction coil, two rods about 8ft. long, and short pieces of wire connecting the poles. The rods were planted in the ground at the will of those handling them, and sounds were then transmitted.

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PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

Lord Windsor's Committee continued its consideration of the "tube" railway bills on Friday last.

Friday, April 25.

PICCADILLY AND CITY, LONDON UNITED, NORTH-EAST LONDON, AND CITY AND NORTH-EAST SUBURBAN RAILWAYS.

Sir EDWARD CLARKE addressed the Committee on behalf of the London United Electric Railways. He said it was to be hoped that these proceedings would result in some satisfactory system of tube railways between the West of London and the City being sanctioned, and a means of traffic provided along a great highway which was at present supplied by no railway. The general considerations were, in his opinion, that such a scheme should be a through line and not a circle, and that the promoters should be financially strong enough to carry out the project. The evidence which had been set out before their lordships proved that this latter consideration was a strong one in connection with these amalgamated lines, and the tramway company, after fostering the traffic in the west should be entrusted with the responsibility of bringing it to the City if they were willing to do so.

Lord WINDSOR: Is it intended to lay before this Committee any definite scheme of administration for the joint working of these lines?

Sir EDWARD CLARKE: I understand that such an agreement is in course of preparation, and will be laid before your lordships.

This concluded the case for the western part of the lines.

Evidence was then given by a number of gentlemen representing various local authorities, &c., on the line of route through which the City and North-East Suburban line is proposed to run.

Mr. Montague S. Stuart, M.P. for Whitechapel, Mr. Spencer Charrington, M.P. for Mile End, Mr. D. J. Morgan, M.P. for Walthamstow, the Hon. Claude Hay, M.P. for Hoxton, and Mr. Courtenay Warner, all alleged that the service of the Great Eastern Railway along the line of route of this proposed tube was inadequate, and spoke of the growing population and consequent need of further travelling facilities.

For the North-East London Railway, Mr. J. C. Hill, a builder, Mr. C. J. Gunyon, engineer and surveyor to the Wood Green Town Council, Mr. O. Thomas, a landowner at Southgate, Mr. J. T. Davies, chairman of the Wood Green Town Council, Mr. George Webb, town clerk of the Metropolitan Borough of Stoke Newington and a member of the Southgate Urban District Council, gave similar evidence in respect of the Great Northern and Great Eastern Railways.

Sir DOUGLAS FOX, who is also engineer to the North-East London Railway, then gave additional particulars of the line to those in his evidence on the Piccadilly and London United lines reported in our last issue. He had now decided to put in the additional platform for emergency purposes in the tunnel as a cover to the conductors on the other side of the tunnel. It was essential that the sleepers should be of wood, but they were not to be creosoted. Thorough mechanical ventilation would be maintained, whilst a fireproof flooring to the track between the running rails would be laid so that the passengers could also utilise this in case of accidents. At Ludgate-circus, if they were required to do so, he proposed to construct a subway both for the convenience of the general public and for the travelling public. After following out the line of route as shown in our map last week, he said that the intention for extending their original line beyond Palmers Green on to Southgate was because it was thought that this latter locality would furnish a class of traffic which would be useful during the less busy hours of the day. The generating station was on Regent's Canal and had a capacity of 20,000kw.

In answer to Lord Robert Cecil, who appeared for Mr. Walker, a landowner on the line, Witness said that it would not be possible to deviate the line so that its open portion would not include a portion of Mr. Walker's land. The reason for not terminating at Palmers Green, although a tramway was authorised to be built to there was given above.

Mr. H. N. THOMAS, for the Metropolitan Railway: Do you know of any precedent of a tube railway running under an existing railway against the wishes of the latter?—I do not know of any precedent, but the Great Northern and City Railway and the City and South London Railway run under each other.

But they both run under easements. Except for that case you do not know of another?—No.

Mr. E. H. PEMBER, K.C., for the District Railway Company: In previous tube bills a clause has been inserted, by which sufficient space for another tube to be constructed should be left between the District or Metropolitan Railways and the tube then promoted?—I am quite willing to agree to this, but I think the tubes should be constructed as near the surface as possible on account of keeping down the cost of constructing the stations, &c.

Monday April 28.

Lord WINDSOR asked for detailed separate estimates of the cost of construction, &c., of all the amalgamated lines.

Sir DOUGLAS FOX promised to prepare these and hand them to the Committee.

The cross-examination of Sir Douglas Fox in respect of the North-East London railway was then continued. In respect of properties in Upper Thames-street, and the possibility of damage to buildings owing to the peculiar nature of the subsoil in this part of the City, the proposed span in this neighbourhood had now been abandoned, as it would have necessitated a confluent junction with the deep-level line authorised to be constructed under the existing District Railway. Arrangements had been made by which, if necessary, an end-on junction with the line in question could be effected. At the Monument they proposed to pass under the City and South London line.

Re-examined: He reiterated his previous opinion that the extension of the Central London Railway to Liverpool-street was necessary and ought to be made. The question of ventilation was a purely mechanical one, and could be easily managed. The system employed on the Central London Railway was not satisfactory.

Lord WINDSOR: I have noticed a very considerable draught of air in the Central London tunnels. I suppose some fresh air gets in from somewhere.

Sir DOUGLAS FOX: A great deal of the draught is, unfortunately, impure air.

Mr. VESEY KNOX, for the North-East London Railway: You think the exhaustion on the Central London Railway insufficient?

Sir DOUGLAS FOX: I understand that the Central London Railway close the shafts every night for a certain time and change the air.

EARL OF LAUDERDALE: You will satisfy the Board of Trade on the question of ventilation.

Mr. VESEY KNOX: Certainly.

Mr. BUCKLAND, land valuer, said the cost of the lands necessary for the North-East London Railway would be £141,000. Throughout the whole of the route no case arose which could not be settled under the Lands Clauses Act. This concluded the case for the North-East London Railway. For the City and North-East London Suburban Railway,

Mr. EDWIN FOX, of Messrs. Fox and Bousfield, estimated the cost of the necessary lands under the 1901 bill at £140,630 and under this year's bill at £663,439.

Mr. Ald. GEORGE DEW, of the London County Council, supported the scheme.

Mr. S. G. FRAZER, one of the engineers to the City and North-East Suburban line, described the general features of the amended proposal as constituted by this year's bill, which had been drafted in order to conform to the wishes of the Joint Committee last year. There were to be 4 miles 1 furlong of tube, which would terminate at the north-east end of Victoria Park, and from that point to the end of the line at Waltham Abbey it ran upon the surface. On the tube portion there were 10 stations, and on the open portion 13 stations. Practically speaking, it was the intention to have interchange stations with all the railways which they crossed throughout the line of route. The average depth under the Metropolitan Railway was from 50ft. to 60ft. Out in the open the railway followed the contour of the country. The generating station was on waste land at Temple Mills, where there was an admirable water supply alongside it. His estimate for the railway was £2,532,998, and for the electrical equipment £900,000, a total of £3,432,998.

Cross-examined by Mr. FREEMAN, K.C., for the Central London Railway, he admitted there was no engineering difficulty in arranging an interchange station between his line and the Central London new proposal at Cannon-street; in fact, he had suggested it some time back.

Questioned as to the negotiations last year with Mr. Perks, on behalf of the District Railway Company, and the rupture which afterwards ensued, Witness said his reason for going to Messrs. Morgan was that he saw little chance of financial support from the District Company, whereas Messrs. Morgan guaranteed a large portion of the capital. He was not willing to withdraw his line from running under the District Railway Company's lines. The route proposed had been forced upon them practically by the local authorities and the London County Council. As a matter of fact, since his amalgamation with the Morgan group, Mr. Perks' attitude had changed considerably.

Cross-examined as to the engineering possibility of constructing a tunnel underneath the Hackney Marshes, over a small portion of which an overhead line was proposed, Witness affirmed that such an alteration would considerably embarrass the promoters. It was not impossible, however.

By Mr. H. N. THOMAS, for the Metropolitan Railway: No consent from this company had ever been given him for running under their lines.

Earl ZOUCHE: Have you any powers to carry goods?

Mr. S. G. FRAZER: No. It is the opinion of all experts that it would greatly inconvenience the service if such were the case.

EARL OF LAUDERDALE: I take it you would have to acquire powers to do so, and that this you have not done?

WITNESS: That is so.

EARL OF LAUDERDALE: Do you agree with Sir Douglas Fox that damage to buildings is only likely to happen during construction?

WITNESS: This would happen only during construction.

Mr. READER HARRIS, for the East London Railway: We are not satisfied with the model clause as to the protection of our signalling apparatus at the point where you cross our line in the Whitechapel-road, and would prefer one similar to that in the Central London Railway Bill for the protection of the Metropolitan Railway?—We have not the slightest objection to meeting your engineers. It is an electrical question. It must also be borne in mind that the Board of Trade will have control over practically everything in connection with these railways, and we are willing to conform to any act or deed which they might think necessary in the interest of the public.

Mr. FRANCIS FOX, partner in the firm of Sir Douglas Fox and Partners, confirmed the engineering evidence. He did not think there was any engineering difficulty in obviating any effect upon the system of signals employed on the East London Railway.

This closed the case for the City and North-East Suburban Railway with the exception that Sir Douglas Fox is to be re-called for cross-examination by Mr. Littler, K.C., on behalf of the Metropolitan Railway.

BROMPTON AND PICCADILLY CIRCUS RAILWAY.

Mr. LITTLER, K.C., addressing the Committee on behalf of this bill, which seeks an extension of time for the construction of the already

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authorised line, and also some extensions of the line itself, said that this line was passed despite very strenuous opposition from a competing scheme in 1897—viz., the City and West End line. The main reason why the capital for the line was not found sooner was, for one thing, that the Central London Railway was not finished at the time an effort was made to secure the capital, and then following this the war broke out, and people did not feel disposed to invest their money at such a time. As time went on, however, the "electrification" of London—if he might use the slang expression—came very much to the front, and prospects brightened considerably. Last year it became quite evident that with the increase in the knowledge of electric traction it must be applied to the Metropolitan and District Railways, and when this had been taken up by Mr. Yerkes the promotion of the Metropolitan District Electric Traction Co. followed. This gentleman also became interested in the Waterloo and Baker Street line, which was now nearly completed as far as the original lines were concerned. Later on, Mr. Yerkes had to consider the position of the Great Northern and Strand Railway, which was authorised to run from Wood Green to Finsbury Park, and thence on to the Strand via King's Cross. The absorption of these lines by Mr. Yerkes led to the registration of the Underground Electric Railway Co. of London (see *The Electrician*, Vol. XLVIII., p. 998), with an already subscribed capital of £5,000,000. This company also took over the Charing Cross, Euston and Hampstead Railway, and these four lines were now absolutely safe as far as construction was concerned. These lines, in conjunction with the already existing Metropolitan and District Railways, which were to be electrified and which would couple up with them, would afford access from the north and north-east over the whole of the south-west of London as far as Hounslow, South Harrow, and so on. In their opinion there was no need for new lines to be built over this portion of London. To the east, the lines joined up with the Whitechapel and Bow Railway, which would be opened very shortly, and so afford a means of communication as far out as Southend by running over the London, Tilbury and Southend lines. This latter company were also to electrify their metropolitan lines. The idea now was to work the deep-level railway from Earl's Court to the City, which was authorised as an express line to the District Company a few years back, only as far as South Kensington and thence to Piccadilly-circus by the Brompton and Piccadilly Circus railway. They also proposed an extension to Charing Cross from Piccadilly-circus joining up with both the District lines and also the deep level line, and another from Piccadilly-circus joining up with the Great Northern and Strand Railway at Holborn. All this communication would be maintained and provided at very much less expense than that proposed by some of his competitors. Another line which was being put on one side for the present, ran from the Brompton-road to Fulham. The total capital and borrowing powers for all his lines was £4,133,000, which only left a margin of something like £300,000 to cover the whole of the financial expenses and other contingencies. The new line promoted by Mr. Clifton Robinson, from Hammersmith to the City, would be subject to the fiercest competition from the two existing lines, and thus could only, at the best, secure one-third of the available traffic. At the present, therefore, it was an absolute waste of money to sanction such a line, for it must be borne in mind that the Brompton–Piccadilly line would be constructed despite anything. The size of the tubes had been a very moot question, and although they were quite prepared to increase the size, which was at present 12ft, Mr. Yerkes would show that all that had been said against the small tube so far was a sheer fallacy. If a larger tube was insisted upon by the Committee, Mr. Yerkes was prepared to meet the difference in cost of construction out of his own pocket. He contended that the platform which the larger tunnel allowed was absolutely useless for the purpose for which it was intended, and that under their system the centre collecting rail was the negative one, and therefore absolutely harmless. The positive conductor was outside the running rail and protected by boards. He also hoped by his evidence to satisfy the Committee as to the other objections which had been to the smaller tube. Their system of signalling would prevent any possible chance of collision, and no danger from fire need be apprehended, inasmuch as fireproof material would be used throughout. The tunnels would also be lighted throughout. The question of the rise in the carriages to make room for the motors consequent on the smaller wheels only meant two steps of 7in. each on the leading and rear coaches of the train, and possibly on the middle one as well. Nobody along the line of route was coming to oppose the size of the tubes. He continued that it would be a moral injustice to allow Mr. Robinson to have a hand in the combination with Messrs. Morgan, as the London United Tramways would unjustly control one route in preference to the others. Much had been said as to the capital being American, but he did not think their lordships would trouble very much about the nature of the capital. What was wanted were effective means of communication, and if we ourselves could not find the money someone else must. Messrs. Speyers, who as every one knew were British, had insisted upon being allowed to provide the majority of the directors for the new company for the next 10 years, and this ensured British control. The Morgan house had come into the field through a feeling of jealousy, Mr. Yerkes being a countryman of Mr. Morgan's.

Earl ZOUCHE: Do we understand that your Brompton and Piccadilly line has actually been commenced?

Mr. LITTLER: The contracts have been let and the work has actually been commenced. Our time limit and the acquisition of lands under our original Act expires in August this year, and for construction early next year, and although we could, if necessary, execute the work by then it will be hustling us rather severely if your lordships refuse us an extension.

Tuesday, April 29.

Mr. R. W. PERKS, M.P. (chairman of the District Railway Co.) explained the eastern and western extensions of that company's lines, which, when opened shortly, would be worked by steam until the electrification of the whole of the railways in the District Company's hands. This latter was expected to be completed in about 18 months or two years' time. From Whitechapel to Bow the line had intercommunication with the Forest Gate, Leyton and Tottenham lines viâ the London, Tilbury and Southend Railway, and passengers could also, of course, exchange trains and get on to Southend. In the west the lines were being extended to Harrow and Uxbridge, and by means of various exchanges one could travel across London to the east. For the extensions just mentioned the whole of the capital had been found by the District Company for the western lines, and half each by that company and the Tilbury Company for the Whitechapel and Bow Railway. Another line to which electricity was to be applied was that running from Mill Hill Park to Hounslow, which had now been practically acquired from the original company by the District Company. From Earl's Court also, there was a line running to Wimbledon viâ Putney over which the District Company had running powers in perpetuity, and by which they got a considerable exchange of traffic with the London and South-Western Railway. Altogether, there were five lines radiating out from Earl's Court besides trains from the London and South-Western Railway and Great Western Railway. The Brompton and Piccadilly Railway Co. had taken over the Earl's Court–South Kensington section of the deep-level authorised line; from here the journey eastwards would be continued by the Brompton and Piccadilly Railway as far as Charing Cross, and thence by the deep-level line again on to the Mansion House.

Lord WINDSOR: How do you propose to run your trains from the authorised Brompton and Piccadilly Railway on to Charing Cross? Will it be without change?

Mr. PERKS said they would construct their junction at Piccadilly-circus in such a way that trains would run by the Hampstead, Euston and Charing Cross Railway on to Finsbury Park, or by the southern junction to Charing Cross and on to the Mansion House, or both. The junctions, as constructed, must necessarily be confluent junctions, but they need not be used as such. For instance, already at Baker-street such a junction was in existence, but had never been used.

Mr. LITTLER, K.C.: These are exactly the points which we desire to leave to the Board of Trade.

WITNESS, continuing, said the cost of the construction of the deep level line between Charing Cross and Mansion House would be £400,000, and for that portion between Earl's Court and South Kensington £350,000. The South Kensington junctions would cost £106,000, from South Kensington to Piccadilly-circus £743,400, Piccadilly-circus to Charing Cross £392,400, Piccadilly-circus to Holborn £409,000, stock, lifts, &c., excluding the Fulham line, £460,000. Leaving out the South Kensington to Fulham section, he estimated a total expenditure of £2,800,000; but, as a matter of fact, it would be less, inasmuch as the line from South Kensington to Earl's Court was sanctioned, as also were the South Kensington junctions, and the South Kensington to Piccadilly-circus section. In this way his company would give communication from Hammersmith to the City for something like £800,000, whereas the cost of the other competing lines amounted to over £3,000,000. By an arrangement with the Great Northern and Strand Railway, contracts for this line had been received, and they hoped to be in a position to let this tender within 10 days. On the question of the time taken for the various journeys, he said the engineers to the District Company had given it as their opinion that Sir Douglas Fox was wrong in calculating upon a speed of 20 miles an hour. Their view was that an electric motor for railway purposes could not be run economically under the prevailing conditions at a higher speed than 16 miles an hour, and all his calculations were made upon the lower speed. The amalgamated lines from Hammersmith past Albert Hall were 6⅛ miles to the Mansion House, and would take 24 minutes. The Brompton and Piccadilly line via Sloane-square was 6¼ miles long, and would take 25 minutes; at the same time it was quite possible that on the high level District line by electric traction they could run a quicker journey than by the tubes. By these figures it would be seen that his competitors, the Piccadilly and City line, in conjunction with the London United Electric Railways, did the journey one minute faster than he did in the tube. At Finsbury Park arrangements had been made with the Great Northern Railway for the building of a very large station under the existing one, for the purposes of the exchange of traffic with the Great Northern and Strand Electric Railway, running on to Wood Green. This would permit of communication from off the Metropolitan Railway on to the Great Northern, feeding Palmer's Green and Southgate and the district included in the bill of the North-East London Railway. The Charing Cross, Euston and Hampstead line would have an interchange at Kentish Town with the Midland Railway. The contract for the Brompton and Piccadilly line had been let and the work was being pushed forward with all possible speed. Dealing with the present and prospective train service over the lines upon which their own trains would run, he said that at present there were six trains from Hammersmith to the City per hour on the District line, and a similar number run by the Metropolitan Railway. From Earl's Court to the City there were also 12 trains per hour each way. When electrical working had been installed over the whole of the lines it was proposed to have six trains from Harrow to Hammersmith in the hour, six from Ealing, six from Hounslow and six from Richmond, or 24 in the hour altogether. These would all run to Hammersmith and from there to the City. There would be a 2½-minute service to the City. From Wimbledon and Putney there would also be a 5-minute service, and all these trains would run through Earl's Court.

Lord WINDSOR: If you had a 2½-minute service from Hammersmith how can you arrange for any trains coming from the South.

Mr. PERKS said that his engineers thought they would have no difficulty in satisfying the Board of Trade that a 1½-minute service could be run if necessary. This was a very common schedule of trains in other countries, and he saw no reason why it should not be done here.

Lord WINDSOR: That is my point.

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WITNESS, continuing, said the service on the Circle when electrically driven would have double the seating capacity of the present one. As to the negotiations with the promoters of the City and North-East Suburban line, he had promised them £15,000 as against their own £10,000 for putting the line before Parliament, and his idea in helping these gentlemen was that the line carried out the intention which they had in respect of the deep-level line—viz, to extend it further east. His first intimation that the promoters had approached Messrs. Morgan and were being assisted by them was conveyed to him by Mr. Dawkin's evidence, and, of course, under the circumstances, he could not but regard it as unjust opposition.

Cross-examined by Mr. E. MOON, K.C., for the Piccadilly-City line: The Committee might take it that if the Board of Trade or the Committee should say there must be no confluent junctions, then one or other of the lines from Charing Cross would be worked on the shuttle system. With regard to contracts for the deep-level line, these had been let for the Earl's Court-South Kensington section.

By Mr. BALFOUR BROWNE, K.C.: No agreement had been made for transferring the section of the deep-level line from Charing Cross to the Mansion House to the Brompton-Piccadilly Company, as under this year's bill they proposed to constitute the deep-level line from South Kensington to the Mansion House a separate undertaking, which could be constructed if the traffic along the route demanded it.

Then you will be competing with yourselves?—Not necessarily.

Have you made no other arrangements with regard to the other piece of deep-level line from Charing Cross to the City?—Not beyond the powers in our bill this year.

Can you put before the Committee any scheme of fares which are to be charged?—No; we do not propose to put this before the Committee. The electrification of the line will necessitate the complete revision of the fares.

Continuing under cross-examination, Witness would not express any opinion as to the desirability of having one set of stations in Piccadilly if the Committee sanctioned more than one line down this thoroughfare. He did not feel disposed to have a clause inserted providing compensation during the working of the railway for the benefit of anyone.

Mr. C. T. YERKES gave the terms of the agreement by which the Underground Railways Co. of London was formed. Under this agreement £4,000,000 of capital was to be provided by Messrs. Speyer, which, added to the £1,000,000 capital of the Metropolitan District Electric Traction Co. which was absorbed, made up the £5,000,000 capital of the new concern. The terms for providing this money were 5 per cent. in shares and 1 per cent. in cash. The central power station in course of construction at Lots road, Chelsea, was in a most favourable position, and from there high-tension current would be transmitted to some 20 sub-stations, where it would be transformed down to 500 volts. The proposal was that each train should consist of seven coaches 50ft. long, each seating 48 persons. On some of the roads there might be six instead of seven coaches, but, of course, the rolling stock on the District existing lines when converted would not be the same as on the tubes. Naturally, the cars for the tube lines would be a little improvement on the Central London trains for several reasons. For instance, they were able to take advantage of any errors which the Central London Company might have made, and, further, they had their own ideas of what a car should be. They would be 44ft. from end to end of the seating portion, and 50ft. over all. At either end of the train there would be a motor car, and also one in the middle. These motor cars would have a space taken away from the seating portion of about 9ft. in order to accommodate the electrical machinery. Of course, the trailer cars had not this space taken off. There was also the 14in. rise from the floor in order to allow of the motor. At that part of the car where the electrical equipment was situated the wheels were 35in., as against 29in. on other portions. He considered there would not be the slightest chance of fire. The coaches would be of entirely non-combustible material. An inflammable car in a tunnel was to be greatly deprecated. The permanent way, he did not think, had anything to do with the inflammable part of the equipment. At the same time, every piece of wood used throughout the equipment would be rendered non-inflammable, which could be done very easily. Even in England there was a process of treating wood which rendered it impervious to fire, and which, when put into a fire, did not give off smoke. He also knew of a system of using compressed asbestos which was equally as good as wood for car construction. With regard to the size of the tunnel a good deal could be said on either side. When he first considered the tube question he was satisfied that a 11ft. 6in. tunnel was too small for the same reason that Col. Yorke had given—viz., that there ought to be a footway alongside the train. After studying the matter very thoroughly, however, he came to the conclusion that there were two points to be be considered—*i.e.*, ease and successful operation, and safety. As regards ease and successful operation there was no doubt that the 13ft. 6in. tunnel was the best, but with regard to safety he had no hesitation now in saying that the 11ft. 6in. tunnel was the best. At the same time, he was open to adopt whatever size tunnel was imposed upon him. In a 13ft. 6in. tunnel there was a space of 2ft. 5in. between the car and the wall of the tunnel, allowing for an 8ft. 8in. car. In such a space a derailment of the car would carry the platform away, while in case of a panic the efforts of the passengers to proceed along such a small platform would lead to very serious consequences. Personally, he thought that, in cases of accident, if a person could not get out of a car he was much better off than the person who got on to this emergency platform. The best method was to have the platform built between the track, so that, in case of derailment, it could not be swept away. In an 11ft. 6in. tunnel the passengers would have to pass to the end of the train and get out on to the track through a doorway which only admitted of one passing through at a time, and so preventing the passengers from crushing and pushing themselves out in a heap. He proposed to have a 24in. doorway for this purpose. Taking everything into account, he did not see any great disadvantage in having the lump in the floor of the car to accommodate the motor. The one advantage, perhaps, in having the platform alongside the car was that it made repairs very much more easily accomplished from the point of view of the workmen, but in an 11ft. 6in. tunnel they had spaces afforded by the cross-overs every 100yds. or 200yds. The repairing was always done at night, and as he proposed an all-night service perhaps he would not get so much work done in the same time. On the District Railway they expected a 15-minute night service, and on the tube lines about 20 minutes or half an hour. Dealing with the conductors, he said it was intended to use both a positive and a negative, so as to ensure the very best insulation and freedom from contact with water pipes and so forth. The positive rail would be at the side of the track, and would be protected by two boards, which would extend to 1½in. above the conductor. Between the running rails the negative conductor would be placed, and, under favourable circumstances, it would be possible to touch it without the slightest shock. The permanent way would be lighted throughout, and so, when the lights in the train went out for any reason, the passengers would not get into that state of panic which they would if left in total darkness. He considered the size of the tunnel had nothing whatever to do with ventilation. At the same time it had been arranged to instal a system of ventilation which would change the air through 1 mile of tunnel every 45 minutes, and the bigger the tube the bigger the ventilating apparatus. Neither did the size of the tube have anything to do with vibration in his opinion. He failed to see how the top of a car coming within 5in. of the tunnel roof should cause any more vibration than one coming within 12in. On the question of speed, he said the only decrease in the speed of the trains would be caused through not having the middle motor car running, as was not always intended. There was to be a 5½in. rail as against the 3in. or 3½in. of the Central London Railway. But he did not think so much of the size of the rail as of the manner in which it was laid, and he had a system of permanent way which had never yet been put into a tube and which would obviate a great deal of vibration. They were making experiments with it on the District Railway. Apropos of confluent junctions, he said it seemed to be the opinion in London that these were very dangerous, and for this reason he did not wish to say they were not, or to force his opinions on anyone. Whatever the Board of Trade decided upon they would conform to. But on the Union Elevated Road in Chicago there were nothing but confluent junctions. This line was the terminal for four other roads running on to one line, and this had been in existence for five years, and there had never been an accident. On one of the tracks there were 61 trains an hour and on another 47.

Lord WINDSOR: Of course, these are all in the open.

Mr. YERKES replied that they were in the open, but elevated and outside the station. But a confluent junction on an elevated road was a much more complicated matter than in a tube, for if a derailment took place the chances were that the train toppled over into the street. Generally speaking, he thought it was a question which the Board of Trade might take up. He generally found this body very intelligent, and did not mind them having the benefit of his experience and opinions. If this were done, it was his opinion that in three or four years we should have any number of confluent junctions. The Chicago lines to which he referred carried about 300 millions of passengers a year.

Earl LAUDERDALE: Do you consider a confluent junction as safe as an end-on junction?—Not exactly, because there could not be any chance of accident with an end-on junction. In fact, this latter was really not a junction at all, but merely the point where trains ran from one person's property on to that of another.

Viscount KNUTSFORD: It is not as if we had no confluent junctions in this country. In Lancashire there are thousands of them. The question is, really, whether there is any more danger in a tube, and I gather you do not think so.

WITNESS answered yes. The proposed average speed was 15 miles an hour in the tubes, and this had been decided upon after a special set of experiments by the General Electric Co. at Schenectady, who had made trials with a train with exactly the same stopping distances as would be met with here—viz., 2,500ft. The wear and tear on the wheels and shoes when running at 18 miles an hour prompted the company to advise him not to adopt such a speed, and he took their advice. There would, of course, be great economy in working all these lines as one united scheme, especially in relation to the power house. Their generating station would be the largest one for traction purposes in the world, as it would have a capacity of some 60,000 H.P. He objected to running the trains from the tube on to open roads in electrical working, and considered tramways served this latter traffic much better. As to the purchase of machinery, he had from the very first considered it his duty to put everything he could in the hands of English manufacturers, and of the £400,000 already let in contracts about 98 per cent. was in English hands, the remaining 2 per cent. going to America simply because he could not obtain what he wanted here. He had also sent out tenders for rolling stock, and in this connection had ordered a sample car from America to show English manufacturers what he considered was a non-combustible car. In his opinion, if London was to be honeycombed by all these tube schemes which were being proposed, there would be excessive subsidences in connection with buildings, and personally he would not think of going in the same street with a tube as someone else. The District Company were not, in his opinion, doing the wisest thing in dealing with the deep-level electric line as they were. This ought to be constructed as an express line, as it was originally intended. Nothing in the shape of a table of fares had yet been drawn up, but he was in favour of a uniform fare of 2d. over all the tube railways.

Cross-examined by Mr. Balfour Browne, for the Piccadilly-City Railway, he admitted that for all outside districts the tubes would be useless, as at the termination of them passengers would have to change on to the existing Metropolitan and District lines. In the same way, a passenger coming from Acton would have to come by the same route as at present to the City unless he changed at Earl's Court into the tube. He was

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unaware that the Liverpool Overhead Railway Co. ran at an average speed of 19½ miles an hour, but at the same time it must be remembered that the District Railway had very numerous stops.

Have you ever seen the Liverpool Overhead Railway?—No. But I have reports and am satisfied that this speed is not attained.

Do you know that they have 14 stations on 6 miles of route?—No.

This makes the stops much more frequent than on the District?—About one every half-mile or less.

Continuing under cross-examination, witness had a long argument with counsel as to confluent junctions which was not finished when the Committee rose. He considered it would be very bad railroading for two trains going in the same direction to meet at a confluent junction. A properly arranged schedule would not allow of this. Of course, if such a thing happened, one train must go forward, and by the block system of signalling the one remaining would, of necessity, keep all the trains on that line back.

Wednesday, April 30.

Mr. Yerkes' cross-examination was continued.

Mr. BALFOUR BROWNE: You said you were quite willing to adopt a 13ft. 6in. tube if necessary?—As far as I am concerned, I should be very willing to do it; but there might be some legal points that I do not know of.

I was going to suggest that you cannot do so under this bill?—I do not know that we cannot.

The disuse of creosoted wood, &c., mentioned in your evidence yesterday can be done by any tube railway?—Yes, of course.

In order to get past the motors in the middle motor car, passengers would have to step up and down two steps. Would it not be better if this could be avoided?—It does not seem to me to be any great inconvenience.

Supposing the District Railway did not exist at all, and you were laying out a route from the West-end to the City, would you not take the route along the Park, through Piccadilly and along the Strand?—I am not sure that we would, and not having considered it, am not sure that we would not.

Is it not obvious that where the Metropolitan and District lines run alongside the river they have only one side to feed them, whereas along the Strand they would have two sides to draw from?—I do not consider there is a very considerable population between the river and the Strand.

If you had an interchange station at Piccadilly-circus could not your passengers be carried to the City by the Piccadilly-City Railway?—I suppose so, but that would entail the abandonment of a portion of our lines.

If you work the Great Northern and Strand Railway as a through line via Piccadilly to the south-west, the little piece from the Strand to Holborn will have to be worked as a shuttle line?—I think that would be a good thing.

The capital of the District Company for the 14 miles which it actually owns is £8,500,000, is it not?—I do not know off-hand.

How much will the electrical equipment cost—1½ millions?—No, it will be something less than a million.

Besides the owned lines, there are leased and worked jointly another 12 miles, for which the capital is £2,500,000. What is the capital expenditure of your four tubes—15½ to 16 millions?—I can only tell you the cost of the Finsbury Park to Earl's Court line and also the junctions in the bill.

But do you not know that it has been estimated at the figure I have mentioned?—That is very likely, but I would not like to swear to it.

Therefore, the whole capital of the District and the tubes when electrically equipped will be something like 28 millions, and upon that you will have to pay interest?—You know; I don't.

I daresay you will help me in this. 4 per cent. interest on that amount would require £1,120,000 a year?—I have not made any calculations.

And if your working expenses are 50 per cent., it would necessitate a gross receipt of £2,240,000. Do you know how many passengers you will have to carry at 2d.—your proposed fare—in order to give you this amount?—I do not pretend to know what the business of the District Company is. I do not think you can expect me to sit here and justify all these matters. It may be that you are right. You will pardon me in saying it, for I have not had much experience with counsel, but it seems to me that counsel, when they are cross-examining a witness, try to make him say something which he does not mean to.

Mr. BALFOUR BROWNE: You must not lecture too much, Mr. Yerkes. Continuing his cross-examination: You said you did not think the through amalgamated line could carry 250 millions of passengers. Do you know that you will have to carry 270 millions in order to pay your interest and working expenses, charging your fare of 2d?—I do not know it.

Mr. LEWIS COWARD, K.C., for the London County Council: You know the London County Council objects to your line, because in their judgment it does not give the one through line from Hammersmith to Piccadilly and the City which the Joint Committee approved last year?—Yes.

You submit, of course, that your proposal does give a through line?—Yes.

Are you aware that when the Great Northern and Strand Railway was promoted it was supposed to give a line from Finsbury Park to the Strand?—No; it is not a fact. I think you will find a clause in the bill which provides that it should connect with the Brompton and Piccadilly Railway, and then run as one line.

The London County Council supported the original bill on the understanding which I have mentioned, and the objects of that bill are now being utilised for another purpose, because all you are now proposing is a shuttle service as between Holborn and the Strand.—That is a very good thing.

How many shuttle services have yot got?—I have not counted them, but will take your statement that there are three.

You know your South Kensington to Parson's Green runs almost cheek by jowl with the King's-road extension line now before Parliament?—Yes.

Re-examined by Mr. LITTLER, Witness said the whole object of combining all these railways was that it would benefit the District Railway. He did not think a better scheme could very well be proposed for the travelling public to all parts north of the Thames at so little expense. He had looked into the matter very carefully, and the reason he had taken such interest in the lines was that when the electrification of the District Company's service was completed they would get back considerably more traffic, through the assistance of these tubes, than they had lost owing to the competition of the Central London Railway. He believed that a shallow line such as the Metropolitan and District Company's lines would compete very successfully when worked electrically with deep-level tube lines. The power-house, also, upon which 1¼ millions of money was being spent, would be available for both the tubes and the other lines. With regard to a through line to the City, this would, of course, be provided by the existing lines of the District Company when the electrical equipment was complete. There would also be the deep level line and the Brompton-Piccadilly line. He did not think the changing which would be necessary was a very serious matter. One minute was the average time taken to change from one train to another.

Mr. C. A. BRERETON, the engineer with Sir James Szlumper to the Brompton-Piccadilly Railway, spoke only of the proposed extension to the south—from South Kensington to Parson's Green—a total length of a little over 3 miles, upon which it is proposed to have eight stations. At Earl's Court the trains ran into the station on the level, and, if the Committee allowed it, they would do so by means of a so-called confluent junction. But these were very much of a bogey with regard to tube railways. The real confluent junction was where two trains met on the level and had to pass over on to the lines of each other. In tube junctions the tunnels were constructed one above the other; and, therefore, there was no interference with the traffic on the other line. Further, when these junctions were made in stations they ran to different platforms. His estimate for the construction, &c., for this section of the railway was £826,875.

Cross-examined by Mr. FREEMAN, on behalf of several hospitals along the route: This line was an addition this session, and was not an essential part of the whole scheme, but as a local line it had some value, the District Railway not being near enough to serve the district thoroughly. He should not say there would be sufficient traffic for this line as well as for the King's-road extension. There was no possibility of damage to the hospitals. The Whitechapel and Bow Railway passed the London Hospital without causing any damage.

But it is a fact that compensation has been paid in respect of Bow Church?—So I have heard.

Mr. VESEY KNOX, for the Piccadilly-City Railway: Your idea of confluent junctions would involve four tunnels, one above the other. How do you reconcile this with the statement of Mr. Yerkes that a number of tubes near each other will cause serious subsidences?—There is a difference in the fact that tubes utilised for such junctions would all be in friendly hands. If there are proper arrangements between the respective engineers there would be no difficulty.

Re-examined: He did not think there would be any difficulty in getting over all the objections which had been made.

Sir HUGH OWEN, a resident at Crouch End, supported the proposed connection with the Great Northern and Strand Railway at Holborn.

Sir JAMES SZLUMPER dealt only with engineering matters. His estimate for the connection with the Great Northern and Strand Railway at Holborn to Piccadilly-circus was works £72,042, and lands £30,130—a total of £102,172. For railway No. 2, from Earl's Court to South Kensington, his total estimate was £409,027, and for No. 3, connecting Piccadilly-circus with the deep-level line at Charing Cross, £240,845 for works and £49,600 for lands. The estimate for railway No. 4, from South Kensington to Parson's Green, had been given by Mr. Brereton. The present application in respect of the already authorised Brompton and Piccadilly Circus Railway was for an extension of time for the purchase of land until August, 1904, and for construction until August, 1906. The existing lines and the authorised Brompton-Piccadilly Railway, in his opinion, amply served the western districts of London, and the duplication of stations caused by these other proposed lines was not necessary.

Cross-examined as to what a passenger would do when he got to Piccadilly-circus in the event of the extension lines being refused, Witness said he did not know. Probably anyone coming from the west into the City would prefer to come by the District Railway.

By Mr. E. MOON, for the London United Electric Railways: Last year he had stated that the north-east London route was a more important one than that to the City; but now that he could supply both with the same construction he advised this to be done.' The line from Piccadilly-circus to Charing Cross was on a gradient of 1 in 42 and 1 in 44, and at the bottom of this there was a 3½ chain curve. He considered that motor cars could easily get round this without any danger or appreciable diminution in speed. He had been obliged, however, to manipulate these gradients and curves on account of the geographical necessity at that portion of the line.

What do you propose to do at Charing Cross with your trains from Piccadilly-circus?—We propose to have a run through on to the deep-level line, and not to have confluent junctions.

This would mean, then, that a passenger coming from Earl's Court to the City would have to change at Charing Cross?—Yes.

You would also have to abandon some portion of your already authorised deep-level line if you are not going to have a confluent junction?—I do not see why.

It is suggested to me that such would have to be the case?—I cannot help what has been suggested to you. It is intended to have an interchange station for passengers by the high-level line, and to have an end-on junction for the trains from the Brompton-Piccadilly line. I am sure you do not understand it.

Mr. MOON: That I am not surprised at, but I am surprised that my engineers who advise me do not understand it. Do you not think that the smaller sized tunnel which you propose will not allow you to comply with the Board of Trade requirements?—I think that we can, and I am of Mr. Yerkes' opinion in this matter.

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Do you know what the weight of the rail will be?—90lb.

Is not the deep-level line which is authorised a disadvantage to the existing District Railway from an engineering point of view when constructed?—We are told not, and I have no doubt that it is so.

The Committee adjourned until to-day.

THE METROPOLITAN DISTRICT RAILWAY BILL.

The Select Committee of the House of Commons, presided over by Mr. H. Hobhouse, sat again on Friday last week for the adjustment of clauses, the preamble having been declared proven on the previous Wednesday, as reported in our last issue.

The CHAIRMAN, referring to his decision on the preamble, said the Committee had laid it down that the street works, cable laying and so forth, should be carried out under the supervision of the Board of Trade. He had forgotten when dealing with the convenience of the road authorities to use the word "reasonable." Their intention had been not to bind the Board of Trade to do everything the authorities required, but to do everything that was "reasonable."

Mr. TALBOT, for the Borough of Chelsea, proposed the adoption in the bill of the words "The Board of Trade before giving such approval shall have regard to the safety and convenience of the public, and shall hear and consider any representation made to them by the local authority." Those words he thought would carry out the intention of the Committee.

The CHAIRMAN accepted this wording of the clause, with the omission of the words "hear and."

Mr. CLODE, for the promoters, brought up the following clause to carry out the decision of the Committee as to the stability of the proposed new generating station:—"The company's generating station shall be constructed as far as practicable of iron, steel, brick, stone, glass and concrete, or such other materials of such description as to secure stability in the said generating station, and minimise risk of danger from fire, and the provisions of the London Building Acts, 1894 and 1898, shall not apply to the generating station."

Mr. FREEMAN (for the London County Council) objected to the concluding words of the new clause. He suggested that there should be a reference to the Board of Trade in this matter as in connection with the breaking up of streets.

The CHAIRMAN said that they were not prepared to bring in the Board of Trade. He would leave in the words "and the provisions of the London Building Acts 1894 and 1898 shall not apply to the generating station."

Mr. METCALF (Parliamentary agent) said he represented two electric lighting companies whose mains ran along the roads through which the promoters' cables would run, and he wished to propose the insertion of an additional clause for the protection of those companies. The clause incorporated sec. 40 of the District Company's Act of 1897, dealing with the protection of water, gas, electric lighting, and suchlike companies—the model clause. It appeared in all the tube railway bills before Lord Windsor's Committee with the exception of the Brompton and Piccadilly, in which case, however, the promoters had given an undertaking, and with the exception of another bill, the promoters of which had not yet given a definite answer. The clause was in a common form. The clause he proposed was as follows:—

"It shall not be lawful for the company to lay down any line or rail, or to do any act or work for working the railway by electricity whereby any electric apparatus of any electric lighting company (hereinafter called the protected company) is or may be injuriously affected, and before any such line or rail is laid down, or any such act or work is done within 10ft. of any part of any electric apparatus of the protected company (other than repairs or the laying of lines crossing the electric apparatus of the protected company at right angles at the point of shortest distance, and so continuing for a distance of 6ft. on each side of such point) the company or their agents not less than 14 days before commencing such work shall give written notice to the protected company specifying the course of the line or rail and the nature of the work, including the gauge of any wire or wires intended to be used for electrical energy, and the company and their agents shall conform with such reasonable requirements (either general or special) as may from time to time be made by the protected company for the purpose of preventing any electric apparatus of the protected company from being injuriously affected by the said act or work."

Mr. CLODE denied that a precedent had been shown for the insertion of the clause by compulsion. It might have been accepted by the promoters of certain tube bills in order to satisfy opposition, but it had not been put upon any promoters by a committee.

The CHAIRMAN: The Committee will add a few words to the proviso to clause 5 directing the Board of Trade to consider any representation made on behalf of the electric railways so as to put this matter entirely in their hands.

The bill was ordered to be reported for third reading.

LONDON COUNTY COUNCIL (SUBWAYS AND TRAMWAYS) BILL.

This bill came before the Select Committee presided over by Mr. H. Hobhouse, on Friday last week, for adjustment of clauses.

Mr. R. BERKELEY, for the Corporation of Westminster, asked for a special protective clause so far as the route of the subway from the Strand to the Victoria Embankment and a convenience at the end of Wellington-street were concerned. He said that more than three parts of the proposed subway were in Westminster. The part the Borough of Westminster were most concerned about is that from the Victoria Embankment to the proposed new street which comes out in the Strand. The clauses he proposed would provide that if the proposed electric tramway or the subway interfered with the sewers and drains of the petitioners, the promoters should be required to submit plans to them, that the engineer to the petitioners should be present when the contemplated work was carried out, that the traffic in Wellington-street should not be interfered with during the progress of the works, and that it should be for the Borough of Westminster to say what condition the place should be left in. Clauses were also proposed dealing with the construction of the subways and the weight they should required to bear, compensation, arbitration, &c.

Mr. WILKINSON, for the London County Council, objected to the proposed clauses.

The CHAIRMAN said he understood that these clauses were given to the London County Council itself by incoming railway companies.

Mr. BERKELEY said that the London County Council in this case must be regarded as an incoming railway company.

The CHAIRMAN: That is true, but they are also a local authority.

After further discussion, the Committee rejected all the proposed new clauses save that bearing upon the underground convenience at the end of Wellington-street.

The Bill was ordered to be reported for third reading.

CAVEHILL AND WHITEWELL TRAMWAYS.

This bill, to empower the Cavehill and Whitewell Tramways Co. to work their existing tramways by electrical power and to raise additional capital, came before the Select Committee of the House of Commons, presided over by Sir Samuel Hoare, on Tuesday last week.

Mr. E. MOON, K.C., in opening the case for the promoters, said the total length of the line was 3¼ miles and it ran from a junction in Belfast to Chichester Park at Whitewell, where were the Glen Gormley Gardens, a very favourite place of resort for the people of Belfast. When it was originally opened in 1882 the tramway was entirely in the county of Antrim, but since that time the boundary of the city of Belfast had been extended, and now about half the route was within the city. In the second place, when the tramway was constructed it was authorised to use mechanical power, and, in fact, the first motive power used was steam, which was changed in 1892 to horse traction. The tramway was not suitable for such traction, for the gradient was something like 1 in 30 the whole way, and the journey of 3¼ miles occupied half-an-hour. The whole opposition of the Belfast Corporation was directed to the point that they desired the power to purchase the undertaking. The Tramways Act of Ireland gave no such power to the local authority, and where the tramway was constructed it was not purchasable. It seemed unfair that the Corporation should oppose them, especially as they had no power to work tramways outside their own district, and half the line of the promoters was outside their limits. There was another point between the promoters and the Corporation. When the tramway was constructed the lines were laid along the side of the road, in deference to the wish of the Antrim County Council, but against the opinion of the company's engineers. The Belfast Council now desired to have the line in the centre of the road, and to that the promoters consented. The Antrim County Council had now withdrawn their opposition.

Mr. ANDREW NANCE, a director of the Cavehill and Whitewell Co., and general manager of the Belfast Tramways Co., then gave evidence in support of Mr. Moon's opening statement. He added that the traffic all the year round just about covered the expenses, and the profit was derived in the summer from the excursion traffic to the Bellevue Gardens, at the end of the line. These gardens were laid out as part of the policy of the company, and were very popular. There was a universal feeling in the district in favour of electric traction. They were already authorised to work the line by mechanical means, but they had no power to erect posts on the road to carry their wires, and had, therefore, to apply for the present bill. They had made an arrangement with the British Electric Traction Co., who would entirely reconstruct the line and equip it for electric traction. With reference to the power to purchase claimed by the Corporation of Belfast, witness said there was in the Irish Tramways Act no provision with regard to purchase, as in the English Act of 1870. All the tramways were unpurchasable. The only exceptions were the Belfast tramways and the Dublin tramways, in which cases the section of the English 1870 Act was inserted as the price of the concessions to the companies. The effect of that at Belfast was that the tramways could not be electrified until the Council exercised their power of purchase in 1907.

Mr. FITZGERALD, K.C. (appearing for the Belfast Corporation), suggested that if there was to be a sale of the undertaking the Belfast Corporation were the people to buy; but witness said the company could still remain a fully constituted company. The company was constituted by an order of the Irish Privy Council in 1881, and there had been several amending orders; but when they applied to the Privy Council for the powers they were seeking in the bill the Council would not listen to them until they got the consent of the road authority, and the Corporation would not give their consent without the purchase clause.

In re-examination, Witness said when the Belfast Corporation took over the powers of the Belfast Tramways Co. they would secure the right to purchase the Cavehill tramway by agreement. The Corporation had, however, never attempted to purchase any of the tramways. The question of purchase at Belfast had become insistent, because the people wanted the lines electrified and the company could not do it.

Mr. FITZGERALD said he was instructed that negotiations were going on between the Belfast Corporation and the Tramways Company for the immediate sale of the undertaking to the Corporation. He was quite willing to promise to bring in a bill next year to purchase the Cavehill tramways compulsorily.

Witnesses living near the line of route were then called to give evidence as to the necessity of improving the tramway accommodation and the advisability of having electric power.

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Mr. STEPHEN SELLON, engineer of the British Electric Traction Co., said there was no physical difficulty in the question of electric traction, and the promoters would fall in with any reasonable requirements of the local authority. With regard to the danger of electrolytic action, they had inserted in the bill the clause approved by the Joint Committee in 1893.

Cross-examined by Mr. HARRISON, K.C., for the Belfast Corporation: His company owned about 60 tramways, and in nearly all they had the overhead trolley system.

Mr. HARRISON: I take it, that supposing the Belfast Corporation adopt a different system of electric traction, a car could not run through?—I beg your pardon, it could.

It does not matter what sort of system of electricity you apply, an electric motor will run over it equally well?—Certainly. I may say the problem is no new one. It is common in Berlin, where they have interchangeable systems of overhead and conduit, and we have a case in this country. We have tramways outside Bournemouth—on both sides of Bournemouth. The Corporation have conduit tramways which they are building inside Bournemouth, and we are going to work interchangeably with the two systems. Continuing, witness said they had scheduled land for the generating station, but they might purchase the current from the Belfast Corporation. In answer to Mr. Macassey (for the Water Commissioners), witness said the rails would be from 91lb. to 95lb. and would rest on a concrete bed of 6in. He was quite willing to give the same protective clause against electrolysis which was given to the gas and water companies in this country.

This concluded the case for the promoters, and Mr. Harrison called witnesses for the Belfast Corporation.

Sir DANIEL DIXON, the Lord Mayor of Belfast, said in 1907 the tramways of the city would be purchased by the Corporation, and they considered they should acquire the Cavehill tramway.

Mr. J. W. McCORMICK and Dr. P. R. O'CONNELL (alderman of Belfast) also gave evidence.

Mr. HARRISON then addressed the Committee on behalf of the Corporation, and

Mr. MACASSEY, on behalf of the Water Commissioners, said he would not oppose the preamble, but would ask the Committee to give them protective clauses.

On Wednesday, The CHAIRMAN announced that the Committee found the preamble proved.

Mr. HARRISON announced that the Belfast Corporation would reserve the right to oppose in the next House, and would not enter into the consideration of clauses.

The bill was ordered to be reported to the House for third reading.

ELECTRICAL MACHINERY ON WARSHIPS.

In the House of Commons on Monday, Mr. GIBSON BOWLES asked the Secretary to the Admiralty whether any regulations had been promulgated by the Admiralty with the effect of transferring the control of electrical hydraulic machinery above deck from the engineer officers to torpedo and gunnery lieutenants; whether this regulation had been withdrawn after a few weeks for further consideration.

Mr. ARNOLD-FORSTER said that when the decision of the Board to make the change was finally adopted, no orders were issued to the fleet, since the regulations necessary to carry the new plan into effect was being considered by a Committee specially appointed for that purpose. The Committee had now made their report, and when it had been duly considered the necessary regulations would be drawn up and orders issued to the fleet.

(Parliamentary Intelligence continued on page 66.)

ELECTRICITY WORKS ACCOUNTS.

Dover Electricity Supply Co. (Ltd.).

There was a considerable increase in this company's business in 1901. The output was 27·5 per cent. more than that of 1900. It is, therefore, rather disappointing to find that, although the total costs were slightly lower, the total generating costs show an increase and the works costs still stand at a rather high value, considering that a traction supply forms so large a proportion of the total load.

For a port the coal item seems excessive, and it is to this item alone that the relatively high total generating costs are due.

Having taken exception to the fuel item, the remaining costs, especially the total management and property charges, deserve commendation, as they exhibit creditable figures. As a result of the slight diminution in the aggregate costs, coupled with the higher output, the working profit shows a rise from 4·19 to 5·4 per cent. on the mean capital. By withholding any contributions in respect of capital depreciation or reserve, it was possible to distribute an ordinary dividend of 5 per cent. It is recorded that the prospects for the current year are brighter—a favourable coal contract having been concluded. At the beginning of the present year a revised price came into operation, under which the charge per unit is 5d. with prompt payment.

As the result of negotiations between the company and the Dover Corporation, it was decided to transfer the undertaking to the latter for £142,228. This price will allow of a distribution of £8. 10s. to each holder of a £5 share, after payment of all liabilities.

Folkestone Electricity Supply Co. (Ltd.).

We are glad to find that the Folkestone undertaking has to some extent regained the good results which were exhibited in 1899, and this in spite of evidently higher coal prices. Apparently, the price of Welsh coal, which we believe is used there, was last year as high as 26s. 6d. per ton—a condition fatal to a favourable costs sheet. It is, therefore, highly creditable to the management that the works and total costs work out at the moderate and average figures which appear in our table.

During the year the business expanded well. The lamp connections increased by 34·5 per cent., and the year's output exceeded that of 1900 by nearly 22 per cent.

£400 was placed aside out of the profits to a reserve fund, £2,216 was paid as interest, and an ordinary dividend of 4½ per cent. was distributed, leaving a balance of £291 carried forward.

To meet the large expenditure on plant, &c., made during the year a further issue of £25,000 of debenture stock was made in September.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 28, 1900
Ayr (Municipal)	Oct. 11, 1901	Kensington & Chiswick (Co.)	Apr. 11, 1902
Barnsley (Municipal)	Jan. 17, 1902	Kingston-upon-Hull (Mun.)	July 18, 1900
Bath (Municipal)	April 20, 1900	Kingston-on-Thames (Mun.)	July 20, 1900
Bedford (Municipal)	Aug. 3, 1900	Lancaster (Municipal)	Feb. 15, 1901
Belfast (Municipal)	Oct. 18, 1901	Leeds (Municipal)	Oct. 11, 1901
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 26, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal	Oct. 4, 1901	Leyton (Municipal)	Nov. 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Sept. 13, 1901
Bristol (Municipal)	Aug. 30, 1901	Morley (Municipal)	June 14, 1901
Bromley (Kent) (Co.)	June 15, 1900	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	Mar. 15, 1901	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	April 21, 1899	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	Aug. 9, 1901	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	April 12, 1901	Notting Hill (Company)	Mar. 29, 1901
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Nov. 29, 1901
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	April 12, 1901
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 16, 1901	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	April 19, 1901	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 23, 1900	Richmond (Company)	June 29, 1900
Croydon (Municipal)	Nov. 22, 1901	Salford (Municipal)	Jan. 24, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	Scarborough (Company)	Dec. 20, 1901
Derby (Municipal)	Jan. 26, 1900	St. Helens (Municipal)	Jan. 10, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dover (Company)	April 26, 1901	St. Pancras (Municipal)	July 5, 1901
Dundee (Municipal)	Dec. 6, 1901	Sheffield (Municipal)	Feb. 1, 1901
Eastbourne (Municipal)	Mar. 14, 1902	Shoreditch (Municipal)	Jan. 31, 1902
Edinburgh (Municipal)	Dec. 6, 1901	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Exeter (Municipal)	Aug. 5, 1898	South London (Company)	May 31, 1901
Folkestone (Company)	April 26, 1901	South Shields (Municipal)	Sept. 20, 1901
Glasgow (Municipal)	Sept. 27, 1901	Southampton (Municipal)	Feb. 8, 1901
Gloucester (Municipal)	Aug. 20, 1901	Southport (Municipal)	Jan. 17, 1902
Great Yarmouth (Mun.)	Dec. 13, 1901	Stafford (Municipal)	Aug. 16, 1901
Greenock (Municipal)	Aug. 30, 1901	Sunderland (Municipal)	Oct. 18, 1901
Guildford (Company)	Oct. 19, 1900	Taunton (Municipal)	June 16, 1899
Halifax (Municipal)	Dec. 27, 1901	Tunbridge Wells (Mun.)	Nov. 1, 1901
Hammersmith (Municipal)	Nov. 15, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hampstead (Municipal)	Nov. 22, 1901	Walsall (Municipal)	June 14, 1901
Hanley (Municipal)	Aug. 9, 1901	Wandsworth (Company)	April 19, 1901
Harrogate (Municipal)	Jan. 25, 1901	Westminster (Company)	April 4, 1902
Harrow (Company)	Dec. 21, 1900	Whitehaven (Municipal)	Feb. 8, 1901
Hast'gs & St. Leonards (Mun.)	July 12, 1901	Winchester (Company)	May 17, 1901
Hereford (Municipal)	Jan. 17, 1902	Windsor and Eton (Co.)	July 19, 1901
Hove (Company)	May 10, 1901	Woking (Company)	Dec. 22, 1899
Huddersfield (Municipal)	Aug. 17, 1900	Wolverhampton (Municipal)	Jan. 24, 1902
Hull (Municipal)	Sept. 20, 1901	Woolwich (Company)	May 31, 1901
Isle of Wight Company)	Dec. 20, 1901	Worcester (Municipal)	April 18, 1902

REMARKS.

DOVER.—*a* Debit balance of £3,471 in suspense account. *b* £1,519 on street lamps, £7,928 on traction machinery and £1,672 on accumulators. *c* Over expended. *d* Superintendence, salaries and wages. *e* Carbons £96. *f* Directors and head office salaries. *g* Auditing £48. *h* Maximum demand system or else uniform charge of 6d. *i* 2½d. to consumers of energy also for light, 2¼d. per unit for traction power. *j* Excluding attendance and renewals on public lamps. *k* Debit balance in suspense account £2,308. *l* Transformers £3,641, street lamps £1,835, accumulators £1,672, traction plant £7,928. *m* Carbons £98.

FOLKESTONE.—*a* Over-expended. *b* Proportion of salaries of engineers, superintendents and officers £345. *c* Proportion of salaries of superintendent and officers £30. *d* Includes insurance. *e* Directors £375, salaries of managing engineers, secretary, clerks, &c., £416. *f* Maximum demand system, 1-hour scale. *g* Includes balance of debenture premiums, £99 at end of 1900 and £400 at end of 1901. *h* Proportion of salaries of engineers and officers £313. *i* Directors £375, trustees £92, salaries of managing engineers, secretary, clerks, &c., £194. *j* After deducting attendance and renewals on public lamps.

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	DOVER.		FOLKESTONE.	
Undertaking Worked by	Dover Electricity Supply Co. (Ltd.).		Folkestone Electricity Supply Co. (Ltd.).	
Date of Commencement of Supply	April, 1895. [cont.-curr. from tramway supply.		November, 1898.	
System of Supply	High-press. alt.-curr. sub-stations with 500v.		3-wire continuous-current.	
Chief Engineer	L. W. Woodman.		T. Hesketh.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	744,352	940,153	515,566	664,497
„ **SOLD (TOTAL)**	**613,093**	**781,809**	**381,776**	**464,392**
„ sold to consumers	261,154	403,870	291,800	380,015
„ sold for public lighting, &c.	82,232	80,638	89,976	84,337
„ sold for traction	269,707	297,301	nil	nil
„ used on works	12,112	13,870	133,790	29,777
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**32·7** [traction	**33·1** [traction	**23·8**	**19·7**
Actual maximum supply demanded	294kw. lighting, 187kw.	301kw. lighting, 325kw.	322·6 kilowatts	434·3 kilowatts
Load factor	13·3% light., 16·5% trac.	18·4% light, 10·4% trac.	13·5%	12·2%
Number of public lamps	40 arcs	40 arcs	66 arc	66 arc, 132 (25 c.p.) glow
Number of consumers	277	354	298	430
Connections to mains in 8-c.p. lamps at end of year	17,837	20,168	24,190	32,532
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	675	900	513	1,000
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£100,000 / £148	£100,000 / £111	£100,000 / £195	£100,000 / £100
Share	75,000 / 111	75,000 / 83·3	50,000 / 97·5	50,000 / 50
Loan (including Debenture charges)	25,000 / 37·1	25,000 / 27·8	50,000 / 97·5	50,000 / 50
RECEIVED (TOTAL)	**76,695** / **114**	**100,000** / **111**	**75,000** / **146**	**97,340** / **97**
Share	51,695 / 76·6	75,000 / 83·3	50,000 / 97·5	50,000 / 50
Loan (including Debenture charges)	25,000 / 37·1	25,000 / 27·8	25,000 / 48·8	47,340 / 47·3
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**23,305** / **34·5**	nil / —	**25,000** / **48·8**	**2,660** / **2·66**
Share (unissued)	23,285 / 34·5	nil / —	nil / —	nil / —
Share (uncalled)	20 / 0·003	nil / —	nil / —	nil / —
Loan (including Debentures)	nil / —	nil / —	25,000 / 48·8	2,660 / 2·66
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	—[a] / —	—[k] / —	} 499[g] / 0·974	800[g] / 0·80
DEPRECIATION FUND	666 / 0·987	666 / 0·74		
EXPENDED (TOTAL)	**85,559** / **127**	**89,858** / **99·9**	**75,150** / **146**	**93,884** / **93·9**
Lands and buildings	16,972 / 25·1	17,270 / 19·2	14,295 / 27·9	16,304 / 16·3
Plant	44,062[b] / 65·3	45,926[l] / 51·0	26,156 / 51·0	39,836 / 39·8
Mains	23,825 / 35·3	25,959 / 28·9	32,214 / 62·8	34,337 / 34·3
Miscellaneous	700 / 1·04	703 / 0·781	2,484 / 4·84	3,407 / 3·41
BALANCE OF CAPITAL ACCOUNT	−8,864[c] / −13·1	+10,142 / +11·3	−150[a] / −0·292	+3,456 / +3·46
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	**£10,161** / **3·980d.**	**£13,122** / **4·031d.**	**£7,881** / **4·953d.**	**£9,720** / **5·025d.**
Revenue from supply	5,489 / 2·149d.	7,569 / 2·324d.	5,829 / 3·664d.	7,607 / 3·930d.
„ meters, &c.	159 / 0·062d.	107 / 0·033d.	120 / 0·075d.	187 / 0·097d.
„ public lighting	1,185 / 0·464d.	1,198 / 0·368d.	1,550 / 0·974d.	1,556 / 0·804d.
„ supply for traction	3,090 / 1·210d.	3,405 / 1·046d.	— / —	— / —
„ miscellaneous sources	238 / 0·094d.	843 / 0·259d.	382 / 0·241d.	370 / 0·191d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£6,775** / **2·652d.**	**£8,393** / **2·578d.**	**£4,888** / **3·073d.**	**£5,645** / **2·916d.**
TOTAL WORKS COSTS	**5,697** / **2·230d.**	**7,127** / **2·189d.**	**3,423** / **2·151d.**	**4,268** / **2·206d.**
Generation of electricity	*5,157* / *2·020d.*	*6,503* / *2·024d.*	*2,948* / *1·854d.*	*3,759* / *1·943d.*
Fuel (including cartage, &c.)	3,102 / 1·215d.	4,025 / 1·236d.	1,795 / 1·128d.	2,422 / 1·252d.
Oil, waste, water, stores	185 / 0·072d.	210 / 0·065d.	140 / 0·088d.	205 / 0·105d.
Wages at station	1,062[d] / 0·416d.	1,275[d] / 0·392d.	721[b] / 0·453d.	684[h] / 0·357d.
Repairs and maintenance at station	620 / 0·243d.	820 / 0·252d.	293 / 0·184d.	447 / 0·231d.
Distribution of electricity	*316* / *0·124d.*	*328* / *0·101d.*	*212* / *0·133d.*	*225* / *0·116d.*
Wages, &c.	261[d] / 0·102d.	290[d] / 0·089d.	191[c] / 0·120d.	194 / 0·100d.
Repairs, renewals of mains, &c.	56 / 0·022d.	38 / 0·012d.	21 / 0·013d.	31 / 0·016d.
Public lighting	*224[e]* / *0·088d.*	*206[m]* / *0·063d.*	*263* / *0·165d.*	*284* / *0·147d.*
Attendance	} 224[e] / 0·088d.	206[m] / 0·063d.	62 / 0·039d.	13 / 0·007d.
Renewals			200 / 0·126d.	271 / 0·140d.
MANAGEMENT AND PROPERTY CHARGES	**1,078** / **0·421d.**	**1,266** / **0·389d.**	**1,465** / **0·921d.**	**1,377** / **0·712d.**
Net rents	*4* / *0·002d.*	nil / —	6 / *0·004d.*	— / —
Rates and taxes	*161* / *0·063d.*	*193* / *0·059d.*	*261[d]* / *0·164d.*	*243[d]* / *0·126d.*
Management	*913* / *0·358d.*	*1,073* / *0·329d.*	*1,198* / *0·753d.*	*1,134* / *0·586d.*
Salaries	495[f] / 0·194d.	643[f] / 0·198d.	806[e] / 0·507d.	892[i] / 0·461d.
Stationery, &c.	120 / 0·047d.	121 / 0·037d.	189 / 0·119d.	61 / 0·032d.
Establishment charges	206 / 0·081d.	225 / 0·069d.	174 / 0·109d.	133 / 0·069d.
Law charges &c.	92[g] / 0·036d.	84 / 0·026d.	29 / 0·018d.	49 / 0·025d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	**£3,386** / **4·19%**	**£4,730** / **5·40%**	**£2,993** / **4·33%**	**£4,075** / **4·85%**
Sum carried to Depreciation Fund	400 / 0·495%	nil / —	— / —	nil / —
Sum carried to Reserve Fund	— / —	nil / —	— / —	400 / 0·476%
Net interest on loans (incl. Debenture charges)	1,281 / 1·59%	1,189 / 1·36%	734 / 1·06%	1,459 / 1·74%
Net profit for the year	1,706 / 2·11%	3,541 / 4·04%	2,259 / 3·27%	2,216 / 2·64%
BALANCE FROM LAST ACCOUNT	54 / 0·067%	−34 / −0·039%	86 / 0·125%	345 / 0·411%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	1,760 / 2·18%	3,507 / 4·00%	2,345 / 3·40%	2,561 / 3·05%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	3½% / —	5% / —	4% / —	4½% / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	66·7%	63·9%	62·1%	58·1%
Expenditure per mean kilowatt capacity	£11. 5s. 10d.	£10. 13s. 0d.	£9. 10s. 7d.	£7. 9s. 5d.
REVENUE PER MEAN KILOWATT CAPACITY	**£16. 18s. 7d.**	**£16. 13s. 5d.**	**£15. 17s. 2d.**	**£12. 17s. 0d.**
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„ „ public lighting	2·80d.[j]	2·95d.[j]	3·43d.[j]	3·62d.[j]
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OUR FAULTY ELECTRICAL LEGISLATION.

It has been repeatedly urged in our columns that the whole of the legislation of this country relating to electric lighting and traction is in need of thorough revision. In 1882 the electrical "infant" was found to have become a precocious child with plenty to say for itself, and was then deemed to have grown too big to remain any longer without a legislative garment. A neat little suit was made for it, and in 1888 it was found necessary to enlarge this to allow further opportunity to develop. Since then no radical alteration has been made. An occasional seam has been let out here in the form of a relaxed Board of Trade Regulation, and a patch has been applied there in the form of Private Bill Legislation, and in some cases, such as the Power Bills, a little more room has been allowed for expansion, but still the principle is retained that the grandmotherly municipalities shall have the first voice in the choice of the attire. Electric traction has been little better off. It was not provided for at all, and had to wear the clothing cast off by the horse tramways, which was fashioned in 1870. A new suit has been made for it in the shape of the Light Railways Act, but it is only allowed to don it on special occasions. The electrical industry is, in fact, suffering, and has been suffering for some time past, from the domination of narrow-minded local government. It is now the regular custom, if a company wishes to undertake any electrical enterprise in a town, for the local authority to "oppose" in order to make the best terms for the purchase of its consent. If it is a new tramway line that is to be built, the company is made to execute extensive road improvements, and is often expected to lay down new roads altogether on part of its line of route; if lighting or power, special terms have frequently to be offered to the municipality if it wishes to be a consumer, and careful precautions are taken so that the new company cannot possibly interfere with the local authority's vested interests and undersell the august municipal trader.

All this must be put an end to, and we are glad to see that a protest will at last be made from the proper quarter. The report (published on another page) of the Committee on Electrical Legislation has been adopted by the Council of the Institution of Electrical Engineers, and, as is seen, it pledges the Council to make representations to the PRIME MINISTER on the subject. A deputation from the body representative of what should be one of the most important, if not the most important industry of this country, should have the desired effect. Parliament has not been blind to the invasion of foreign machinery of all classes into the country, which formerly held by a long way the first place in all the engineering industries. In this case, however, a remedy is pointed out, and, even if only a partial remedy, it should be given a fair trial. The main suggestion made is that "local veto" should be abolished as regards electric supply and traction schemes, and the deputation should have no difficulty in convincing Lord SALISBURY as to the advisability of removing this burden on the electrical industry.

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There is another recommendation, one perhaps that will meet with less opposition, but one whose *raison d'être* is not so apparent. It is to the effect that the staff of the Government departments should be strengthened to enable these departments "to keep in touch with all developments in engineering matters both in this country and abroad." Even without this recommendation, it is reasonable to expect that the technical staff of the Board of Trade will shortly be augmented in view of the additional duties which will be imposed upon it as a result of the deliberations of the Parliamentary Committees on London underground railways, but this recommendation must assuredly have some reference to past events or past grievances. It is to be regretted that these, shall we say, accusations of inefficiency have not been made more specific.

Finally, we may mention one matter which, to our surprise, has not been alluded to in the Committee's report. Nothing is said about the purchase clause in the Tramways Act of 1870. It is not always possible to obtain powers for tramways under the Light Railways Act, although the Light Railway Commissioners have construed the definition of a light railway in a laudably wide sense. Surely this clause has done as much to check the growth of electric traction as any other legislative bar to its progress. If the Tramways Act is to be remodelled, this clause should be the first to be readjusted. Perhaps, however, the "inadequate" staff of the Government department concerned has already received instructions that electric tramways are henceforth light railways.

REVIEWS

(Copies of the undermentioned work can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The New Volumes of The Encyclopædia Britannica. 1902. (Edinburgh and London: Adam and Charles Black and *The Times*).

First Notice.

"It has been proposed of late to employ electromagnetic machines for lighting streets and workshops, and the experiment has been tried with some success." We quote the above from the article on electricity in the Ninth Edition of the "Encyclopædia Britannica," and this quotation alone will suffice to show the necessity there has been for a new edition, or, at all events, a supplement to the old one. The first volume of the ninth edition bears the date 1875, and the last volume 1889—and since this no revised edition has been published—until to-day when the first of the eleven volumes, which are intended to form a supplement bringing the whole work up to date, issues from the publishers' hands.

The grave mistake, made in the last edition, of extending the publication of the book over a long period of years will not be repeated in this instance, for we are promised that the complete supplement will be ready by the end of the present year. An excellent illustration of the bad policy of protracting the period of publication of a work of reference such as this is afforded by following out in the former edition the articles on a progressive subject such as electricity. The article on electricity in the ninth edition was written in 1878, and the state of the electrical industry at that date may be gathered by the sentence which we have quoted at the opening of this notice. "Lighting, Electric," came in a later volume published in 1882, and although filling only 4½ pages ("Æsthetics," by the way, occupied 12 pages), consisted of an excellent summary of the engineering questions involved, from the pen of the late Dr. John Hopkinson. In it, dynamos are classified into alternating current and continuous current machines; it is explained that the latter may be made self-exciting by using the whole current from the armature of the machine itself for exciting the magnets, and that the machines, arranged so that the electromagnet is a shunt to the exciting circuit, "are sometimes called shunt dynamos." The carbon filament lamp comes in for description as well as the arc. Later (1886), under "Railway," there is a description of the Portrush line, successful experiments in electric train lighting are mentioned, station lighting by electricity is referred to, and electric methods of signalling are dealt with—all these matters having developed since the original article on electricity was written. Finally, in the article on "Traction, Electric" (1888), although but two pages were devoted to it, enough was written to show that it was a coming industry. In the last-mentioned article, which was written by Prof. Ewing, accumulator traction is considered; but those who look back in the earlier volumes to find what an accumulator is will be disappointed. However, each contribution, not only on electrical matters but on all subjects, was from the pen of a leading man, and the excellence of the production as a whole was undisputed, the ninth edition of the "Encyclopædia" being still regarded as an authoritative work of reference on literature, history and arts even if its scientific and industrial side were antiquated. In fact, the result of the reprint made a few years ago was that during the last four years no less than 40,000 copies were purchased in the United Kingdom—although this phenomenal sale of such a costly work is undoubtedly largely attributable to enormous advertisement and the "easy" payment system. This is emphasised by the fact that the total sales of the ninth edition were only somewhat over 50,000, but, it may be added, 400,000 have been disposed of in the United States.

Returning to the present supplement. It is edited by a triumvirate, constituted by Sir Donald Mackenzie Wallace (foreign editor of *The Times*), Mr. Arthur T. Hadley (president of Yale University), and Mr. Hugh Chisholm, who assumed the direction of the editorial work during the time Sir Donald Mackenzie Wallace was away with the Prince of Wales on his Colonial tour. After these come Departmental Editors, the majority of these having been most happily chosen. Thus, Dr. Fleming, whose success as a writer and teacher on electrical subjects and whose recent identification with wireless telegraphy research renders him particularly qualified for the task, is editor for electricity, and Dr. Larmor, the eminent author of "Æther and Matter" and one of our leading progressive mathematicians, has taken charge of the mathematical department. There appears to be no general engineering editor, however, although American support has been obtained for the mining and railways sections, Prof. H. M. Howe, of Columbia University, being editor of the former and Major H. G. Prout (editor of the New York *Railway Gazette*) of the latter section. The article on "Electricity" will be divided under six general headings:—

Electric Conduction, Electrolytic Conduction, Electric Current, Electric Units, Electric Discharge through Gases, and Electric Waves.

In addition, there will be articles on electrical subjects under the following headings:—

Accumulators; Atmospheric Electricity; Dynamo; Electricity Supply (including Lighting and Traction); Electro-chemistry; Electromagnet; Electro-metallurgy; Magnetism; Magnetism, Terrestrial; Magneto-Optics; Measuring Instruments, Electric; Power Transmission, Electric; Telegraph; Telephone; Thermo-Electricity; Transformers; and Welding, Electric.

The first volume, published to-day, has articles in alphabetical order, from "Aachen" to "Australia," and therefore includes articles under the first two headings enumerated above, by Prof. Hibbert and Dr. Chree respectively; and also (*inter alia*) articles on Acetylene (Prof. Vivian Lewes), Acoustics (Prof. Poynting), Acid and Alkali Manufacture (Prof. Lunge), Aeronautics (M. Chanute), Æther (Dr. Larmor), Algebra (Mr. G. B. Mathews), Algebraic Forms (Major P. A. McMahon), Alloys (Sir W. C. Roberts-Austen), Aluminium (Mr. Ristori), Argon (Lord Rayleigh), and Astronomy (Prof. Simon Newcomb). Without going into detail in the present notice, we may add that the articles, on the whole, appear to be well and clearly written, and to be of a character in keeping with the aims of the "Encyclopædia Britannica." There are evidences, however, that some of them have left the authors' hands at least a year ago, and that although they may clearly define the state of scientific thought and industrial progress up to the end of last century, they have not been corrected down to the year of publication. Perhaps this is unavoidable in a book of this class, but it is none the less regrettable.

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ELECTROLYTIC CONDUCTION WITHOUT ELECTRODES.*

BY CARL HERING.

Although much is known concerning the theory of electro-chemical action, there are still many points about which there is not yet indisputable, positive knowledge. About Faraday's law, which is one of the chief foundation stones of all electro-chemical actions, there is fortunately no doubt, provided this law is correctly stated, which is not always the case, but about some other fundamental laws which are also important, though less so than Faraday's, our knowledge is not yet of a positive kind. Certain questions, for instance, arise from the fact that *two* electrodes have always been required in every electro-chemical action, and all we know concerning certain numerical values, like the E.M.F. for instance, is the algebraic sum of those at the two electrodes, as distinguished from the actual values at each. Electrolysis with only *one* electrode has never yet been possible, and will probably always remain impossible, for if electrolytic conduction is characteristically different from conduction in solids, then in every circuit in which a current flows from one electrode to one electrolyte, there must of necessity always be a second point at which the electrolytic conduction changes back into metallic conduction. Or, in other words, such a thing as a gradual change in imperceptibly small steps from one to the other must always remain impossible.

Other questions in the theories of electro-chemistry arise from the fact that it has always been found necessary to use electrodes in order to pass a continuous current through an electrolyte, and it is therefore claimed by some that electrodes must, of necessity, form a part of every electric circuit containing an electrolyte, or, in other words, that electrolytic conduction without electrodes is impossible, a conclusion with which the writer does not agree. Some even go so far as to define electrolytic conduction by the action at the electrodes, and according to such a definition there would be no electrolytic conduction (as distinguished from metallic conduction) if no electrodes were used. It is, therefore, of no small interest, and sometimes it may be of great importance, to know whether electrolytic conduction without electrodes is possible or not, and to be able to make experiments under such conditions.

It has been suggested to form a circuit entirely of electrolytes separated by porous cups, and choose these electrolytes so that the chemical combination of several of them produces an E.M.F. sufficient to send a current through the whole circuit. Whether such a combination is theoretically possible is still questioned; as far as the writer knows, no one has yet succeeded in making just such a circuit, although probably many have tried. It is claimed by some that the direct and counter E.M.Fs would always add up exactly to zero, just as they do in a closed thermo-electric circuit the whole of which is at the same temperature, and in which a current would mean perpetual motion. Such an analogy, however, does not seem to be correct, as there is energy set free by many combinations of chemicals.

The nearest approach to such an electrodeless circuit seems to be the so-called "liquid element," in which "reversible" electrodes were used at the two ends of a series of electrolytes—that is, electrodes at both of which the chemical change is identical but in a different direction, so that whatever energy is consumed at one is set free again in exactly the same amount, at the other. Copper electrodes in copper sulphate, zinc in zinc sulphate, mercury with calomel in chlorides, &c., are reversible electrodes. Such current producing cells have been described by Nernst† and by Worm Mueller.‡ Evidently the electrodes were used merely to be able to connect the cell to a galvanometer in order to measure the E.M.F. and current, and if the two ends, which always contained the same electrolyte, had been brought together by using a circular trough with porous partitions, and the electrodes removed, a current would have circulated. For, if the actions at the two electrodes are exactly the same but opposite in direction, the cell ought to give current just as well as if they were removed. Nernst's device, however, was really a concentration cell, the energy of which was not obtained from true chemical combinations, but from the heat of solution or dilution of substances in water.

An unquestionable solution of the problem of conduction without electrodes which has been suggested frequently§, and has been tried, consists in placing a circular trough around the core of a transformer and in inducing an alternating current in it by making it the closed secondary circuit of the transformer. This will undoubtedly operate; and, in fact, was tried with success by Behn-Eschenburg for measuring electrolytic resistance. To show that a current actually flows under these conditions, and to measure it without using electrodes, it has been suggested|| to make this trough pass around the cores of two separate transformers, so that it is the secondary of one and the primary of the other; by measuring the induced current in the metallic secondary of the second, the current which has passed through the electrolyte could be calculated. Another method would be to fill a rubber hose with the electrolyte and wind it around the transformer cores, or pass it around an alternating current galvanometer just as though it were a wire. Another method of showing the presence of the current and measuring it without electrodes, is to measure the primary when the electrolytic secondary is closed and then when it is opened by emptying the tank or inserting a solid insulating diaphragm. Or by replacing the tank with a wire of the same resistance and measuring the current in it, after adjusting it so as to make the primary current the same. These methods are suggested because it has been claimed by some that without electrodes it would be impossible to find out whether the current really flowed or not.

Unfortunately, however, the current produced in the electrolyte by a transformer is of necessity an alternating one, and there are, therefore, no chemical changes in the circuit; for this reason it seems that it cannot be used to settle the question of whether chemical changes, either by substitution or by true decomposition, can be produced by electrodeless conduction. Those who believe it cannot are, therefore, strengthened in their belief.

It has been thought by some to be an impossibility to devise any apparatus in which a direct current could be produced continuously in an electrolyte without electrodes. As far as the writer can find out, no such apparatus has ever been used, and as it would be of interest, it is safe to assume that if it had been used, descriptions would have been published. Korda describes an alleged unipolar induction apparatus,* but it is easily seen by applying the well-known laws of induction, that he has made a mistake, like many other designers of unipolar machines, as the current will not flow as he thinks. Von Heuser† described an apparatus in which there is unipolar induction. He makes the electrolyte flow in a very rapid stream through a magnetic field. He suggests that it might be used in commercial electrolysis in which the electrodes, which must be used in the ordinary method, are soon destroyed by such products as oxygen and chlorine. His mistake, however, seems to lie in the fact that he believed that the gases will be liberated where a sufficient fall of potential exists, even though there are no electrodes there. It is hardly likely, therefore, that this method of induction, although correct, could be used for commercial electrolysis.

This brings up the question of the location and nature of the chemical reactions in such a circuit, supposing a current to exist. It would undoubtedly be at the junctions of the different electrolytes; but suppose a gas was evolved by the combination of the two ions which meet there, would gas bubbles rise out of the liquid there? This would be an interesting experiment if it could be devised. The writer has obtained a gas on the surface of a porous partition separating two electrolytes; it was thought at the time to be vapour due to heat, but this would have been condensed immediately in the cold liquid. Unfortunately the record of this experiment was lost. Another interesting question is whether there would be a similar "skin effect" in electrolytes with high frequency currents as there is in solids.

A simple, but slow, method of generating an intermittent direct current would be to take the same transformer device above described, but to use an intermittent direct current in the primary, and open-circuit the electrolytic secondary by inserting an insulating diaphragm every time the primary current is broken.

In view of the fact that it has often been claimed to be impossible to induce a continuous current in an electrolyte without electrodes, and in view of the fact that some interesting theoretical questions concerning the electrolytic conduction might be settled by means of such an apparatus, a description of the following, which was devised by the writer some time ago, may be of interest.

The apparatus is in principle a mere unipolar machine, in which the current is induced in a column of the electrolyte instead of in copper bars or discs, as usual. The circuit of this current is then closed through one or more electrolytes, without any electrodes.

Referring to the adjoining Fig. 1, which shows a vertical section, and Fig. 2, a side view of a modification, M is an ironclad electromagnet with its coil at CC, and the annular gap at SN and NS; the paths of the lines of force are shown dotted. It also contains a circular tank, AA, which is connected by means of tubes with the middle tank B; these are filled with the electrolyte. The whole magnet, with its tank, is revolved. A stationary U-tube, T, also filled with the electrolyte, is inserted as shown, so that one limb passes through and is cut by the magnetic field. A continuous current will then flow through the liquid circuit; the direction will be as shown if the conditions are those indicated. As the tank revolves with the magnetic field there will be no induction in the return circuit and the action will be that of a true unipolar machine, so-called. Unfortunately, in all such machines there must always be two sliding contacts, which, in the present case, are where the

* Paper read before the American Institute of Electrical Engineers.

† *Zeitschrift für Physikalische Chemie*, Vol., IV., p. 129, 1899.

‡ Planck; *Wiedemann's Annalen*, Vol. XL., p. 561, 1890.

§ *Zeitschrift für Elektrochemie*, March 2, 1899. *Electrical World and Engineer*, April 8, 1899, p. 448. *The Electrician*, London, June 2, 1899, p. 202.

|| By Kahlenberg, I believe.

* *The Electrician*, and *Electrical Review*, London, June 30, 1899; *Electrical World and Engineer*, July 22, 1899, p. 135.

† *Elektrochemische Zeitschrift*, June 1900.

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U-tube enters the tanks. With liquids these may give rise to some inconvenience, but if the bottoms of the tube are surrounded by porous cups there ought to be no serious trouble due to the pressure produced by the rapidly moving liquid.

The illustration is only a diagrammatic one, unessential details being omitted for the sake of clearness. In its actual construction the proportions would naturally be quite different. The top of the stationary tube, T, being visible, can be filled with various electrolytes either separated by porous partitions or contained in mineral gelatine, and the action of the current can be observed therein. If, however, an open trough is desired, the arrangement shown in Fig. 2 might be used; in this the ends of the trough are connected with the liquid circuit in the machine by means of the U-tubes. The writer has not constructed the apparatus, but merely offers the description of it here to show that it is possible to devise an apparatus in which there would be a continuous induced current in a circuit consisting entirely of electrolytes. A simple calculation shows that if the annular field is made about 40cm. (16in.) in diameter, then with a field of 17,000 lines per square centimetre there would be induced about 1·8 volt for every 10cm. height of the annular field at a speed of 500 revs. per min. As the voltage required to circulate a current in a complete circuit of electrolytes is probably only very small, it would be quite possible to generate it with such an apparatus. It would even be possible to generate sufficient voltage for most decompositions if it were possible to bring about decomposition without electrodes.

The question arises how to detect a current in such an apparatus. One way would be to separate the circuit into parts by porous partitions, and place in one of these compartments sulphate of copper,

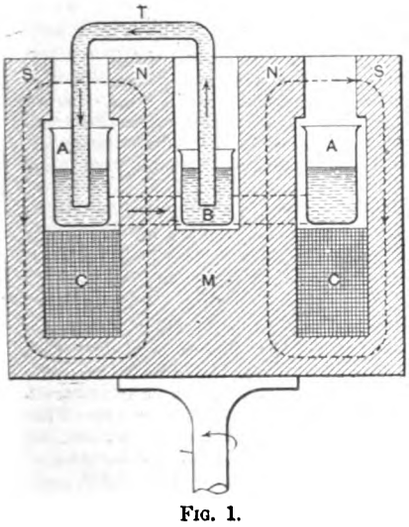

FIG. 1.

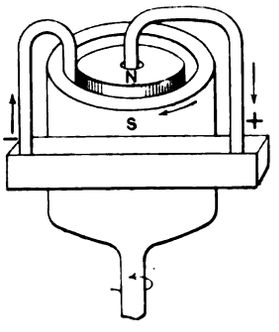

FIG. 2.

and in the two adjacent ones sulphuric acid. Then the blue copper sulphate ought to move into one or the other of these compartments, depending on the direction of the current. Another method is to mix the different electrolytes with mineral gelatine and then place them side by side in a glass trough; the current ought then to produce visible changes at their surfaces of contact.

Such an apparatus would show whether or not such conduction in electrodeless circuits were possible. With a series of electrolytes separated by diaphragms there would then necessarily be changes of composition due to the exchanges of the different ions; there would be what the chemists call mere substitution, such as when precipitates are formed by the mere exchange of atoms, in the mixture of different compounds. Whether or not there can be true decomposition, such as reduction and oxidation (or perduction) which takes place at all electrodes, is quite a different matter, and should, therefore, not be confused with the other. It is quite an interesting question whether such decomposition would be possible in an electrolytic circuit without electrodes, as it would have an important bearing on the modern theories of electrolysis. It is not apparent how such decomposition could be possible in the light of present theories, and therefore there is no prospect of such a method ever being used commercially for decomposition without electrodes, as was suggested by Heusser, and perhaps others also. For bringing about chemical substitution, as distinguished from true decomposition, such a method might be made useful, but in that case it would probably be simpler to use reversible electrodes, rather than such a somewhat cumbersome machine as the one described above. In the writer's opinion the above-described apparatus need be used only to settle the first question; that is, whether electrolytic conduction is possible without electrodes. Or, in other words, is what takes place in the electrolyte independent or dependent on what takes place at the electrodes. All further questions could then be investigated more readily with the aid of like reversible electrodes, as Nernst and others used.

THE INSTITUTION AND ITS PROPOSED MODEL CONTRACTS.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on April 24th, upon the form of model general conditions for use in connection with contracts for plant, mains and apparatus for electricity works, drafted by a committee of the Institution. An abstract of the conditions was published in our last issue:—

Thursday, April 24.

Mr. ROBERT HAMMOND said he had much pleasure, on behalf of the Council of the Institution, in laying before the members a draft set of model general conditions for use in connection with electricity supply works. For some 13 years prior to 1893, his status in the industry was that of seller or contractor, and since 1893 he had been engaged in advising buyers. The experience which he gained as a contractor caused him at an early date in his career as a consulting engineer, to endeavour to form a set of general conditions, to be attached to contracts for electrical plant, which should be fair between both buyers and sellers, and he had been rewarded by observing that the set of general conditions published by him many years ago, in one of the electrical papers, had, with various slight modifications, been adopted by the members of the profession. He had noticed, however, that the tendency of the consulting electrical engineer was originality, with the result that when manufacturers of plant were call upon to tender, it became necessary for them to peruse with great care the set of general conditions attached to the specifications, and in some cases to go to the expense of appealing to their solicitors in order to safeguard their legal responsibility. But this would not be the case if standard general conditions were adopted. Turning to a kindred industry, it was interesting to note that, as far back as 1868, it was thought desirable to have a generally accepted set of conditions for building operations, and in 1870 the Royal Institute of British Architects, after consultation with the London Builders' Society, issued the first heads of conditions, and in 1882 the Royal Institute of British Architects issued an amplified form somewhat similar to the one at present in use. He (the speaker) had submitted to the Council the idea that a set of general conditions should be considered by the Institution and adopted by it as the standard general conditions which they recommended to be attached to contracts. The Council of the Institution of Electrical Engineers was good enough to approve of his suggestion, and referred the matter to a committee consisting of the President, Prof. J. Perry, Prof. Ayrton, Col. Crompton, Mr. Hirst, Mr. A. J. Lawson, Sir Henry Mance, Mr. W. M. Morley, Sir William Preece, Mr. Rider, Mr. M. Robinson, Mr. Alexander Siemens, Prof. Thompson, and himself. The committee also had the assistance of certain members who were elected to the committee after it was formed;—Mr. H. R. J. Burstall; Mr. Ruthven-Murray, representing the Incorporated Municipal Electrical Association, Mr. T. Callender, Mr. W. E. Gray, Mr. A. H. Howard and Mr. G. Sutton representing the Cable Makers' Association; Mr. B. Antill, representing Electrical Engineering Plant Manufacturers Association; and Mr. Siemens also represented Engineering Employers' Federation. The first step taken was to circulate extensively amongst the leading contractors and consulting engineers copies of a set of general conditions submitted by himself. The result was the receipt of ample criticism, and from time to time the committee had met and carefully considered the suggestions made from all quarters upon the conditions, and also upon the amended conditions, which resulted from the preliminary ones. The conditions as finally settled had been submitted by the honorary solicitor to counsel, and now they were in a form to be submitted to the full body of the members of the Institution. The Council did not expect that the Institution would be able to issue a *fiat* that no contract should be entered into in the United Kingdom except under these general conditions, nor did they expect that in every case the general conditions would be used *en bloc*. But they did urge that the path of both consulting engineers and tenderers would be made clearer by the adoption of some definite general conditions as a standard. These conditions would be on sale, and instead of it being necessary to print them in every specification, they might be incorporated by reference. In drawing up these model general conditions the Council had endeavoured to balance carefully the interests of the contractor and purchaser, and they trusted that the general conditions now laid before the Institution would be acceptable to both parties.

Major-Gen. C. E. WEBBER thought the Institution was very much indebted to Mr. Hammond for having originated the suggestion. At the same time, he would like to point out to him that the idea of a standard set of general conditions for building contracts dated back far earlier than the date he had given. When he first joined the service the first thing placed in his hands was a printed volume, published by the public departments, of general conditions, which laid down as well as anything he had ever seen since all that was necessary to define the legal aspect in the carrying out of contracts. In criticising the present set of conditions he asked how the two sets of drawings under rules 2 and 6 were to be made to coincide or work together so that there should be no conflict or confusion. [Clause 2: "The drawings issued with the specification are enumerated under the different sections to which they refer. They will be issued only to tenderers under these sections." Clause 6: "The tenderer is required to fill in the details of his tender in the spaces provided for the purpose at the end of each section of the specification. Such statement will be accepted in lieu of a detailed specification, but the tenderer is at liberty to add any further information that he may deem desirable, and in the event of his doing so shall print or type the same and annex it to the specification returned by him."] In considering such a document as this, it was essential that there should be the most complete absence of any possibility of confusion. There was also one thing which struck him as distinctly novel in clause 12—viz., the

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interview with the engineer—the interview between the contractor, who no doubt wanted to give the very best results for what he had tendered, and the engineer, who wanted, at any rate, to get the best possible results for his employer, the purchaser. [Clause 12: "The contractor shall, after executing the contract, and within 14 days of receipt of notice in writing from the engineer, meet him or his duly authorised representative on the site or at his office, as the engineer may determine, to settle details."] This did not appear necessary to him.

Mr. J. S. RAWORTH said he was sorry the names of the committee had been read by Mr. Hammond, because he wanted to say quite frankly what he thought of the contracts' specification. Personally, he considered they should all be put into the waste-paper basket. Major-Gen. Webber had given the key to the whole situation, This was a specification for purchasing machinery and not for putting up buildings, and they had only to look through this specification to see that it was nothing more than a replica of the building contractors specification with the addition of the word "plant." When they looked at the heading they saw it was for use in connection with contracts for plant, mains and apparatus for electricity works. The word "plant" there meant anything which they could find in the dictionary. It covered the whole of the three departments mentioned—viz., plant, mains and apparatus. Turning to the definition of terms, they were told what "work" and "works" should mean. He undertook to say that if they went into any engineer's office in Great George-street, and put that before him and asked what the word "plant" meant, he would say wheel-barrows, pickaxes and jib-cranes. In this set of general conditions the word plant was spelt with a capital P, when it obviously meant the machinery to be supplied under the contract; but the definitions of terms ought to have included a definition of the word plant, in order that no difficulty might arise. He, as a representative of a company, could go into the market and buy half-a dozen sets of any of this machinery without all these conditions. The whole matter could be carried out to a successful issue without following out the lines of specifications for buildings and other things where the work was built on the spot. With regard to the "Rejection of Inefficient Work" (*The Electrician*, April 25, p. 15), he said that all who had been in the business knew that it was the thing for every engineer to say that he would give a unit of electricity for 24lb. of steam, and when the tests came to be made it proved that he was an unwitting liar. But the purchaser took 25lb. and said "My dear boy, I knew you would never do it when I gave you the order, but you came considerably nearer than I expected, and I will fine you £20 and let you off." This was the ordinary thing. There was no provision made in this clause except for patching up or re-pointing a brick wall which was not quite water-tight. The people who made that clause had no idea of adapting the bricks and mortar specification to the needs of the electrical profession. There was no differentiation in this document between a high-tone engineer like Mr. Hammond and an engineer who happened to be the servant of a corporation. He suggested that there should be special provisions for the case where the engineer was the servant of the purchaser. Again, there was not a word in the specification to compel the engineer to give certificates when the work was done. The clause on patents (*The Electrician*, April 25, p. 14) threw the whole responsibility on the contractor or manufacturer for supplying things which were absolutely free from patent rights, but said not a word as to what would happen if the said things had been specified by the engineer.

Mr. A. JECKELL, while endorsing a great deal said by the previous speaker, thought one thing had been omitted. When a company or person wished to buy plant, they could ask a few people whom they could thoroughly trust to tender for that plant—people with whom they did not want any general conditions whatsoever. It was generally considered necessary in the case of a corporation or local body, that they should advertise, and they might get some good, some bad and some most undesirable contractors. Of course he knew that there was not probably 1 per cent. of the contractors in England who need be feared, but, unfortunately, there were some contractors whom it was necessary to put under some very strong conditions, and in this case the innocent had to suffer for the guilty. He did not know whose fault it was, but sometimes a manufacturer had an unfortunate manager who would not carry out the work expeditiously, and this was one of the reasons why these conditions would have to be vastly more stringent than many of them wished. Turning to clause 8, he presumed there was no reason why tenders should be delivered in the afternoon, and he would suggest that it be "p.m." or "a.m." Probably this was a misprint.

Mr. HAMMOND: Oh, no.

Mr. JECKELL said that 10 a.m. was the usual time specified in the tenders He approved of the note in connection with this clause, saying that it should be stated specifically in the advertisements what was required and that a specification should be on view so that the tenderer could if he liked come and have a look at it. At the bottom of clause 6, "Contract and bond" (*The Electrician*, April 25, p. 14), last paragraph but one, he said the difficulty he had frequently to contend with was that they desired to attach to the tender the general arrangement of the plant, but as it very frequently took three months to arrange this he presumed if the contractor did not deliver within the time this clause would not hold good. But he did not see any clause to that effect. Clause 23 (*The Electrician*, April 25, p. 14) he thought might, in justice to the contractor, state by whom the seven days' notice should be signed. In Corporation contracts it was stated that it should be signed by the town clerk. Clause 25, "Inspection and testing at makers' works" (*The Electrician*, April 25, p. 14) stated that the engineer should be at the works within a certain time. Might not a note be put at the bottom of this to state, "unless some other mutual arrangements have been made," because the engineer might have written making some other arrangements, and as these conditions did not take any notice of this it might place the engineer in a rather awkward position. In connection with clause 36 (*The Electrician*, April 25, p. 15) he asked why 11 months guarantee was more convenient than 12 months. It appeared from the manner in which the payments were to be made that 11 months was the figure. He was delighted to find something stated as to the definition of what was meant by taking over the plant. With regard to arbitration, Mr. Hammond had made considerable reference to the Royal Institution of British Architects. He believed these latter conditions allowed certain things to be settled absolutely and solely by the architect, and did not leave everything open to arbitration. These things included quality of material, but this did not seem to have been followed in these conditions. A contractor might find himself very much behind-hand and desire to gain time by starting arbitration upon some trivial matter. Should there not be some arrangement that the work went on whether or not such a dispute was on? The following clause was inserted in some contracts:—"Provided also that notwithstanding any dispute or difference, the contractor shall carry out the works in accordance with the instructions of the engineer . . . . within the time provided by these conditions, and all disputes and differences, unless previously abandoned and arranged, shall be decided by arbitration after the term of expiration for maintenance."

Mr. G. H. NISBETT regarded the drafting of these conditions the most important thing the Institution had undertaken. The electrical manufacturer had too long been under the incubus of a set of general conditions which had been drawn up entirely in the interest of the purchaser, and it was with a view to remedying what had become a growing evil that was the primary cause of the formation of the Electrical Plant Manufacturers' Association, and certainly of the Cable Manufacturers' Association. As a manufacturer he could point to several clauses in this set, however, which was not quite fair to him, The second paragraph of clause 8 "Tenders" (*The Electrician*, April 25, p. 14) stated that the purchasers reserved the right, &c. He thought the purchasers or prospective purchasers should be responsible for the expense incurred if they did not let the contract. There was one particular town in Ireland that asked the whole of the electrical industry to tender three separate times, and then let the contract in Germany.

Mr. HAMMOND: Did anybody tender a second time?

Mr. NISBETT: Yes.

Mr. HAMMOND: I do not think they ought to be paid.

Mr. NISBETT, continuing, referred to the last paragraph of this clause 8 as to the sum deposited by the tenderer to be returned to him if he did not get the contract. In the case of Corporations this was often delayed from month to month, and he thought it should read "one month from the date of deposit." A new clause should also be added specifying that tenders should only be binding on the tenderers for a maximum period of one month.

Mr. HAMMOND: Would you regard it legally binding for one month?

Mr. NISBETT: Yes.

Mr. HAMMOND: Would not you at present withdraw it after you sent it in if you thought fit?

Mr. NISBETT thought this open to doubt. Continuing, he said the whole cost of the tender was put upon the contractor, and seeing that the purchaser got the whole benefit by going into the open market and getting competitive tenders, they could very well afford to be sufficiently generous to the contractor to give him a duplicate copy of the specification. He regarded clause 9 (*The Electrician*, April 25, p. 14), "The contractor to inform himself," as the most dangerous clause of the lot from the manufacturer's point of view. Supposing the contractor did not do as he was advised in this clause, what happened? If he was to be held responsible for not having disclosed any ambiguity in the specification to the engineer at the time, and had, as a consequence, not followed the latter's reading of the specification, the arbitration clause became null and void at once. With regard to clause 10, "Contract and bond" (*The Electrician*, April 25, p. 14), he proposed that the sureties should only be bound during the construction of the work, and not during the period of guarantee after the completion of the works. Otherwise the poor surety might have his liability going on for 10 years, and if the surety died the executors would have considerable trouble in winding up the poor man's estate. Clause 11, "Local Government Board's sanction" (*The Electrician*, April 25, p. 14), he also regarded as most objectionable from the contractor's point of view. He was told that his tender was accepted subject to the sanction of the Local Government Board. He did not know whether he had the contract or not. It was a most difficult position, and he did not think this clause should be made a standard one. It provided only for exceptional circumstances. If the contract were made subject to the sanction, he would suggest that this wording be added:—"If the sanction of the Local Government Board be not received at the date of signing the contract, then the contractor shall be re-imbursed for any difference in the cost of the raw material to him that may have occurred beween the date of the tender and the date of the engineer's instruction to put the work in hand. If the sanction is not received within one month of the signing of the contract, then the contract shall be void at the contractor's option." With reference to clause 15, "Defects in contractors' drawings," he thought it would be only fair to make the purchaser equally responsible for any defects which might occur in their engineer's drawings, In clause 18, "In all cases where the plant or apparatus of 'approved' type is required by the terms of the specification, the engineer's approval thereof in writing must be obtained before such plant or apparatus is constructed or ordered," there was a very favourite expression of the engineer—viz., "approved apparatus." This also was very objectionable from the contractor's point of view. For instance, in cable work an engineer specified that the joint boxes were to be of an "approved" pattern, and the contractor sends a drawing with the tender. After the acceptance of the tender and the drawing with it, the engineer insisted that under the specification the contractor was bound to supply a £15 box instead of the £2 tendered for. He would suggest that, where the plant was specified to be of an "approved" type, it should be insisted that the engineer would not require more than detailed modifications of the plant, as shown in the

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drawings submitted with the tender. With regard to patent right, there was the rather loose wording in the clause that the contractor was responsible for not only the work he supplied but also for the system or method upon which it is used after supply. He did not think this was right. For instance, a cable maker might supply a low tension cable, and if the three-wire patent was in force at the time, he would be held responsible, despite the fact that at the time of sending out the cable he did not know in what manner it was to be connected up.

The discussion was then adjourned until May 8.

PHYSICAL SOCIETY.

Ordinary meeting held April 25, 1902, Prof. S. P. Thompson, president, in the chair.

Dr. DAWSON TURNER exhibited and described

A Mechanical Break for Induction Coils.

The use of induction coils in the production of Röntgen rays and in wireless telegraphy has made the construction of a suitable break a matter of importance. The ordinary break is unsuitable because of the wearing away at the point of contact, and there are objections to the use of mercurial breaks. The portable mechanical break which was shown by Dr. Dawson Turner consists of two metallic rollers with their axes parallel and kept in contact by a spring. One of the rollers has a cam attached to its spindle, and can be made to rotate by means of a small electric motor. Once in each revolution the cam separates the rollers, thus making the break, and at the same time causing the second roller, which rides loose upon its axis, to turn about one-eighth of a revolution. As soon as the cam has passed, the rollers are brought into contact by the spring, and the next break occurs at a different place. The wearing is thus distributed evenly over a large surface. The break is placed in a box containing alcohol or petroleum, and works best when rotating rapidly. An objection to the arrangement is the noise it makes when working. Some experiments were then shown on the discharge of electrified bodies by ultra-violet light. A disadvantage of the electric arc when used to furnish ultra-violet light for use in medicine is that the light is accompanied by heat, so that it is necessary to shield the patient from the heat without interfering with the passage of the light. A condenser spark between iron electrodes is useful because it gives a large amount of ultra-violet radiation without much heat. Dr. Turner showed that this light is capable of discharging bodies whether positively or negatively electrified. He then showed that glass and mica are opaque to the radiation, while pure rock salt is transparent.

Mr. WILSON NOBLE exhibited a mechanical break similar to the one already shown. A roller and a disc, with their axes parallel, are placed in contact and made to rotate in the same direction by a motor. Longitudinal slots are cut upon the surfaces of both, and the break occurs when a slot in the roller comes opposite a slot in the disc. Since the two are moving in opposite directions at their point of contact the break is very sudden. To vary the length of the break without altering the rate of rotation the slot in the roller is wider at one end than the other, and the disc can be placed so as to touch the roller at any point of its length.

The CHAIRMAN said he knew of no metal which would withstand continual sparking without wearing, and suggested that breaks should be so designed that the parts affected by the sparking could be easily replaced. He asked if there was any difference in the wear of the two rollers. Referring to an experiment shown by Dr. Turner, in which ultra-violet light discharged a positively electrified body much quicker than a negatively electrified one, he asked if this would be the case if the apparatus were surrounded by an earthed metallic screen.

Mr. WATSON suggested that the wearing of the edges in Mr. Wilson Noble's break might be lessened by filling the cavities with slate.

Mr. DUDDELL said that the worst substance for making contact pieces was carbon, then came zinc, brass and copper, with platinum best. These were the results in air, but the effects in liquids were different. With rapidly moving contacts all metals are equally good, but in ordinary coils the contact pieces move slowly.

Prof. EVERETT said it was interesting that rock salt, which is very transparent to long waves, should also be transparent to very short waves.

Dr. DAWSON TURNER said that if the experiment referred to by the chairman had been performed inside an earthed metallic screen the negatively electrified body would have been more quickly discharged.

Mr. R. S. WHIPPLE exhibited

A Temperature Indicator for use with Platinum Thermometers,

in which readings are automatically reduced to the gas scale. The instrument is very similar to the well-known Callendar and Griffiths' temperature indicator, with the exception that it is so arranged that the readings obtained are automatically reduced to the gas scale, thus avoiding the necessity of applying a correction. It consists of a simple Wheatstone's bridge with equal ratio arms, the other arms being the thermometer and a long helical bridge wire, together with the compensating leads. A travelling contact is moved round the wire until a balance is obtained. The bridge wire is wound on an ebonite drum, on the outer surface of which a helix has been cut. The contact piece, which is connected electrically with the galvanometer, is carried from the inside of a cylinder fixed to a shaft. A white celluloid tube, on which the scale is divided, is fixed to the outer surface of the cylinder. A screw of the same pitch as the helix on the ebonite drum is cut on the shaft, so that by rotating the shaft the contact is caused to travel along the bridge wire, and at the same time the scale is carried past an index placed above it. The scale has been so constructed that the reading at the index gives, directly, the temperature of the thermometer reduced to the gas scale. The instrument reads from 0° to 1,400°C.

Dr. CHREE asked the following questions:—Was not the instrument so constructed restricted to platinum thermometers of wire having a given specified value of δ; if so, what was this value? Did the helical wire balance the entire resistance of the thermometer or only the excess above the resistance at 0°C.; and could the instrument measure temperatures below 0°C.? What error was likely to come in when measuring temperatures up to 1,000°C. from changes in the resistance of the helical wire under the variations of atmospheric temperature to which it would be exposed in ordinary use? Would not there be some wear between the wire and the contact piece?

Dr. HARKER asked what were the limits of the value of δ for wires now supplied for commercial purposes. He thought that the accumulation of dust between the contact piece and the wire, due to continual scraping, was a more serious objection than the wearing away of the wire.

Mr. WHIPPLE said the scale was calculated for a value of $\delta = 1{\cdot}5$. The value of δ seldom exceeded 1·52, and wire could be obtained with $\delta = 1{\cdot}5$. The instrument shown was made to read from 0°C., but could be easily arranged to read below 0°C. The wearing between the contact piece and bridge wire was very slight.

CORRESPONDENCE.

RAILWAY AND TRAMWAY MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of yesterday, Mr. J. N. Dodd refers to my contribution to the discussion on Messrs. Swinburne and Cooper's Paper. Mr. Dodd cannot, I think, have been present at the meeting, or he would not have repeated the reporter's error in crediting me with the statement that the range of torque per ampere between full and half load of the English Electric Company's 75kw. railway motor was only 110 to 100. The figures I actually gave were 150 to 100, which are practically the same as those given by Mr. Dodd.

Mr. Dodd goes on to say that there are objections to increasing the range of torque per ampere, but the only objection which he quotes is the one I referred to at the meeting, namely, that to get sparkless commutation without high saturation means a design involving greater weight and expense. This is precisely my argument, and, as I read Mr. Dodd's letter, he entirely agrees with me. It is a fact that, to obtain sparkless running, torque range, the equivalent of a variable gear ratio, has been sacrificed to lightness and cheapness. If increased weight and expense are more than counterbalanced by the advantages of a large variable gear ratio, as the advocates of the Ward-Leonard and other systems maintain, by far the simplest way of attaining the desired end would be to develop the possibilities of the much maligned series-wound motor.—

Yours, &c., C. A. CARUS WILSON.

Westminster, S.W., April 26.

AMERICAN PLAGIARISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your review of "Foster's Electrical Engineering Pocket Book," which appeared in *The Electrician* of April 18th, you say, "He has culled useful information on all electrical engineering matters from various sources, sometimes with and sometimes without acknowledgment . . ."

Now, Sir, this is really a very mild form of castigation for such a flagrant case of wholesale copying from British and other books, especially as you will find in the beginning to the third paragraph of the preface of the said book, the following statement. "The matter included is representative of American practice, and no effort has been made to include any other, except in special cases."

I can give about a dozen instances of downright plagiarism from "Munro and Jamieson's Pocket Book of Electrical

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Rules and Tables." In some of these instances, the exact and entire figures have been *photographed* therefrom, including all signs, letters, arrows and even the complete subheadings! Figures and text which I know so well, because I drew and wrote them for the first time with my own hands. No liberty to do so was *ever asked or given*. No reference or acknowledgment of any kind is made. In a few cases actual mistakes have been copied!

Probably other British authors and publishers have a similar complaint to make against this "American practice." If so, they should let themselves be heard with no uncertain sound. We should always endeavour to obtain permission from authors and publishers before making any extracts from their books, and then take the first available opportunity of thanking them in our several prefaces, or by a distinct footnote, &c. Every man's work which is worth quoting from should be duly appreciated and acknowledged.—Yours, &c.,

ANDREW JAMIESON,
Joint Author of Munro and Jamieson's
"Pocket Book of Electrical Rules and Tables."

Glasgow, April 23.

PARLIAMENTARY INTELLIGENCE.

(*Continued from page 58.*)

TYNESIDE TRAMWAYS AND TRAMROADS COMPANY EXTENSION BILL, 1902.

This bill came before a Select Committee of the House of Lords, of which Lord Stanmore is chairman, on Friday last week.

Mr. BALFOUR BROWNE, K.C., who appeared for the promoters, said it was a bill to confer further powers upon the company for the construction of tramways and for other purposes. One important part of the scheme was the construction of a tramroad, and he might point out that the only distinction between a tramway and a tramroad was that a tramway ran along a public highway and a tramroad was made through private land. The main objection to the bill came from the Newcastle Tramway Co. They opposed on the ground of competition, and also because they objected to the promoters' line crossing their own near the town of Gosforth, but they had now withdrawn their opposition on the ground of competition. The local authorities and the County Council were in favour of the scheme. He called

Mr. WILLIAM McCLELLAN, engineer to the promoting company, under whose supervision the authorised line of the Tyneside Tramway Co. had been designed and constructed. He knew there were grave objections to their crossing the Newcastle Tramway on the level near Gosforth, but it was absolutely necessary to do so. In his opinion there would be no danger, and two cars approaching one another on the different lines would be visible to each other for a distance of 100yds. If it were dangerous the Board of Trade would not allow the line to be opened. The promoters thought of putting a signalman at the crossing, and that would cost something like £100 per annum, which, capitalised, would be £2,000. It would be cheaper to take an alternative route suggested by the petitioners, but that would not serve the district as they wished to serve it. He admitted that a driver might lose his head, but he could not think that their driver and the Newcastle driver would lose their heads simultaneously. The brakes used were the Westinghouse magnetic.

Mr. STEPHEN SELLON agreed that the Board of Trade had power, notwithstanding the powers granted by Parliament, to refuse their certificate for opening a line for working. They had frequently done so. He said he could not understand the Newcastle objection, because they crossed their own line in many places in Newcastle.

Mr. JOHN G. BOSS, of Gosforth, chairman of the Council, and also chairman of the Tramway committee of the Council, said the alternative route suggested was a ridiculous one.

Mr. F. J. EDGE was called on behalf of the petitioners. He said he was city engineer of Newcastle. He thought the proposed crossing would be a very dangerous one. In his experience of level crossings he had never seen anything so dangerous.

Mr. WILLIAM CAIL, a member of the Newcastle Corporation, and for some years chairman of their Tramways committee, said the crossing would be exceedingly dangerous, as the roads on each side were macadam, and macadam roads in the winter were very greasy. If a car was coming from the west and another from the north, they would not be able to see each other until they were 12yds. from the crossing. It was impossible to pull up the cars within their own length.

Mr. HANS HAMILTON having addressed the Committee on behalf of the promoters, the CHAIRMAN stated that the Committee were unanimously of opinion that the preamble was abundantly proved.

THE NORTH METROPOLITAN TRAMWAY BILL

The Select Committee of the House of Commons, over which Mr. H. Hobhouse presides, had before them the North Metropolitan Tramway Bill on Wednesday last. Mr. Wheeler, K.C., and Mr. Munro were for the promoters, and Mr. Earle for the Middlesex County Council.

Mr. WHEELER, in presenting his case, said that so far as the preamble was concerned there was no opposition. The lines in respect of which they asked for these powers were those which belonged to themselves and which ran between Wood Green and Finsbury Park, and from Finsbury Park to Edmonton. These were in the County of Middlesex. Inside the County of London the company were lessees under the London County Council. When the bill was before the House of Commons on second reading, objection was taken by Sir A. Rollit that the company had dropped part of their night service, and after some discussion it was left to the Committee to decide how the matter should be dealt with. An instruction had been given to the Committee to inquire, if they saw fit, as to the night service and the hours at which the cars should be run, and to provide accordingly. He pointed out that the company, when they ran their cars at night (which they did for two years) incurred a heavy loss. The newspapers having said that there was a rush on the part of the public to take advantage of the night cars, the company had taken precautions to ascertain exactly the amount of patronage the night cars received. The "rush" was so great that it brought in only £1. 5s. a night, which meant a loss of between £15 and £16 a week, or £800 or £900 a year. The company respectfully asked that no condition as to night cars should be imposed on them.

The CHAIRMAN asked if the company proposed to work the lines inside the county of London by electricity.

Mr. WHEELER said that that would depend upon the County Council. The power now sought was only as to the lines outside the county of London.

Mr. E. HAMMOND, manager of the North Metropolitan Tramways Co., said that the lines to which the measure would apply were 8½ miles in length, and both of them—so far as electrification was concerned—stopped at the county boundary (where the County of Middlesex joined the County of London). It was very desirable that the Middlesex portion should be electrified, and the Middlesex and all the local authorities through whose districts the lines ran desired to see electricity applied to them. Dealing with the question of all-night cars, he said that on the section on which they had abandoned them they had originally started to run three cars an hour through the night, charging workmen's fares—that was to say, 1d. for a single journey and 2d. for a return. Later on, however, they had charged ordinary fares. At no time had the cars paid the cost of running. They had run them from January, 1899, down to September, 1900, and on these four lines they found they lost £1,800 a year. When they ascertained that they decided to discontinue the service. On the Hampstead and Holborn route they ran six journeys, or one every half-hour—12 cars in all. The first day the experiment was tried the "rush" was as follows:—1st journey to Holborn 8 passengers, 2nd 2, 3rd 4, 4th 1, 5th 7, 6th 4, and to Hampstead 1st 33, 2nd 10, 3rd 13, 4th 6, 5th 8, 6th 6. From Gray's Inn-road to Highgate the passengers on the six journeys were, respectively, 15, 11, 8, 5, 22 and 19. The money value of the "rush" was between Hampstead to Holborn 11s. 9d., and between Highgate and Holborn 13s. 3d., or £1. 5s. together, meaning a considerable loss on the work. During the first three weeks they made a net loss of £15. 14s. 6d. a week, and during the year £817. 14s. The London County Council waived their right to have 12½ per cent. of the gross receipts of the undertaking, but even then they only paid 1¾ per cent. on their capital. It was hardly fair to ask the Committe to increase their loss.

The CHAIRMAN, in giving the decision of the Committee, said: We have carefully considered the matter, and are not prepared to make any recommendation to the House. We feel sure that the company, in their own interest, will do all that is reasonable for the benefit of the district they serve, and that the London County Council will look after the requirements of the public.

The Committee passed the preamble of the bill.

THE LONDON, TILBURY AND SOUTHEND RAILWAY BILL.

This bill came before the Committee presided over by Mr. H. Hobhouse on Friday, April 25.

Mr. LITTLER, K.C., in opening the case for the promoters, pointed out that the measure was of an omnibus character, including widenings, junctions, diversions, &c. The bill would enable the promoters to purchase or take on lease the Whitechapel branch railway of the Metropolitan District Railway Co., and would also empower them to work their railways by electrical energy, and to purchase lands for the purpose of a station for generating electrical energy. The promoters did not propose to bind themselves to work by electricity, but to do so when it seemed to them most necessary. They proposed to take land for the erection of a generating station which would be sufficiently large for the practical working by electricity of the whole of the company's railways. No doubt the time would come when the powers asked for would be necessary, but it was not pretended that the electrical method of working would be adopted at the beginning. The Whitechapel and Bow Railway—which was in course of construction, and would be at work, it was hoped, in June—had been originated by the promoters of the Metropolitan District Railway Co. with the idea of linking up the London, Tilbury and Southend Railway with the Metropolitan District Railway. In 18 months or two years the District Railway would be worked by electricity. The result of that would be that it would be desirable for the promoters to work their line, or certain of the trains in connection with it, by electricity, so as to give electric traction communication between their system and Hammersmith, Ealing and the West of London. He did not know that there was any serious objection to the electrical portion of the bill.

Witnesses having been called on this part of the case, both on Friday, April 25, and Monday, April 28, and counsel having been heard, the Committee decided that the preamble was proved so far as the land proposed to be taken from the Stepney Guardians was concerned, also that relating

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to land which was now the property of the gas company, on the promoters undertaking to construct a certain subway.

On Tuesday the Committee considered the petition of the inhabitants of Barking, which prayed for the abolition of a dangerous level crossing, and decided that the level crossing was a nuisance and should be got rid of. They gave the promoters time to consider what offer they would make in the matter.

On Friday the last point in dispute was decided. This was a petition by a Mr. Benning, a landowner, bearing upon the compulsory acquisition of land at the western side of the river Roden for a generating station. Mr. Benning asked for compensation for the stopping up of the Manor Way, of a bridge over the river at Little Ilford, and for the construction of a railway station at the latter spot. The Committee passed the preamble of that part of the bill relating to the generating station.

Yesterday it was announced that the report of the Local Government Board as to power to supply electrical energy had been met by the clause the bill.

NEWCASTLE-UPON-TYNE CORPORATION TRAMWAYS EXTENSION.

The bill of the Newcastle-upon-Tyne Corporation, by which they seek powers to extend their tramway system on the east to Walker and on the west to Benwell and Fenham, came on Monday before a Select Committee of the House of Lords, presided over by Lord Stanmore.

Mr. PEMBER, in opening the case for the Corporation, said the proposal was to extend the tramways of the Council along Union-road and Welbeck-road to the urban district of Walker, passing through that place, and thence to the river-side in the neighbourhood of the large works. There were also two small extensions from the Westgate-road and Elswick-road termini to the districts of Benwell and Fenham that were not opposed. The original proposals of the bill included an extension through Walker to Wallsend, the next district to the east, but in consequence of the opposition of the road authorities that portion had been struck out of the bill. The Walker tramways had been projected to carry out the pledge the Council gave last session. In 1901 the Tyneside Tramways and Tramroads Co. proposed to construct lines in Walker, and were opposed both by the Newcastle Corporation and the Walker District Council. The bill passed the House of Lords but was rejected by the Commons, and on its rejection the Newcastle Council undertook to bring forward a scheme in the present year. The learned counsel dealt with the opposition of the Tyneside Tramways and Tramroads Co. and of the inhabitants and manufacturers of Walker. The company, in their petition, objected that there was no compulsion on the Corporation to make the tramways; that the period allowed for the construction—six years—was far too long, and that the connection promised with their system had not been provided. He (Mr. Pember) contended that the time was the usual time, and that by their proposal there would be a through route to Shields, although they did not provide for a physical connection between the two systems. He suspected that the object of the petitioners in asking for a physical junction was that they might be able to apply for running powers over the Corporation tramways, which the Council were not willing to give.

Mr. BALFOUR BROWNE, on behalf of the Tyneside Tramways Company, said the pledge given last year was that the tramways should be constructed forthwith; but the bill proposed a term of six years. The promoters should be compelled to proceed with the work at once, or should allow the petitioners to do it at the Council's expense.

The Committee decided in favour of the *locus standi* of the Tyneside Company, but against that of the Walker inhabitants and manufacturers.

Evidence was then given in support of the promoter's case, the first witness being Mr. WILLIAM CAIL, the chairman of the Tramways committee of the Newcastle Corporation. He briefly described the proposed new routes, and said that the Corporation fully intended to proceed with the construction of the tramways at once, and did not oppose a reasonable limit of time being placed upon them. With the exception of one branch along Welbeck-road, all the Walker tramways would be completed in 2½ years.

The Rev. Father BERRY, chairman of the Walker Urban District Council, said the unanimous opinion of the Council was in favour of the scheme.

Mr. LE ROSSIGNOL, the general manager of the Corporation tramways, said there were many objections to giving an outside company running powers over their tramways, as it would, in such a case, be difficult to secure the necessary regularity of the service. The streets were were much congested, and in some streets the cars passed every 30 seconds, and that would soon be increased to 20 seconds. He estimated the cost of the electrical equipment of the tramways to be authorised by the bill at £113,200.

On Tuesday evidence on behalf of the Tyneside Company was given by Mr. Stephen Sellon, of the British Electric Traction Co. and Mr. W. MacLellan, engineer and manager of the Tyneside tramways.

The Committee passed the preamble of the bill.

Clauses were arranged with the various opponents of the bill, and it was moved to be reported for third reading in the House of Lords.

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL.

A Select Committee of the House of Commons, presided over by Mr. Cawley, commenced, on Wednesday, the consideration of this bill, by which it is sought to make further provisions with respect to the purchase of electric undertakings in the administrative county of London by the local authorities and the London County Council, and with the supply of energy from stations of the London County Council, and for other purposes.

Mr. FITZGERALD, K.C., in opening the case for the promoters, said that, under the Electric Lighting Act of 1882, undertakings were purchasable at the expiration of 21 years from the coming in force of the order selling up the undertaking. That was found to be too short a period to induce the public to invest in these undertakings, and an amending act in 1888 increased the period to 42 years, and in other respects the terms of purchase were made rather more favourable to companies. At the same time a provision was inserted that the granting of authority to any undertakers to supply electricity within any area by licence or provisional order, should not restrict the granting of a licence or order to a local authority, Parliament thus recognising free competition in these matters. At the time the development of the use of electrical energy which had since taken place was not contemplated, and the idea was that each district should be supplied from its own generating station, and that a local authority would purchase a self-contained undertaking. To a large extent throughout England that was so, but the position of affairs in London was entirely different. After the Act of 1888 was passed, a number of promoters came forward with schemes of various kinds, and after an inquiry held by the Board of Trade in 1889 a number of orders were granted to various undertakings in respect to remote districts in London. In illustration of the state of things that arose, the learned counsel took the case of the London Electric Supply Corporation with a generating station at Deptford. The company in question was granted powers in Greenwich, Deptford, Camberwell, Southwark, Lambeth, Westminster and Chelsea, For the supply of those districts the company established a large generating station at Deptford, but when the time came to purchase those six local authorities could each only purchase the amount of their undertaking within its area, while the local authority of Deptford would have a generating station, but considerably too large for its local requirements. As a result of this the powers of purchase were rendered nugatory. In 1898 a Joint Committee of the two Houses of Parliament examined into the question of the supply of electrical energy, and reported to the effect that the business of supplying electrical energy in bulk did not, as a general rule, appear such as local authorities should acquire, but that the Board of Trade should have power to insert special purchase clauses in orders on good cause being shown. While in the provinces there were many instances of companies supplying electricity in bulk, in London there were no such undertakings. The nearest approach to such undertakings was that of the Central London Company, which had power to supply two other undertakings, which were really part of its own undertaking, only under different names. Dealing with the clauses of the bill, the learned counsel drew special attention to clause 3, which provides that: "Where under any act, whether passed before or after the passing of this act, a company has power to establish a generating station and supply electrical energy generated at such station to any authorised undertakers for distribution, but such company has not the power to supply to persons other than authorised undertakers, then the undertaking of such company shall be subject to purchase, as if the same were an undertaking under the Electric Lighting Acts, 1882 and 1888; and the undertaking shall include any station and lands of the company used wholly or in part for the purpose of their undertaking, whether within or without the county." In connection with this clause, Mr. Fitzgerald pointed out that it would enable the City of Westminster to exercise powers of purchase, and would place the Central Company in a very favourable position. Clause 4 of the bill provided power to enable local authorities to combine to purchase undertakings. Clause 5 set forth that no local authority should enter into combination with any other local authority or authorities for the purposes of the Act, except in pursuance of a resolution passed in the manner provided by section 3 of the Electric Lighting Act, 1882. The effect of clause 6 was that, if the districts supplied did not prefer to continue it, the London County Council might exercise the power of purchase for them with the consent of the majority of the local authorities. Clause 7 of the bill dealt with the power of the Council to supply electrical energy in bulk. Clause 8, which gave a local authority power to purchase an undertaking under the Electric Lighting Acts or special act, was merely to supply an omission in electric lighting acts, and to give power to a local authority to purchase by agreement at an earlier period than the time stated in those acts. Clause 9 desired to give powers to local authorities to carry on an undertaking after purchase. Nearly all the electric lighting companies in London had presented a petition against the bill. They objected to their undertakings being purchased before the date mentioned in their acts. Out of the 128 local authorities in London, the City of Westminster, who was represented at the meeting of local authorities when resolutions were passed in favour of the promotion of the bill, was the only one petitioning against it, but he thought they had done so under a misapprehension of its provisions.

Mr. RADFORD, chairman of the Parliamentary committee of the London County Council, who was examined by Mr. H. LLOYD, said that the bill was promoted at the request of the metropolitan boroughs. It did not confer on the Council any power to supply electrical energy in the metropolis, except as stated in clause 7 of the bill. All the other powers could only be exercised by the consent or at the instance of the local authorities concerned. The main object of the bill, as had been stated by Mr. Fitzgerald, was to make effective the powers conferred on local authorities to purchase electrical undertakings under the purchase clauses contained in the Electric Lighting Act of 1888. It was desired by the bill to supply electrical power only in bulk to a local authority, and to meet the present conditions of electrical science.

In cross-examination by Mr. PEMBER, K.C., on behalf of the London Electric Supply Corporation, Witness said that that company had generating works at Deptford. There were nine local authorities in that district. Supposing five of those local authorities were in favour of purchase, and four were opposed to it, he thought it was right that the company should be compelled to sell

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Mr. A. B. BRYCESON, town clerk of Woolwich, who was next examined, said the borough for electricity purposes was divided into three areas—Woolwich, Plumstead and a part of the Parish of Eltham. In the interests of these places it was desirable that the powers sought to be obtained by the bill should be granted.

Mr. GUNYON, one of the engineers of the Council engaged in electric lighting matters, gave evidence. The Chelsea, South London, Brompton and Kensington and Lewisham and Woolwich Companies would not, he said, be directly affected by the provisions of the measure. Indirectly the Westminster, St. James' and Pall Mall, Notting Hill and Kensington and the Knightsbridge Companies would be affected. The Metropolitan, Charing Cross and Strand, City of London, County of London and Brush, Crystal Palace and District, Blackheath and Greenwich Companies, and the London Electric Supply Corporation would be directly affected. Nine of the Local Government divisions in the metropolis would not be affected in any way by the bill. The County Council were not, under clause 7—to which the companies had principally taken objection—authorised to erect or acquire any generating station, but were merely authorised, after having acquired a generating station under other powers, to supply a local authority from it. Objection had also been taken to clause 8, on the ground that it advanced the time of purchase, but that could only be done by agreement with the company concerned.

Cross-examined for the electric light companies, Witness said the Board of Trade now had power to prevent the acquisition by a local authority of one or two out of a number of companies competing in its area—the whole or none must be purchased. He took it that if the County Council under this bill proposed to buy one or two competing companies, the Board of Trade would not have power to intervene, and he supposed the remaining company would be subjected to rate-aided competition. The County Council would not be prevented from purchasing, for instance, the Central Company's generating station in Marylebone, and leaving the St. James' and Westminster Companies, which derived their supply from that station, unpurchased.

Mr. FREEMAN, for the promoters, said that to meet that objection, he would be quite prepared to say that the two should go together.

Mr. PEMBER inquired whether it would be made quite clear that the Central Electric Supply Co.'s generating station would not be acquired by the Council unless it also bought the two companies supplied from it.

Mr. FREEMAN said they would be treated as a whole.

Mr. PEMBER: And you will not buy the St. James' Company and the Westminster Company unless you buy the Central's station?

Mr. FREEMAN: No.

On re-assembling after a short adjournment,

The CHAIRMAN said it was the decision of the Committee that they would not allow the majority clause. They would not allow a majority of local authorities to compel a minority to come into any scheme whether the majority was based on rateable value, area, population or otherwise. At the same time the Committee considered that some provision should be made in the bill against the possibility of a very small district, either in regard to population or rateable value, preventing, by its objection, a desirable combination of local authorities for the purchase of an electric undertaking.

Mr. H. H. Gurdon, vice-chairman of the Electric Lighting committee of the Stepney Borough Council, Mr. C. W. Tagg, town clerk of Camberwell, and Dr. H. M. Robinson, town clerk of Shoreditch, were examined in support of the bill, and the Committee adjourned.

REPAYMENT OF LOCAL LOANS.

The Select Committee of the House of Commons on the Repayment of Loans of Local Authorities sat again on Friday last, with Mr. Grant Lawson in the chair. Further evidence with regard to Scotland was received.

Lord Provost CHISHOLM, of Glasgow, was examined by Mr. BONAR LAW, and he was of the opinion that the sinking fund payable on borrowed money under certain acts was in excess of any reasonable requirement, and frequently prevented the carrying out of important improvements. He thought that the public benefit should be the main point in view when settling loan periods, and, theoretically, it was desirable the repayment should be at an early date, but to say that municipal debt should be repaid in 30 or 40 years would be imposing a heavy burden on local industries, and prevent municipalities from embarking on undertakings essential to the public health. With electrical works large capital was expended, which only became remunerative after some years, and people were slow in taking up the light and power because of its high price. This had to be kept high to begin to pay off capital which had been expended. Freedom from sinking fund for the first five years of expenditure on electricity works would place the undertaking in a very much stronger position. The Glasgow Corporation, though not required to do so by law, set aside a depreciation fund, regarded as a regular charge against revenue. Depreciation funds of gas department amounted to £1,177,266, tramways £423,972, electricity £47,555, improvements £17,779 and water department had no fund, but all renewals, &c., were met out of revenue. Summing up his remarks, he said remunerative undertakings should postpone the sinking fund for so many years, varying from five years for electricity works to 15 for water works. Where land had to be acquired no sinking fund should be paid until the land was used for public purposes. The normal sinking fund repayable out of the rates should be not less than 50 years.

Mr. ROBERT CRANSTON, treasurer of the City of Edinburgh, on examination, said that of the outstanding debt at Edinburgh of 3¼ millions, 3 millions were for purposes controlled by the town council; 1¼ millions was for remunerative undertakings as electric light and tramways, the remainder being wholly unremunerative debt. He thought that loans for ordinary purposes should not extend over 30 years, and that 50 years should only be allowed for exceptional cases in which improvements would be of a permanent kind and a boon to the general public.

SCOTTISH PROVISIONAL ORDERS.

The Commissioners on Scottish Provisional Orders considered on Monday and Tuesday an order promoted by the Aberdeen Suburban Tramway Co. for powers to construct tramways to serve the suburbs of Aberdeen. Counsel for the promoters explained that the existing tramways were started by a private company in 1872, and were taken over by the Corporation in 1898. The proposed new tramways were to be worked by electricity, and would serve the Donside and Deeside districts. The promoters sought borrowing powers for £24,000.

On Tuesday, in the House of Commons, Mr. PIRIE, member for Aberdeen (N.), asked the Lord Advocate for Scotland a question as to the holding of this inquiry at Edinburgh instead of at Aberdeen, and not being satisfied with Mr. Graham Murray's reply, subsequently moved the adjournment of the House to consider the matter as one of urgent public importance.

The LORD ADVOCATE explained that there was no desire on the part of the Scottish Office to interfere with the powers of the Commissioners to fix the place of inquiry under the Scottish Private Bill Procedure Act, and that if the Aberdeen tramway people had thought it expedient for the Commission to go to Aberdeen there was no reason why they should not make the application, and there was, further, no reason in law why the Commissioners should not have exercised their discretion as to the granting of this application.

After some discussion the motion was by leave withdrawn.

LONDON TELEPHONE SYSTEM.

In the House of Commons on Monday, Mr. LLOYD MORGAN asked the Secretary to the Treasury, as representing the Postmaster-General, whether he was aware that the Post Office telephone authorities four or five months ago had laid telephone wires in the Paddington district, but had not yet connected up the houses, although residents had applied for connection; whether he would state the reasons of the delay and the date when the telephonic system would be completed in that district.

Mr. A. CHAMBERLAIN said that a Post Office telephone exchange was being constructed in Bond-street, Oxford-street, to serve the district bounded on the east by Regent-street, and extending between Piccadilly and Regent's Park. It would also include a considerable part of Paddington and Bayswater. Owing to difficulty in the acquisition of premises, it had not yet been possible to commence the necessary structural alterations, but it was hoped to do so in a few weeks. It would, therefore, not be possible to open that exchange before the end of the present year.

COMMITTEE ON MUNICIPAL TRADING

In the House of Commons on Monday, in reply to a question by Mr. Kimber, Mr. BALFOUR said that he would be glad to see the Committee on Municipal Trading appointed as soon as possible, but he feared that in the present condition of public business he could not find time for a debated motion upon the subject.

OTHER ELECTRICAL BILLS.

The Islington and Euston Railway Bill came before the Standing Orders Committee of the House of Lords on Friday last week on report of non-compliance with the rules of Parliament. It seems that the promoters had made application for leave to insert an additional financial provision, enabling the City and South London Railway Co. to be associated with the project. Leave was given for the introduction of the proposed clauses, and the bill was allowed to proceed to the next stage.

The Northumberland Electric Tramways Bill came before a Select Committee of the House of Lords on Friday last week. The Tyneside Electric Tramway Co. had petitioned against it, but it was stated that that and other opposition had been withdrawn, terms having been agreed to.

In the House of Lords, on Friday last, the Manchester and Liverpool Electric Express Railway Bill was read the second time.

On Monday last in the House of Commons clauses and amendments by the promoters were introduced in the Garston and District Tramways and Electric Supply (Transfer) Bill.

The South Wales Electrical Power Distribution Bill was considered on the same day and ordered for the third reading.

The London United Tramways Bill was read a second time in the House of Commons on Monday last.

The Derbyshire and Nottinghamshire Electric Power Bill was read a third time in the House of Lords on Monday last.

York Corporation Bill.—This omnibus bill recently obtained a section seeking powers for the Corporation of York to purchase, construct and work tramways, but this portion of the measure has been struck out, as it had not been authorised by the ratepayers. The bill as amended, which contained no clauses of electrical interest, was passed by a Select Committee of the House of Commons on Tuesday.

The Cavehill and Whitewell Tramways Bill was read a third time in the House of Commons on Tuesday.

The Halifax Corporation Bill, which included in its objects powers to construct additional tramways, the development of the municipal electricity undertaking and the establishment of a municipal telephone system within the borough, was passed by a Select Committee of the House of Commons last week.

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BENEVOLENT FUND OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Mr. F. H. Webb, hon. secretary of the Institution Benevolent Fund, is sending out the following letter. We would call the attention of all classes of members of the Institution to the appeal contained in its opening sentence :—

I am directed to call your attention to the fact that the above fund has been in existence for 12 years, and that the amount accumulated in that time is only about £1,700, and that the number of contributors of £5 and upwards, and of subscribers of £1 per annum or more is, in all, under 100. It has been represented to the Committee of Management that, if the affairs were managed by a Committee of Management nominated by the Council of the Institution, and therefore more directly in touch with that body, there is a reasonable probability of an increase both in the number of contributors and in the funds.

The Committee is anxious that the Fund should receive more support than it has had in the past, and has, therefore, determined to bring the proposal before the contributors, and accordingly a notice convening an extraordinary general meeting is sent herewith, setting out the alterations which have been proposed in order to carry out the above objects. The opportunity has been taken to propose, also, certain other alterations in the rules that appear to the Committee to be desirable.

A notice convening the meeting of the contributors to the fund on May 9th accompanies the letter.

A NULL METHOD OF MAGNETIC MEASUREMENTS.*

BY RUDOLF GOLDSMIDT.

The number of lines of force, N_1 and N_2, generated by two coils, S_1 and S_2 (Fig. 1), can be compared with one another by winding N_1 with s_1 auxiliary turns, and N_2 with s_2 turns. These auxiliary windings are so connected in series with a continuous-current millivoltmeter that, when N_1 and N_2 are reduced to practically zero, the E.M.F.s introduced in them are in opposite directions. If the

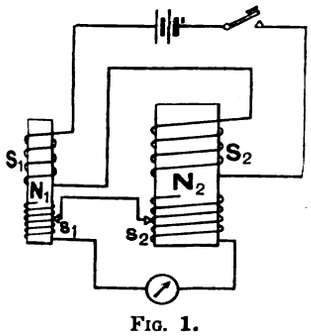

Fig. 1.

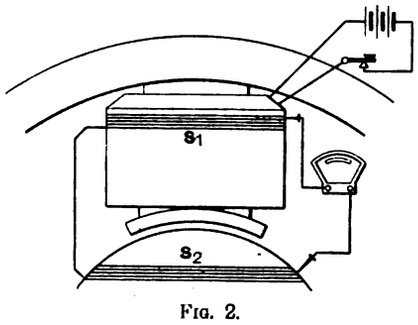

Fig. 2.

number of turns s_1 and s_2 are varied in number so that there is no swing of the millivoltmeter on interrupting the exciting circuit, the following equation holds :—

$$N_1 N_2 = s_1 s_2.$$

The above equation is correct so long as the time taken for the number of lines of force to become very small is small compared

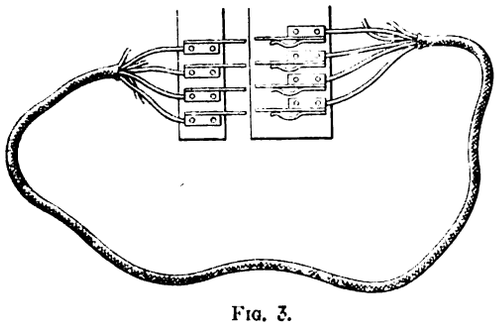

Fig. 3.

with the period of the millivoltmeter needle—a condition fulfilled in most measurements in practice. As the condition of a balance can be observed very sharply, this method enables fairly accurate measurements to be made. The direction of the swing of the needle reverses as soon as the number of windings is more or less than that required for balance, and accuracy of $\frac{1}{10}$ per cent. can be arrived at with suitable arrangements.

* From the *Elektrotechnische Zeitschrift.*

As a first example, the measurement of magnetic leakage on a continuous-current machine may be taken (Fig. 2). In this case a particular degree of accuracy is not needed, and we can employ few turns. As a matter of fact, 10 auxiliary windings (s_1) are placed on the magnet coil and 11 on the armature (s_2). s_1 and s_2 are connected in opposition. The wires may be thin and insulated with cotton, so that the insulation can easily be pierced by a needle, or the wires may even be quite bare. The instrument is not placed quite near to the machine, and the leads to it end in points with which the insulation of the wire can be pierced, and any desired number of windings, s_1 or s_2, included in the auxiliary circuit. The measurement is then made as below :—

Number of turns included in the auxiliary circuit.		$s_2/s_1 = N_2/N_1$.	Swing of the millivoltmeter needle on interrupting the magnet excitation.
s_1.	s_2.		
9	10	1·11	+
6	10	1·25	+
6	8	1·33	+
8	11	1·375	+ *ca.*3°
5	7	1·40	− *ca.*1°
7	10	1·43	−

Thus the leakage coefficient lies between 1·375 and 1·4, and nearer to 1·4. By interpolation we get 1·395. In this case, therefore, it would only have been necessary to make four or five turns accessible for the adjustment, and this can always be done if the relation between the number of lines of force is known roughly.

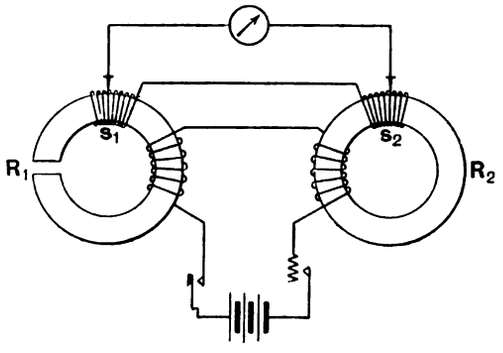

Fig. 4.

In a similar manner it can be ascertained whether an armature is properly centred. Auxiliary windings are pushed on between two poles of opposite polarity, the exciting current is interrupted, and the number of lines of force which emanate from the poles are compared, as explained above. In the case of armature windings connected simply in parallel, in which good centring is necessary, one can shift the armature during the measurement. The position of the armature is then so adjusted that the millivoltmeter gives no deflection when the exciting circuit is interrupted, and one can then be certain that there will be no out-of-balance current when the machine is in use.

Another interesting test is the determination of the back ampere-turns of a continuous current armature for different positions of the brushes. A number of auxiliary turns are wound round one pole and connected to the millivoltmeter. The armature is then excited, and the back ampere-turns are compensated by the field excitation. When there is no longer any swing of the instrument needle on interrupting the current this compensation is correct.

In order to save the somewhat troublesome winding of these auxiliary coils another method is to leave all the turns of the winding open and connecting their ends to contacts arranged on a small board. These open windings are then laid around the pole, and they are all connected together by means of contact springs (Fig. 3). In this way a convenient means is afforded to change the number of turns.*

This method of comparing from magnetic fluxes may also be employed for direct measurement if the value of one of the fields is known. For taking magnetisation curves, for instance, a calibrated iron ring, R_1, may be compared with the ring R_2 to be tested (Fig. 4). If the standard ring R_1 is given an air-gap, so that there is proportionality between the number of lines of force and the excitation, one need only know this constant. Instead of varying the number of turns, one may also vary the current A_1 and A_2 taken by the unknown and known sample, somewhat as in Fig. 5. It is necessary to choose rheostats of fairly high resistance in order to keep down the time constant of the parallel exciting circuits R_1 and R_2. Then A_1 multiplied by a constant (determined by the proportionality factor of the

* I am indebted to my colleague, Herr Veprek, for devising this arrangement.

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standard ring, the comparative number of auxiliary windings, the cross-section of the iron ring R_2) gives directly the flux density in R_2. Thus consecutive readings are taken of A_2(which gives the magnetising current) and A_1 (which gives the flux density).

The measurement of magnetic fluxes with the assistance of a comparative coil may also be extended to measuring the distribution of the field beneath the pole-shoes by means of a narrow search coil, and it may also be employed for the determination of the number of turns when this is unknown, the testing of armatures for short circuits, &c. A simple method for determining the ratio of transformation in transformers may also be mentioned. The primary and secondary coils S_1 and S_2 (Fig. 6) of one limb of the transformer are connected in parallel and then joined up to a small battery, B, through resistances R_1 and R_2. The number of lines of force generated by S_1 and S_2 pass through the same path, so that the auxiliary windings S_1 and S_2 may be replaced by a single winding, and for this the ordinary winding of the second limb of the transformer may be employed.

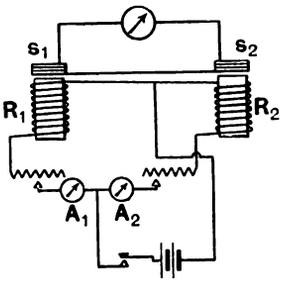

FIG. 5.

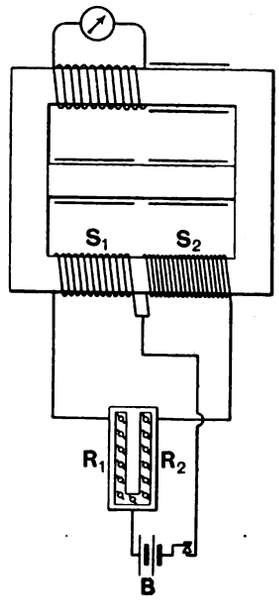

FIG. 6.

The resistances R_1 and R_2, which are both simple plug resistance boxes for small currents, are adjusted until no swing is shown on the millivoltmeter when the current is broken. Then, neglecting the resistance of the transformer winding, the ratio of transformation is $R_1 : R_2$. This test gives very accurate results.

These methods were first applied by the firm of Kolben & Co., in Prague.

LEGAL INTELLIGENCE.

Rattee v. Norwich Electric Tramway Co. (Ltd.).

On Tuesday, this appeal of the defendant company (from a judgment of Mr. Justice Grantham, and a special jury, at the Norwich Assizes) came before Lord Justices Vaughan Williams, Romer and Mathew in the Court of Appeal, London. The appellants asked for judgment or new trial.

The action was brought by Mr. D. E. Rattee, to recover damages for personal injuries caused by the alleged negligence of defendants' motorman. Defendants' pleaded that the accident was unavoidable, and that plaintiff was guilty of contributory negligence in not having proper control over his horse. The jury found for plaintiff with £854 damages. For the company it was contended that there was no evidence of negligence by the motorman, that there had been mis-direction by the judge, and also that the damages were excessive.

It appeared that plaintiff was driving to Norwich on April 27, 1901, and when on the Newmarket-road saw a tramcar approaching. His horse, though generally quite in harness, became restive, and plaintiff held up his hand and shouted to the motorman to stop. Instead, the driver sounded his bell, and the more he sounded it, the more frightened did the horse become, until plaintiff could no longer control him. A collision resulted, and plaintiff was thrown out and rendered unconscious. He sustained serious injuries. His claim for compensation, based on the ground that had the driver stopped the car when signalled to, the accident would never have occurred, was repudiated by the company, who took up the position that having a statutory right to use the road for the purpose of running electric cars on the metals, and having given due notice of the approach of the car by sounding the bell, they were not liable.

In giving judgment, Lord Justice VAUGHAN WILLIAMS said the jury found, in effect, that the driver of the tramcar disregarded the signals and the cries of the plaintiff to pull up the tramcar, and negligently went on. The question the jury had to decide was whether the driver, by his conduct, rendered the company liable. The company said judgment ought to have been entered for them, because what they did was done within the powers granted them by their Act of Parliament. It seemed to him that that contention was altogether wrong. The case of a tramway running on a highway was altogether different to that of a railway. In the old railway case of R. v. Prince it was laid down that there was an absolute power given to railway companies to run their trains on their lines, and that such statutory power was not qualified by any implied condition that in the exercise of their statutory powers they must not create a nuisance or interfere with the right of the public using the adjacent highway. But plaintiff's case was not based on an allegation that the tramways were a nuisance or dangerous, but that the accident was caused solely because the tramcar driver did not pull up when told to do so by plaintiff. The accident was not alleged to have been caused by defendants using the tramlines, for in that case they would be exempt from liability by their statutory powers. Plaintiff alleged that the accident was caused because the driver did not exercise proper care ; the jury agreed with the plaintiff, and he saw no reason why the Court should interfere with their verdict. The appeal would, therefore, be dismissed.

Lord Justice ROMER, who concurred, said that no doubt defendants were entitled to work their tramway, and people could not complain that a tramway was in itself noisy or dangerous. But defendants were clearly bound to work their tramway showing reasonable care to avoid injury to others. There was evidence on which the jury could reasonably find that defendants' motorman was guilty of negligence, and that it was his negligence which caused the injury to plaintiff.

Lord Justice MATHEW also concurred, and the appeal was dismissed with costs.

Mr. WITT applied that the damages paid into Court should remain in Court, as his clients wished to appeal to the House of Lords ; but the Lords Justices declined, and ordered the money to be paid out to plaintiff.

National Electric Wiring Co. v. Canterbury Corporation.

At Canterbury County Court, on Tuesday, plaintiffs sought to recover £15 damages from Canterbury Corporation for removing from certain premises electric light fittings, &c, supplied on the easy-payment system. It appeared that a man named Wildman, who was tenant of the Rose Tap inn, gave an order to the National Electric Wiring Co. to put in an electric lighting installation in his house and entered into an agreement, which was also signed by his landlords, who consented. Wildman gave up possession in December last, and the incoming tenant refused to enter into or be bound by the agreement, but had another installation put in, and called upon the Corporation to supply him with current. The Corporation being compelled by their provisional order to supply electric energy, did so, and requested the plaintiff company to take away their fittings, but as the company refused, the Corporation removed them to avoid the liability of the minimum rental reserved under Wildman's agreement being cast upon them. The fittings were held at the risk of the plaintiffs. For this removal without their consent the company now sued and also claimed the minimum rental due under their agreement with Wildman. No evidence was called, the following facts being admitted :—(1) The agreement of Oct. 19, 1898 ; (2) that the installation was removed by the Corporation and remained in their possession at the disposal of plaintiffs ; (3) that the removal was done by the Corporation without any request from Mr. Wildman or from the landlords (Messrs. Ash & Co.) with a view to protecting themselves from liability for the minimum rental.

The JUDGE (Sir W. L. Selfe) thought the Corporation had made a mistake. The original agreement with the company was not very clear as to what should take place when a consumer using energy supplied by means of the installation put in by the company ceased to take supply, and the incoming tenant refused to continue to use the installation. The point seemed to have occurred to the advisers of the Corporation beforehand, and they suggested a proviso which, if adopted by the company, would probably have put the matter at rest, because that proviso proposed that in such a case the fittings should be removed, if required, by and at the expense and risk of the company, the company to save harmless and keep indemnified the Corporation in respect of all claims for injuries or damage done in consequence of or in connection with such removal. The company did not, however, agree to this. The installation when removed was not of the same value as when in position, and if the company were to be called upon to take out an installation whenever a consumer chose, they might find they had incurred large capital expense which would not be recouped, and this class of installation work would cease to be remunerative, therefore the company did not agree to the suggestion, but modified the proviso, the alteration reading :—"That in the event of a consumer being desirous of discontinuing the use of the electric light, the company may, if they so desire, remove the wires and fittings from the premises of such consumer, but such removal shall be effected by and at the expense and risk of the company." That gave the company the right to remove the wires as between themselves and the Corporation if they so desired. The agreement between the consumer and the Corporation was supplementary, and it provided a mode of payment either for the installation itself, if the consumer desired to purchase it, or by way of interest on the capital expended by the company in putting in the installation. Another clause provided that if the consumer or occupier should cease to take electric energy from the Corporation, or should neglect or refuse to pay for the use of the installation, the Corporation might enter and remove the installation at any time. It was contended that that gave the right to move the installation as between the consumer and the Corporation. It could not be so, however, because the effect of that would be that the supplying company would be entitled to say that without the consent of

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the Wiring Co. the consumer did not desire to go on taking energy through their installation, and therefore the energy-supplying company would take out the wires whether the Wiring Company liked it or not. The agreement should be construed on the lines that the Corporation could remove the fittings after the company had given consent, not otherwise. If they did it against the protest of the company they must pay damages for so doing. He gave judgment for plaintiffs for the amount claimed for damages. As to the claim for rent, he did not consider defendants were responsible if they could not recover it from the consumer, who was the person liable to pay. He was not satisfied that Wildman was unable to pay up to Dec. 31 last. Therefore it appeared to him that Wildman was still liable to pay £1. 2s., less the 7s. 11d. he paid for the time he was in occupation. He did not think the Corporation were called upon to sue Wildman, except at the request of, and on the indemnity of the Wiring Company. He would give judgment that the Corporation pay the minimum rent for the last quarter from Jan. 1, to March 31, 5s. 6d., making the total of damages £15 and rent 5s. 6d.

Mr. NORMAN CRAIG, for the defendants, asked for leave to appeal, which was granted.

British and Foreign Light Railway Syndicate (Ltd.) v. Electric Tramways Construction and Maintenance Co. (Ltd.).

On Tuesday Mr. Justice Bigham heard this action, which was for the recovery of £3,500, alleged to be due from defendants under an agreement dated January, 1902, for the purchase for £5,000 of rights conferred by a light railway order.

Mr. PICKFORD, K.C., for plaintiffs, said the only question to decide was whether there was a concluded bargain between the parties, and that question turned on the construction of documents. Plaintiffs obtained an order for the construction of a light railway between Ormskirk and Southport, and alleged that defendants agreed to purchase from them the benefit of that order. The first document, dated Jan. 27, was a letter from a Mr. Chadwell, an engineer, to the secretary of defendant company. In that letter Mr. Chadwell stated that the best offer he could obtain for plaintiffs' rights under the order was £5,000, payable £1,000 down, £2,500 in a month, and the balance in three months. In reply, defendants' secretary wired to Chadwell: "Agree to terms. Kindly get contract at once or put solicitors into communication." These communications were between Mr. Chadwell and defendants, and were not known at the time to plaintiffs. On Jan. 30, Mr. Chadwell went to plaintiffs with the documents and also a letter addressed to him by defendants in which they confirmed the arrangement to purchase the order on the terms mentioned subject to contract. Thereupon the directors of plaintiff syndicate resolved to accept that offer. Defendants pleaded that there was not a concluded bargain, because they stipulated "subject to contract."

His LORDSHIP, after hearing Mr. Hamilton for defendants, held that there was a valid agreement, and gave judgment for the amount claimed with costs. A stay of execution was granted pending appeal.

Electricity Supply Agreements.

At Lambeth (London) County Court recently, before Judge Emden, the South London Electric Supply Corporation sued Wm. Bell to recover £1. 3s. 4d. for electric current supplied from August, 1901, to December last.

After hearing evidence for the plaintiffs, defendant deposed that in 1900 he only agreed to take current for a period up to September 29, 1900, and signed a document to that effect. At the end of the time named he wrote to plaintiffs to take away the fittings. In reply, they informed him that he had signed for a three years' supply. As he had carefully read the document before signing, and was positive there was no clause relating to a three years' agreement, he refused to pay for the supply after September 29, 1900. He was sued for the service to August, 1901, and as he was not able to appear through sudden illness judgment went against him.

The agreement was now examined by the judge, and upon it was printed, in small type, "and this agreement shall be operative under any circumstances for a period of not less than three years." Defendant swore that this had been printed on the document after he had signed it.

The representative of the plaintiffs stated that after the agreements had been printed it was decided to insert the clause in question, and it was printed on the already-printed agreements, but before they were signed.

The judge, at this stage, adjourned the case for a fortnight for further evidence.

The hearing was resumed on Tuesday this week, when Mr. HARGREAVES, for the corporation, said that although the amount sued for was small, the point at issue affected some hundreds of cases.

Mr. WAYRE, printer, stated that he printed the agreement produced. There was an order given for 500 copies, but after 100 had been delivered a message came by telephone that an important clause had been omitted. The words "and this agreement, &c.," were then printed on the 400 undelivered copies. The additional printing was not put on any agreements which had been signed.

Mr. CLEMENT, plaintiffs' canvasser, who took the defendant's order and witnessed his signature, could not swear whether the clause was or was not there when the agreement was signed by defendant.

Mr. HERBERT H. BOYER, secretary of plaintiff corporation, said there was no truth in the suggestion that the agreement had been altered after it was signed. The charge was a most serious accusation against himself, and most emphatically he denied it.

Judge EMDEN said the case was peculiar. Defendant's tenancy would terminate before the expiration of the three years, but plaintiffs put in the fittings free, and it would be only reasonable for them to bind the customer for a term. Electric lighting companies had a bad system with respect to agreements, inasmuch as they did not supply a counterpart or a copy to the customer. How was a man to carry all the clauses of a long agreement in his head?

Mr. BOYER said copies of agreements were supplied if they were asked for.

After further discussion, his Honour pointed out that the agreement contained the words "My tenancy expires ——— day of ———." In the present case it was September 29, 1900. In very small type underneath there was the clause about the three years. The two were absolutely inconsistent.

Mr. BOYER: We hoped he would renew his tenancy.

The JUDGE was glad he had not to decide whether the three years' clause was or was not on the agreement when it was signed. He thought it was there, but unfortunately it was in very much smaller type than the rest of the document, and in a place where no one would expect to look for such a thing. That was not a proper way to insert such an important clause—the most important if it were valid—in the agreement. But he held that it was not valid, as a man could not bind himself for a longer term than his tenancy. The action must, therefore, be dismissed with costs.

Speed of Electric Tramcars.

On Monday, at Glasgow, before Sheriff Fyfe, Mr. Thomas Simpson again prosecuted Glasgow Corporation for running electric tramcars at excessive speeds. The complaint set forth that, on Feb. 17 and 18, 12 cars going east and 12 cars going west along Albert-road, Pollokshields, were run in excess of the speed allowed by Board of Trade regulations. Objection was taken to the relevancy of the complaint on the grounds (1) that the complaint was inept in respect of the absence of the word person; (2) lack of specification in respect of the speed at which each of the cars was run, and that the penalties to be claimed were not clear; (3) that the complaint was vague and ambiguous, as the penalties sued for were not mentioned; (4) that complainer did not disclose averments showing a title to sue; (5) that the complaint fell to be dismissed in respect of another complaint at the instance of the complainer, charging the same offence, having been brought before the Court last month and not yet having been withdrawn. The Sheriff overruled the objections, and the case was adjourned for trial to May 28.

Workmen's Compensation Act.—Wrigley v. Whittaker.

In the House of Lords on Monday, before the Lord Chancellor and Lords Macnaghten, Shand, Davey, Brampton, Robertson and Lindley, an appeal action was heard under the Workmen's Compensation Act, 1897, from an order of the Court of Appeal, the late Master of the Rolls and Lords Justices Collins and Romer, in March, 1901, dismissing an appeal by Sarah Ann Wrigley against an award made by the judge of the County Court of Lancashire, February, 1901, in an arbitration in which the appellant in this action was applicant and Messrs. Bagley and Wright and Messrs. William Whittaker & Sons were respondents. The appellant was the widow and administratrix of Joseph Wrigley, millwright, who, at the time of the accident, was in the employ of Whittaker & Sons, millwrights, Oldham. Wrigley was employed by Whittakers, as contractors in repairing an engine at Wellington Mills, in the occupation of Messrs. Bagley and Wright. The accident was caused by a stone flag falling upon Wrigley's head and body, killing him instantly. His earnings for the past three years had exceeded £600, and appellant, as his legal representative, claimed for herself and two infant children, as dependants of the deceased, £300 compensation, to be apportioned by the arbitrator. Respondents denied liability on the ground that the employment of Wrigley was not an employment to which the act applied. The arbitration was taken by Judge Bradbury, sitting at Oldham, when it was proved that respondents were engaged in fixing a new driving-wheel to an engine at Wellington Mills; that the work was being done under written contract, which provided that Bagley and Wright were to furnish the unskilled labour, whilst skilled labour and tackle and the wheel itself were to be furnished by Whittakers; that blocks were used in fixing the wheel, the lifting being done by means of pulleys attached to a double-handed winch, of which the handles were turned by hand. The County Court judge found that the pulleys and winch did not constitute "machinery driven by steam, water, or other mechanical power" within sec. 7 sub-sec. 2 of the act, holding that the driving power was hand power and not mechanical, and he directed an award to be entered in favour of respondents. The Court of Appeal affirmed this award, and held that respondents were not liable as "undertakers" in respect of the "factory" in which the accident took place.

The LORD CHANCELLOR now moved that the appeal be dismissed, contending that the accident did not happen in respondents' "factory." To make the employer liable the accident must take place in his factory, whereas here it was on the premises of others where work was being carried on. The thing manufactured by respondents had been completed and finished on their own premises, and sent to what might, under other conditions, be a "factory"; but the act meant the factory of the person who was to be liable for accidents. Here the work was executed entirely away from respondents' place of business.

The other noble and learned lords concurred, and the appeal was, therefore, dismissed.

Trade Union Law.

The case of Thomas *v.* Amalgamated Society of Carpenters and Joiners was heard at Manchester Assizes last week. The action, which was similar to Giblin *v.* Amalgamated Labourers' Union of Great Britain and Ireland (reported in our issue of 11th inst.), was for the recovery of damages from a trade union for unlawfully procuring the dismissal of a workman, and for conspiring to prevent employers from giving him work.

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The PLAINTIFF, Sydney Joseph Thomas, alleged that certain members of the Joiners' Union at Warrington had brought about his dismissal by a threat that if he were not sent away the other workmen would be withdrawn. He applied to be admitted a member of the union, and had been refused on the ground that he had on one occasion accepted strike pay from the union, been enabled by the union to find work elsewhere, and had on his return to Warrington taken work in a "black" shop.

Evidence having been given on both sides,

The JUDGE (Mr. Justice Wills), in summing up, said if the jury thought that, although defendants were annoyed with Thomas because of what he had done, their real motive was to advance their trade interests and not vindictively to punish the man, the verdict should be for the defendants. If, on the other hand, they thought the guiding motive was to punish Thomas because he had done something of which defendants disapproved, the verdict ought to be for plaintiff. The questions left to the jury were these:—(1) Did Ward and Fothergill (delegates of the union) give Bramhall and Bissell (manager and foreman joiner of Thomas's employer) to understand that if Thomas were not discharged they would call the men out? (2) Did that bring about Thomas's discharge? (3) In doing so did they carry out the intentions of the Warrington branch of the Society? (4) Was the guiding motive of this action to promote the interests of the Society and its members or to punish Thomas for having taken piecework elsewhere?

The jury, without leaving the box, found for the plaintiff on all points, and gave him £100 damages.

The Judge entered judgment accordingly, and granted an injunction against defendants.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Board of Management of the East London Hospital for Children and Dispensary for Women, Shadwell, require an officer for the electrical department. Candidates must be capable of organising and superintending a new department for electrotherapeutics and radiography. An advertisement contains further particulars. Applications to the secretary, Mr. T. Hayes, by 17th May.

Southwark (London) Borough Council have vacancies for two pupils at their electricity works. Particulars from the town clerk (Mr. J. A. Johnson), Town Hall, Walworth-road, London, S.E. See advertisement.

The trustees of the Victoria Jubilee Technical Institute (Bombay) invite applications for the professorship of physics and electrical engineering. Applications should be sent to Prof. Ayrton, City and Guilds Central Technical College, Exhibition-road, London, S.W. An advertisement contains additional particulars.

Ilkeston Corporation require an electrical engineer and general manager of their tramways. Applications to the town clerk (Mr. Wright Lissett) by May 8. See advertisement.

York Corporation require a junior assistant engineer and a managing clerk for the electricity department. Further particulars are set out in advertisements. Applications to the city electrical engineer (Mr. C. A. Midgley), Electricity Works, Foss Islands-road, York, by May 12.

Marconi's Wireless Telegraph Co. (Ltd.) require junior electricians to train at their private school for staff appointments. Applications to the secretary, 18, Finch-lane, London, E.C. See advertisement.

The Marconi International Marine Communications Co. (Ltd.) require a number of first-class operators for service on board ship and at shore stations. Applications to the secretary, 18, Finch-lane, E.C. See advertisement.

An assistant meter inspector is required by the Newcastle-upon-Tyne Electric Supply Co. (Ltd.), 50, New Bridge-street, Newcastle-upon-Tyne. See advertisement.

Manchester Tramways committee require a general foreman and two deputy foremen for their car depôt Applications to chairman, 55, Piccadilly, Manchester, by May 10. See advertisement.

Falkirk Town Council require a resident electrical engineer. Forms of application from town clerk.

Canterbury Electric Lighting committee require a shift engineer. Applications to chief engineer, Mr. C. A. Blascheck, by May 5.

Mr. James L. Graham has been appointed superintendent of the Pinkston power station, Glasgow, in succession to Mr. J. W. Donnet.

Mr. J. W. Willmot, superintendent of the Post Office instrument factory, has been appointed by the Postmaster-General to the newly-created position of Controller of Factories.

Mr. Lionel E. Harvey, of Leeds, has been appointed superintendent of tramways overhead construction at Halifax at £150 per annum.

Mr. A. D. Leiper, assistant superintendent of telegraphs at Aberdeen, has been made superintendent, and Mr. D. Fraser has been promoted to be assistant superintendent.

Mr. P. J. S. Tiddeman, of St. Anne's-on-the-Sea, has been appointed resident electrical engineer at Stoke-on-Trent. Mr. Tiddeman commenced his electrical career at the School of Electrical Engineering, Hanover-square, London. He afterwards entered the works of Messrs. Crompton & Co. at Chelmsford; in Jan., 1895, was appointed resident engineer at the Pontypool electricity works, and about three years ago was appointed resident and consulting engineer in connection with the St. Anne's on Sea electricity supply scheme.

Accrington.—The accounts of the electricity department for the year ended March 31st show a net loss of £1,558. The receipts were £1,622, and the working expenses £1,229; interest came to £1,077, and sinking fund instalment to £974 97,869 units of current were sold at an average of 3·886d. per unit. The average price was 4·058d. per unit for private lighting, and 1·821d. for power. The capital expended during the year was £8,414, bringing the total to £36,979. There are only four public lamps.

Last week an inquiry was held into the application of the Council to borrow £2,000 for electric lighting, £1,200 for refuse destructor works, and £525 for the electric lighting of the market shops and stalls. The borough accountant (Mr. Beckett) said the first portion of the loan was required for cable extensions. The first year's working of the undertaking had resulted in a gross profit of £493, which was highly satisfactory. In regard to the £525 required for market wiring, the work was being carried out at the suggestion of the tenants, who would pay a slightly increased rental to cover capital charges.

Argentina.—From a recent report from the British Consul at Buenos Ayres it appears that a steady demand exists in that city for all descriptions of domestic electric appliances, including fans, ventilators, lifts and plant and accessories for electric tramways and lighting installations. There are at present in Buenos Ayres 62 miles of electrically-worked tramways and the remainder of the 268 miles of line within the city area are being rapidly converted. Over 30,000,000 passengers were carried on the electric lines in 1901, compared with 95,500,000 over the remainder of the tramways. Automatic lifts are in almost universal use for offices and residential flats of any size, and, in fact, the various applications of electricity are being utilised to their fullest extent. There are no municipal tramways in Buenos Ayres.

Australian Telegraphs.—It is estimated that a loss of £45,000 will be made on the telegraph revenue of the State of South Australia if the proposed uniform telegraph rates are adopted, by which eight words are to be allowed free for name, address and signature to inland telegrams.

Automatic Telephones.—The Strowger system of automatic telephones is about to be adopted in Chicago. This system has been in operation in several small towns in the eastern States for the past two years. It is stated that at Falls River, Massachusetts, there are 615 subscribers on this system, the cost of working with one attendant being £16. 10s. A newly-constituted company is to work the system at Chicago. The charge is to be 2½d. for each message, with a maximum of £17. 10s. 6d. per annum, or an alternative rate of 2½d. per message up to 1,700 for the year, and the remainder free. The present charges for the telephone service run as high as £33 per annum per subscriber for business telephones.

Ayr.—The poll on the subject of the running of Sunday trams has resulted in a majority of nearly 3 to 1 in their favour.

Bath.—The special committee appointed to investigate the present position of the electricity undertaking have presented a report, and recommend the Council not to accept either of the two offers recently made for the purchase of the electricity works.

Beverley.—An inquiry was held here on Friday last into the application of the Corporation to borrow £15,000 for electricity works. The town clerk (Mr. J. W. Mills) said a provisional order had been obtained so as to keep out companies. As the result of a partial canvass, 74 out of 136 ratepayers promised to take electric current, 69 were probable users and only 18 refused. Mr. Baker (Messrs. Baker and Appleby) submitted estimates and technical details. Canon Nolloth was in favour of the introduction of the electric light into the Minster, which, he said, suffered from the fumes and discolouration of gas. The inspector (Col. W. Langton Coke) concurred in this opinion, and said that the money saved in cleaning by the use of the electric light was considerable. There was opposition on the part of ratepayers, who alleged that the works would be a burden on the rates.

Birmingham.—An inquiry will be held, on Tuesday, into the application of the Council to borrow £251,974 for electricity supply.

Brighton.—The municipal electric tramways are operated under probably the most severe conditions in regard to gradients of any town in the kingdom. Although nearly 3,000,000 passengers have been carried, up to the present there has not been a single hitch or accident.

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Camberwell (London).—In a report prepared by the town clerk on the conditions on which the Board of Trade offered to grant the Borough Council's application for a provisional order, the Council is recommended to inform the Board that they withdraw their application, as the clauses relating to the purchase of the undertakings of the companies supplying electricity in the district are too onerous.

Canterbury.—At the end of the financial year the electricity department had 343 consumers against 259 last year. The gross profit was £2,602. 6s. 3d., against £1,885. 14s. 9d. in 1901, and, after paying interest and sinking fund instalments, and including last year's balance forward of £419. 10s. 6d., there is a surplus of £1,150. 4s. 8d. to be dealt with.

Cardiff.—Estimates of the approximate revenue and expenditure of the electricity department for the year ended March have been issued. The expenses were £9,594, while interest and sinking fund came to £5,676, a total of £15,270, which left a profit of £1,023 against £9 in the previous year. In the report of the engineer and manager (Mr. A. Ellis) it is stated that the gross profit was about 6½ per cent. on the capital. It has been decided to extend the electric lighting mains into the Woodville-road district, at an estimated cost of £708.

Last week the Electrical committee considered a report from the chief engineer and manager of the electricity works (Mr. A. Ellis) as to the necessity for erecting a sub-station at Cardiff Docks. It was estimated that a 1,500 H.P. load for lighting and power would be obtained from firms in that district. The matter was deferred.

Coronation Illuminations.—We have received a copy of the regulations issued by the St. Pancras Borough Council for wiring and charges for supply for additional temporary lighting for Coronation illuminations on June 26 and 27. The Council reserve the right to refuse applications after a safe limit to the station, sub-station or house-lead capacity has been reached. Special connections will be made at actual cost, which will be refunded if supply becomes permanent within three months. For current the charge of 1d. per 8 c.p. lamp or its equivalent per night will be made. The following wiring regulations for temporary work will apply:—

(*a*) Current density. The maximum current allowed by the I.E.E. rules will be approved, viz.:—

Size S.W.G.	Amperes.
18	4·2
17	4·4
16	6·8 &c.

(*b*) Insulation to earth. If tested in wet weather to be such that not more than $\frac{1}{15000}$th of the whole current required can leak, assuming one pole to be earthed. If tested in dry weather to be such that not more than $\frac{1}{30000}$th of the whole current required can leak, assuming one pole to be earthed.

(*c*) Joints need not be soldered, provided that the wires are well cleaned, that the joint is mechanically strong, that the joint is well insulated with both pure rubber and black tape. (The "Britannia" form of joint is preferable.)

(*d*) Not more than 50 8 c.p. lamps are to be connected with one circuit and each circuit is to be brought direct to the temporary switchboard, and there controlled by a single pole switch and fuse in each conductor. No other fuses are to be used.

(*e*) Temporary leads are to be secured at points not exceeding 1yd. apart, either by wood cleats or binding to insulators.

(*f*) A temporary switchboard is to be fixed close to the supply service. The board should be of hard wood or soft wood covered with sheet asbestos and to be fixed in a horizontal position on brackets like a shelf. The wires to be brought up from underneath through holes in the board to various switches, &c. It is important that there should be at least 3ft. headway above the board.

(*g*) Sufficient lead must be provided to connect the supply service.

(*h*) If any temporary wires are connected in any other manner than provided by these rules the ordinary wiring rules will hold good.

The circular concludes by recommending that the amount of inflammable material, including electric light wires, should be kept as low as possible. They should be as far removed as possible from fascia boards or other wood work.

Customs Dues.—The Russian Customs department announces that incandescent lamps of glass and china with metallic attachments are dutiable under sec. 169 of the Russian Customs tariffs at the rate of 7½d. per pound.

The duty on incandescent lamps imported into Norway has recently been fixed at 1kr. 50ore per kilog, and transformers, which were formerly allowed in free, are now charged at 5 per cent. ad val.

Dover.—During the past year over 3,000,000 passengers were carried by the municipal electric tramways and there was a net profit of £1,100.

Durham.—At the meeting of the Durham County Council, on Tuesday, it was resolved to institute an inquiry as to how far the county was covered by electric supply companies working under statutory powers; as to any special facilities existing in the county for generating electricity by water-power, &c., and as to the practicability of such facilities being employed to the advantage of the county; as to the financial results of electric schemes undertaken by municipal bodies; how far it would be practicable and wise to develop a scheme of electricity supply for the county through the medium of urban or rural councils, consistent with Acts of Parliament already obtained by existing companies; and as to the best mode of procedure for giving effect to the Council's views and recommendations.

Electricity Supply in Cheshire.—A scheme is being formulated for the erection of electricity works for supplying current for lighting and power in Cheshire and North Staffordshire. Parliamentary powers will probably be applied for next session.

Electricity Supply in South Wales.—The question of supplying electricity in Neath, Aberavon, and Margam was discussed at a conference last week between members of the three councils and Mr. Edmund Hill, manager of the South Wales Electrical Power Distribution Co. It was agreed to recommend the Councils to take electricity in bulk from the company on terms to be agreed.

Exhibitions.—There is to be held from May 3 to May 10 inclusive a laundry exhibition at the Agricultural Hall, Islington, London, when a very complete display of laundry machinery will be exhibited.

The opening ceremony in connection with the Wolverhampton Exhibition was performed by T.R.H. the Duke and Duchess of Connaught yesterday (Thursday).

The formal opening of the Cork International Exhibition by the Lord-Lieutenant of the County (Lord Bandon) also took place yesterday.

Hampstead (London).—At the end of March there were 2,540 customers of the electricity department, representing the equivalent of 150,602 8 c.p. lamps connected, an increase of 478 and 24,710 respectively during the year.

Lancaster.—Application is to be made for a further loan of £25,000 for electric lighting and tramways.

Light Railways.—The Grimsby and Saltfleetby Light Railways (Amendment) Order has been submitted to the Board of Trade for confirmation. Objections by May 2.

The Board of Trade have, after modification, confirmed the Gower Light Railway (Amendment) Order, 1902.

Middlesex County Council have decided to apply to the Light Railway Commissioners for permission to construct light railways through the Alexandra Park and to erect a generating station thereon.

An inquiry will be held on May 13 into the application for an order to construct a light railway between Torquay and Paignton.

May 15 has been fixed as the date for holding an inquiry into the application for constructing extensions of the Cheltenham and District Light Railway.

Maidstone Council have decided to apply for a light railway order for the construction of light railways in their district.

An inquiry will be held on Wednesday into the application to construct the Clacton-on-Sea and St. Osyth light railway.

On Wednesday Gloucester Council decided to proceed with their application to construct light railways as extensions of the present tramway system.

London County Council.—At Tuesday's meeting the Highways Committee reported that the Council, on March 4 last, accepted the tender of Messrs. P. and W. MacLellan (Ltd.) for the supply of track rails, slot rails and accessories required in connection with the reconstruction for electric traction of a portion of the Council tramways. The materials to be supplied under the contract included 155 tons of sole-plates of a special pattern, regarding which Mr. L. Cooper, Leeds, holds certain patent rights. The result of negotiations between the Council and the other parties concerned was an arrangement under which the sole-plates required will be supplied direct to the Council by Mr. Cooper for £1,846. 5s., while an item of 155 tons of track rails will be added to Messrs. MacLellan's contract in place of the sole-plates, and by way of compensation for the reduction in the value of the contract. The amount of the originally accepted tender was £41,742. 4s. 4d., which, under the new arrangement, would be reduced to £40,509. 19s. 4d.; but, in addition, there would now be the amount to be paid to Mr. Cooper, making in all £42,356. 4s. 4d., an increase of £614. Against this additional expenditure must be set the 155 tons of rails, valued at £1,023, which the Council would obtain. The Council approved the committee's action.

Market Drayton.—The Parish Council are supporting the application of the Market Drayton Electric Light and Power Co. for a licence to establish electricity supply.

Municipal Telephony.—Consideration of the National Telephone Co.'s bill for additional powers in regard to their Hull undertaking has been postponed, in view of a probable settlement of the differences between the Corporation and the company. Proposals made by the Corporation are at present under consideration by the company's directors.

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New German Atlantic Cable.—The s.s. "Von Podbielski" is about to sail for Fayal (Azores), and thence to North America, to take soundings in the Atlantic for a new German-American submarine telegraph cable.

Northampton.—The Council recently acquired the local horse tramways, and have decided to introduce electric traction and carry out extensions at an estimated cost of £120,000.

Nottingham.—The Woodborough-road electric tramway route is ready for official inspection. A successful trial trip over the route was made on Wednesday.

Obituaries.—We regret to record the death of Mr. Granville C. Vines, borough electrical engineer at Kimberley, South Africa. The death took place recently at Kimberley from enteric fever.

Mr. William Samuel Wentworth, senior partner in the old-established electrical and gas engineering firm of Wentworth & Co., Newgate-street, London, committed suicide on Sunday last. He had suffered lately from giddiness and depression, and the coroner's jury returned a verdict of suicide while temporarily insane.

Penny Postage to China.—Prepaid penny postage has been established for all places in China where British post offices are maintained. This includes correspondence with the following places (in addition to Hong Kong):—Amoy, Canton, Foochow, Hangkow, Hoihow, Liu Kung Tau (Wei-hai-wei), Ningpo, Shanghai and Swatow.

Personal.—On April 26 Mr. Reginald J. Wallis-Jones, M.I.E.E., Assoc.M.Inst.C.E., sailed for New York on a short business visit to the States in connection with electric welding and other matters.

A large gathering was entertained at the Criterion Restaurant on Friday last by the directorate of Electric Lighting Boards (Ltd.) as a send-off to Miss A. Ashton Bence on her departure to the Cape on the company's behalf. Miss Bence, it will be remembered, visited the United States last year to negotiate the sale of the company's patents in America. The object of her visit to the Cape is of a similar nature.

Pontypool.—Negotiations are in progress for the purchase of the undertaking of the Pontypool Electric Light and Power Co. by the District Council, and Messrs. Wheatley Kirk, Price & Co. have been called in to report.

Pontypridd.—Application has been made for sanction to borrow moneys for electricity works.

Presentations.—On Tuesday last week the borough electrical engineer at Maidstone (Mr. E. E. Hoadley) was presented with a marble clock on the occasion of his approaching marriage. The chief assistant (Mr. Carr) made the presentation.

Last week Mr. F. C. Pay, of Hammersmith, who is taking up the position of chief engineer at Newton Abbot electricity works, was presented with an oak case of drawing instruments, &c. The presentation was made by the chief engineer, Mr. G. G. Bell.

Salford.—The Lower Broughton electric tramway routes will be opened for traffic to-day (Friday).

Singapore.—With regard to the construction of tramways at Singapore, to which reference has recently been made in our columns, the detailed particulars of the requirements in regard to these works is set out in the Government Gazette of the Straits Settlements of March 27, which can be seen at the Commercial Intelligence Branch of the Board of Trade, Parliament-street, London, S.W. One of the provisions of the Ordinance provides that all engines, boilers, electrical generating apparatus and power-station equipment, car bodies and electrical equipment therefor, including motors, shall be of British manufacture; and the Governor in Council may, in case the same or any of them shall not be of British manufacture, forfeit the same, and for this purpose remove the same and dispose thereof as he may think fit for the benefit of the Government.

Spain.—La Sociedad Union Industrial Minera of Linares is putting down plant to utilise the waters of the river Guadalquiver at Batan de la Fuente in the generation of electric energy at Marmsleje, Villa del Rio, Montoro, Bujalanie and Cañete. The plant comprises three 250 H.P. Voith turbines connected to Schuckert three-phase alternators.

Telegraph Convention of St. Petersburg.—Uruguay has adopted the St. Petersburg Convention, and becomes a member of the International Telegraph Bureau.

Telephones in the Temple.—The Benchers of the Inner Temple have conditionally consented to Post Office telephones being introduced into the chambers and buildings of their Inn. The Benchers of the Middle Temple, on the other hand, have refused their consent.

Trunk Telegraph Line to Scotland.—It is announced that the construction of an underground telegraph line in extension of the existing line from Birmingham is about to be taken in hand by the postal authorities, and is to be continued on to Manchester, Liverpool, and, finally, to Edinburgh and Glasgow.

Tynemouth.—Application for sanction to a further loan of £8,000 for electric lighting extensions has been made.

The salary of the electrical engineer (Mr. C. Turnbull) has been increased to £300 per annum.

Wolverhampton.—The official inspection of the electric tramway between the Railway Station-drive to Coleman-street took place on Saturday, and the line was opened for traffic on Monday.

Wrexham.—For some time past complaints have been made of breakdowns in the supply of electricity, and these have been attributed to faulty cables. A special meeting of the Council was held on Tuesday to consider a letter from the contractors (the St. Helens Cable Co.) with reference to their investigation of the complaints. The Council decided to leave the matter in the hands of their engineer (Mr. W. H. Trentham). As various statements have been published in regard to the matter, the contractors have made a statement, from which we extract the following:—

The fact of the matter is, that this company have agreed to take out a few lengths of lead-covered cables, the lead covering of which has been damaged by electrolysis setting in through the faulty suspension of the arc lamps, for which we were not responsible, the quality of the cable being absolutely up to standard. Of course, all paper cables are dependent for their safe working on their lead covering, and if this is once pierced by electrolytic action, as has happened in many places—for instance, at Bootle, St. Helens, Glasgow, Dublin, &c., where the cables were laid in the same perfect manner as our cables were laid in Wrexham—then the cables must naturally break down, and some of the most eminent engineers in the country agree that lead-covered cables will have to come out sooner or later in many places. We have agreed to replace about £300 worth of damaged cable with our new patent non-lead-covered cable, with the full sanction and approval of the consulting engineer.

The following revised scale of charges for the supply of electric current has been adopted, in place of the uniform charge of 6d. per unit:—Up to 100 units, 6d.; from 100 to 300, 5d.; from 300 to 1,000, 4½d.; from 1,000 to 1,500, 4½d.; and from 1,500 upwards, 4¼d. The present discounts are to be withdrawn, and a uniform discount of 2½ per cent. on all lighting accounts allowed if paid within a month. Meter rental has been raised from 1s. to 2s. per quarter. The revised scale comes into force on July 1.

The consulting engineer has submitted estimates of the cost of providing plant for the supply of current to the Wrexham District Tramways Co. The capital outlay is put at £6,572.

NOW READY.

Price 12s. 6d., by post (U.K.), 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. United States, 15s.

"The Electrician" Electrical Trades' Directory and Handbook for 1902 (corrected to February 10, 1902).—In addition to the well-known features of this DIRECTORY AND HANDBOOK (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including Time Table for various proceedings in connection with Parliamentary Procedure, &c., the Parliamentary Record for 1901, the revised regulations of the Board of Trade as to guard wires on electric tramways, the new (Feb., 1902) Post Office Specification for Municipal Telephone Exchanges, Telephonic Developments in the United Kingdom (including particulars of the Post Office Telephone Service in London and the agreement between the Postmaster-General and the National Telephone Co.), Notes on the progress of Wireless Telegraphy, &c., a considerable extension of the particulars relating to Municipal Technical Schools and Institutions, &c. The latest developments of State and Municipal Telephone enterprise are set out from official sources, as well as the progress of the National Telephone Co.'s service. In the division of "Electric Light, Power and Traction," the valuable Digest of the Law on these subjects by Mr. A. C. Curtis-Hayward, B.A., solicitor, has again been greatly extended. The Sketch Maps and particulars of the Electric "Bulk" areas have been added to and include all schemes which have yet received Parliamentary or Board of Trade sanction. The sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete to Feb. 12. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and electric power and traction. The Directory Division has been carefully extended and corrected up to Feb. 10, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. New sketches of the careers of well-known electrical experts have been added to the Biographical Division, and many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can now be obtained post free. From this digest it will be seen that the industry has been provided, within the two covers of the BIG BLUE BOOK, with all the information, technical, financial and general, that it is possible to compile.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us by first post Thursday morning; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

West Ham Corporation invite tenders for two steel chimneys, four fans and engines for induced draught, brickwork in connection with the flues and economisers. Specifications, &c., from the borough electrical engineer (Mr. Jas. K. Bock), and tenders to the town clerk (Mr. Fred. E. Hilleary) by 4 p.m. of May 13. An advertisement contains additional particulars.

West Ham Corporation also require tenders for the construction of eight transformer chambers. Tenders by May 13.

Glasgow Corporation invite tenders for the supply of motor-driven boosters and relative switching apparatus. Specifications, &c., from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow, and tenders to the town clerk (Sir J. D. Marwick) by 5th May. See advertisement.

Glasgow Corporation also require material for extension to switchboard at Coplawhill sub-station. Tenders to town clerk by 5 p.m. May 7.

Halesowen Rural District Council, having obtained authority to erect electricity works and to construct light railways, invite communications from companies willing to take over their powers, and to carry out the works authorised and obligations imposed by the orders. Further information from the clerk (Mr. E H. Grove), to whom communications are to be sent by May 21. Plans may be seen at the offices of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. See advertisement.

Ilford District Council invite tenders for the supply of three 10 H.P. electric motors. Specifications, &c., from the chief engineer (Mr. Arthur H. Shaw), electricity works, Ilford, and tenders to the clerk (Mr. J. W. Benton) by noon May 13. See advertisement.

Swindon Corporation invite tenders for the supply, delivery and erection of a storage battery of 252 cells, and accessories. Specifications, &c., may be seen at the offices of the engineers (Messrs. Lacey, Clirehugh and Sillar), 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, and obtained from latter office only. An advertisement contains further particulars. Tenders to the town clerk (Mr. Robert Hilton) by May 19.

Erith District Council invite offers from firms willing to take up free wiring in the district. Communications to the clerk (Mr. Charles H. Fry) by noon May 5. See advertisement.

EXTENSION OF TIME.—*London County Council* invite tenders for wiring and fittings for the electric lighting of the Euston-road fire station. Tenders to the clerk (Mr. G. L. Gomme), County Hall, by 10 a.m. May 8.

Fulham (London) Establishment committee invite tenders for a 600kw. two-phase steam alternator (with Willans, Bellis or Allen engine) or a 600kw. Parsons' turbo-alternator. Tenders to town clerk, Town Hall, Walham Green, London, S.W., by 7 p.m. May 5.

Dartford District Council require tenders for a 300kw. steam dynamo, with steam and exhaust pipes, switchboard instruments, &c.; one Lancashire boiler with feed pump, additional feed pipes and extension to economiser. Tenders to clerk by noon May 10.

The *War Office* invite tenders for the manufacture of a self-propelled lorry for military purposes. Specifications, &c., from Director of Army Contracts (Mr. A. Major), War Office, London, S.W., to whom tenders by noon July 31.

Aberdeen Electric Lighting committee invite tenders for a 20-ton electrically-driven overhead crane for their Dee Village electricity works. Tenders to city electrical engineer by mid-day May 7.

Dublin Lighting committee invite tenders for the construction of a cast-iron subway under the Grand Canal Dock. Tenders to chairman by noon May 13.

The Great Northern Railway Co. (of Ireland), *Belfast*, require a dynamo and a 41 H.P. Crossley high-speed gas engine. Tenders by May 12.

Oldham Electricity committee invite tenders for lighting and traction switchboards and instruments. Tenders to Mr. Andrew, Gas and Water Offices, Oldham, by May 6.

Harrogate Corporation invite tenders for material for laying about 600 yds. of light railway for electric or steam traction. Tenders to engineer (Mr. E. W. Dixon), 14, Albert-street, Harrogate, by May 12.

Grimsby Corporation require continuous-current arc lamps, arc lamp posts, stoneware pipes, cables, &c. Tenders to borough electrical engineer (Mr. W. A. Vignoles), by May 5.

Bedford Electricity committee invite tenders for economisers. Tenders to chairman by May 19.

Colchester Electric Light and Power Co. invite tenders for the extensions of their boiler and engine houses. Tenders by 5 p.m. May 7.

Clyde Navigation Trustees invite tenders for electrical and other stores for 12 months. Tenders to Mr. T. R Mackenzie, 16, Robertson-street, Glasgow, by noon May 8.

Barrow Corporation require arc lamps, columns, switchboard, pillars, &c. Tenders by noon May 7.

Bury Corporation invite tenders for tramway feeder and pilot cables, conduits and accessories. Tenders to town clerk by May 8.

Dewsbury Electricity committee invite tenders for a traction switchboard. Tenders by May 12.

Woolwich Borough Council require 10,000 pairs of arc lamp carbons and a 70 H.P. motor. Tenders by May 15.

The municipality of *Ottawa*, Canada, is about to call for tenders for a municipal telephone service, with exchange and apparatus for 4,000 subscribers.

The Municipal Authorities of *Calarashi-Stirbeiu* (Roumania) invite tenders until May 31 for the concession for electric lighting for 35 years.

Gualeguay (South America) municipality will shortly invite tenders for public electric lighting.

TENDERS RECEIVED AND ACCEPTED.

Plymouth Town Council have accepted the tender of Messrs. Heath & Co. for wiring the refuse destructor works at £67.

We are informed that during the past few days the British Insulated Wire Co. have obtained, among other contracts, orders from South Shields (for extensions), Brighton (1in. cable), Salford (high tension cables for one year), British Electric Traction Co. (cables for Lye tramways), Islington (high tension arc lighting cables), Partick (extensions), Guernsey (telephone cable), Coventry (extensions), Blackheath and Greenwich Electric Supply Co. (extensions), Great Central Railway (copper wire for one year), Bexhill (extensions), Bristol (8 miles of low tension power cable), and Cleckheaton (extensions).

Bristol Corporation have accepted the tender of the British Insulated Wire Co. for power cables. Tenders were also submitted by Siemens Bros. & Co., the Telegraph Manufacturing Co., St. Helens Cable Co., Johnson and Phillips, W. T. Henley's Co., Western Electric Co., W. T. Glover & Co., and Callender's Co.

The contract for all the switchboards required by the Bengal-Nagpur Railway Co. in connection with the electrical equipment of their workshops has been placed with Messrs. Kelvin and James White (Ltd).

Messrs. Kelvin and James White have also obtained the contract for traction switchboard and extension on main switchboard at Warrington.

Swansea School Board have accepted the tender of Mr. John S. Brown for wiring the Central Higher Grade School at £329.

Hull Corporation received nine tenders, ranging from £3,207 to £3,816, for the supply and erection of pipework, pumps, motors, &c., and that of Messrs. Thornton and Crebbin was accepted at £3,312.

Dundee Council have accepted the tender of Messrs. Hurst, Nelson & Co., for the supply of tramcars and that of Messrs. Dick, Kerr & Co. for the electrical equipments.

Southampton Corporation have accepted the tender of Callender's Company for the supply of cable at £1,206, that of Messrs. Herbert Morris and Bastert for a crane at £272, and that of Messrs. Oates and Green for earthenware troughing.

Stafford Council have accepted the tender of Callender's Company for cable at £1,150.

Brighton Corporation have not yet opened the tenders recently sent for a high-rate discharge battery and automatic reversing booster and switch gear, their consideration having been deferred.

Luton Town Council have received 10 tenders for distributing mains, and these are at present under consideration by the resident electrical engineer.

BUSINESS NOTICES.

The London office and show room of Messrs. Elliott Bros. have been removed from 101, St. Martin's-lane, to 36, Leicester-square, W.C. The telegraphic address, "Ohm London," and telephone, No. 3852 Gerrard, remain as heretofore.

Messrs. D. Wilson, J. W. Graham and R. Graham (trading as Wilson, Graham & Co.), electrical engineers, Fitzwilliam-street and St. John's-road, Huddersfield, have dissolved partnership. Debts by J. W. and R. Graham.

We are informed that Mr. E. MacGregor Duncan has resigned his position upon the staff of Messrs. Kennedy and Jenkin, and has commenced practice as a consulting engineer at 27, Old Queen-street, Westminster, S.W.

Messrs. Moores, Farrell & Co. have removed to Mynshull's House, Victoria-street, Manchester. The firm are sole agents for Brockie-Pell arc lamps, consolidated telephones, Everett-Edgcumbe electrical instruments, &c.

The Irish office of the British Thomson-Houston Co. has been removed from 21, Lincoln-place, Dublin, to 9, Donegal-square West, Belfast.

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BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the Auto-Electro Feed Water Purifier Co. (Ltd.) will be held at Lich Gate, Wolverhampton, on May 31, to receive an account of the winding-up.

Claims against the British Electric Meter Co. (Ltd.) must be sent to the liquidator (Mr. F. S. Springett, 146A, Queen Victoria-street, London, E.C.) by June 10.

Mr. H. E. Abbott, of 5, Fenwick-street, Liverpool (with a committee of inspection), has been appointed liquidator of the Electrical Regulating and Lighting Syndicate (Ltd.).

The liquidator in the liquidation of the Epstein Electric Accumulator Co. (Ltd.) has been released.

Application for the discharge of J. G. M. Hilton, electrician, Trafalgar Works, Bow Common-lane, London, E., will be heard at Bankruptcy-buildings, London, on 15th inst.

A first and final dividend of 2s. 3d. is payable at 14, Chapel-street, Preston, in the bankruptcy of Thos. Morley, electrical engineer, 16, Whalley-road, and Argyle-street, Accrington.

In the bankruptcy of Lewis Bayliss, electrical accessories maker, Wednesbury and London, Mr. W. R. Davies, 63, Temple-row, Birmingham, has been appointed trustee.

The Court has approved of a composition of 10s. being paid by H. D. McIntyre, electrical engineer, &c., 15, Werter-road, Putney, London, and Glanamman Colliery, Carmarthenshire.

Plant for Sale.—Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Some electric lighting plant (including two Crossley gas engines, two dynamos, switchboard, &c.) is advertised for sale in another column. Applications to Kelly's Directories Limited, 182–4, High Holborn, London, W.C.

Factory Sites.—Messrs. Humbert and Flint, Watford, Herts., and 11, Serle-street, Lincoln's Inn, London, W.C., announce in another column some convenient factory sites in the Watford district for disposal.

Mr. J. H. Osborne, 15, Charterhouse-street, London, E.C., has for disposal convenient freehold sites for factories, under 11 miles from City, and adjoining railway and navigable river.

"Simplex" Coronation Fittings.—A new price list of these fittings, specially designed for Coronation illumination devices, is being sent out by the Simplex Steel Conduit Co. (Ltd.), of Birmingham, London and Manchester. Several devices are illustrated.

Fuse Box Patents.—The Reason Manufacturing Co. (Ltd.), Brighton, call attention in an advertisement to the judgment recently given in their favour in regard to patent No. 5,863 of 1894. The proceedings in this action were fully reported in our last issue.

Time Switches.—The General Electric Co. describe and illustrate, in their circular No. 1,003, Wilson's patent automatic time switch, which has been designed "with a view to overcoming the many faults of the maximum demand system." It is claimed for the Wilson time switch that it is adaptable to any existing watt-hour meter and for any shunted meter, either for continuous or alternating current. Instructions for fixing are given.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 23 to April 29, with the ports of destination :—

Africa—Alexandria, £25; Cape Town, £435; Durban, £1,425; Port Elizabeth, £22; Suez, £18,966 (submarine cable). *Argentina*—Buenos Ayes, £333 (including £250 telegraph material). *Australasia*—Adelaide, £435; Auckland, £15,889; Brisbane, £147; Cooktown, £24; Launceston, £95; Perth, £4,805; Rockhampton, £280; Sydney, £973. *Ceylon*—Colombo, £50. *China*—Shanghai, £179. *Chili*—Valparaiso, £107. *Denmark*—Copenhagen, £51 (telegraph wire). *Germany*—Cologne, £1,750 (telegraph apparatus); Hamburg, £10. *Holland*—Amsterdam, £65. *Hong Kong*, £1,948. *India*—Calcutta, £314 (including £24 telegraph wire). *Japan*—Tokio, £48. *Norway*—Christiania, £27 (telegraph wire). *Siam*—Bangkok, £100. *Sweden*—Gothenburg, £321 (including £23 telegraph wire). Total, £48,824, against £15,002 in the corresponding week last year (April 24 to 30).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Small Dynamos and Motors: How to Make, Test and Repair Them." By F. E. Powell. (London: Dawbarn and Ward, Ltd.) 6d.

"Lord Kelvin, G.C.V.O." By John Monro. Bijou Biography. London: H. J. Drane.) 1s.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, of 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Where not otherwise stated, the application is made in London.

February 3, 1902.

2,682. H. FARRAR. Manchester. Shade holders for incandescent lamps.
2,689. W. SUTTON and S. LORD. Liverpool. Grinding in position commutators of dynamo-electric machinery.
2,694. F. G. BUCHER. Glasgow. Buttons for switches.
2,700. G. LAMBERT. Glasgow. Telephone exchange circuit.
2,701. G. LAMBERT. Glasgow. Telephone line jacks.
2,732. G. HOOKHAM. Coin freed meters.
2,736. G. HONOLD. Magneto-electric ignition apparatus.*

February 4, 1902.

2,763. E. H. LAWSON. Newcastle-on-Tyne. Adjusting appliance for tramcar trolleys.
2,774. R. F. HALL. Birmingham. Switches.*
2,820. P. GARNTI and R. POMPILI. Voltmeters.*
2,825. H. J. COGSWELL. Time electric switches.*
2,828. M. F. WHITON. Rail bonds.
2,840. E. STANLEY and BRITISH PRISM GLOBE ELECTRICAL CO. Street lamps for incandescent lamps.
2,847. S. BIBBY. Cables.
2,869. A. VANDAM and T. H. MARSH. Automatic fuse cutouts and cutins.

February 5, 1902.

2,950. C. G. WATSON. Electric distribution systems.
2,959. A. K. ANDRIANO. Telephone systems.*
2,934. A. H. ADAMS and J. T. MOULD. Starting and controlling electric motors.

February 6, 1902.

2,990. J. SWINBURNE and M. SOLOMON. Incandescent lamps.
2,999. C. J. WIGHTMAN and A. HUDSON. Bradford. Casings for electric wires.
3,024. B. CRUVELLIER. Leicester. Electric traction by surface contact system.*
3,059. L. LAVAGNE and L. BERTRAND. Liverpool. Current collectors.
3,061. A. E. CARTER. Brighton. Automatic shunt coil core for arc lamps.
3,063. F. CARTER. Brighton. Double-acting arc lamp brake for feeding at a uniform rate.

February 7, 1902.

3,116. A. D. SMITH. Bradford. Safety fuses.
3,134. J. GREENWOOD and J. HARTLEY. Trolley heads.
3,141. E. TWAITS. Norfolk. Repeating semaphore signals by electric bell in cab of engine during foggy weather or falling snow.
3,153. C. E. G. GILBERT. Chingford. Electromagnetic switch.
3,154. S. FRANK. Sockets for uniting two telegraph wires.*
3,157. H. T. HARRISON and IMPROVED ELECTRIC GLOW LAMP CO. Arc lamps.
3,163. R. GRISSON. Secondary circuits of alternating currents.
3,165. D. BERGMAN. Multipolar electrical machines.*
3,176. T. J. RORKE and E. RORKE. Telephony.

February 8, 1902.

3,224. L. CERBOTANI and M. BAUMER. Switch systems for telephone circuits.*
3,227. T. F. and T. S. WALKER. Electrical ship log.
3,248. P. JENSEN. Electric signal register and telephone systems. (The Yurgae Signalphone Mfg. Co., U.S.)*
3,256. C. M. JOHNSTON. Terminals of electric fittings.
3,259. E. SCHATTNER. Mercury vapour electricity lamps.
3,272 and 3,273. W. P. THOMPSON. Liverpool. Carbons for arc lamps. (C. Conradty, Germany.)

February 10, 1902.

3,279. J. PLACE & SONS and W. H. PLACE. Halifax. Conduits.
3,299. E. TOWNSEND. Birmingham. Electric light fittings.
3,336. R. HOPFELT. Resistances.
3,350. C. W. WROE. Harrow. Telephone clips.
3,374. J. Y. JOHNSON. Protective operating device for electric motors. (Electric Controller and Supply Co., U.S.)*

February 11, 1902.

3,390. J. E. PARKER. Shallow conduit for electrical tramways and railroads.
3,392. B. T. S. BAGNALL. Liverpool. Lamp suspender adjusting device.
3,411. BARRY, HENRY & Co. and R. B. DAVIDSON. Glasgow. Guards for electric tramcars.
3,416. J. JONES and J. JONES, jun. Switches.*
3,428. P. J. S. TIDDEMAN. Manchester. Electric lamps and lamp-holders.
3,490. SIEMENS BROS. & Co. Lightning dischargers. (Siemens and Halske A. G., Germany.)*
3,491. SIEMENS BROS. & Co. Brush-holder. (Siemens and Halske A. G., Germany.)*
3,497. G. EARL-ADAMS. Machinery for generating electricity.
3,533. C. M. CROOK. Electrically-wound clocks.*

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February 12, 1902.

3,553. M. Brooks. Lancashire. Combined telephone transmitter and receiver.
3,556. H. F. Clough. Birmingham. Electric fog signalling.
3,603. G. H. Russell. Kingston-on-Thames. Conducting current from overhead cables to trams.
3,608. Siemens Bros. & Co. Strands for telegraph and telephone cables. (Siemens and Halske A. G., Germany.)*
3,609. C. A. Vigreux and L. V. Brillié. Governors for regulating electricity supply.
3,610. F. B. Behr. Electrically-propelled vehicles for single rail elevated railways.*
3,622. W. Kuppers. Cleaning and polishing electrical collectors.*
3,624 and 3,625. C. E. Osborn and British Motor Traction Co. Sparking candles for explosive motors.
3,629. L. Wirtz. Arc lamps.
3,631. L. A. R. Wallace. Table stand and wall bracket for electric light.
3,647. J. C. Jackson. Open-slot electric traction systems.
3,652. P. R. Monro and J. M. Bowman. Current collectors.
3,657. J. F. Cummings. Insulated electrical conductors.*
3,658. A. Ford-Lloyd and C. Stirling. Fixing and carrying electric cables.

February 13, 1902.

3,686. W. H. Johnson and R. Marsh. Manchester. Electric ignition of miners' lamps.
3,704. A. E. Kearsley and T. Sparrow. St. Anne's-on-the-Sea. Shade carriers.
3,737. R. A. Hadfield. Electric and magnetic apparatus.
3,746. A. F. Spooner. Electric ignition devices. (J. Guenet, France.)
3,748. W. M. Mordey. Alternate-current distribution.
3,751. F. H. Loring. Arc-projecting lanterns.

February 14, 1902.

3,788. P. Graham. Manchester. Point shifting appliance for electric tramways.
3,798. J. C. Macalester. Glasgow. Lamp switch.
3,811. W. J. Mildon. Railway signalling.*
3,819. J. T. Niblett. Storage batteries.
3,858. R. H. Hammond and J. Taylor. Reflecting, increasing and intensifying light from electric lamps.
3,859. L. Sunderland. Switches, switch bases, and connecting circuits to be controlled with same.

February 15, 1902.

3,894. F. Brown. Birmingham. Glow lamps for occasional illumination.
3,907. A. M. Davis and M. G. Waggott. Supplying energy to electric tram cars.
3,912. P. L. T. Héroult. Electric furnaces.
3,913. J. H. Reeves. Coherers for wireless telegraphy.
3,921. A. Petzenburger. Elevated electric railways and trains.
3,932. H. F. Joel, sen. Dynamo-electric machines and motors.
3,938. C. Wrede and H. Jungbluth. Storage and distribution of electricity by accumulators.
3,942. H. Bean. Casings for electric conductors.
3,953. H. H. Lake. Telegraphic and telephonic apparatus (Aktieselskabet "Progress," Norway.)*

February 17, 1902.

3,967. G. H. Archer. Bradford. Electrically-connecting tram and like rails.
3,983. G. L. Hogan. Lightning and current arresters, equalisers, condensers and the like.
4,009. Pierre de Chimkevitch and Edouard Barazer. Electrical needle registering devices.
4,032. L. Andrews. Electrical distributing systems.

February 18, 1902.

4,043. C. Hamilton. Glasgow. Making electrical connections.
4,044. S. Blight. Blackpool. Street conduit trolley system.
4,054. H. Ramsbottom and J. M. Richardson. Terminals for secondary batteries.
4,076. C. Miles. Bristol. Time-checking apparatus.
4,091. J. A. Heany. Arc lamps.*
4,096. A. J. Boult. Dynamo-electric machines. (T. B. Hatch, U.S.)*
4,097. R. L. Wills and J. A. Ewing. Magnet cores.
4,104. B. Klein. Safety device for electric tramways.
4,107. G. L. Hogan. Transmission and utilisation of electrical impulses.
4,147. E. Plançon. Electrically illuminated signs.
4,161. H. McGillivray. Lighting of electric cars.
4,179. C. Bauer. Speed regulator for electro-motors. (H. L. Rochat, India.)
4,180. K. Edgcumbe, E. J. Everett and F. Punga. Electrical synchronism indicators.

February 19, 1902.

4,185. W. Wardle and J. W. Cutler. Manchester. Electric advertising devices.
4,188. W. Barry. Stockton-on-Tees. Trolley heads.
4,196. J. Hetherington & Sons and E. P. Hetherington. Manchester. Appliance for making holes for standards.
4,254 and 4,274. H. H. Lake. Batteries. (Société Anonyme "Le Carbone," France.)
4,271. H. H. Lake. Automatic electric brakes. (Invention Developing Co., U.S.)
4,273. P. Offenbroich and L. Mafell. Automatic electric fire alarms.*
4,285. Yost Miller Co. Sockets for incandescent lamps.*

February 20, 1902.

4,357. Siemens Bros. & Co. and W. Dieselhorst. Flexible conductors.*
4,368. R. Gaillard and E. Ducretet. Microphones for high tension currents.*
4,374. J. A. Rignon and E. Eisenmann. Arc lamps.*
4,377. J. C. Fell. Electrically printing typewriter. (Union Typewriter Co., U.S.)*

February 21, 1902.

4,397. F. R. Lane. Pewsey. Towing boats by electricity.
4,416. A. H. Mayes. Hove. Preventing sparking on trolley lines.
4,426. H. J. P. Kimpton. Manchester. Electric light fittings.
4,438. G. Roselieb and B. Dellagana & Co. Process and means for perforation of electro-deposited films.
4,445. E. A. Faller. Automatic telephone system. (Date applied for August 22, 1901, date of application in U.S.)*
4,463. H. Faraday. Electric switch.

February 22, 1902.

4,473. J. Swinburne. Electric railways.
4,492. A. W. Elwood and A. H. Porter. Electrical signalling.
4,496. W. Hayden. Chichester. Electro-magnetic gravity pin.
4,520. V. G. Apple. Batteries.*
4,521. V. G. Apple. Storage batteries.*
4,522. V. G. Apple. Electric ignition apparatus.*

February 24, 1902.

4,596. E. B. Wedmore. Rugby. Automatic switches for motor starting rheostats.
4,623. Siemens Bros. & Co. Cutting out large quantities of electrical energy, particularly when of high voltage. (Siemens & Halske, A.-G., Germany.)*
4,624. Siemens Bros. & Co. Cutting out contact devices. (Siemens & Halske, A.-G., Germany.)*
4,631. C. D. Abel. Mantles for carbons of arc lamps. (Siemens Bros. & Co., Germany.)
4,640. D. R. Broadbent. Enclosed or open arc lamps.
4,645. G. G. M. Hardingham. Rail bonds. (Felten & Guilleaume, Carlswerk A.-G., Germany.)
4,648. F. A. Pocklington. Liverpool. Cutouts or fuse boxes, feeder pillars, and other devices for interconnection of a number of conductors.
4,664. E. J. Williams and A. N. Rye. Electroliers.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.).

The thirty-fifth ordinary general meeting was held on Wednesday, under the presidency of Mr. J. Herbert Tritton.

The SECRETARY (Mr. L. Pagenkopf) read the notice calling the meeting, and

The CHAIRMAN, in moving the adoption of the report and accounts, said: At our last meeting I expressed a strong wish on behalf of the Company that the reduction of the telegraphic rate to India could be brought about. Unfortunately, there were obstacles in the way at that time, and it appeared to be almost impossible to overcome them. In several quarters this Company was held to be the stumbling-block, but this was by no means the case. The International Telegraph Convention provides that every interested administration shall give its consent before an alteration in the rates can be made. This Company expressed, without the slightest reserve, its cordial concurrence in the plan of the reduction when first mooted, and endeavoured by persistent negotiations to procure the assent of all parties, but this was not obtained until this year, when, of course, the reduction was brought into force forthwith. It is unnecessary to impress upon you the considerable decrease that may be expected in the revenue, seeing that the rate has been reduced from 4s. to 2s. 6d. per word, making a reduction of 1s. 6d. per word. The Indian Government has, however, agreed to share in the reduction to the extent of one-third of the loss that will have to be sustained. Several reductions, of minor importance, have been introduced over the Company's system, and the rate for messages exchanged between this country and Australia has been further reduced to 3s. per word, the standard for this traffic having been maintained for three years. The policy of the Company is to give reductions in telegraphic rates where possible, to facilitate commercial enterprise, so long as the revenue of the Company is not reduced to too narrow a margin. I informed the shareholders at the last general meeting that experiments for direct working were being made with the Wheatstone apparatus between Emden, in Germany, and Teheran, the terminal station of the Company's route in Persia, and I am glad to say that the result of these experiments at the time was highly satisfactory, and consequently the system has now been finally introduced, and has been working for some months. The result has exceeded our expectations, inasmuch as the delay between London and Teheran has been reduced by at least a third, and this in the face of increased traffic brought about by the reductions in the rate to Australia and India. We now hope to introduce the Wheatstone apparatus between London and Emden, or, better still, London and Berlin, thus having the one system from end to end of the line, and by this means we anticipate a further reduction in the time of transit over the Company's system, and a consequent greater carrying capacity of the wires. The Marconi system of wireless telegraphy has, according to what we read in the public press, rival systems to contend with, while presumably it is not itself fully matured. The future may have in store surprises for wireless systems, should they be multiplied; but the speed, secrecy and certainty of land wires and ocean cables do not appear to be threatened. The Inter-Departmental Committee on Cable Communications issued an interim report in August last, and have, within the past few days, issued their final report. The con-

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clusions therein arrived at are generally favourable to the telegraph companies, and recognise the value of the services they have rendered to the empire and commerce. They do not recommend further reductions of tariffs, though they are in favour, under certain circumstances, of a system of deferred rates. Turning to the financial position of the Company, the gross receipts show a slight increase over last year, which is to be accounted for to a great extent by the satisfactory increase in the traffic with South Russia. The debit for maintenance is, for the year ended Dec. 31 last, only £23,185, instead of £38,827 in the last year, and somewhat similar amounts in previous years, the reason being that there has been no need to make any appropriation for writing down the value of the lines of the Company by the amount which, as I have repeatedly explained, has been included under the head "Maintenance and Charges." You will see that the word "charges" is omitted this year. The amount carried out of revenue account into profit and loss is, consequently, £89,181. 12s. 8d., as against last year £73,284. 5s. 5d. You have, no doubt, noticed in the profit and loss account that an amount of £33,992. 13s. 11d. has been paid to our partners in the joint purse, on account of an alteration in the outpayment made to the German Government by this Company, and an explanation of this outpayment is necessary. We must go back to the year 1877-78, when this Company formed a joint purse with the Eastern Company and the Indo-European Telegraph Department; the outpayment to Germany was notified to our partners as being 2.50fr. for every 20 words. However, the German Government did not favour this form of payment, because if, after the establishment of the joint purse, the bulk of the traffic passed over the Eastern Company's cables, the amount under this 20-word payment that would be paid to her would be considerably reduced, and it was therefore arranged that Germany should receive a percentage of the receipts of the Company from the joint purse, and our accountant at that time worked out this percentage so that the amount paid to the German Government should be the same as she would have received under the word payment. The German Government, in accepting this arrangement, reserved to itself the right to revert back to the original word payment. Under these circumstances the accountant seems to have been under the impression that this was a private arrangement, and did not concern our partners, more particularly as at first it was adverse to the Company, and he did not make out the joint purse accounts in the corresponding form. Eventually, as the traffic increased, our actual "paid outs" became less than that accounted for in the joint purse accounts. Nobody seems to have discovered the discrepancy until the year 1901, when the matter was brought to our attention by our partners, and the Board, after giving the matter their full consideration, decided that the only course to pursue was to pay into the joint purse the balance that had thus accumulated. Seeing that the Company have had a prosperous year, we thought it better to wipe out this sum at once instead of spreading it over two or three years. We have, therefore, charged this amount of £33,992. 13s. 11d. to profit and loss account, and the amount that remains over is naturally considerably diminished. The usual dividend and bonus absorb £31,875, and the Directors propose to add £5,000 to the reserve, and carry forward £14,897. 16s. 1d. to next year. Now, gentlemen, you are no doubt anxious to hear whether I have any news to impart with reference to the renewal of the German concession, and I am happy to say that the managing director has just returned from Berlin, having concluded terms with the Imperial German Telegraph Department for the prolongation of the concession for 20 years from 1904; the document, now signed, only awaits the approval of the Imperial German Chancellor, and this we expect to receive during the course of a week or so. Shareholders are aware that the Russian and Persian concessions have been similarly renewed.

Sir WILLIAM BROOKE, K.C.I.E. seconded the adoption of the report and accounts, which was carried unanimously.

The retiring Directors, Sir W. R. Brooke and Dr. H. Meier, were re-elected, as were the auditors, and a vote of thanks to the Chairman, Directors and staff terminated the proceedings.

Oriental Telephone and Electric Co. (Ltd.).

The eighth ordinary general meeting was held on Wednesday, Sir AUCKLAND COLVIN, K.C.S.I., presiding.

The SECRETARY (Mr. Alexander B. Chalmers) read the notice calling the meeting, and also the report of the auditors.

The CHAIRMAN said the net profits show a very considerable increase over those of the preceding year, due to a great extent to the progress made in the electrical branch. This branch of our business is now well established, and we look forward with confidence to a further steady development. With regard to the Company's telephone exchanges, they also have contributed their usual share to the prosperity of your undertaking, the difficulty being the finding of sufficient space on the existing constructions to accommodate the ever-increasing number of subscribers. This difficulty has been complicated in many places by the introduction of electric lighting and of electric tramways, whose current has adversely affected the efficient working of our telephones. The prospect of further introductions of both electric lighting and electric tramways, in places which have been, so far, without either, compelled us to initiate steps to effectively meet the whole question. We, therefore, in the autumn of 1900, commissioned our colleague, Mr. Grëwing, jun., to proceed to the East, to personally inquire into the actual condition of your different exchanges and to suggest a reliable and permanent remedy. This remedy, it appears, can only be found in duplicating our wires, and in consolidating them into cables either overhead or underground, wherever practicable. In deliberating on this question, two further very serious questions presented themselves—viz., the cost of the suggested improvements, and the life of our present licences in India, the latter of the two being the most important. We therefore requested Mr. Grëwing, being in India, to proceed to Simla to open negotiations with the Government for the extension of the term of our present licenses. These negotiations led to a definite settlement with the Government of India, who examined our proposals in a fair and equitable spirit, and has now definitely approved them, with such modifications as were considered necessary by it, and accepted by your board. We have been materially aided in this matter by Sir Allan Arthur a director of the Bengal Telephone Co., to whom our best thanks are due. Mr. Grëwing, jun., himself, had proceeded to Egypt before the final conclusion of the negotiations in connection with the reconstructions in Cairo and Alexandria, which then commenced and are mentioned in the report, but before leaving India he had laid the foundation of the subsequent settlement. I now move the adoption of the report and accounts.

A discussion followed on the question of the proposed dividend, and as to the issue of fresh capital. The Chairman having replied, the report was adopted.

A resolution was then approved amending the articles of association and the proceedings terminated.

Eastern Extension, Australasia and China Telegraph Co. (Ltd.).

The following report of the directors for the half-year to Dec. 31 will be submitted to the fifty-seventh half-yearly meeting, to be held at River Plate House, Finsbury-circus, London, E.C., on May 7, at 2:30 p.m.:—

The gross receipts have amounted to £324,209. 7s. 6d., against £360,889. 3s. 2d. for the corresponding half-year of 1900. The working expenses, including £29,447. 4s. 4d. for maintenance of cables, absorbed £120,294. 0s. 7d., against £104,640. 3s. 1d., leaving £203,915. 6s. 11d. From this is deducted £7,714. 18s. 7d. for income tax, £6,400 for debenture interest, and £262. 16s. 1d. for donations to the London School of Tropical Medicine and Yangtse Flood Relief Fund, leaving as net profit for the half-year £189,537. 12s. 3d. Adding £15,023. 4s. 11d. brought forward, there is available £204,560. 17s. 2d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is proposed to distribute another of like amount on May 8, making, with the interims for the first half-year, a total of 5 per cent. It is also proposed to pay a bonus of 4s. per share (2 per cent.), making a total distribution of 7 per cent. for the year 1901. The balance, £69,560. 17s. 2d., has been transferred to reserve.

The "standard revenue" fixed by the Cape-Australian cable agreement for regulating the Australasian tariffs having been maintained during the past year, further reductions of rates were brought into force on Jan. 1 for telegrams exchanged with South Australia, Western Australia, Tasmania and New South Wales. (These have been previously announced.) Reduction in the tariffs for telegrams exchanged with the Straits Settlements and Netherlands India have also been made, and took effect on April 1.

The last section—between Perth and Adelaide—of the Cape-Australian cable having been successfully laid, the whole line was opened for traffic on March 1. The company's expenditure on account of this cable up to Dec. 31 was £1,102,442. 19s. 1d., of which £500,000 has been charged against capital, and the remainder taken from reserve.

Cuba Submarine Telegraph Co. (Ltd.).

The directors' report for the half-year to Dec. 31 states that the total receipts of the six months were £11,363. 9s. 7d., expenses £5,334. 5s. 4d., leaving £6,029. 4s. 3d., to which is added £4,761. 2s. 1d. brought forward, giving £10,790. 6s. 4d. to be dealt with. The traffic receipts show an increase of £366. 4s. 10d. compared with the corresponding period of 1900. Preference dividend absorbs £3,000, leaving £7,790. 6s. 4d. The directors recommend an ordinary dividend at the rate of 4 per cent. per annum, tax free, the balance, £4,590. 6s. 4d., to be carried forward.

The broken Cape Cruz-Santiago section of the Manzanillo-Santiago cable was repaired on March 31 by the s.s. "Newington," under the superintendence of Mr. George Keith, and the whole of the cables are now in good working order. The company's claim against the United States Government for re-imbursement of the cost of repairing the cables cut during the Spanish-American war has not yet been settled, but a bill is now pending in the House of Representatives, and it is hoped will be satisfactorily dealt with during the current session.

With regard to the claim for payment of the subsidy of £2,000 per annum in respect of the coast cables, now in arrear since January, 1899, no reply has been received from the United States Government, but in view of the change in the Government of Cuba, which has been fixed for May 20, the directors will press upon the local authorities there the company's claim for payment of the subsidy in accordance with its concession.

BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)—At the meeting on Tuesday the chairman (Sir John A. Willox, M.P.) reported steady progress of business. When the company commenced operations in February, 1900, the number of consumers was 132, and the lamps connected were equal to 5,957 8 c.p. At the end of 1900 they had 342 consumers and 14,473 lamps, and last year both consumers and lamps had more than doubled, the figures being 746 and 29,449. Since Jan. 1 104 additional applications had been received, representing 4,100 lamps. Negotiations were being conducted in regard to some large installations, and their prospects were good. The financial results also exhibited an improvement. In the first year there was a small credit balance of £73, while the revenue account now showed a credit balance of £2,150. During the first quarter of the present year the receipts from current were £3,680, compared with £1,880 in the same period last year. There was a gratifying increase in the supply of energy for power. A slight change had taken

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place in the area of supply, consequent on an arrangement for the sale of the Eltham area to Woolwich Corporation, who had paid them for their expenditure on mains, &c., and had given them £3,500 as compensation for disturbance. The trading profit and the sum obtained from the Corporation had enabled them to pay the whole debenture interest and to leave a credit balance of £1,700. The directors had deemed it judicious not to appropriate this sum, but to keep it in hand.

BRITISH COLUMBIA ELECTRIC RAILWAY CO.—An extraordinary meeting was held last week. The chairman (Mr. R. M. Horne-Payne) said the meeting had been convened for approving the recommendations for carrying on the business contained in his report of last February. The most important of the recommendations was that which dealt with the installation of the water power at Coquitlam Lake for generating electricity for the Vancouver and New Westminster divisions. The board had selected two electrical engineers to make reports on the proposals. Both reports endorsed the views of the company's engineers and consulting engineers, and also coincided in all but one or two minor details in the plan which was proposed for supplying the water power to the company's plant. In regard to cost, in consequence of fresh information now obtainable, he was constrained to add to the future additional net earnings to be obtained by the company for the water-power plant. His estimate was £20,000, but he could not now work the profit out at less than £25,000 per annum. If they earned that sum he knew no reason why it should not be distributed, and if distributed it meant dividends of 12 per cent. per annum on the ordinary and 10 per cent. on the existing preference shares. The moment the resolutions became effective, the board would invite the shareholders to subscribe for £40,000 new 5 per cent. cumulative perpetual preference stock, and as soon as the money was received the directors would pay the ordinary dividend as usual. They also proposed to offer £20,000 of the new stock to the debenture-holders, making the total issue £60,000. The necessary resolutions were carried unanimously.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.)—The report for 1901 states that the loan from bankers was reduced from £5,000 to £3,000 (now £2,500), and the profit and loss account shows a reduction in the directors' fees and office salaries and rent, printing, &c. Patent charges were higher. With regard to the Metall Company, owing to the drop in the price of copper at the end of last year, a heavy loss was incurred, whereby all the profit made was swept away and a loss made. A considerable saving had been effected in the cost of production, and, notwithstanding the great depression in trade in Germany, the company not only maintained its sales, but actually showed an increase. The whole of the company's stock of copper had been written down to the low price which existed on Dec. 31, since when the price of the metal has considerably increased. There had been increases in all the charges to profit and loss, none of which could be avoided. The German Government had again given the company practically the sole contract for the next three years.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The directors' report for the year to Dec. 31 announces that the gross receipts amounted to £32,106. 11s. 2d., against £30,888. 1s. 6d. in 1900—an increase of £1,218. 9s. 8d.; working expenses were £23,022. 4s. 10d., against £23,046. 8s. 4d.—a decrease of £24. 3s. 6d. After providing £6,000 for debenture interest and £800 for interest on income bonds, there remains £2,284. 6s. 4d., to which is added £588. 3s. 10d. brought forward, making £2,872. 10s. 2d. Of this, £1,500 has been placed to general reserve and £1,000 to maintenance ships' reserve, leaving £372. 10s. 2d. to be carried forward.

NEW COMPANIES, STATUTORY RETURNS, &c

BEYER, PEACOCK & CO. (LTD.)—Reg. April 25, capital £500,000 in £1 shares (300,000 5½ per cent. cumulative preference), to acquire the business of Beyer, Peacock & Co. (Ltd.), and to carry on the business of manufacturers, builders, hirers of and dealers in and with locomotives and engines propelled by steam, electricity, or other motive power, manufacturers of machinery, metal workers, electrical engineers, builders of rolling stock, railway carriages and waggons, motor cars, &c. In addition to the share capital, £300,000 4½ per cent. redeemable debenture stock has been offered for subscription. The first directors are Sir F. Lacy Robinson, K.C.B., Sir Vincent Caillard, T. Craven, D.L., and Col. Ralph Peacock. Reg. office: 34, Victoria-street, S.W.

BRITISH SUBMARINE BOAT CO. (LTD)—Reg. April 18, capital £20,000 in £1 shares, to carry on the business of builders, charterers, hirers and owners of electric and other marine or submarine ships and vessels, mechanical and electric engineers, &c. The subscribers are:—Admiral Sir E. R. Fremantle, G.C.B., C.M.G.; W. F. Leese; Lieut. C. W. Bellairs, W. A. Casson, J. S. Allen, Capt. H. Garbett and Major-Gen. A. E. Turner.

COOPER PATENT "ANCHOR" RAIL JOINT CO. (LTD.)—Reg. April 14, capital £6,007 in £1 shares, to carry on the business of makers of rails and rail joints for railways and tramways and materials for securing rails and rail joints and parts thereof to under-beds of railways and tramways, &c., mechanical and electrical engineers, &c., and to acquire the business carried on by Mr. L. Cooper and others at Leeds. The first directors are L. Cooper, L. Cooper, jun., and G. H. Archer. Reg. office: Central Bank-chambers, Leeds.

ELECTRO VOELKER SYNDICATE (LTD.)—Reg. April 25, capital £5,000 in £1 shares, to carry on the business of electrical engineers, &c.

GENERAL MOTOR CAR CO. (LTD.)—Reg. April 23, capital £1,000 in £1 shares, to carry on business of manufacturers of and dealers in automobiles, &c., electricians, manufacturers of electrical apparatus, electrical and mechanical engineers, &c.

LONDON ELECTRICAL SYNDICATE (LTD.)—Reg. April 24, capital £2,000 in £1 shares, to acquire any inventions relating to improvements in galvanic and other cells, and in particular to acquire from G. B. Pushmüller the benefit of certain inventions, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, &c. First directors: G. Pearson and G. B. Pushmüller.

MEDWAY STEEL CO. (LTD.)—Reg. April 14, capital £25,000 in £10 shares, to carry on the business of engineers, omnibus and motor car manufacturers, electricians, manufacturers of railway and other plant, steel and iron founders and merchants, &c. The first directors are Albert and Douglas Vickers (nominated by Vickers, Sons and Maxim) and T. L. Aveling and R. T. Porter (nominated by Aveling and Porter).

METROPOLITAN AMALGAMATED RAILWAY CARRIAGE AND WAGON CO. (LTD.)—Reg. April 18, capital £1,500,000 in £1 shares (400,000 "A" preference and 100,000 "B" preference), to acquire the businesses of the Ashbury Railway Carriage and Iron Co., Brown, Marshalls & Co., Lancashire Railway Carriage and Wagon Co., Metropolitan Railway Carriage and Wagon Co. and the Oldbury Railway Carriage and Wagon Co., to carry on the business of manufacturers of and dealers in engines, carriages, wagons and rolling stock for railway, tramway, road or other traffic, makers of wheels, axles, motors and machinery, manufacturers of and dealers in rails, girders, &c., mechanical, electrical and general engineers, carriers, &c. The first directors are W. Charlton, G. D. Churchward, L. C. Docker, C. W. Hazlehurst, W. L. Hodgkinson, J. Kershaw, J. P. Lacey, W. L. Matthews, Sir G. S. Robinson, W. O. Roper, J. T. Sanderson, A. L. Shackleford, W. C. Shackleford, H. Wheeler and P. Wheeler.

PROVINCIAL ELECTRIC CONSTRUCTION CO. (LTD.)—Reg. April 15, capital £3,000 in £1 shares, to acquire the business of an electrician and contractor carried on by G. F. Rimmer, and to carry on the business of generators and suppliers of electricity for lighting, heat and power, constructors of cables, wires, accumulators, lamps and works, electricians, electrical and mechanical engineers, manufacturers of rolling stock, &c. Mr. G. F. Rimmer is sole managing director.

RECEIVER SYNDICATE (LTD.)—Reg. April 28, capital £2,000 in £1 shares, to acquire and turn to account patents, concessions and rights relating to wireless telegraphy and telephony and apparatus connected therewith, &c.

ROSARIO ELECTRIC CO. (LTD.)—Reg. April 24, capital £120,000 in £5 shares (12,000 preference), to carry on in the Argentine Republic or elsewhere in South America the business of generators, storers and distributors of and dealers in electricity, electric lighting, railway and tramway contractors, engineers, electricians, &c.

ROTARY METER SYNDICATE (LTD.)—Reg. April 26, capital £5,000 in £1 shares, to acquire and develop patents and to manufacture and deal in and with electricity, gas and water meters, &c.

GEORGE RUSSELL & CO. (LTD.)—Reg. in Edinburgh April 22, capital £40,000 in £10 shares, to acquire the business carried on by George Russell & Co. at Motherwell, and to carry on the business of engineers and crane builders, manufacturers of electric, hydraulic and general machinery, &c. The first directors are G. Russell and J. Russell. Reg. office: Alpha Works, Motherwell.

EASTERN TELEGRAPH CO. (LTD.)—The return to Feb. 12 gives the capital as £6,000,000 in £4,000,000 ordinary stock and £2,000,000 preference stock, £5,955,565 of which has been taken up and paid for in full. Mortgages and charges, £1,534,645.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The return to March 19 has been filed, and gives the capital as £350,000 in 50,000 ordinary, 10,000 first preference and 10,000 second preference shares of £5 each, of which 21,000 ordinary, 10,000 first preference and 10,000 second preference have been taken up. £5 has been called up on each of 15,968 ordinary, 10,000 first preference and 10,000 second preference shares, and £179,840 has been received. £25,160 is considered as paid on 5,032 ordinary shares. Debt in respect of mortgages and charges, £90,000; ditto in respect of debenture stock issued in conjunction with the Notting Hill Electric Lighting Co., £115,000.

LONDON ELECTRIC WIRE CO. (LTD.)—The return to Feb. 18 gives the capital as £100,000 in 10,000 preference and 10,000 ordinary shares of £5 each, of which 7,512 preference and 8,295 ordinary have been taken up. £5 per share has been called up and paid on 3,652 preference and 4,435 ordinary shares. £38,600 is considered paid on 3,860 preference and 3,860 ordinary shares. No mortgages or charges.

MAZARRON ELECTRIC LIGHT CO. (LTD.)—In the return to Jan. 12 the capital is given as £15,000 in 500 preference shares of £10 each and 10,000 ordinary shares of £1 each, of which 151 preference and 10,000 ordinary have been taken up. £10 per share has been called up and paid on 151 preference and £1 per share on seven ordinary shares; 9,993 ordinary shares considered as fully paid. Mortgages and charges, £820.

MORLEY ELECTRICAL ENGINEERING CO. (LTD.)—According to return to Feb. 26 the capital is £5,000 in £1 shares, of which 1,524 have been taken up. £1 has been called up and paid on each of 504; 1,020 shares are considered fully paid. Mortgages and charges, £1,000.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (LTD.)—The return to March 11 gives the capital as £200,000 in 20,000 shares of £10 each, all of which have been taken up. £9 per share has been called up on 10,000 and £2 per share on 10,000 shares. Mortgages and charges, £50,000.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)—The return to Feb. 15 gives the capital as £50,000 in 10 "A" and 49,990 "B" shares of £1 each, of which 10 "A" and 40,322 "B" have been taken up. £40,332 has been received. Mortgages and charges, £34,600. [5,000 shares have been allotted subsequent to date of above return.]

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NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—In the return to March 18 the capital is £200,000 in 16,452 ordinary, 2,998 ordinary preference and 550 founders' shares of £10 each, of which 10,852 ordinary, 2,998 ordinary preference and 550 founders' shares have been taken up. £144,000 has been received. Mortgages and charges, £50,000; ditto issued jointly by company and Kensington and Knightsbridge Electric Lighting Co., £115,000.

PONTYPOOL ELECTRIC LIGHT AND POWER CO. (LTD.)—According to return to March 27 the capital is £10,000 in 2,000 shares of £5 each, 1,143 of which have been taken up. £5 per share has been called up and paid on 669, and £4 per share on 474 shares. Mortgages and charges, £5,000.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—The return to Feb. 25 gives the capital as £300,000 in 20,000 preference and 40,000 ordinary shares of £5 each, all of which have been taken up. £5 per share has been called up on 20 000 preference and 39,650 ordinary shares, and £298,250 has been received. £1,750 is considered as paid on 350 ordinary shares. Mortgages and charges, £150,000 3½ per cent. debenture stock.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—In the return to Feb. 14 the capital is given as £100,000 in 10,000 shares of £10 each, 6,000 of which have been taken up. £9 per share has been called up and paid on 5,000, and £6 per share on 1,000 shares. No mortgages or charges.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—In the return to Feb. 28 the capital is £100,000 in 20,000 shares of £5 each, 12,000 of which have been taken up. £5 has been called up and paid on each. Mortgages and charges, £58,000.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 23 7/16d. per oz. (May 1). Consols (2¾ per cent.) 94 1/16—94 1/16 for money, 94 1/16—95 1/16 for account; 2½ per cent. 94¼—95¼ (April 30). Consols Pay Days, May 2 and June 2; Stocks and Shares Continuation Days, May 13 and 27; Ticket Days, May 13 and 27; Pay Days, May 14 and 28; Mining Share Carry-over Days, May 9 and 23.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)—The directors' report from Nov. 20, 1900, to Dec. 31 last states that the net amount in dividends received on the shares held by the company was £42,430 for 1901, and after adding the amount attributable to revenue for the period from Nov. 20 to Dec. 31, 1900 (£2,821), and sundry receipts (£650), there was a balance to credit of revenue account of £45,912. After deducting general charges in London and expenditure in Brisbane there remained a net balance of £42,815. Debenture interest absorbed £15,916, and the interim preference dividend absorbed £10,000. The directors recommended that the balance of £16,898 be appropriated to the payment of a balance preference dividend of 2s. 6d., making the full 5 per cent., carrying forward £7,523. The extensions which the company undertook to construct on behalf of the Tramways Company were now either open to traffic or approaching completion, and the power station had recently been equipped with additional generating plant, enabling the company to deal with a considerably increased traffic.

BRITISH INSULATED WIRE CO. (LTD.)—This company is making an issue at par of an additional 10,000 6 per cent. cumulative preference shares of £5 each to shareholders. This brings the total issued capital up to £1,000,000.

CIE FRANCAISE POUR L'EXPLOITATION DES PROCEDES THOMSON-HOUSTON.—A dividend of 25f. per share has been declared for the past year, compared with 55f. for 1901. The profits in 1901 exceeded those of the previous year, but, owing to the tramway crisis, it has been found necessary to write down the value of the company's securities in consequence of market depreciation. The net surplus amounts to £90,151, whilst the special reserve of £1,000,000 remains intact, and the statutory reserve is increased to £41,000.

ELECTROLYTIC ALKALI CO. (LTD.)—The first batch of letters of allotment in the recent further issue of capital has been posted.

LEAMINGTON AND WARWICK ELECTRICAL CO. (LTD.)—At the meeting last week the chairman (Mr. Emile Garcke) explained that the majority of the shares were held by the British Electric Traction Co., and under an agreement they would provide the capital for the conversion of the line to electric traction. A dividend of 6 per cent. on the ordinary shares was declared. (This company was formerly known as the Leamington and Warwick Tramways and Omnibus Co.)

MUNICIPAL ISSUES.—The Torquay Corporation are inviting applications for £107,792 3 per cent. redeemable stock at 92 to provide funds for electric lighting and other purposes.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—An abridged prospectus will be found set out on another page of the South Wales Electrical Power Distribution Co., which is incorporated by Act of Parliament for supplying electric energy in the county of Glamorgan and part of the county of Monmouth, having an area of 1,034 sq. miles and a population of over 1,000,000. The share capital of the company is £750,000, in £10 shares, and power to issue £250,000 debenture stock. 42,750 shares are now offered for subscription at par, payable 10s. on application, £1. 10s. on allotment and the balance in calls not exceeding £2 per share at not less than three-monthly intervals. The company's area of supply contains no less than 240 collieries and factories at the present time, and this number is being constantly added to. Electric tramways are being constructed or promoted in various parts of the company's district, and the substitution of electric for steam-driven plant in the numerous works with which the district is covered justifies the directors in anticipating the complete success of the company's operations. It is estimated that the steam power at present installed exceeds 500,000 I.H.P., and the company has, consequently, a vast field of work. The full prospectus, an instructive map showing the company's area of supply, and forms of application can be obtained at the offices, Royal Chambers, Queen-street, Cardiff, at any of the branches of the London, City and Midland Bank, or of the brokers and solicitors to the company. The list of applications opens on Tuesday, May 6, and will close not later than 4 o'clock on Thursday, May 8, for London, and Friday, May 9, for country applications.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to £500,000 4 per cent. mortgage debenture stock of the *British Westinghouse Electric and Manufacturing Co. (Ltd.)*, and the £10 fully-paid ordinary and 6 per cent. cumulative preference shares of the *Electrical Power Distribution Co. (Ltd.)*, and also to allow the further issue of £102,377 4 per cent. mortgage debenture stock of the *Eastern Telegraph Co. (Ltd.)* to be quoted. The committee has ordered £400,000 4½ per cent. redeemable first debenture stock of the *Brisbane Electric Tramways Investment Co. (Ltd.)* to be quoted in lieu of the provisional certificates.

SUBMARINE CABLES TRUST.—The report of the trustees for the year to April 15 states that the revenue amounted to £24,615. 0s. 4d., and the expenses to £1,250. 12s. 4d., leaving £23,364. 1s., to which is added £44. 9s. 5d. from last account, making £23,408. 10s. 5d. After providing £19,725 to meet payment of coupons, £3,611. 19s. has been transferred to redemption fund, leaving £71. 11s. 5d. to be carried forward. Thirty-one certificates have been redeemed since the last report, by purchase in the open market.

TELEGRAPH MANUFACTURING CO. (LTD.)—The transfer books of the ordinary and preference shares are closed from April 30 to May 10 inclusive.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—The directors recommend a dividend of 6s. per share on account of arrears of dividend on the first preference shares of the company.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Apl. 19	646	+ 11	46	32,596	+ 2,042
Ayr Corporation	„ 26	179	...	31	4,341	...
*Birmingham Tramways.	„ 26	4,868	+ 395	16	73,681	+ 27,533
*Blackburn Corporation..	„ 25	710	- 17	17	10,647	+ 1,337
Blackpool Corporation...	„ 24	481	+ 101	4	1,697	- 216
Blackpool and Fleetwood	„ 26	288	- 59	17	3,889	+ 299
Bolton Corporation	„ 27	1,536	+ 122	4	5,724	- 387
Bradford Corporation ...	...	...	...	...	...	...
Brighton Corporation ...	„ 27	753	...	22	12,433	...
Brisbane Tramways.....	Mar. 12	2,393	+ 598	11	25,338	+ 2,492
*Bristol Trams & Carriage	Apl. 25	4,241	- 407	16	65,679	+ 4,720
Burnley Corporation ...	„ 26	668	+ 207	‡4	2,579	+ 733
*Buenos Ayres & Belgrano	Mar. 30	2,599	- 270	13	34,982	- 728
Calcutta Tramways Co...	Apl. 26	R22,237	+R3,749	17	R376,456	+R32,649
Carlisle Tramways Co....	„ 26	169	- 21	†17	2,212	+ 58
Central London Railway	„ 26	6,357	+ 245	17	112,809	+ 8,213
City & South London Ry.	„ 27	2,993	+ 1,145	17	50,537	+ 16,563
Cork Elec. Tramways Co.	„ 24	445	- 66	§16	6,133	+ 142
Devonport & Dist. Trams	„ 18	409	...	15½	5,939	...
Dover Corporation	„ 26	198	+ 4	4	739	+ 133
Dublin & Lucan Railway	„ 27	102	+ 4	17	1,541	+ 147
Dublin Southern Dist....	„ 25	802	- 54	¶16	12,034	+ 3,447
Dublin United	„ 25	3,724	+ 110	¶16	55,896	
Dudley—Stourbridge ...	„ 18	693	+ 148	15½	10,054	+ 1,967
*Dundee Corporation ...	„ 23	703	+ 94	...	...	...
East Ham Council	„ 26	428	...	44	16,624	...
Gateshead & Dist. Trams	„ 18	667	...	15½	9,791	...
*Glasgow Corporation ...	„ 26	11,941	+1,829	20	215,740	+ 80,237
Greenock & Port Glasgow	„ 18	551	+ 341	15½	6,068	+ 3,399
Hartlepool Tramways ..	„ 18	235	+ 56	15½	2,947	+ 204
Hull Corporation	„ 26	1,642	+ 70	4	6,597	+ 37
Isle of Thanet Co.	„ 26	495	+ 103	...	...	...
Kidderminster & Dist....	„ 18	110	+ 18	15½	1,517	+ 154
*Liverpool Corporation...	„ 19	9,438	+ 871	16	142,244	+ 14,190
Liverpool Overhead Rly.	„ 27	1,398	- 193	‡17	23,839	- 2,080
Manchester Corporation	„ 26	2,654	...	§46	94.327	...
Merthyr.....	„ 18	150	- 109	15½	2,963	- 294
Middleton	„ 18	277	...	3½	1,046	...
Newcastle-on-Tyne Corp	„ 26	2,456	...	...	...	...
Oldham, Ashton & Hyde.	„ 18	485	+ 47	15½	7,216	+ 29
Perth (W.A.) Elec. Trams	„ 25	1,054	+ 162	‡43	41,852	+ 13,854
Poole & Dist.....	„ 18	255	+ 59	15½	3,114	+ 28
Portsmouth Corporation	„ 26	1,312	+ 694	...	...	...
Potteries	„ 18	1,446	+ 160	15½	21,121	+ 829
*Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ..	„ 27	3,896	+ 380	17	62,452	+ 13,077
Southampton Corporat'n	„ 24	836	+ 84	16	12,888	+ 2,590
Southport Tramways ...	„ 18	226	+ 91	15½	2,403	+ 625
*S. Staffordshire Trams...	„ 18	736	+ 62	15½	11,220	+ 602
Swansea Trams.....	„ 18	409	+ 49	15½	6,348	+ 615
Taunton Trams.....	„ 18	55	...	15½	845	...
Tynemouth & Dist.	„ 18	205	+ 41	15½	3,041	+ 159
Wolverhampton District	„ 18	142	+ 97	15½	2,040	+ 1,313

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 23.	Price Wednesday, Apr. 30.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 30	
						£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.						
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½ ¼	½ ¼		...	⅜	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100 104	103 101	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11 12	11 12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103 106	103 106	4 4 8	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9 9⅛	9 9⅛	6 5 2	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9⅛	9 9⅛	4 4 8	...	...	...
30,000	5	2/6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8⅛ 9⅛	8½ 9⅛	3 13 8	March and September	...	...
10,000	5	...	Do (Nos. 20,001-30,000)	8 9	8 9	2 7 4	...	...	...
£250,000	Stock	...	Central Electric Supply Co. 4% Guar. Deb. Stock	106 108	106 108		...	...	...
50,000	5	6 0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9 10	9 10	3 14 9	...	...	...
			Do. (50,001 to 70,000)	..	8 9	5 0 0	February and August	9⅛	...
70,000	5	...	Do. 4½ per Cent. Preference		...	...	..	...	...
70,000	5	2/8	Do. 4½ per Cent. Preference	5¼ 5⅜	5¼ 5⅜	3 18 3	,, ,,	5⅜	...
£200,000	Stock	4/0	Do. 4% Deb. Stock Red.	105 107	105 107	3 15 6	...	106¼	106
44,426	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5¼ 5⅜	5¼ 5⅜	3 9 7	March	5⅜	5¼
£110,000	Stock	4½	Do. 4½ per Cent. Debenture Stock (red.)	110 113	110 113	4 0 2	June and December	...	...
70,879	10	10/0	City of London Electric Lighting Ord.	8 9	8 9	5 5 7	February and August	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12	...
£400,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	123 128	123 123	3 18 10	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103 106	103 106	4 6 0	...	...	...
40,000	10	6/0	County of London and Brush Prov. Ordinary	8 9	8 9	4 8 11	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	...	...
£400,000	Stock	4½	Do. 4½% Deb. Stock (all pd.) (red.)	107 110	107 110	4 3 0	...	108½	108⅞
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	⅞ 6¼	⅞ 6¼	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½ 6⅝	6½ 6⅝	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...	...
£100,000	Stock	4%	Kenstn. & Knghtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104 107	104 107	3 14 11	...	...	...
110,000	3	...	London Electric Supply Ordinary	1½ 1⅝	1½ 1⅝		...	...	...
49,840	5	3/0	Do. 6 per Cent. Preference	4¼ 4⅜	4¼ 4⅜	6 6 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95 100	95 100	4 0 4	Mar., June, Sept., Dec.	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15 16	15⅛ 16⅛	2 18 8	April and October	16⅛	15 15/16
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 115	111 115	3 18 2	June and December	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 100	97 100	3 10 8	...	99⅛	...
8,652	10	6/0	Notting Hill Electric Ordinary	14 15	14 15	4 0 0	March	...	...
19,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	93 101	98 101	3 19 3	...	...	...
300,000	1	...	Rand Electric	1 1/16 1 1/16	1 1/16 1 1/16	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	65 70	65 70	...	January and July	...	...
£107,800	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	102 104	102 104	4 3 4	April and October	...	...
40,000	5	9 6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8⅛ 9⅛	8⅛ 9⅛	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98 101	98 101	3 9 6	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅞ 2¼	1⅞ 2¼	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2⅞ 3¼	2⅞ 3¼		...	...	...
109,518	5	5 6	Westminster Electric Supply Ordinary	11 12	11 12	4 7 6	March and September	11⅜	...
28,141	5	...	Do. 5 per Cent. Cumulative Preference	3½ 4	3½ 4	...	...	3⅜	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007) xd	3⅞ 4⅛	3⅞ 4⅛	4 17 0	April and October	4 1/16	...
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	115 30	125 30	4 13 9	...	...	...
20,000	10	...	Barcelona Tramways Ordinary	7⅛ 8⅛	7⅛ 8⅛	...	...	8 3/16	8 1/16
10,000	10	5/0	Do. 5% Cumulative Preference	8 9	8 9	5 11 1	...	...	...
£49,800	100	5%	Do. 5% Debentures	98 102	98 102	4 18 9	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	92 97	94 99	4 10 11	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13 14	13 14	4 12 10	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3 3⅛	3 3⅛	...	...	3 3/16	...
75,000	5	2/8	Do. 5% Cum. Pref.	4½ 5	4½ 5	5 0 0	...	4 3/16	4⅛
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	103 106	104 107	4 4 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	109 111	109 111	3 12 1	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	6⅝ 7⅛	6⅝ 7	2 16 1	...	...	...
20,000	10	5/0	Do. 5% Preference xd	9⅛ 9⅝	9⅛ 9⅝	5 2 7	May and November	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	100⅞ 102⅞	100⅝ 102⅞	4 8 0	...	102½	...
100,000	10	6/0	British Electric Traction Ordinary	13⅛ 14⅛	13⅜ 14⅜	6 4 2	...	14 1/16	13 15/16
100,000	10	6/0	Do. 6% Cum. Pref.	12⅛ 12⅝	12⅛ 12⅝	4 14 1	February and August	12⅝	12⅛
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126	126⅛
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅛ 1⅜	1⅛ 1⅜	...	...	1 1/16	...
40,000	5	3/0	Do. 6% "A" Cum. Pref. xd	5 5⅜	4⅞ 5⅜	5 14 4	...	...	...
27,500	5	10/0	Do. "B" xd 3s. and 7s. on a/c of arrears	5⅛ 5⅝	4⅞ 5⅛	5 3 8	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 4	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 0	...	...	...
34,440	10	6/0	Calcutta Tramways (Nos. 1 to 34,440) xd	13⅛ 14⅛	14 15	2 0 2	...	14⅜	14
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	106 108	106 108	4 4 0	...	107⅛	...
440,000	1	1/2⅝	Cape Electric Tramways Shares	2⅛ 2⅜	2⅛ 2⅜	4 4 2	...	...	...
£1,969,800	Stock	4%	Central London Ordinary Stock	103 106	103 106	3 15 11	June and December	105½	104¾
£440,100	Stock	4%	Do. 4% Preferred Stock	103 106	103 106	3 15 11	...	106⅛	...
£440,100	Stock	4%	Do. Deferred Stock	100 103	100 103	3 17 10	...	103	...
£898,201	100	4%	Do. 4% Deb. Prov. Scrip. Certs	116 118	116 118	3 8 0	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5⅛	5 5⅛	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...	...
£855,000	Stock	2½%	City and South London Railway Con. Ordinary	65 68	69 71	2 16 5	February and August	70⅛	67⅛
37,500	10	1/0⅜	Do. Ordinary (Nos. 22,501 to 60,000)	...	...	...	,, ,,	...	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	...	...	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 15 5	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	123 126	124 127	3 18 10	...	125⅞	125
£150,000	Stock	...	Do. (1901)	120 124	120 124	...	...	...	...
£13,913	Stock	4%	Do. 4 per Cent. Perpetual Debenture	112 116	112 116	3 9 0	May and November	...	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛ 12⅛	11⅛ 12⅛	4 0 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½ 15⅛	14½ 15⅛	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...	...
33,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4 4½	4 4½	6 13 4	...	...	...
£70,000	Stock	40/8	Do. 5 per Cent. Debenture Stock (red.) xd	...	101 104	...	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%) xd	8 9	8 9	3 6 8	...	8⅛	8⅜
20,000	10	8%	†Imperial Tramways Ordinary	26½ 27½	26⅝ 27⅛	3 18 6	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14 14½	14 14½	4 0 0	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110 112	110 112	4 0 6	January and July	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4⅞ 5	4⅞ 5	3 0 0	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10½ 11	10⅛ 11	4 11 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98 99	98 99	4 0 10	January and July	...	...
£350,000	Stock	4%	Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd)	102 104	102 104	3 16 11	...	103½	...
$6,103,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cu. Mrt. Bonds	111 115	111 115	4 6 11	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	103 105	103 105	4 15 3	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	102 104	102 104	4 6 7	...	...	...
24,000	5	4/0	New General Traction Ordinary	2½ 3½	2½ 3½	5 14 4	...	...	...
40,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4 5	4 5	6 0 0	May	4⅜	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96 100	96 100	5 0 0	...	...	...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stck.	99 102	99 102	4 13 2	...	100½	100½
9,334	10	8/0	Potteries Electric Traction Ordinary	9½ 10½	9½ 10⅛	3 16 2	...	...	...
16,440	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	106 109	106 109	4 2 9	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...	...	...	...
51,132	1	...	Do. 6% Preference (10/0 paid)	...	...	...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...	...	...	,, ,,	...	...
£500,000	Stock	...	Do. 4½% Debenture Stock (50% paid)	...	...	...	January and July	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	91 94	91 94	3 4 0	June and December	93	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 23.		Price Wednesday, Apr. 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 30.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅜	4⅜	3⅜	4⅜	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£804,720	Stock	12/6	Anglo-American	44	47	44	47	5 19 5	Feb., May, Aug., Nov.	44½	...
£3,097,640	Stock	25/0	Do. Preferred	87	89	88	90	6 9 2	" "	90	87½
£3,097,640	Stock	2/0	Do. Deferred	7	7⅛	7	7⅛	1 6 8	" "	7⅛	7⅛
$13,333,300	$100	$1⅔	Commercial Cable Capital Stock	150	160	150	160	5 0 0	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	93	96	93	96	4 3 4	" "	94	...
16,000	10	4/0	Cuba Submarine Ordinary	4	5	4	5	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 10	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	3	4	3	4	5 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8⅜	9⅜	8⅜	9⅜	5 5 3	" "	...	...
£30,000	50	4¼%	Do. 4½ per Cent. Debentures	98⅞	102⅞	98⅞	102⅞	4 8 3	January and July	...	
60,710	20	3/0	Direct United States Cable	9½	10⅛	9⅛	10⅛	6 3 10	Jan., Apr., July, Oct.	10 3/16	9⅝
£101,300	100	4¼%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary ..[to 1,200) (red.)	122	132	123	132	5 5 3	Jan., Apr., July, Oct.	125⅛	123½
£1,930,807	Stock	17/6	Do. 3½ per Cent. Preference Stock	83	86	83	86	4 1 5	" "	85½	84
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	105	109	105	109	3 14 3	May and November	108⅛	107⅝
300,000	10	2/6	Eastern Extension	12½	13½	12½	13½	5 3 8	Jan., Apr., July, Oct.	13⅛	12⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	103	113	107	113	3 11 10	February and August	107⅝	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	93	101	93	101	3 17 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100%	103%	100%	103%	3 17 8	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen	27	29	27	29	5 3 5	January and July	28⅜	...
£75,000	100	4¼%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos.	99	103	99	103	4 8 3	June and December	...	...
17,000	25	12/6	Indo-European [1 to 1,200) (red.	35	39	36	40	6 5 1	May and November	37½	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 7	June and December	...	...
15,609	...	...	*West African Telegraph Shares	1½	2½	1⅜	2⅜	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99	101	99	101	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	⅜	⅝	⅜	⅝	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅜	⅝	⅜	⅝	...	May and November	½	...
34,563	10	£/0	Do. 5 per Cent. 1st Preference	5	5½	5	5⅛	5 9 1	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3½	4½	3⅞	4⅛	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	12	13	11⅛	12⅛	5 16 4	Mar., June, Oct., Dec.	12 5/16	11⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 3	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 18 5	...	...	...
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3½	4	3½	4	6 5 0	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛	⅜	⅛	⅜	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	96⅞	96
200,000	5	0/1½	Do. Preferred Shares (£3. 17s. paid)	3⅛	3⅝	3⅛	3⅝	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	57	61	56	60	7 10 0	...	57	...
15,000	10	0/0	Do. 6 per Cent. Cumulative 1st Preference	12	14	12	14	4 5 9	February and August	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	12	14	4 5 9	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	4⅞	5⅛	4 17 7	" "	5 1/16	5
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	93	96	93	96	3 13 0	June and December	94⅛	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	101	105	101	105	3 16 2	...	104	102½
171,504	1	0/6	Oriental	1/16	1 1/16	1/16	1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	4⅜	5⅜	4⅜	5⅜	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	5 0 0	June and December	...	...
£ 79,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	105	102	105	4 15 3	June and December	102	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜	⅝	⅜	⅝	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	1/16	3/16	1/16	3/16	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅝	¾	⅝	¾	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	8	9	8	9	8 6 8	July and February	8 1/16	...
70,000	5	3/0	Do. 6 per Cent. Preference	5½	6	5½	5⅞	5 4 0	January and July	...	...
£250,000	Stock	5/3	Do. 4½% 1st Mort. Deb. Red.	102	105	102	105	4 5 11	...	...	...
150,000	5	3/0	British Westinghouse 6% Preference	5⅜	6	5⅜	6	5 0 0	...	...	...
105,731	2	...	Brush Electrical Engineering	½	1	½	1½	...	March	1 1/16	⅝
150,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	1½	2	½	1½	3 4 3	March and September	1½	1 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	101	104	4 6 7	March and September	103	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	95	100	95	100	4 10 0	January and July	...	...
30,000	5	5/0	Callender's Cable Construction Ord.	17	18	17	18	4 3 4	" "	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	6	5⅛	6	4 3 4	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111	115	111	115	3 18 4	November and May	...	...
450,000	1	0/4½	Castner-Kellner Alkali Co. (fully paid)	¾	1	¾	1	3 0 0	...	1 1/16	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	87	92	87	92	4 17 10	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅜	½	⅜	½	7 2 3	March	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	¾	1	¾	1	6 0 0	...	...	...
85,000	3	1/9	Crompton and Co. (Nos. 1 to 54,000)	3	3½	3	3⅛	6 8 6	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103%	105%	103⅝	105⅝	4 12 8	" "	...	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	¾	1	¾	1	6 0 0	...	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜	⅝	⅜	⅝	...	February and August	½	...
17,139	5	...	Do. (£5 paid)	2	3	2	3	...	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	73	83	73	83	4 15 3	June and December	...	...
£100,000	Stock	5%	Do. 5% 2nd Deb. Standing Prv. Cts. (all pd)	82	87	82	87	5 14 11	...	...	...
26,500	5	2/6	Edmundson's Electricity Corporation Ord.	6½	6⅝	6½	6⅝	5 3 3	Half-yearly	6 1/16	...
20,000	5	3/0	Do. 6% Cumulative Preference xd	6	6⅜	6	6⅜	4 12 4	...	...	...
£120,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	106	109	4 2 7	...	...	...
112,100	2	1/2½	Electric Construction Co.	1½	1⅝	1½	1⅝	6 17 2	January and July	1⅝	1⅝
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅝	3	2⅝	3	4 13 4	July	2⅝	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97	101	97	101	3 19 3	January and July	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	9⅜	10⅜	9⅜	10⅜	4 17 7	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98	101	98	101	3 19 3	...	...	...
35,000	5	10/0	Henley's Telegraph Works Ordinary	17	18	17	18	4 3 4	February and August	...	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	6	5⅛	6	3 15 0	" "	5⅞	...
£49,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	115	111	115	3 18 3	" "	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21⅜	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34	37	34	37	6 9 8	March and July	36½	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	103	106	3 15 5	January and July	...	...
25,000	5	4/0	Do. Manufacturing Ordinary	10½	11½	10⅜	11⅜	5 4 4	...	10⅝	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	6	5⅛	6	4 3 4	...	...	...
66,666	5	5/0	Willans and Robinson Ordinary	8⅞	9⅛	8⅛	9⅛	5 5 3	April and October	8⅝	8 1/16
66,666	5	3/0	Do. 6 per Cent. Cumulative Pref.	6⅛	6⅝	6⅛	6⅝	4 8 11	" "	6 1/16	...
£ 60,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105	107	105	107	4 0 2	May and November	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	5⅝	5⅛	5⅝	5 9 1	...	...	...
180,237	10	2/6	Globe Telegraph and Trust xd	8⅛	9⅛	8⅛	9⅛	5 10 6	Jan., Apr., July, Oct.	8⅛	8 1/16
180,042	10	3/0	Do. 6 per Cent. Preference xd	12⅛	13⅛	12⅛	13⅛	4 8 11	" "	13	12⅛
11,889	8	4/0	Reuter's	6½	7⅛	6⅝	7⅛	5 6 8	April and October	...	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	110⅛	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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NOTES.

IT is an undeniable fact that several large dynamos generating current for lighting and traction in this country have been manufactured in the United States or on the Continent, and that some big contracts have recently been placed abroad for such machinery. One of the causes of this dates back a few years ago, when our leading electrical manufacturers were so occupied with orders for standard plant that deliveries were sometimes a year overdue, and the makers had no time to busy themselves with the apparently less remunerative occupation of looking forward and working out designs of larger and more modern machines for future demand. Owing to the fact of several orders going abroad, a false idea has fastened itself in people's minds that England was no longer manufacturing large electrical machinery, that it had become merely an importer, and had ceased to be a producer of this class of material. There had certainly been a pause in our development in this direction, but the repeated warnings in the technical press, and the more concrete warnings in the shape of imported dynamos, had their effect long before the "foreign invasion" scare had reached its maximum, and our manufacturers have gone forward once again and, we trust, will soon regain their leading position. Proof of this is afforded in two articles we publish in the present issue—one describing the extensions made recently at the works of one of our oldest-established manufacturers, and the other sketching the construction of large generators at one of the latest acquisitions to the ranks of British manufacturers. And these do not stand alone. Other works are daily turning out electrical machinery of large output which will compare with the best that can be bought abroad, and large new works are rapidly approaching completion—some, in fact, causing an unprecedented number of bricks to be laid per day in their construction. A few years hence we shall look back with amusement at the scare of an industrial foreign invasion that marked the beginning of the present century.

OUR readers will hardly be surprised that the London County Council (Electric Supply) Bill has failed to pass the Committee stage. The proceedings in Committee are reported at considerable length in *The Electrician* of May 2nd and to-day, and it is shown that the main object of the London County Council's scheme was evidently to put the Council in a position to acquire, at a later date, the large outlying electricity works which supply London, and furnish electrical energy on a wholesale basis to the various London Borough Councils, who would then distribute it. Since, however, the companies owning the various works which it was desired to purchase were opposed to the scheme, as it would mean a rescission of some of the powers originally conferred on them by Parliament, we need not wonder that the Committee refused its sanction.

THE four underground railway schemes competing for powers on the Hammersmith–Piccadilly–City route have now laid their evidence before Lord WINDSOR'S Committee. The independent opposition to these schemes is being heard, and it may be expected that a decision will be come to shortly. Of the four schemes, that which appeals to the public as the simplest is the extension of the present Central London Railway round the narrow loop shown in the sketch map on page 107 of this issue. Another scheme, which also has the merit of simplicity, proposes to run directly from Hammersmith to Charing Cross, practically in a straight line, but unfortunately this stops at Charing Cross. The other two schemes are more ambitious. One is the outcome of the desire of Mr. YERKES to convert the District Railway into a paying concern, and embraces a vast network of lines in almost all directions. A map of these lines is also given in our present issue. Finally, Mr. PIERPONT MORGAN, apparently desiring to "go one better" than his compatriot, proposes a working arrangement between existing and projected tramways and tubes which will connect the extreme north, south and west with the central and east central part of London and one another. A map of the lines in the Morgan

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group was given in our issue of April 25th, page 21. From the remarks made by the Chairman, it seems not improbable that the extension of time sought for by Mr. YERKES will be granted, together with another of these schemes—possibly the Central London extension—with the object of encouraging competition; but whatever the result, the travelling public of London will be the gainer and the cause of electric traction considerably advanced.

GAS engineers are to be congratulated on the recent progress that has been made with incandescent gas lamps for street lighting, and their efforts should be greatly appreciated by those towns which have not yet got electric light within their reach. That electric light can hold its own against the most improved Welsbach burner for this purpose is shown by the discussion at the Paddington Borough Council, which we report in another column of this issue. A proposal was made to replace the arc lamps in Westbourne-terrace by incandescent gas burners in order to effect an economy, but it was admitted by the chairman of the Gas and Electricity Committee that the replacement of 14 arc by 56 incandescent gas lamps would result in a diminution in the illumination of the street. It may also be mentioned that the price charged for the maintenance of the arc lamps is well above the average, owing to the small extent to which the Paddington Borough Council has adopted them hitherto. The result was that the proposition was not carried, and the suggestion was made by one of the councillors that the Council had better first devote its attention to improving the gas lighting in other streets before it interfered with the good results obtained in Westbourne-terrace.

AN interesting development has taken place in connection with the electric lighting of the Borough of Camberwell, and a decision on the question has been obtained from the Board of Trade, which will be useful as a precedent, and a warning to other Metropolitan Borough Councils who may desire to take advantage of the peculiar distribution of electric lighting areas in London to drive a sharp bargain in the acquisition of electric lighting undertakings. In Camberwell there are two competing electric supply companies, if we except the Crystal Palace District Electric Supply Co., which has only powers to supply in a small portion of the Borough. It appears that the Camberwell Borough Council approached each of the two companies separately with a view to purchasing so much of their undertaking as lay within the Borough, and that the London Electric Supply Corporation offered to sell for £25,000 (this sum not including a generating station). Estimates were made which showed that by spending an additional £125,000 the Borough Council could develop this distributing system into an independent electric supply system. The other Company (the County of London and Brush Provincial) were also willing to sell on terms fixed in their provisional order, but as they had developed their business in the district to a greater extent than the competing company, their price was higher. Consequently the Camberwell Councillors thought that it would be an excellent business move to buy up the London Electric company and enter into active competition with the other undertakers, this being obviously cheaper than buying up the two concerns in the ordinary and straightforward manner. The audacity of this proposal is emphasised by the fact that this is not a case in which two companies had agreed to divide the district between them and not poach on one another's preserves; there are actually mains of the two competing companies side by side in the same street.

FORTUNATELY, the Borough Council was compelled to apply to the Board of Trade for permission before it could execute this excellent stroke of business. A report of Mr. PELHAM'S enquiry into the matter was published in our issue of March 14th (p. 880), and, after due consideration, the Board of Trade decided that the Borough Council could only be allowed to purchase the undertakings of all the companies concerned on the usual terms, and that it would be willing to grant a provisional order to allow this to be done. This reply, with the town clerk's report upon it, came up for consideration at the meeting of the Camberwell Borough Council last week, when, instead of accepting the decision as obviously the only fair and equitable one, a resolution was passed expressing a "strong protest against the action of the Board of Trade," and insulting remarks were levelled at its permanent officials. The electric lighting industry is to be congratulated that a large electric supply undertaking has not passed into such hands as these.

Lord Kelvin in America.—A New York correspondent of *The Times* reports that the honorary degree of Doctor of Laws was conferred on Lord Kelvin at Yale University on the 5th inst.

Greater Manchester Electricity Supply.—The Stuart-street station of the Manchester Corporation will be opened on Tuesday, 27th inst., when the first 2,500 H.P. set will be started.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Bolama	April 19, 1902
Puerto Plata—Martinique	May 6, 1902

Swedish Telephones.—A bill which has been recently laid before the Swedish Parliament for the purchase by the State of the rights and stock of the two private telephone companies (Allmänna and Bell) has been rejected.

Annual Dinner of King's College (London).—The forty-second annual dinner of King's College will be held at the Café Monico on Monday, June 16th, with the Right Hon. and Right Rev. the Lord Bishop of London in the chair.

Conference with Reference to the Factories and Workshops Act, 1901.—The Institution of Electrical Engineers has issued invitations for this Conference at 8.30 p.m., on Monday, May 12th, in the rooms of the Society of Arts, kindly lent for the occasion.

Cable Makers' Combination.—The negotiations for the amalgamation of the undertakings of the British Insulated Wire Co., Prescot, and the Telegraph Manufacturing Co., Helsby, have been completed, and the formal agreements were duly executed on Wednesday.

Recent Thunderstorms.—Thunderstorms of a more or less severe nature have passed over certain portions of the country during the week, and at Halifax a tramcar was, according to the *Yorkshire Post*, struck by lightning, but no damage was done except to the lamp circuit in the car. At Chelmsford there were also many vivid flashes, which disturbed certain local telephones.

Royal Society.—The following gentlemen have been selected by the Council of the Royal Society to be recommended for election to Fellowships:—

Mr. H. Brereton Baker, Prof. Henry T. Bovey, Prof. Rubert Boyce, Mr. John Brown, Mr. Willliam Bate Hardy, Mr. Alfred Harker, Mr. Sidney S. Hough, Mr. Robert Kidston, Mr. Thomas Mather, Mr. John Henry Michell, Mr. Hugh Frank Newall, Prof. William M. Flinders Petrie, Mr. William Jackson Pope, Mr. Edward Saunders and Dr. Arthur Willey.

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Fire on Charing Cross Company's Mains.—On Wednesday last a fire occurred on the above company's mains in Cranbourn-street, Leicester-square, and when the fire brigade, which was hastily summoned, arrived on the scene the cables were burning fiercely. The mains of the Metropolitan Electric Supply Co., which were close by, were also interfered with, and some nine disconnecting boxes gave out large volumes of smoke. The fire was subsequently extinguished after considerable difficulty, and it is satisfactory to note that no one was injured.

Wireless Telegraphy.—The New York correspondent of the *Standard* says that five tenders, which are very diverse in character, have been offered to instal wireless telegraphy in the Government Alaskan stations. Prof. Fessenden offers guarantees of the fastest speed—exceeding 25 words per minute, or double the rate offered by Mr. Marconi, who requires a royalty of $2,560 and $60 annually per instrument. The longest distance required is 150 miles, and the successful bidder must demonstrate over 60 miles to the satisfaction of the Government. All promised equipment before the winter.

Overhead Wires in Washington.—A bill is now pending in Congress, under the recommendation of the House Committee of the District of Columbia for the placing of telephone and telegraph overhead wires, in suitable conduits, in the city of Washington. The District Commissioners will be empowered to cause removal of overhead wires in thickly-populated portions of the district, and at their discretion to issue permits to the telephone company to instal ducts or make house connections. At the present time telephone companies must apply for permission to Congress before wires can be laid across street or alley, either underground or overhead.

Working of Steam Boilers.—This subject is dealt with in the third edition of the National Boiler and General Insurance Co.'s booklet in a very comprehensive manner. The efficient working of boilers of all classes is detailed, and the fullest instructions to boiler attendants are given for proper management and inspection. A number of illustrations, taken from photographs, give some curious shapes into which boiler plates have been twisted by explosions, and there are also interesting examples of corrosion blistering and burning. The increase in water-tube boilers calls for special attention to their management, and superheaters also are dealt with, there being instructions for firing and flooding according as the superheater is placed.

Post Office Appointments.—The Postmaster-General has appointed Mr. M. Roberts, M.Inst.C.E., and Major W. A. J. O'Meara, C.M.G., R.E., Assistant Engineers-in-Chief to the Post Office. Mr. Roberts, as is well known to our readers, has been on the engineering staff of the Post Office for many years, and was second Assistant Engineer-in-Chief. Major O'Meara is, on the other hand, not so familiar a figure in the department, although in 1891-92 he was engaged on the construction of the London–Paris trunk telephone line. He has been acting as Government Commissioner for Johannesburg and District since May, 1901, and has, in fact, been employed in South Africa since 1899. For a period he was chief intelligence officer at Bloemfontein, and during the siege of Kimberley was chief staff officer to Col. Kekewich.

University of Birmingham.—A Faculty of Commerce has been created in the above University, and will begin its work on October 1, 1902. There will be a course of training suitable for men looking forward to business careers. Its object is the education, not of the rank and file, but of those who will ultimately guide the business activity of the country. A three years' course, leading to the degree of Bachelor of Commerce, has been drawn up, and it comprises studies falling into four main categories: Languages and History, Accounting, Applied Science and Business Technique, and Commerce. Prof. Ashley will be at the University building, Edmund-street, Birmingham, to meet and advise intending students from September 22nd to 30th (inclusive), between 10 a.m. and 1 p.m., or he may be seen at other times by appointment.

A Tramway on Ice.—The crossing of the river Neva at St. Petersburg is usually effected by bridges and steamboats, the latter being used by reason of the scarcity of the former; but when the river becomes frozen traffic by this means is stopped. The *Tramway and Railway World*, in a recent issue, describes a tramway which was temporarily installed on the ice across the Neva. Two lengths of lines were laid down—one 550yds. and another 1,100yds. long—the overhead lines being carried on wooden poles embedded in the ice. The routes were lighted by means of arcs attached to the supporting poles. Our contemporary remarks on the absence of frontagers, and local authorities insisting on road widenings, fancy poles, &c., on such lines, which, it is anticipated, should afford a good return to the promoters.

Institution of Electrical Engineers.—The annual conversazione will be held in the Natural History Museum on Tuesday, July 1st. In view of the fact that the Tramways and Light Railways Congress will then be sitting, and that many of the foreign delegates to the congress are likely to attend the conversazione; and that the Incorporated Municipal Electrical Association will also open its convention in London on the following day; and, further, that the date is within a week of the date of the Coronation. when London is expected to be very full, the Council has decided, by permission of the trustees, to open one of the large side galleries in addition to the Central Hall of the museum. The Metropolitan District Railway has, we understand, also kindly promised to open the subway from the South Kensington station to the grounds for the benefit of guests travelling by their line.

Electrical Utilisation of Blast Furnace Gases.—Mr. Brierly Healey made the above the subject of a recent Paper before the Society of Engineers, drawing comparisons at the outset between old and new methods of working and what advances had been made during the past 40 years. As an example, the average output of British furnaces 40 years ago was almost 200 tons of pig-iron per week, but now 200 tons per day could be obtained without difficulty. The latest improvements in blast furnace plant were described, and the author stated that the gas from a 1,500 ton per week furnace, working coke, after allowing $\frac{7}{20}$ths for heating the blast, 900 I.H.P. for gas-driven blowing engines, and 100 I.H.P. for charging the furnace and clearing away the slag, left a surplus of 5,000 I.H.P. for electrical energy. Designs were being prepared for the rebuilding of a works in Staffordshire, where steam boilers would be absent and the power obtainable from the furnace gases would be fully utilised.

British Association.—The following arrangements have been made in connection with the British Association meeting at Belfast, which commences on Wednesday, September 10th, under the presidency of Prof. James Dewar, F.R.S. On that day the presidential address will be delivered, and on the evenings of September 12th and 15th lectures will be given by Prof. J. J. Thompson, F.R.S., on "Becquerel Rays and Radio-Activity," and by Prof. W. F. R. Weldon, M.A., on "Inheritance" respectively. The various sections will assemble on September 11th, 12th, 13th, 15th and 16th. The following are the sections of electrical interest, with the presidents:—Section A—Mathematical and Physical Science, Prof. John Purser, M.A.; Section B—Chemistry, Prof. E. Divers, F.R.S.; Section G—Engineering, Prof. John Perry, F.R.S.; Section L—Educational Science, Prof. H. E. Armstrong, F.R.S. The concluding meeting will be held on Wednesday, September 17th, at 2:30 p.m. As already announced, the 1903 meeting will take place at Southport. The address of the local honorary secretaries is 2, Wellington-place, Belfast.

Electric Headlights for Locomotives.—A compact form of headlight for use on steam locomotives is described in a recent issue of the *Railway Review*, of Chicago, and an official trial has proved its efficiency in illuminating the track for about $\frac{3}{4}$ mile ahead. A small dynamo, driven by a steam turbine, is mounted on a common baseplate with a projector, the entire combination being fixed at the front of the smoke stack. The turbine, which resembles a De Laval in construction, has a normal speed of 2,000 revs. per min, this being kept constant by a simple governor, which is also easily

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accessible. The dynamo furnishes a current of about 30 amperes at 30 volts pressure, to the arc, which is automatic and self-focussing, giving an illumination equal to 6,000 c.p. A deflector, arranged at an angle of 45deg. across the lantern "goggle," intercepts about 40 per cent. of the beam, which is then projected vertically, to form a warning signal to following trains. The light on approaching locomotives can be seen at a distance of several miles, while, to prevent the dazzling of drivers when passing each other, a blind can be temporarily drawn over the lower portion of the glass.

Paris Exhibition Literature.—MM. Hospitalier and Montpellier's excellent account of the electrical features at the Paris Exhibition ("L'Electricité à l'Exposition de 1900," Vve Ch. Dunod) would have been of incalculable service had it been published simultaneously with the opening of the exhibition. As a record, however, it still possesses considerable utility, and there is much of interest in the last three parts published. One of these is on transformers and accumulators, another on meters, and the last number issued is on electro-chemistry *v.* electro-metallurgy, by M. A. Brochet. Under the heading "Transformateurs Hétéromorphiques," in the first of these, there are interesting descriptions of various forms of interrupters for induction coils, but hardly anything about rotary converters, except an instructive full-page table of the dimensions and data of seven machines exhibited by four makers. The section on accumulators, by M. A. Bainville, appears to be complete, and is well-written and well-illustrated; but, as M. Bainville says, the exhibition revealed nothing particularly new in this branch of the industry. In the part relating to meters many patterns are described that are not well known in this country, but it would seem that our meter makers have not much to learn from their foreign competitors.

Electric Haulage in Coal Mines.—In a recent issue of the *Electrical World* some interesting comparisons are drawn between early mining locomotives and those at present employed, illustrations being given of locomotives constructed in 1887 and 1889, the latter of which is still in use. Attention is drawn to the close resemblance between the designs of mining locomotives and those adopted in street railway practice, railway motors being used mounted on the axles in the usual manner and spring suspended from the side frames of the locomotive. The locomotive controller is arranged for starting the motors in multiple, as the drivers are then independent of each other, and the slipping of one pair of wheels has no effect upon the other. If the motors were in series, the counter E.M.F. of the slipping motor would limit the current and decrease the terminal potential in the other motor, thereby reducing its torque and tendency to accelerate. A typical installation is subsequently described in which three-phase currents at 5,600 volts potential are transmitted to a rotary converter sub-station in the mine, 9,000ft. from the power house. Double-current generators are used, the direct currents from the machines being applied to haulage and other purposes in the neighbourhood of the station on the surface.

Royal Institution.—The annual meeting of the members of the Royal Institution was held on May 1st, when the following gentlemen were unanimously elected as officers for the ensuing year:—

President: The Duke of Northumberland. Treasurer: Sir James Crichton-Browne. Secretary: Sir William Crookes. Managers: The Right Hon. Lord Alverstone, Sir James Blyth, Bart., Sir Frederick Bramwell, Bart., Dr. Thomas Buzzard, Dr. Donald Hood, Sir Francis Laking, Mr. George Matthey, Dr. Ludwig Mond, Dr. Hugo Muller, Mr. Edward Pollock, Sir Owen Roberts, Sir Felix Semon, The Right Hon. Sir James Stirling, Mr. John I. Thornycroft and Mr. James Wimshurst. Visitors: Dr. Henry E. Armstrong, Dr. Charles Edward Beevor, Mr. John B. Broun-Morison, Mr. Francis Elgar, Mr. Francis Gaskell, Dr. Dundas Grant, Lord Greenock, Mr. Maures Horner, Sir Henry Irving, Mr. Wilson Noble, Mr. W. R. Pidgeon, Mr. Arthur Rigg, Mr. W. S. Squire, Mr. Harold Swithinbank and Mr. Charles Wightman.

At a general monthly meeting on the 5th inst. the special thanks of the members were returned to Sir Thomas Sanderson, G.C.B., K.C.M.G., for a donation of £5. 5s. to the fund for the promotion of experimental research at low temperatures. The chairman announced that His Grace the President had nominated the following vice-presidents for the ensuing year:—The Right Hon. Lord Alverstone, Sir Frederick Bramwell, Dr. Donald Hood, Mr. George Matthey, Dr. Ludwig Mond, The Right Hon. Sir James Stirling, Sir James Crichton-Browne and Sir William Crookes.

Electrical Trade Section of the London Chamber of Commerce.—From the annual report of the above we learn that 18 meetings have been held in connection with a number of important questions affecting the electrical industry. The question of "earth returns" and the action of certain gas and water companies regarding the same had been dealt with by a special committee, which, in co-operation with the Tramways and Light Railways Association, had waited upon Lord Morley, chairman of the Joint Committee which reported on the question in 1893, and there was reason to believe that his lordship made representations to subsequent committees, since the decisions in connection with the most recent bills had been favourable to electrical enterprise. The committee and association were still jointly acting in the matter. A committee on Electrical Power Mains Regulations was appointed in February to consider whether and what modifications were desirable in the Board of Trade rules affecting electric power supply and transmission. Comparing the position here with that of other countries, the committee considered that certain modifications be asked for, and a letter embodying these recommendations had been sent to the Board of Trade. Conjointly with the Institution of Electrical Engineers, a sub-committee representing the section on clause 45 of the Factory and Workshops Amendment Bill had obtained some alteration in the bill, whereby electricity works and sub-stations were included in the Factory Act as non-textile factories. At a conference held at the Board of Trade in March regarding the proposal to reduce the maximum price of electrical energy from 8d. to 6d. per unit, the late Sir Courtenay Boyle, who presided, said that the Board of Trade had decided to withdraw the proposition to make the maximum price 6d., that each order would be considered on its merits, and that in prejudicial cases it would not be made obligatory. Other matters considered were, interruption of telegraphic communication between London and the North, the agreement between the National Telephone Co. and the Post Office, and the appointment of the Board of Trade Committee on Light Railway and Tramway legislation.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 9th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. Ordinary Meeting in the Lecture Hall of the Literary and Philosophical Society, Westgate-road, Newcastle-upon-Tyne. Included in the business of the evening will be the announcement of the names of the new president and council, and also the installation of the new president. The discussion on Mr. George Parker's Paper on "Workshop Records" will be resumed, and a discussion will also take place on Mr. R. P. Links' Paper, "Co-operation and Mechanical Aids to Workshop Cost Keeping."

SATURDAY, May 10th.

INSTITUTION OF JUNIOR ENGINEERS.

10 a.m. Visit to the Great Eastern Railway Co.'s Stratford Works.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

10 a.m. Visit to the works of Messrs. Elliott Bros. at Lewisham.

TUESDAY, May 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.—GLASGOW SECTION.

8 p.m. Annual General Meeting, for the election of office bearers, at 207, Bath-street, Glasgow.

WEDNESDAY, May 14th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM SECTION.

4 p.m. Visit to the Corporation Electricity Supply Works, Water-street. Following this, at 5:30 p.m., the Annual General Meeting will be held at the Grand Hotel, when the list of officers for the ensuing session will be announced.

ROYAL SOCIETY.

9 p.m. Conversazione at Burlington House.

THURSDAY, May 15th.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Extra General Meeting at the Society of Arts, John-street, Adelphi. Paper to be read: "Electrical Traction on Steam Railways in Italy," by Prof. C. A. Carus-Wilson.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Ship's Compasses.—H. Meldau gives a summary of the guiding principles underlying the construction of the modern mariner's compass. It is now generally recognised that the only effective way of avoiding the disturbing swing of the compass needle is to increase the period of swing. The old normal compass of the Admiralty has a period of 18sec., while the now almost universal Kelvin pattern has a period of 38sec. The equality of mechanical moment about various horizontal axes is brought about by the subdivision of the originally single needle into several needles, mounted parallel to each other at various distances from the centre of the rose. The moment of inertia of the latter is increased, after Kelvin's example, by placing the mass of the rose near the margin, the central portion consisting practically of silk threads only. Another successful method of providing the required steadiness is that of employing a liquid in which the needle floats. The liquid usually employed is a mixture of alcohol and water. The magnetic system has, of course, to be much stronger owing to the viscosity of the liquid. The quadrantal deviation by masses of soft iron can only be obviated by means of needle induction. In the German navy soft iron masses are attached to the compass box itself.

[H. Meldau, *Physikal Zeitschr.*, April 15, 1902.]

Absorption of Becquerel Rays.—The absorption of Becquerel rays by gases imparts to the latter a conductivity due to ionisation. Both Tommasina and Curie have recently found that the rays also increase the conductivity of liquid and solid dielectrics. It is, therefore, increasingly important to study the absorption of these rays by liquids. T. Tommasina has made a set of quantitative determinations which yield valuable material to work upon. He used the liquid electroscope devised by Curie, and measured the fall of potential without any liquid and with the liquid, and both again when a tube of radium-barium salt was introduced. Also the rate of discharge when the tube was surrounded by liquid to various depths. Thus, in the case of carbon bisulphide, the rate of discharge was originally four divisions. Introducing the Becquerel tube without a liquid increased the rate to 64·5. On introducing the liquid, the corresponding rates were 3·5 and 46·0 respectively, so that the carbon bisulphide absorbed about one-third of the rays. On adding a further thickness of 0·5cm. three times running, the rates fell to 28·3, 18 and 13 respectively, and on withdrawing both the liquid and the rays, the original rate of about three divisions was resumed. There is, therefore, no after effect. The greatest absorptions were due to benzene and ammonia.

[T. Tommasina, *Comptes Rendus*, April 21, 1902.]

Magnetic Field due to Electric Convection.—The lack of an explanation of the discrepancy still existing between the results of Crémieu and those of certain American and Italian physicists led A. Righi to make an appeal to mathematical physicists to fully investigate the problem of "an electromagnetic field produced by a charge in uniform rectilinear motion on the other side of an infinite conducting plane." This special case presents the simplest and, probably, the easiest case involved, and has since been completely solved by Prof. Levi, who finds that the magnetic field is smaller on the other side of the plane than it would be were that plane not there. If the charge moves with a velocity equal to one-millionth of the velocity of light parallel to an infinite copper plate 1mm. thick, the magnetic field on the other side is only 8 per cent. of what it would be in the absence of the copper plate. It would be 49 per cent. if the plate were of tinfoil 0·2mm. thick. This result shows that the screens used in all experiments on electric convection must have a pronounced effect upon the magnetic field observed if the moving charges are discontinuous. If the electric field does not change the effect of the screen is nil, and since the magnetic field of a current is not sensibly intercepted by a conducting screen, it follows that the electrons must move in the conductor in a practically continuous stream.

[A. Righi, *Physikal Zeitschr.*, April 15, 1902.]

Electrotherapeutics.—Madame B. Maurel gives an account of the service of medical electricity at the General Hospital of Tours as practised during the last six years. A special floor has been set apart for this service. There are four wards and a waiting-room. One of them contains the old apparatus for treatments with induction coils and influence machines, comprising Wimshurst, Bonetti and Carré machines as well as "postes faradiques." The second ward is furnished with X-ray apparatus and high-frequency machines, together with an Oudin resonator. The third ward is set apart for gynæcology, and the fourth for galvanocautery. In the period of five years ending July, 1901, 717 cases were treated, 207 of which were sent for electro-diagnosis, while the rest consisted largely of cases of hemiplegia, rheumatism, uterine affections and constipation. The radiographs taken amounted to 217, and included cases of a revolver bullet lodged in the skull, and a child's gullet containing a sou piece. The authoress claims that, in spite of certain structural disadvantages of the establishment, the electro-medical wards offer all the facilities which can be expected of an hospital equipped in accordance with modern resources. The influence machines are employed for what is still called "franklinisation."

[B. Maurel, *Arch. d'Electr. Méd.*, April, 1902.]

Zinc Images.—P. Vignon, recently known through his researches on the Holy Shroud, describes the formation of images of reliefs by the "emanations" of freshly prepared zinc. Medals and bas-reliefs in plaster or other material coated with powdered zinc gave a negative image on a sensitive plate. This is due to the fact that the zinc vapour acts most powerfully at small distances. The action diminishes rapidly with increasing distance. The general impression is as if the object were seen through a mist, but for all that the delineation of the various outlines is more correct than that obtained by photography with illumination in the ordinary way. Similar impressions may be produced by the action of ammoniacal vapours upon linen impregnated with a mixture of powder of aloes and olive oil. The relief image of a plaster hand impregnated with ammonium carbonate and enveloped in a suede glove may thus be obtained. Such carbonate is produced by the fermentation of urea in many febrile affections. These facts are the basis of the author's sensational theory concerning the authenticity of the Holy Shroud.

[P. Vignon, *Comptes Rendus*, April 21, 1902.]

The Reichsanstalt.—The business done during 1901 in the Physikalisch-Technische Reichsanstalt included several works of electrical interest. Platinum resistances were standardised up to 500deg., and found to be correct within 0·15deg., whereas the error at the temperature of liquid air exceeds 2deg. Small standard resistances of 0·1, 0·01, 0·001 and 0·0001 ohms were tested after several months' rest, and were found to have remained constant to within a few millionths of their values. The tests of the d'Arsonval galvanometer are nearly concluded, and the investigations concerning the Clark and Cadmium cells have been published. An important piece of work has been carried out with regard to the absolute temperature of a black radiating body, and the laws which put the total energy at a given wave length proportional to T^4, and the maximum energy proportional to T^5, lay the foundation of a new scale of temperature. Some analyses of fine spectrum lines have been carried out by Lummer and Gehrcke, with an extraordinary degree of delicacy by means of a new interference method utilising the properties of a plane-parallel plate. The technological work included the examination of a number of electrical measuring instruments, chiefly wattmeters, and the testing of insulating materials and arc-light carbons.

[Official Report, *Zeitschr. für Instrumk.*, April, 1902.]

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THE ELECTRIC CONSTRUCTION COMPANY'S WORKS.

Since we published a description of the fine works of this company three years ago,* considerable extensions have been carried out there, and the output and number of employés have been greatly increased simultaneously with the growth of the works themselves. Having in our previous article described the works and their equipment in considerable detail, we propose now to confine ourselves chiefly to the developments which have taken place during the last few years. Principal among these is the large machine and erecting shop which has been added during the last 12 months. This shop has been especially designed for the construction of large generating sets, and is equipped with machine tools of large size, representing the most modern practice in works equipment.

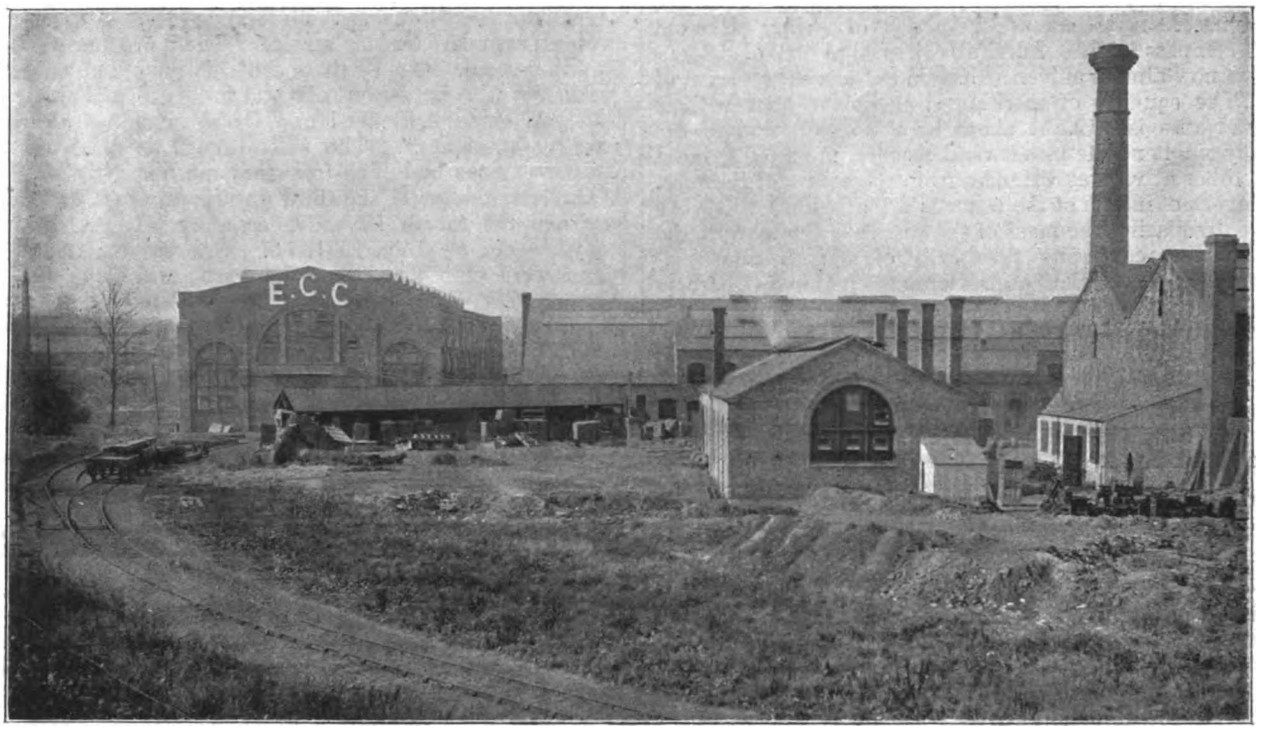

FIG. 1.—GENERAL VIEW OF THE WORKS.

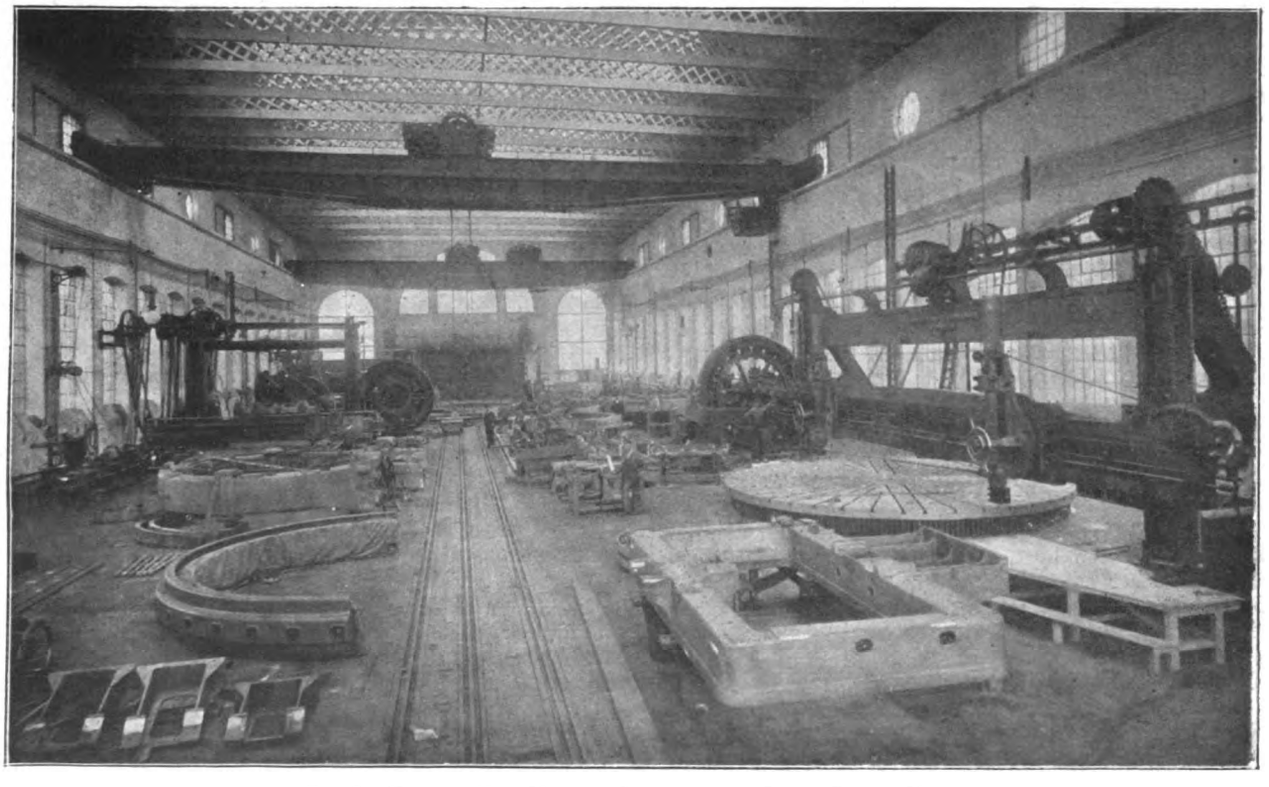

FIG. 2.—VIEW OF NEW MACHINE SHOP, SHOWING LARGE BORING MILL.

* *The Electrician*, Vol. XLII., p. 677.

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In our illustration showing the general view of the works (Fig. 1), the new shop is seen on the left, it being the one bearing the three large letters E.C.C., and Figs. 2 and 3 are photographic views, each showing about half the length of the shop. Owing to the effect of perspective, these two illustrations hardly convey an idea of its length, however, for it measures 300ft. from end to end. The width is 80ft. and the height 30ft. to the rails of the travelling crane and 10ft.

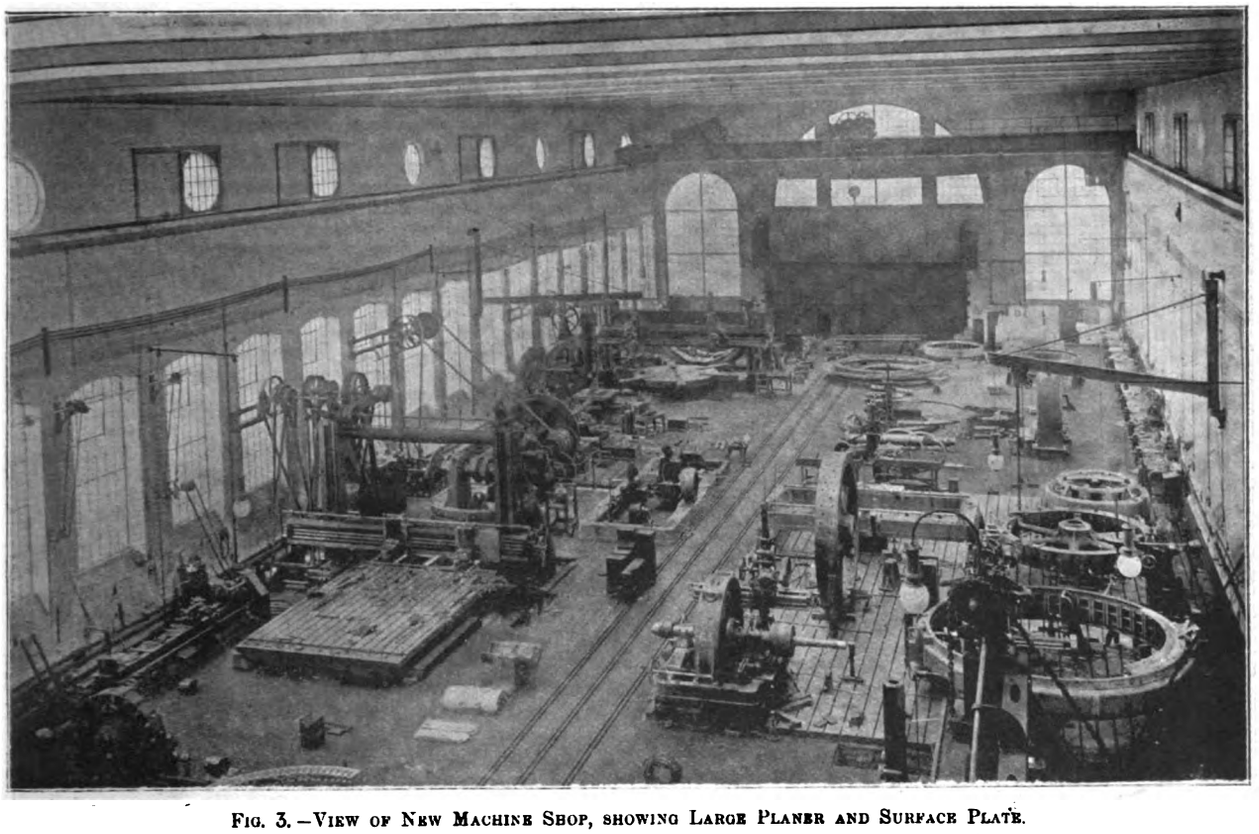

FIG. 3.—VIEW OF NEW MACHINE SHOP, SHOWING LARGE PLANER AND SURFACE PLATE.

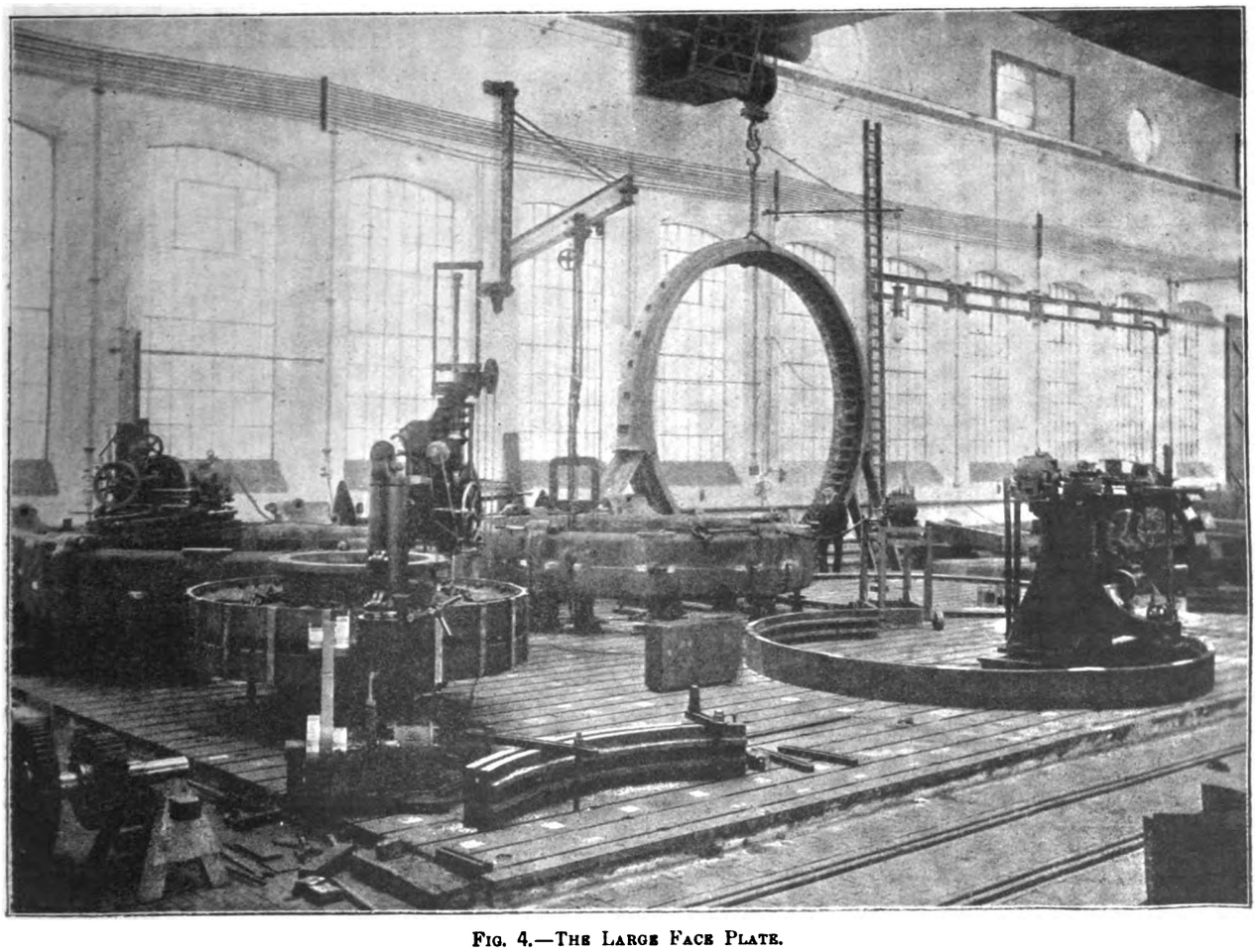

FIG. 4.—THE LARGE FACE PLATE.

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beyond. It is built of brick and wood and is extremely well lighted, there being windows both at the top and sides. The artificial lighting is by means of arcs suspended from brackets on the walls.

which drives the machine through a belt and speed cones. Another boring mill in the same shop can take work up to 20ft. diameter. Both these tools, and, in fact, almost all the machine tools in this shop have independent motors, and it

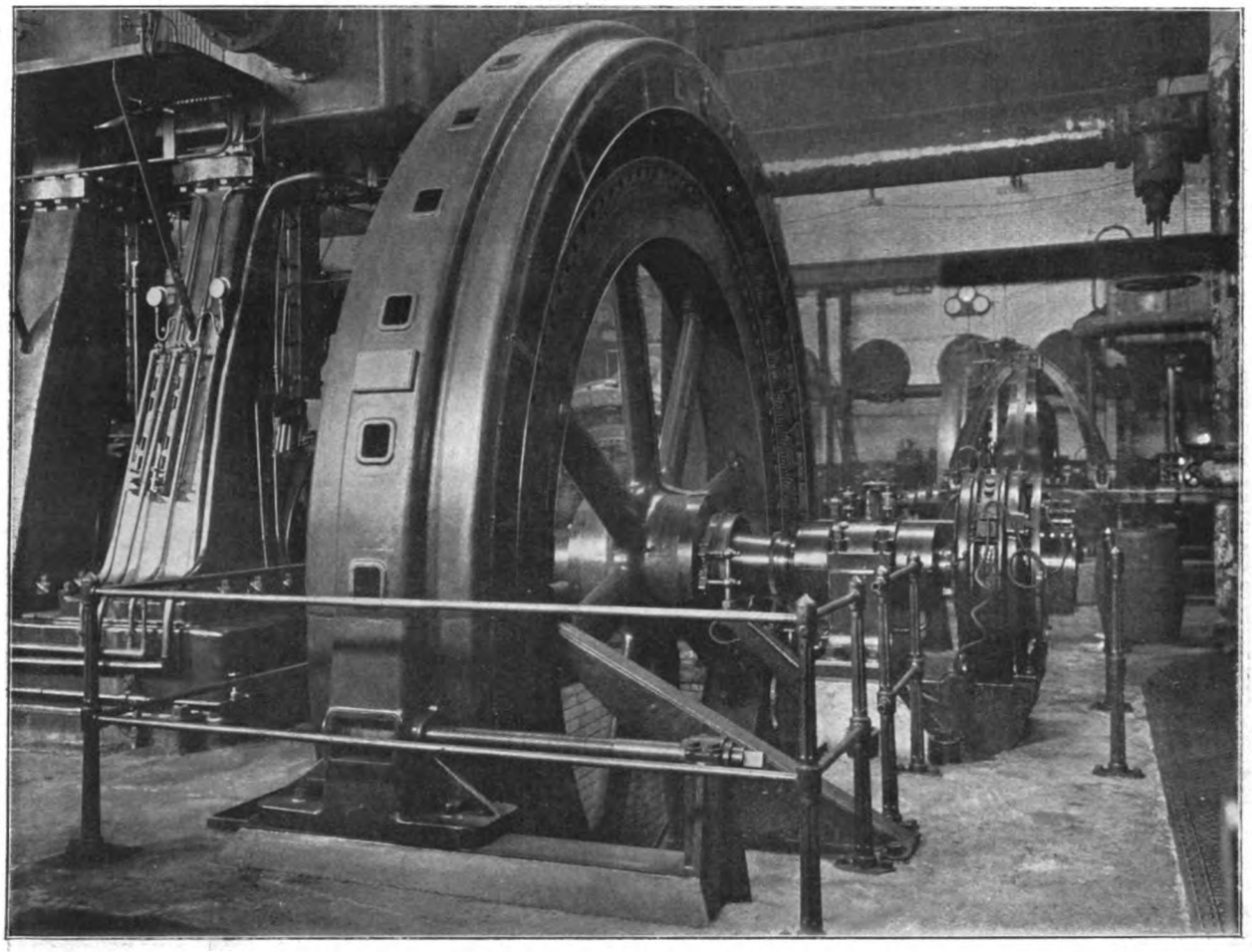

FIG. 5.—600kw. TWO-PHASE E.C.C. ALTERNATOR AT THE SHEFFIELD ELECTRIC LIGHT STATION. 200 volts, 50 ∿ per sec., 125 revs. per min.

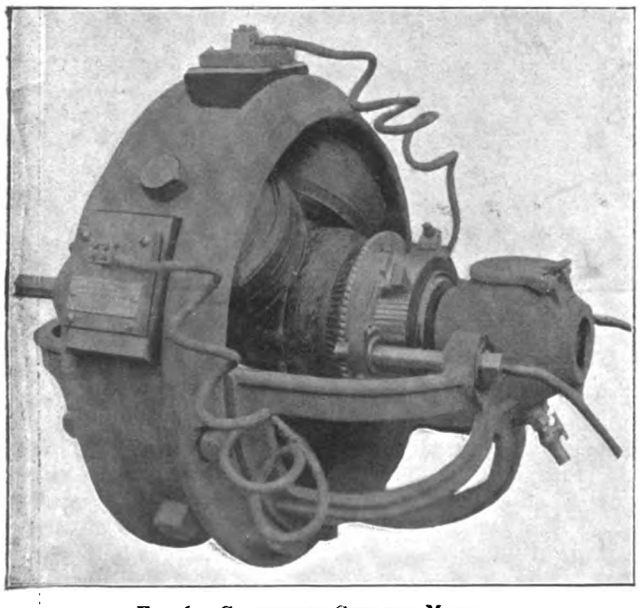

FIG. 6.—CONTINUOUS-CURRENT MOTOR.

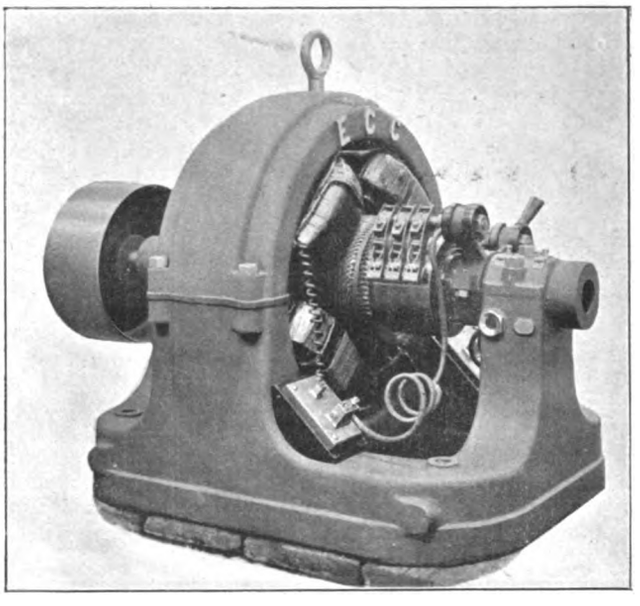

FIG. 7.—CONTINUOUS-CURRENT MOTOR.

Among the large machine tools is a boring mill, seen in Fig. 2, which is capable of dealing with work up to 32ft. diameter and is, we believe, the largest that Messrs. Hetherington & Son have manufactured. It is driven by a 10 H.P. three-phase induction motor through a short countershaft, is found feasible to switch them on directly without the aid of starting resistances.

The large planer, seen in Fig. 3, can take work 18ft. by 12ft. by 8ft. There is a radial drill for boring rings up to 20ft. diameter from the floor level, and among other machine

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tools in regular use in the new shop, we may mention a shaping machine with a special circular feed adjustable to any desired diameter of pole pieces, and a lathe with a key-way cutting attachment. One most interesting feature in the equipment shop is the large face-plate seen in Figs. 3 and 4. Here portable tools are employed to a large extent for shaping, milling, drilling, and other purposes, some of these being of fairly large size, so that not only is time saved by bringing the various tools to the heavier castings, but rapid work is done on them also. This method of working would almost be impossible without motor driving. In the majority of cases the motors are fixed directly on to the portable tools, but drive them through short belts and speed cones. In addition to the electrical supply, compressed air at 80lb. pressure is laid on, and this is employed for chipping chisels and other purposes. There are two electrically-driven travelling cranes, rated at 60 tons each and spanning the whole 80ft. of the shop. These

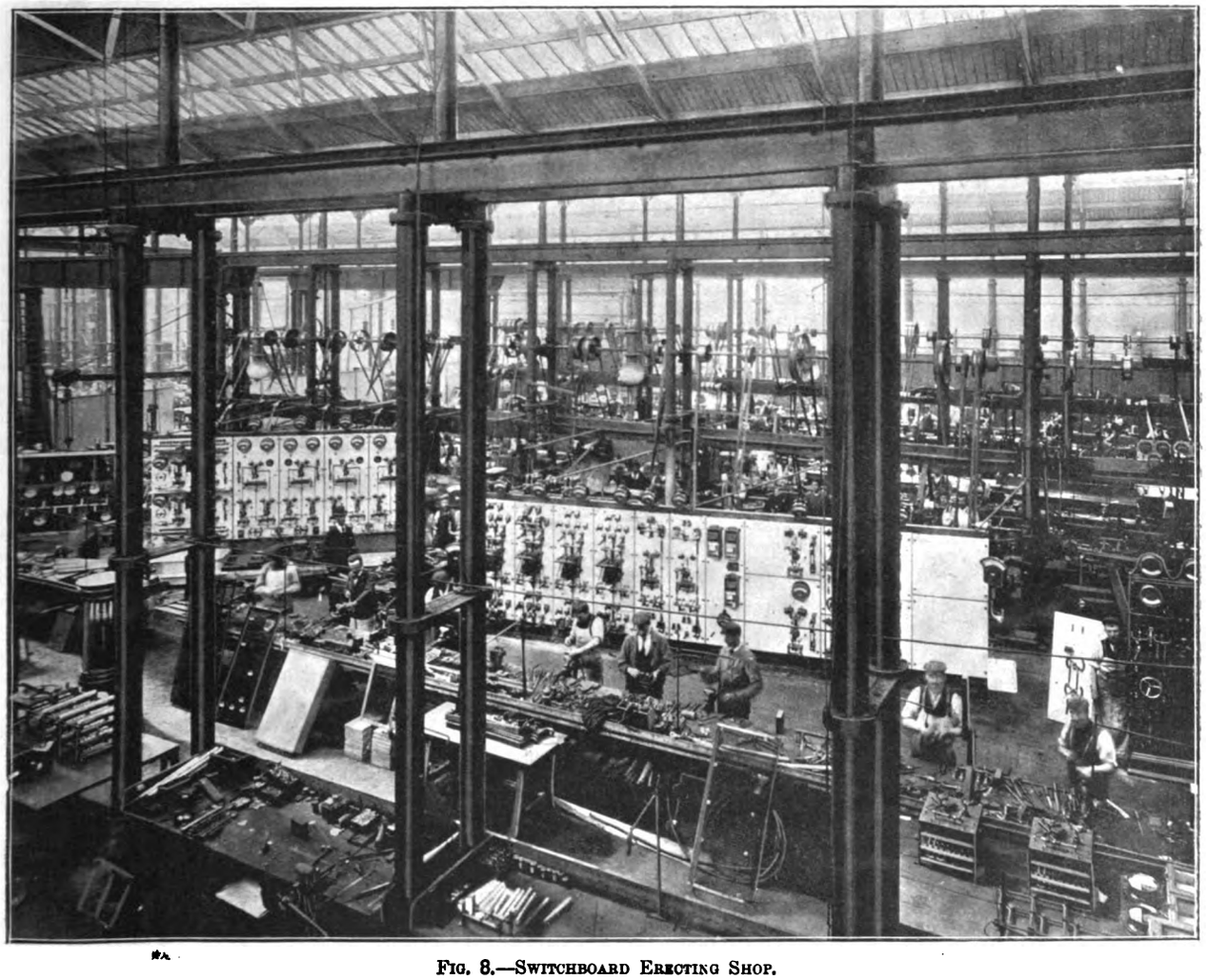

FIG. 8.—SWITCHBOARD ERECTING SHOP.

are driven by continuous-current motors, as are the remainder of the works, but with this exception three-phase current at 200 volts and 50 ~ per sec. is employed exclusively in the new shop.

Among the other large generators which were under process of manufacture at the time of our last visit to the works, we may mention a 1,400kw. two-phase alternator, the stator of which is seen in Fig. 4. Some machines of this pattern and size have been ordered from the Electric Construction Company for the municipal electricity works at Leeds and Sheffield, and a view of a similar machine of 600kw. capacity, erected at the Sheffield electric lighting station, is given in Fig. 5. Other examples of the firm's recent designs are shown in Figs. 6 and 7, the former being a cheap pattern of motor recently brought out to compete with American imports. The company are also devoting particular attention at present to polyphase induction motors, and have a useful list of standard sizes from 1 to 45 B.H.P. The efficiencies of these are from 80 to 88 per cent. at full load, and 77 to 87 per cent. at half load, the corresponding power-factors being 84 to 90 per cent. and 74 to 83 per cent. In these motors the ratio of maximum to full load torque is 2 in the smallest size, rising to 3 in the 45 H.P. motor.

Other parts of the works have also undergone modifications and improvements since our last description of them appeared. Fig. 8 shows the switchboard shop at a busy moment. In passing through the works we noticed that a new and larger smithy had been built, so that the company is able to make large forgings as well as all its iron and brass casting. The tool-grinding department, attached to the tool stores, has proved a considerable saving. All the tools are ground there before they are served out to the workmen, a system which has always been found to avoid much time wasting around the grindstones and emery wheels. Among the tool-grinding machines we noticed an interesting "Universal" emery wheel (made by the Gisholt Machine Co., of Madison, Wisconsin) for grinding the cutting tools at various angles, a chart being provided, so that the setting of the machine is done almost mechanically, and another machine for sharpening twist drills.

The generating station, supplying current to the works, may be passed over with a very short reference. It does not represent the pattern of machines which the company is manufacturing at present, but rather affords examples of the extreme old age to which well-designed dynamos can attain. In addition to the continuous-current and three-phase generating plant, a rotary converter is employed as an auxiliary.

At a press view of the works on Friday last week, Mr. J. Irving Courtenay, one of the Directors of the Company, made the following remarks :—

In the regretted absence of our Chairman, Sir Daniel Cooper, it is my agreeable duty to welcome you to Bushbury Works. The Electric Construction Company has, what I think may fairly be termed a very

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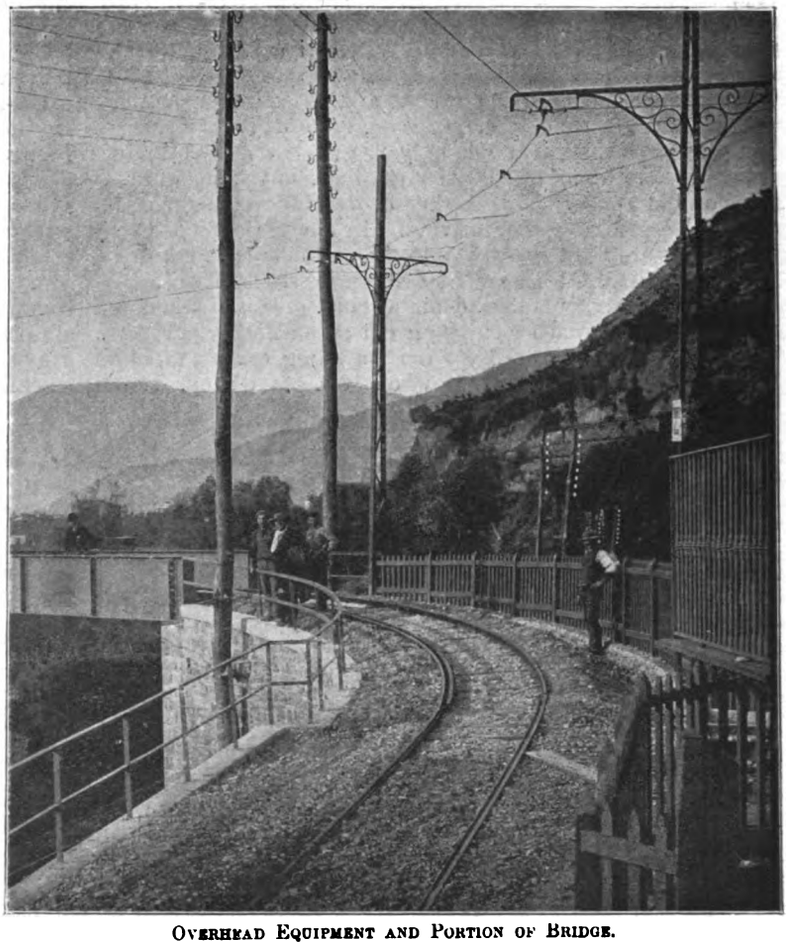
creditable exhibit at the exhibition, but as sometimes we are asked whether the Electric Construction Company is in a position to turn out the large work now demanded, it was thought that ocular demonstration would be the most convincing proof of our ability to turn out the very largest electrical plant required anywhere; our new shops having been recently finished and equipped after long delay, owing to the difficulty in getting delivery of the superb and up-to-date machine tools you will see in them. The Electric Construction Company does not manufacture electrical accessories, such as meters, small switch work, &c., but lays itself out for all kinds and sizes of electrical machinery. The Company is not engaged only on continuous current machines or traction machinery, but is manufacturing the latest and most efficient machines for dealing with the newest problems, both continuous and polyphase current, whether motors or generators, and thus the breadth of our experience is perhaps greater than that of any other British firm. We have a staff that has experience in handling large contracts in their entirety, and controlling them right throughout. In these days when foreign competition is upon us in full swing, it behoves those whose duty it is to face and overcome this competition, to be on the alert, and the Directors of the Electric Construction Company have spared neither money nor endeavour on their part to render its workshops, by these important additions, capable of executing well and speedily whatever may be required of them, and I feel sure that, with the assistance of our staff, with Mr. Moore at their head, we shall be able to hold our own against all comers, and that during the inspection your own observation will satisfy you that the words I have used are justified.

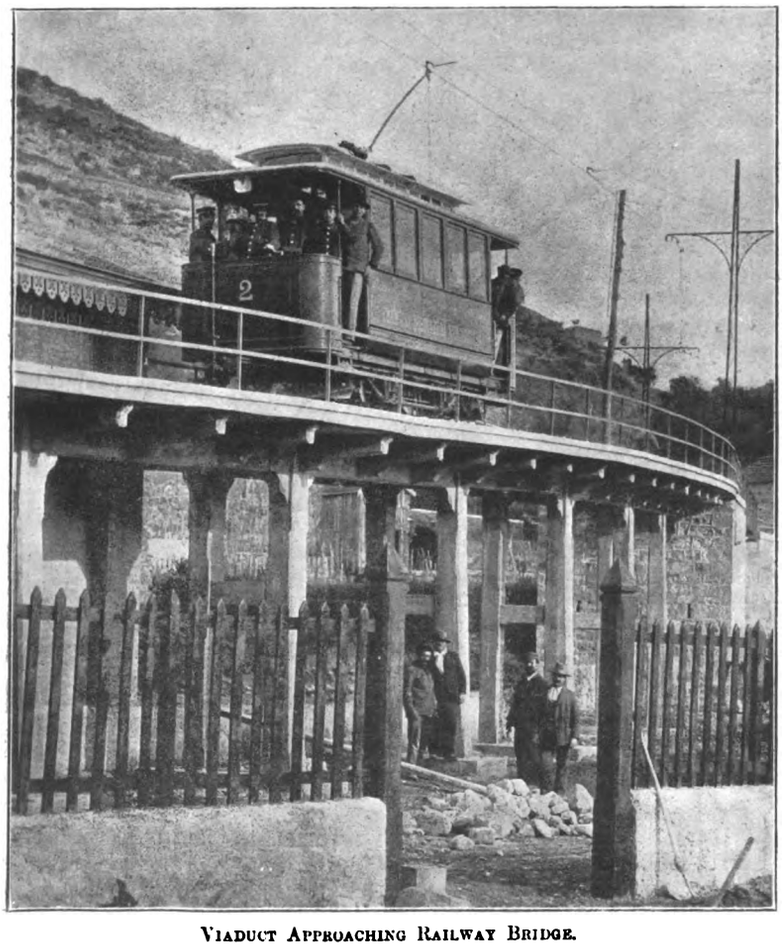
THE BORDIGHERA AND VENTIMIGLIA ELECTRIC TRAMWAY.

At the end of last year the towns of Bordighera and Ventimiglia, on the Italian Riviera, were connected by the opening of an electric tramway, which has been laid between them. The Woodhouse and Bailie Riviera Electricity Co. (Ltd.) are the owners of the tramway, and have carried out the preliminary work which is essential before such undertakings can be started—the obtaining of concessions and permission from those parties who will be most affected by the laying of the lines. The original concession was granted to the company in 1898, but the scheme was opposed by the Mediterranean Railway Co., who succeeded in delaying the undertaking for two years. The railway company's line crosses the provincial road about half-way between the towns of Bordighera and Ventimiglia, and their consent to the tramway crossing, either above or below the metals, was necessary before the Government could authorise the construction of the line. At first they refused to consider any proposal from the concessionaires, but upon influential pressure being brought to bear, they were compelled to come to an arrangement. It was finally decided to construct a bridge over the railway lines, some little distance to the west of the level crossing, the approach to the bridge being by way of a viaduct. The bridge is built up of iron girders resting on masonry and the viaduct, consisting of seven spans 16ft. 3in. long, is made in re-inforced cement. In the official tests of this viaduct each span was loaded with 32 tons of earth in sacks, and under this weight the deflection of the central portion was, in no case, more than 0·9in. A loaded car, with an approximate weight of 12 tons, passing up and down, caused no deflection whatever.

The line is nearly 3½ miles long, and there are three turnouts, while the lines are double at the ends. The overhead trolley system has been adopted, the wire being carried on side brackets or centre poles, according to the nature of the line. The cars, similar to the type common in Genoa and Milan, have a seating capacity for 16 and standing



Overhead Equipment and Portion of Bridge.



Viaduct Approaching Railway Bridge.

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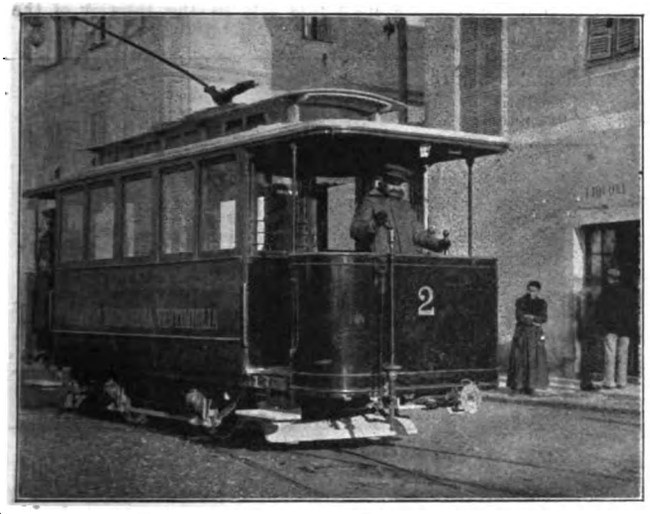
room on the platforms for 12 additional passengers. Four cars run a fifteen-minute service, and the car sheds are situated near the middle of the line, close to the bridge over the railway. The cars have been constructed by Messrs. Diatto, of Turin, and they have two motors of 20 H.P. each by Messrs. Alioth, of Basle.



TRAMCAR USED ON THE BORDIGHERA LINE.

The power for the operation of the line is supplied from the company's generating station situated at Ventimiglia, some half-a-mile from the end of the tramline in that town. There are two dynamos of 55kw. capacity at 650 volts, driven either by water turbines or gas engines. The turbines develop 75 H.P., and the gas engines, with Dowson producer gas, 90 H.P. each. The latter engines are by Crossley Bros. and Andrews & Co. respectively. A battery of Tudor accumulators has been installed at the car shed, for the purpose of equalising the load on the power house and the pressure of the line, and the cells have a capacity of 128 ampere hours. The power station also supplies both light and power for the towns of Bordighera and Ventimiglia.

During the first three months of operation some 120,000 passengers have been carried, the greater portion of this number being local inhabitants, though the line is much patronised by English visitors to the Riviera. The concession for the tramway is held for a term of 50 years, and it was granted by the Province of Porto Maurizeo and confirmed by Royal decree.

After the projected works for the development of additional water power have been completed, extensions of the present line will be made eastward to San Remo and westward to Mentone, Messrs. Woodhouse and Bailie holding the necessary concessions for the work.

CONTINUOUS-CURRENT GENERATORS.

Messrs. Dick, Kerr & Co. have issued a finely illustrated book on the above subject, giving an interesting sketch of the manufacture of standard continuous-current dynamos at the works of the English Electric Manufacturing Co. The following is a short summary of a portion of its contents, and reproductions of some of the illustrations on a much reduced scale. The Preston generator, shown in Fig. 1, represents the firm's standard dynamo. The magnet frame, comprising a circular yoke and a number of pole-pieces, is made of a special quality of cast iron, and divided on a horizontal plane, the upper and lower halves being firmly held together by four bolts. These are let into pockets on the inner surface of the castings, thus avoiding projections on the outer surface of the frame. The lower of the two halves has, cast in with it, supports, which are finished accurately on the underside to a plane parallel with the armature shaft. The magnet frame is held in a vertical position by these supports resting on two foundation girders, having screws for the adjustment of armature clearance horizontally, and a number of shim plates for adjustment vertically. The armature can be inspected by the removal lengthwise of the entire frame, and in this position it is also possible to examine or remove individual magnet spools.

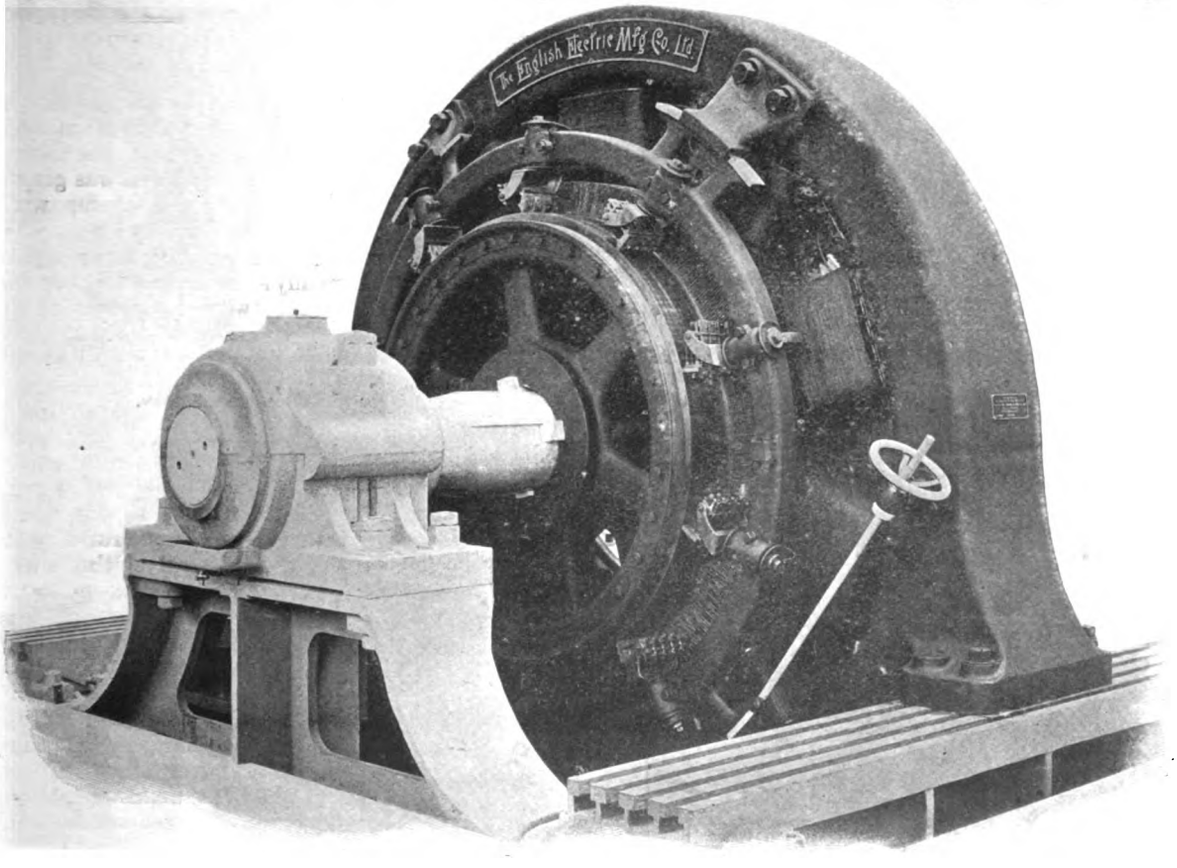


FIG. 1.—THE PRESTON GENERATOR.

The pole-pieces are of laminated steel, cast-welded into the inner

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surface of the frame. The construction of these poles can be gathered from Fig. 2, which illustrates the laminations of sheet steel, about $\frac{1}{8}$in. thick, and the clamping plates of cast steel, against which the holding rivets are driven up. When assembled, the cores, to the number required, are placed in the mould prepared for casting the frame, the ends to be cast welded (which are notched for security), being coated with a suitable flux to assist the union between the

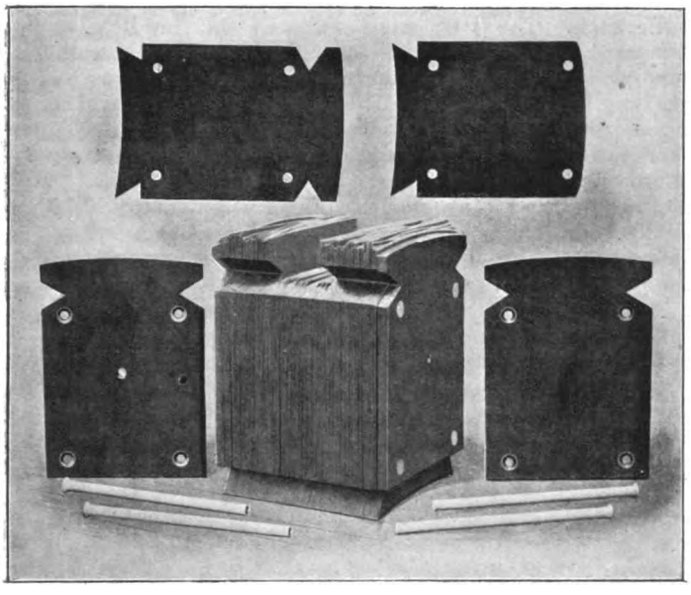

FIG. 2.—POLE PIECES.

molten iron and the steel. The prepared halves of the completed mould are illustrated by Fig. 3, and after pouring, the yoke remains in the sand several days, cooling slowly and annealing both the cast iron and steel poles, by this means increasing the permeability of the magnetic circuits. The two portions of the frame castings are then machined, bolted together, and set up on a special mill, where

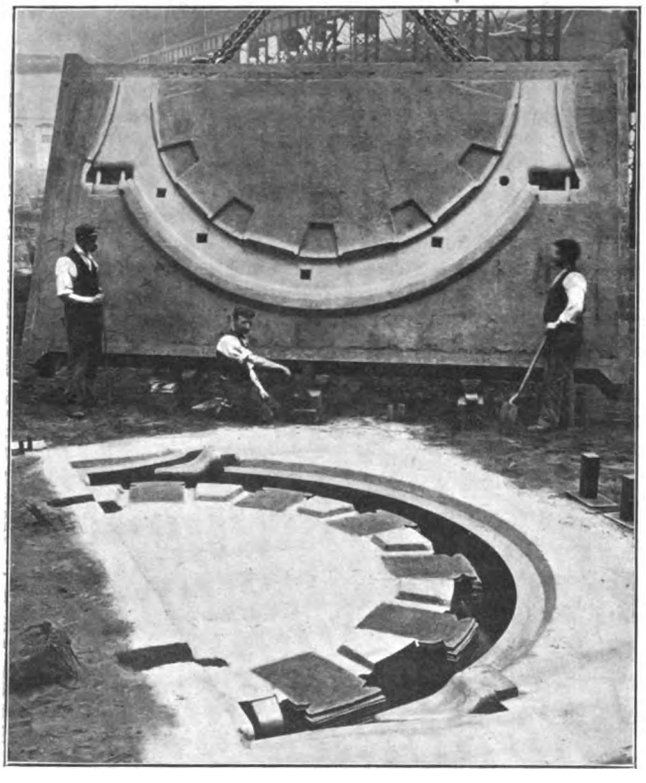

FIG. 3.—CASTING MAGNET FRAME.

the pole faces are turned true to receive the armature. A tool on the same boring bar also turns out the grooves in the brackets for the brush rocker ring, these being securely bolted to the magnet frame for the purpose.

The field coils are wound on a rectangular steel shell just large enough to slip easily over the pole-piece, brass flanges being riveted to the ends of the shell, thus forming a spool. About two-thirds of the bobbin is taken up by the shunt winding, of double cotton covered wire, the remaining one-third receiving the series winding of copper ribbon. There are no joints left in the interior of the

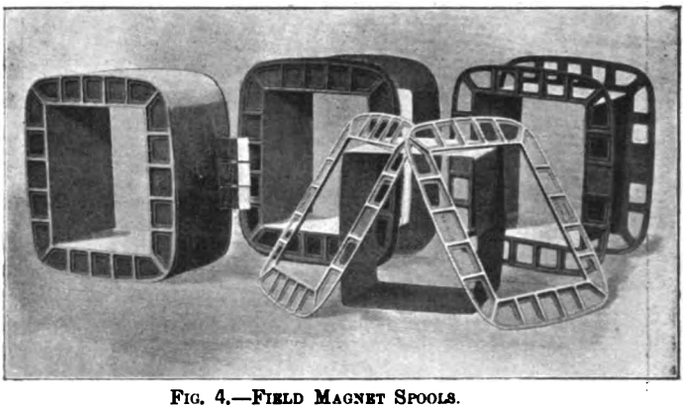

FIG. 4.—FIELD MAGNET SPOOLS.

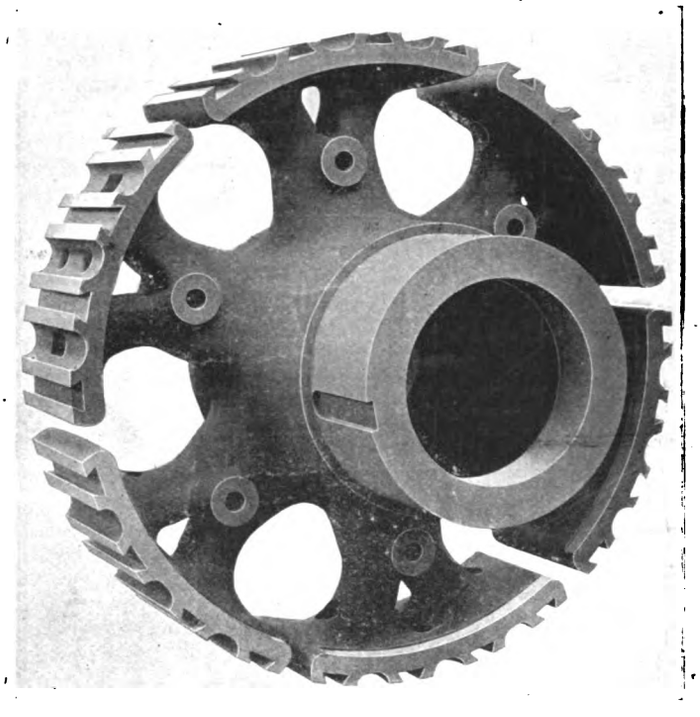

FIG. 5.—ARMATURE SPIDER.

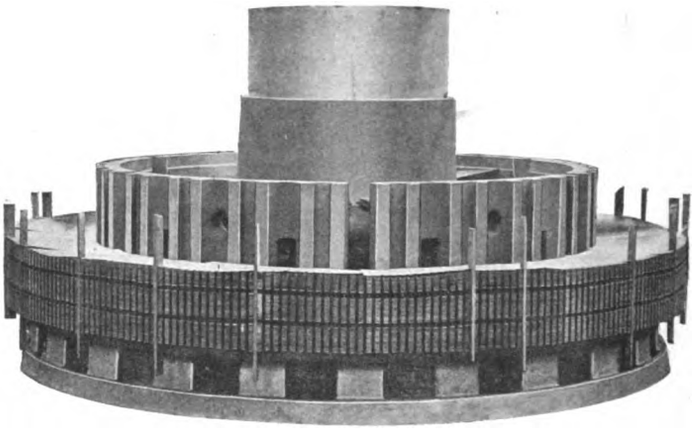

FIG. 6.—ARMATURE CORE IN PROCESS OF BUILDING.

coils, the ends of each terminating on the surface, as will be seen in Fig. 4.

The armature core stampings are built up on a massive spider (Fig. 5) keyed to the engine shaft, and the ends of the spider arms are so designed that air is admitted to the inner surface of the core, and forced through radial ducts in the laminations so as to ventilate

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the core, armature coils and field magnets. The core is built up of thin steel punchings, having keys on the inside to fit into dovetails on the spider, and slots on the outer side to receive the armature coils. These are shown in Figs. 7 and 8, the latter being the spacing segment, which is somewhat thicker than the others, and has projections punched on one or both of its sides, to form air passages through the armatute core. After being annealed and painted on both sides, a number of the segments are built up together on the spider, to form a thickness equal to the width of the pole-face, spacing discs being introduced at 3in. intervals (Fig. 6). Clamping rings securely hold the laminations together, the bolts passing through inside the core. The ring furthest from the commutator has a perforated flange at its outer edge, to support the ends of straight-wound armature coils, the ring nearest the commutator having a number of clamps for securing the balancing rings, which are connected at intervals with the commutator bars.

The commutator is assembled on a steel ring, keyed to the shaft, the segments being clamped firmly by end rings, the bolts for which pass beneath the commutator bars, in pure mica tubes. The wearing depth of the bars is never less than 1in. and the surface insulation is 1¼in. The armature coils are formed of pure copper strip, insulated with mica, red rope paper and Japanese paper, prepared with a special insulating varnish, the whole being taped over with linen braid and then dipped and baked. The commutator ends are soldered to the connectors of the segments, and the insulation resistance of a complete winding after connection to the commutator is several megohms.

The brush-holder support is a cast-iron ring, made in halves and bolted together, the entire ring being carried in brackets rigidly attached to the magnet frame, and fitted with a screw and hand-wheel for rocking purposes. No moving joints are used for the passage of current in the brush-holding gear, but a complete metallic path is provided, from the carbons to the cross connecting rings. These latter deliver the entire current to a terminal board at the bottom of the magnet frame.

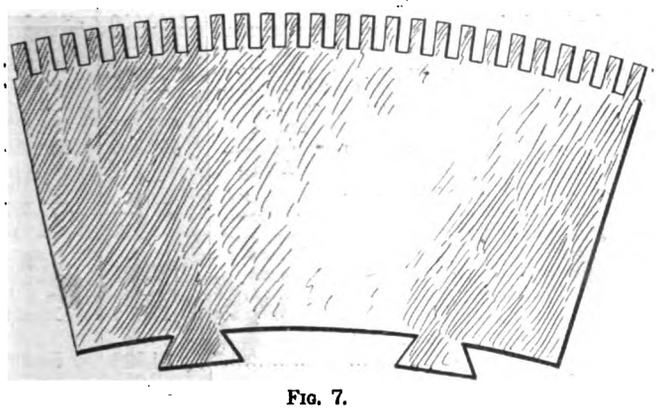


FIG. 7.

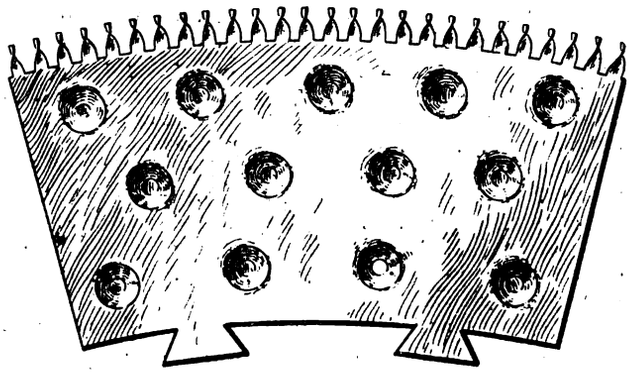
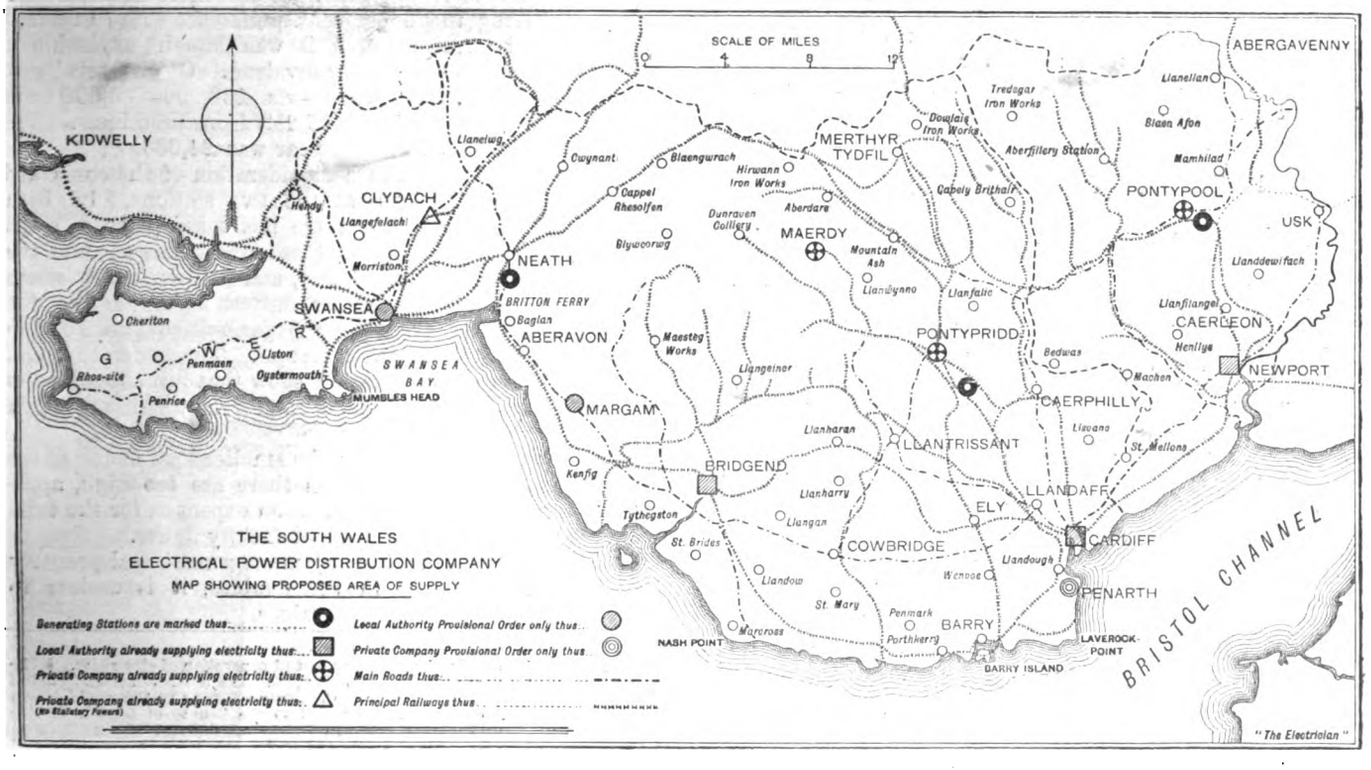


FIG. 8.

THE SOUTH WALES ELECTRICAL POWER DISTRIBUTION WORKS.

As already announced, the formal laying of the foundation stone of the first, or Pontypridd, power generating station of this company took place on the 30th ult. At present the outward and visible signs of the company's operations are practically limited to the concrete foundations for the generating sets. We reproduce below the map of the district covered by the company's powers, which we published at the time that its bill was under consideration in Parliament. This shows that the northern limits are roughly co-terminous with the northern boundary of the South Wales coal field, the area including Glamorganshire and that portion of Monmouthshire lying west of the Usk river. It is intended to put down stations at Neath, at Panteg, and other places. The site of the Pontypridd station is about 2 miles south-east of Treforest, close to the Taff river and between it and the Taff Vale Railway.

Being considerably below the level of the railway, the natural facilities for the handling of the fuel supply between the siding and the furnace hoppers are very favourable.



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The designs for the completed station provide for a building 760ft. long by 277ft. wide and 55ft. high, with a total capacity of 75,000 H.P. It is thought that the more immediate requirements will be met by the erection of a part of the station, measuring 258ft. long by 146ft. wide. As a temporary plant, partly to nurse up a load and partly to furnish power for the erection of the permanent station, two large locomotive type boilers and four direct-coupled generator sets, each of 240 H.P., are being installed, together with the necessary switchboard and other auxiliary plant.

To return to the permanent plant, it is proposed to put down at once 24 water-tube boilers of the Niclausse type, made by Messrs. Willans and Robinson, at their works on the Dee near Chester. Each boiler is of an evaporative capacity of 14,000lb. of water per hour. The boiler steam pressure is to be 200lb. per square inch, and the furnace draught will be produced by fans, which, with the feed pumps and other auxiliary plant, are to be electrically driven.

A fifth of the ultimate plant capacity is to be put down at present. Five generating sets, each of 3,000 H.P., represent the generating plant. The engines are of the Willans vertical triple-expansion, three-crank condensing type. The three cranks are, as usual, set at 120deg. apart, and are each served by virtually a complete single-acting, triple-expansion engine. These engines are similar to the two shown at the Paris Exhibition, and run at 120 revs. per min. The rated power is developed with an initial steam pressure of 180lb. and a condenser vacuum of 25in. Surface condensers will be installed in the basement below their respective engines, and the air and circulating pumps will be electrically driven.

Directly coupled to each engine will be a three-phase Ganz generator, developing current at 12,000 volts, with a frequency of 25 ~ per sec. The alternators will, of course, be run in parallel, and will be excited by a separate continuous-current generating set.

The three-core cables are to be paper insulated, lead-covered, and laid in earthenware troughs, run in with bitumen and covered with protecting tiles. The Callender Company, contractors for the mains, will commence laying cable up the Rhondda Valley early this summer. The other contractors are: For the engines, boilers and general equipment of the stations, Messrs. Willans and Robinson; for the electrical plant, Messrs. Ganz & Co.; and for the buildings, Messrs. Holloway Bros., of London. Messrs. Bramwell and Harris are the consulting engineers.

ELECTRICITY WORKS ACCOUNTS.

County of London and Brush Provincial Electric Lighting Co. (Ltd.).

This week we summarise the accounts of working during 1901 of the two London stations of the above company, the City-road works supplying the districts of St. Luke, Clerkenwell, Eastern and Western Holborn, St. George and Limehouse, &c., and the Wandsworth station for the supply of Wandsworth, Putney, Tooting, Streatham, Clapham, Camberwell, Southwark and St. Olave.

In the official accounts the several orders under which supply is carried out are separately accounted for, but there are head office expenses, salaries, &c., incurred in the working of the two stations which form part of the working expenditure, but which we are unable to include, as usual, in the respective costs table, since these expenses are grouped in the general revenue account of the company.

Besides the London undertakings the company have interests in provincial stations, but latterly the revenue from these extraneous sources has considerably dwindled. In the following table are given some of the chief particulars of the general accounts. It will be noticed that of the total revenue the London earnings form all but an inconsiderable proportion, therefore the bulk of the expenditure (£8,858) might justly be considered as additional cost to those given in our tables of analysis. A study of the financial results or net revenue accounts shows that during the last two years, at least, the only contributions out of revenue in respect of depreciation and renewals have been considerable negative quantities, – £3,815 in 1900 and – £5,259 in 1901. Divested of their minus signs these sums represent the total repairs and renewals bills of the two stations. To keep up this useful depreciation fund contributions are periodically made to it from premiums on share issues, £8,000 having been thus transferred in 1900, and £9,159 last year. The balance at the credit of the fund is now £20,000, and in a premium reserve fund £8,265. These two funds represent the whole of the reserve for depreciation on the company's expended capital of over £1,000,000.

Items.	1900.	1901.
CAPITAL.		
Authorised capital	£800,000	£800,000
Share capital received	600,000	633,279
Loan capital received	397,515	509,000
Depreciation, repairs and renewals fund	16,100	20,000
Reserve fund (from premiums on shares)	nil	8,265
Capital expended on Northern Districts orders	408,321	451,659
Capital expended on Southern Districts orders	484,356	569,355
Capital expended on Battersea Electric Lighting Order, 1900	—	1,445
Capital expended on lands, buildings, &c.	34,138	479,367
Capital expended on provisional orders	3,537	2,867
Capital invested in Bournemouth and Poole, Dover, Scottish House-to-House and Marylebone Electric Supply Companies	107,501	124,510
Preliminary & legal expenses, suspense account, net	15,671	15,591
REVENUE.		
Total	34,923	52,803
From miscellaneous sources	2,060	2,298
From Northern Districts (working profit)	15,476	24,128
From Southern Districts (working profit)	13,572	21,116
Add repairs and renewals paid out of depreciation fund	3,815	5,259
EXPENDITURE OUT OF REVENUE.		
Total	7,555	8,858
Directors' fees, rents, taxes, insurance, wages and proportions of salaries	5,480	6,249
Miscellaneous charges	2,075	2,609
FINANCIAL RESULTS.		
Balance from General Revenue Account	27,368	43,945
Balance from last account	12,594	3,639
Net interest charges	9,607	16,988
Sum available for distribution	30,355	30,596
Dividend on ordinary shares	4%	4%
Dividend on preference shares	6%	6%

After satisfying the 6 per cent. preference share dividend and £16,988 interest charges, it was thought advisable to distribute a 4 per cent. ordinary dividend. Of the total sum given as available for distribution—viz., £30,596—£3,639 came from the preceding year, and £5,259 from premiums. The amount carried forward to next year was £4,036.

It is a pleasure to turn to a consideration of the costs and the growth of the business at the two stations. In both respects and in both places there has taken place a great improvement. Naturally, the Clerkenwell station has the advantage of the higher load factor, and to this fact as much if not more than to the higher output, is, no doubt, due the lower costs and average price per unit sold recorded to the credit of the Clerkenwell station. The generating and total works costs at that station show that full advantage is now being taken of the splendid conditions which prevail in favour of low expenses.

Even making allowance for the smaller load factor of the Wandsworth load, the works costs there are too high, apparently as a result of heavy distribution expenses, for the total generating costs present a most satisfactory figure.

For the good reason that many management and property charges are not included in these tables, it is useless to attempt to discuss the total cost values.

REMARKS.

CLERKENWELL.—*a* Date of commencement of generation of electricity. *b* The total authorised capital of the *company* is £800,000. The net revenue and capital accounts are not separately rendered from the totals referring to the whole of the company's operations. *c* Capital appropriated to the County of London (North) Electric Lighting Order, 1892, the Northern Extensions Order, 1897, and Holborn and St. Giles Order, 1898. *d* £307 stores and works expenses. *e* The engineers' salaries are included under "Wages at Station" and "Distribution of Electricity" and other officials' salaries are grouped together in the general accounts of the company. *f* Insurance £167, auditing £65, law £24. *g* Maximum demand system. *h* Insurance £236, auditing £75. *i* For continuous current. For alternating, 6d. (first hour) to 3d., maximum demand system.

WANDSWORTH.—*a* The *total* authorised capital of the *company* is £800,000. The net revenue and capital accounts are not separately rendered from the total respecting the whole of the company's operations. *b* £114 to stores and works expenses. *c* Engineers' salaries are included under "Wages at Station" and distribution wages and officials' salaries are grouped together under the general accounts of the company. *d* Auditing £70, law £13, insurance £140. *e* Maximum demand system. *f* Insurance £180, auditing £80, law £58.

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	CLERKENWELL or Northern Districts.		WANDSWORTH or Southern Districts.	
Undertaking Worked by	County of London and Brush Provincial Elec-		County of London and Brush Provincial Elec-	
Date of Commencement of Supply	September, 1897.[a]	[tric Lighting Co. (Ltd.)	January, 1897.	[tric Lighting Co. (Ltd.)
System of Supply	Alternate-current from transformer sub-stations for light and continuous-current at 500 volts for power.		High and extra high-press. feeders, alt.-curr. trans. sub-stations under streets supplying low-press. 2-w. network.	
Chief Engineer	C. P. Sparks.		C. P. Sparks.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	2,549,205	3,781,079	1,403,929	2,103,626
„ **SOLD (TOTAL)**	**1,976,651**	**2,839,713**	**1,013,487**	**1,511,392**
„ sold to consumers	1,976,651	2,839,713	1,013,487	1,511,392
„ sold for public lighting, &c.	nil	nil	nil	nil
„ sold for traction	nil	nil	—	nil
„ used on works	90,335	177,906	26,964	51,947
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**21·6**	**30·6**	**25·0**	**23·0**
Actual maximum supply demanded	1,826 kilowatts	1,898 kilowatts	1,453 kilowatts	1,777 kilowatts
Load factor	12·35%	17·1%	7·96%	9·71%
Number of public lamps	nil	nil	nil	nil
Number of consumers	1,027	1,346	1,361	1,849
Connections to mains in 8-c.p. lamps at end of year	119,076	173,704	90,472	120,130
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	**2,900**	**3,050**	**1,700**	**2,500**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	—[b] —	—[b] —	—[a] —	—[a] —
Share	—[b] —	—[b] —	—[a] —	—[a] —
Loan (including Debenture charges)	—[b] —	—[b] —	—[a] —	—[a] —
RECEIVED (TOTAL)	£408,321[c] £141	£451,659[c] £148	£484,356 £285	£569,355 £228
Share	—[b] —	—[b] —	—[a] —	—[a] —
Loan (including Debenture charges)	—[b] —	—[b] —	—[a] —	—[a] —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	—[b] —	—[b] —	—[a] —	—[a] —
Share (unissued)	—[b] —	—[b] —	—[a] —	—[a] —
Share (uncalled)	—[b] —	—[b] —	—[a] —	—[a] —
Loan (including Debentures)	—[b] —	—[b] —	—[a] —	—[a] —
REPAID (TOTAL)	—[b] —	—[b] —	—[a] —	—[a] —
RESERVE OR SINKING FUND	—[b] —	—[b] —	—[a] —	—[a] —
DEPRECIATION FUND	—[b] —	—[b] —	—[a] —	—[a] —
EXPENDED (TOTAL)	408,321 141	451,659 148	484,356 285	569,355 228
Lands and buildings	74,728 25·8	75,237 24·7	71,972 42·3	76,173 30·5
Plant	170,204 58·7	195,034 63·9	131,462 77·3	163,353 65·3
Mains	153,869 53·1	171,249 56·1	278,366 164	326,807 131
Miscellaneous	9,519 3·28	10,139 3·32	2,556 1·50	3,022 1·21
BALANCE OF CAPITAL ACCOUNT	—[b] —	—[b] —	—[a] —	—[a] —
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	**£33,647 4·085d.**	**£45,903 3·878d.**	**£25,532 6·053d.**	**£37,816 6·009d.**
Revenue from supply	32,667 3·968d.	44,665 3·775d.	24,369 5·780d.	36,356 5·780d.
„ meters, &c.	979 0·119d.	1,235 0·104d.	1,158 0·275d.	1,459 0·232d.
„ public lighting	— —	— —	— —	— —
„ supply for traction	— —	— —	— —	— —
„ miscellaneous sources	1 —	3 —	5 0·001d.	1 —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£18,170 2·206d.**	**£21,775 1·840d.**	**£11,960 2·835d.**	**£16,700 2·654d.**
TOTAL WORKS COSTS	**15,381 1·866d.**	**18,190 1·537d.**	**10,660 2·527d.**	**14,638 2·326d.**
Generation of electricity	*14,159[d] 1·719d.*	*16,227 1·371d.*	*9,083[b] 2·153d.*	*11,970 1·902d.*
Fuel (including cartage, &c.)	9,177 1·114d.	9,612 0·812d.	4,640 1·100d.	6,762 1·074d.
Oil, waste, water, stores	692 0·084d.	1,279 0·108d.	610 0·145d	1,096 0·174d.
Wages at station	2,374[e] 0·288d.	2,876[e] 0·243d.	2,023[c] 0·480d.	2,272[c] 0·361d.
Repairs and maintenance at station	1,609 0·195d.	2,325 0·196d.	1,696 0·402d.	1,840 0·292d.
Distribution of electricity	*1,222 0·148d.*	*1,963 0·166d.*	*1,577 0·374d.*	*2,668 0·424d.*
Wages, &c.	1,068[e] 0·130d.	1,530[e] 0·129d.	1,221[c] 0·289d.	2,007[c] 0·319d.
Repairs, renewals of mains, &c.	154 0·019d.	433 0·037d.	356 0·084d.	661 0·105d.
Public lighting	— —	— —	— —	— —
Attendance	— —	— —	— —	— —
Renewals	— —	— —	— —	— —
MANAGEMENT AND PROPERTY CHARGES	**2,789 0·339d.**	**3,585 0·303d.**	**1,300 0·308d**	**2,062 0·228d.**
Net rents	*679 0·082d.*	*683 0·058d.*	*149 0·035d.*	*68 0·011d.*
Rates and taxes	*1,450 0·176d.*	*2,040 0·172d.*	*536 0·127d.*	*1,020 0·162d.*
Management	*660 0·080d.*	*862 0·073d.*	*615 0·146d.*	*974 0·155d.*
Salaries	—[e] —	—[e] —	—[c] —	—[c] —
Stationery, &c.	252 0·031d.	255 0·022d.	228 0·054d.	277 0·044d.
Establishment charges	153 0·019d.	269 0·023d.	164 0·039d.	379 0·060d.
Law charges &c.	255[f] 0·031d.	338[h] 0·029d.	223[d] 0·053d.	318[f] 0·051d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	**£15,476 4·15%**	**£24,128 5·61%**	**£13,572 3·14%**	**£21,116 4·01%**
Sum carried to Depreciation Fund	—[b] —	—[b] —	—[a] —	—[a] —
Sum carried to Reserve Fund	—[b] —	—[b] —	—[a] —	—[a] —
Net interest on loans (incl. Debenture charges)	—[b] —	—[b] —	—[a] —	—[a] —
Net profit for the year	—[b] —	—[b] —	—[a] —	—[a] —
BALANCE FROM LAST ACCOUNT	—[b] —	—[b] —	—[a] —	—[a] —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	—[b] —	—[b] —	—[a] —	—[a] —
Deficit	—[b] —	—[b] —	—[a] —	—[a] —
ORDINARY DIVIDEND PAID	—[b] —	—[b] —	—[a] —	—[a] —
PERCENTAGE OF TOTAL COSTS TO REVENUE	54%	47·5%	46·9%	44·2%
Expenditure per mean kilowatt capacity	£6. 4s. 2d.	£7. 6s. 5d.	£9. 4s. 0d.	£7. 19s. 2d.
REVENUE PER MEAN KILOWATT CAPACITY	**£11. 10s. 0d.**	**£15. 8s. 5d.**	**£19. 12s. 10d.**	**£18. 0s. 0d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**7s. 6d.**	**6s. 3d.**	**7s. 0d.**	**7s. 2d.**
Price charged for lighting, per unit	7d. (1½ hrs.) to 3d.[g]	7d. (1½ hrs.) to 3d.[g]	7d. (1½ hrs.) to 3d.[c]	7d. (1½ hrs.) to 3d.[c]
Price charged for power, per unit	2½d.	2½d.[i]	6d. (1 hr.) to 3d.[c]	2½d. per unit
Price charged for public lighting	—	—	—	—
Receipts per unit for private supply	3·97d.	3·78d.	5·78d.	5·78d.
„ „ public lighting	—	—	—	—
„ „ traction	—	—	—	—

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ELECTROMAGNETIC THEORY. Vol. III. By OLIVER HEAVISIDE. *In preparation.*

THE ELECTRICAL DISTRIBUTION OF POWER IN SOUTH WALES.

By the laying of the foundation stone of the first of the generating stations of the South Wales electrical power distribution undertaking, Sir FREDERICK BRAMWELL, on Wednesday week, inaugurated an enterprise which may have a pronounced effect upon South Wales industries. In any attempt to arrive at an opinion as to the measure of success that will attend this scheme, there are important considerations involved, besides the main question as to whether the company can afford to deliver power at a price that will make it worth while for the consumer to use it rather than generate for himself. Undoubtedly, however, it is chiefly by that criterion that the fate of the enterprise will, in the long run, be decided; but a difficulty in predetermining that fate is that the costs of production and distribution of power and the extent of its use are mutually dependent on each other.

The one, and practically the only, reason for anxiety respecting the success of these undertakings as a class, is the relatively great capital expenditure involved on distributing mains. It is almost useless to seek guidance on this question of costs from what has been done in America and on the Continent in power distribution. In such places the price of fuel is generally higher than obtains in the industrial centres of South Wales, while the general use abroad of aerial transmission lines lightens the capital load which the undertakings have to bear, and they are not hedged round with such restrictions and regulations as in this country. We believe that the statistics of our lighting and traction stations at home are, interpreted with judgment, likely to give a closer estimate of what the cost of production and transmission will probably be, and, moreover, that those statistics give a decidedly hopeful view of the possibilities of the South Wales scheme.

The curves of electricity supply works costs which appeared in these columns at the beginning of the year (*The Electrician*, Vol. XLVIII., p. 410), show that the total costs of production and distribution (including an allowance for interest and depreciation) diminish both with increase of output and of load-factor. The influence of increase of output, although pronounced, is comparatively small with large outputs, but the effect of increase in the load-factor is maintained at all values; and as the proportion of the total costs represented by capital charges increases, so does the relative influence of the load-factor for economy greatly increase. These points are, of course, to a great extent obvious, but their bearing on the present question is vital, and therefore it may not be considered irrelevant to give a few figures in support of our argument. Allowing 6 per cent. of the capital expenditure in the case of municipal concerns, and 7 per cent. in the case of company-owned works, as an allowance for capital charges, the average total costs in 1901 for the former came to 4d. per unit, and for the latter to 5·7d. Of the 4d. of the municipal undertakings, 2·24d. represented the works and management costs, and only 1·76d. the capital charges estimated on the above scale. Of the companies' 5·68d. per unit, 2·68d. were for the works and management

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costs, and 3d. for the capital charges. It will be found from an inspection of the curves that the total costs and charges of the municipal concerns diminish on an average about 0·17d. for every 1 per cent. by which the load-factor rises, and that the company costs, with their larger proportion of capital charges, fall about 0·3d. for every such 1 per cent. of the load-factor. The average load-factor was between 12 and 13 per cent. It would be rash to make any guess as to what load factor would obtain for the South Wales power stations, but it is certain that it would greatly exceed the highest yet recorded value for a traction and lighting load—that of Liverpool, which was as much as 24 per cent. last year. The costs obtained there with an output of a little over 20 million units in the year were 1d. per unit for works and management expenses, while interest on loans, depreciation and sinking fund charges (totalling 7 per cent. on the capital) increased the costs to 1·9d. per unit sold. We should be surprised if the value of the South Wales Company's load factor did not exceed 35 per cent.

It is hardly possible to imagine anywhere in the world an industrial community with a more favourable "diversity factor" than exists in the colliery and iron districts of Glamorganshire and Monmouthshire in respect to the consumption of power. Not only would this characteristic of the districts served ensure a high average load-factor, but, what is also important in connection with the mains problem, the nature of many of the industries involve high load-factors for their individual demands. As examples may be cited the pumping and ventilating loads of collieries, the demands of electro-chemical works, and the motor loads of such works as have to be intermittently carried on day and night.

The district covered by the scheme has an area of 1,084 square miles, with a population of over 1,000,000. The industries at present include collieries, steel, tinplate and copper works, quarries, railways, tramways, docks, engineering and ship-repairing works, foundries, chemical works and factories. In the immediate neighbourhood of Pontypridd the staple industry is, of course, coal mining. Unfortunately there is some reasonable opposition as well as prejudice to be overcome in the employment of electricity underground in the collieries, although this application appears one of the most obvious and advantageous of any. Up to the present the chief experience of the use of electricity below ground in South Wales has been gained with the continuous-current motor, and to anyone familiar with the conditions obtaining in such situations, it is not surprising that, on the whole, the verdict has been distinctly adverse to its employment underground. It is certain that the much more robust induction motor will present itself with far better credentials for this class of work. This type of motor is admirably suited for most purposes underground, and ought generally to displace steam, rope transmission, and even compressed air, notwithstanding the one or two peculiar advantages of the latter. For pumping, and in such places where the endless rope system of haulage is in use or applicable, the induction three-phase motor is well adapted. Compared with the continuous-current machine, its simplicity and complete freedom from sparking will remove the chief objection to the use of electricity for power underground in dusty and fiery mines. With motors installed in such situations, it will probably be found safest to provide special and separate cables to each motor from the bank or from near the bottom of the pit, where the controlling switches and automatic cut-outs would be placed.

As to the employment of electrical power in the place of steam on the surface works, the utmost economy would only be secured by its universal use to the complete exclusion of steam. Powerful conditions stand in the way of such a consummation. Colliery engineers would view with invincible reluctance the state of complete dependence of a colliery's existence on an outside agency. Then there is the very common practice of coke-making, carried on in conjunction with collieries, and in such cases advantage is now almost always taken of the heat evolved to produce steam. Given the use of steam to some extent on the surface works, it is unlikely that electrical power would ever be used for winding coal. But with steam thus at hand as a reserve power, it seems probable that electrical power might very advantageously be used normally for ventilating and pumping as well as for other purposes.

It would probably be particularly to the advantage of the consumer and the power company to arrange for the supply of power for ventilating, pumping, the driving of tipplers and picking belts, lighting and sawing. Some idea of the opportunity there exists for economising power in colliery practice may be gained by remembering the mere fact that in many works the length of steam piping, even above 6in. diameter, continuously under steam may be expressed in miles.

Perhaps of all the four power bills of 1900 which obtained Parliamentary powers, the circumstances of the South Wales scheme are the most promising. A hopeful feature for the success of this enterprise is that its promoters are connected with the industries in the area of operation. We believe their local interests amount to as much as £22,000,000 of capital. The principal prospective customers of the undertaking are likely therefore to be the promoters themselves. This characteristic of the enterprise, the sliding scale by which the permissible dividend of the company is regulated by their prices for power, and the general economy of production of a commodity arising out of a pooling of diversified needs, are features which should and will act powerfully towards the justification in practice of the undertaking. Its success would undoubtedly conduce to the industrial welfare of the whole of South Wales.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Electrician" Wireman's Pocket Book. Edited by F. C. RAPHAEL. (London: "The Electrician" Printing and Publishing Co.) 5s.

The first thing which strikes one about this pocket book is that it is really a book which can conveniently be put into an actual pocket, one of the rarest attributes of works of the kind; it is 8in. by 3½in., and less than ½in. thick, well printed on thin paper, not too flimsy, and to its 330 pages of matter only six pages of trade advertisements (excluding books published by "The Electrician" Company) have been added, which shows that the merits of the contents are relied upon to yield the profit on the publication.

The editor of the book gives a liberal interpretation to the word "wireman," only about half the matter relating to house wiring, the remainder including such subjects as systems of distributing mains, underground conductors and overhead tramway equipment.

The tables are a prominent feature of the book; all are clear, to the point, and give information that is really useful, a number being cast in a distinctly novel form. Some are merely reproductions from the trade lists of particular manufacturers, but, *faute de mieux*, they are of considerable use as a guide, and they have evidently been selected as being representative and with impartiality, so that they are free from the taint of intentional advertisement. The fact that they are derived from such sources brings into relief the lamentable absence of standardisation of electrical fittings as compared with those for gas.

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After preliminary information as to conductors generally, house wiring is dealt with in section A. A *résumé* is given of the maximum current densities allowed by the different fire offices and the Institution of Electrical Engineers. The existing rules of the Institution, together with the hoary treatise of the Phœnix Office, are given *in extenso*: the rules of other important fire offices are then touched on, the salient points of divergence of these from those quoted being pointed out, a far better way of dealing with the matter than throwing them bodily at the head of the unhappy wireman. It is to be devoutly hoped that by the time the next edition of the pocket book is brought out the 45 pages relating to wiring regulations may be reduced to the number required for the new Institution rules, now nearly ready for publication, and may the new edition of the pocket book speedily appear! Useful information is given in this section about jointing, details of connections, and other practical matters, though what human being wants to control one lamp from four points it is hard to guess, unless it be as a pleasing conjuring trick. The three-wire system of wiring buildings is described, but the absolute necessity for there being no fuses in the neutral wire is not pointed out, which is a serious omission. Three-wire services are highly desirable for installations even of small size, since they greatly facilitate the balancing of the system; but the carrying forward of three wires only throughout the building cannot be too strongly discountenanced. Installations supplied from three-wire services should always have the lamps split up evenly into two-wire circuits. Sixteen pages of condensed information as to the declared pressures and special regulations of central stations are given, corrected up to February, 1902; this should be very useful to contractors tendering for distant jobs. The Board of Trade rules for motors wound for more than 250 volts are given, and also the London County Council rules for theatres, and Lloyd's regulations for ship lighting. There next follows a description of testing instruments in common use, from which one is surprised to see the very useful Kelvin set omitted, and this leads up to a description of some means of fault finding. It may be doubted whether the average wireman often uses the telephone for this purpose, at all events in the sense intended. Various systems of wiring are then described, and the section concludes with information concerning the reading of meters and details connected with these instruments and demand indicators. The weights of Hookham meters are given in a table, but it would take many tables to induce the average meter-fixer to believe that the weight of the meter he is carrying is not a function of the distance he has to take it.

Section B deals with underground lines. It is surely rare for cable manufacturers to employ other numbers of wires than 19, 37, 61, &c., and it is difficult to imagine any circumstance under which such an exact resistance could be required as to necessitate a faultily constructed cable.

Tables 28 and 29 might well be dispensed with, seeing that table 31 gives the Cable Makers' Association standard sizes. Any attempt at standardisation deserves to be welcomed and supported to the utmost.

In connection with the conductor resistances of cables, it has long appeared to the present reviewer to be absolutely wrong to specify either the sectional area or the resistance. What one wants to buy is conductivity, and so long as a cable has the conductivity required, it matters not at all how it be attained; but cable manufacturers are too conservative for one to dare to talk to them about mhos.

A number of particulars are given in tabular form of cables generally and of those made by particular firms, after which the leading systems of distribution are described, including polyphase arrangements and arc lighting. Then follow 22 pages describing various systems of mains in which one is pleased to find a good description of the Crompton system of bare copper strip. If the critics of this system were to study even the brief description that is here given, it would probably be useful to them. A number of methods of testing cables and localising faults are given. Next follow in full the Board of Trade regulations made under the Electric Lighting Acts, and some of the special regulations made for extra high-pressure supply. The section concludes with particulars of telephone cables.

Section C deals with overhead lines giving the Board of Trade and London County Council and other urban authorities' regulations respecting these. In view of the possibility of such conductors being allowed in connection with large power schemes, some details as to the setting out and erection of the lines would have been useful, and might with advantage be added in another edition. Some particulars are, however, given with respect to the erection of telegraph and telephone wires. The section concludes with a short account of overhead tramway construction.

Section D deals with electrical bells and interior telephone wiring, and Section E is devoted to miscellaneous matters, among which may be mentioned arc lamps, lightning conductors and batteries. One could wish that one were on somewhat more certain ground with regard to what is really required for the efficient protection of buildings against lightning.

Section F, the last, gives some detailed representative estimates for house wiring prepared by Mr. Justus Eck.

In conclusion, one may confidently recommend this book as containing a considerable amount of very useful information in accesible and convenient form for all those engaged in electrical engineering. C. H. WORDINGHAM.

THE BALLISTIC MEASUREMENT OF HYSTERESIS.

BY G. F. C. SEARLE, M.A.

Introduction.

§ 1. In 1895 I described a method* by which the energy lost through magnetic hysteresis, for a given range of the magnetic force, can be measured by the "throw" of a ballistic electrodynamometer as rapidly as changes of magnetic induction can be measured by the "throws" of a ballistic galvanometer. Though the theory of the method is, in its most elementary form, very simple, yet there are a good many details to which attention must be paid before the method becomes practical; during the last few years I have been engaged at the Cavendish Laborarory, Cambridge, with Mr. T. G. Bedford in working out these details. The results of our investigations are embodied in a joint Paper "On the Measurement of Magnetic Hysteresis,' published in Vol. 198., A, pp. 33–104 (1902) of the *Phil. Trans.* of the Royal Society. The ballistic method has also been used by Mr. R. L. Wills at the Cavendish Laboratory for the measurement of hysteresis.

The first measurements of hysteresis made in 1895 by this method gave results more than 100 per cent. too great. But though I soon found how to modify the apparatus so as to make the method yield results which agreed very well with those deduced from the areas of B-H loops obtained by the use of a ballistic galvanometer, yet it was long before I reached the more complete theory which is necessary both to indicate the mathematical expressions for the corrections which may, in practice, be required, and also to show what additional measurements are to be taken in order to determine these corrections experimentally. Under these conditions, when Mr. Bedford joined me in the investigation in 1898, we turned our attention chiefly to the examination of the effects of tension and torsion upon hysteresis—effects which are so large that any small errors due to the non-application of corrections would not alter the character of the results. I hesitated to put forward the method as giving a means of obtaining *absolute* determinations of hysteresis, although I knew by experiment that, under suitable conditions, it yielded results of considerable accuracy. I waited in the hope that some day I might be led to a more complete theory. When this theory occurred to me in 1900 there was no reason for further delay in the publication of the results which Mr. Bedford and I had already obtained.

It has thus come about that a small part only of the Paper published by the Royal Society is occupied by matter of direct interest to an electrical engineer. In the present article I endeavour to give a connected account of the principles

* "A Method of Measuring the Loss of Energy in Hysteresis." *Proc.* Cambridge Phil. Soc., Vol. 9, Part I., November 11, 1895.

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involved in the ballistic method of hysteresis measurement, together with a description of the practical details of the method. The general theory given in the Royal Society Paper is rather long, but by confining myself to the consideration of such forms of test pieces as engineers would require to test, I shall be able to present the theory in a form which will not only be exact enough for all practical purposes, but also at the same time both will make clear the methods to be adopted if the results given by the elementary theory are to be approximately accurate, and will indicate the procedure to be followed in determining the corrections when appreciable.

Since, with proper apparatus and with suitable test pieces, the values of the hysteresis given by the elementary theory are very nearly exact, it will be well to begin with an account of the theory in its simplest form.

§ 2. The theory by which the late Dr. John Hopkinson* obtained a mathematical expression for the energy lost in hysteresis, forms the starting point of my work. In this theory a fine iron wire is supposed to have its ends welded together so as to form a circular ring of large radius; the length of the wire is l cm. and the area of its cross section A sq. cm. Let this ring be uniformly wound with insulated wire at the rate of N turns per centimetre, so that the total number of turns is Nl, and let the wire be without resistance. Then, if C be the current at any time, and H the magnetic force acting on the iron, $H = 4\pi NC$. If B be the magnetic induction in the iron, the total flow of induction through the circuit at any instant is $AlNB$, provided the wire be wound closely upon the iron. Hence, when B changes, there is, by Faraday's law, an E.M.F. $AlNdB/dt$ between the ends of the magnetising coil; the rate at which work is done in driving the current against this E.M.F. is $AlNCdB/dt$ ergs per sec.

Here and throughout the Paper, unless the contrary is specified, C.G.S. units are employed.

Using the relation $H = 4\pi NC$, and noting that Al is the volume of the iron, we see that the rate of working per cubic centimetre is $1/4\pi \cdot HdB/dt$. The work spent per cubic centimetre during any finite change is thus

$$\frac{1}{4\pi}\int H\frac{dB}{dt}dt = \frac{1}{4\pi}\int H dB, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which is Hopkinson's expression.

In the present Paper we are only concerned with the work spent in causing a complete cycle of magnetic changes; since the electromagnetic energy is the same at the end as at the beginning of a cycle, when a cyclic state has been reached, this work is equal to the energy dissipated during the cycle. I shall use W to denote the energy dissipated by hysteresis per cubic centimetre per cycle, and shall express W in ergs per cubic centimetre per cycle. Thus

$$W = \frac{1}{4\pi}\int H dB. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

To obtain the value of W by means of this expression it has been usual to construct a B-H loop, best by the method described by Ewing,† and to find its area. This process is easy enough, but since it involves not only the observations necessary to find 10 or 12 points on the B-H loop, but also the estimation of the area after the loop has been plotted, quite an hour is required for each determination of W.

Approximate Theory of the Method.

§ 3. Let an iron ring, of section A sq. cm. and mean circumference l cm., be wound with N turns of primary windings per centimetre, so that the total number of turns is Nl. The current C, which passes through the primary and magnetises the iron, producing the magnetic force $4\pi NC$, passes also round the fixed coils of a sensitive electro-dynamometer. A secondary coil of n turns is wound on the ring, and is connected in series with the suspended coil of the dynamometer, and with an earth-inductor or some other appliance for causing a known change of induction through the circuit; let the total resistance of the secondary circuit be S.

In finding the total flow of induction through the secondary coil, we must notice that since the secondary will not generally be closely wound upon the iron, there will be a certain flow of induction through the secondary due to the magnetic force H produced by the primary current. The total flow of induction through the secondary coil is thus $AnB + MC$, where M is some constant.

Let the primary current C change gradually (1) from $+C_0$ to $-C_0$ and back again to $+C_0$, so as to complete a cycle, or (2) from $+C_0$ to $-C_0$, making a semi-cycle. At any instant, during the change, the E.M.F. $And B/dt + MdC/dt$ is set up in the secondary. If the resistance S of the secondary be very great, so that the "time-constant" of that circuit is very small, the effect of self-induction may be neglected, and the current in the secondary may be taken to be

$$c = \frac{An}{S}\frac{dB}{dt} + \frac{M}{S}\frac{dC}{dt}.$$

Let the couple experienced by the suspended coil of the dynamometer, in its equilibrium position, when the currents in the fixed and suspended coils are C and c respectively, be qCc dyne-centimetres. Then, when S is so large that the magnetic force due to c is negligible, we may write H for $4\pi NC$, and thus we find for the couple at any instant

$$\text{Couple} = qCc = q\frac{An}{4\pi NS}H\frac{dB}{dt} + q\frac{M}{S}C\frac{dC}{dt}.$$

If the time of vibration of the moving coil be so great that the cycle or semi-cycle is completed before the coil has sensibly moved from its equilibrium position—a necessary condition if the instrument is to be used ballistically—the angular momentum acquired by the coil is

$$K\omega = \int qCc\,dt = \frac{qAn}{4\pi NS}\int H\frac{dB}{dt}dt + \frac{qM}{S}\int C\frac{dC}{dt}dt, \quad . \quad . \quad (3)$$

where K is the moment of inertia of the coil and ω the angular velocity imparted to it by the impulse.

Now, when C goes through either a cycle or a semi-cycle, $\int CdC$ vanishes, and thus

$$\frac{1}{4\pi}\int H dB = \frac{NS}{An}\int Cc\,dt. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Let θ radians be the greatest angular displacement or throw of the coil, and f the restoring couple exerted by the suspension per radian of displacement. Then, equating the initial kinetic energy to the potential energy at the end of the swing, we have $\frac{1}{2}K\omega^2 = \frac{1}{2}f\theta^2$.

or
$$K^{\frac{1}{2}}\omega = f^{\frac{1}{2}}\theta. \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The three quantities q, K and f are eliminated, and the "constant" of the dynamometer is determined in the following manner:—Let a constant current C′ flow in the primary circuit, through the fixed coil, and, while this current is passing, let a known change, P, in the flow of induction through the secondary circuit, be made by inverting the earth-inductor, or in any other convenient manner. The time-integral of the current thereby produced is P/S, and hence the initial angular momentum of the suspended coil is

$$K\omega' = qC'P/S. \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

If ϕ be the throw produced, we have by (5) $\omega/\omega' = \theta/\phi$, and hence, by (3) and (6),

$$\int Cc\,dt = \frac{C'P}{S\phi}\theta. \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Thus, by (4)
$$\frac{1}{4\pi}\int H dB = \frac{NC'P}{An\phi}\theta. \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Since it is only the ratio θ/ϕ which appears in (8), we may take, instead of θ/ϕ, the ratio of the two throws of the spot of light along the scale, provided that the throws are not so large that $\tan 2\theta$ differs appreciably from 2θ. With a *circular* scale this limitation is not required.

The effect of damping has, so far, been neglected. We shall correct for this if we understand the symbols θ and ϕ in (8) to be the throws when corrected for damping. The corrections should be applied to θ and ϕ separately, since the logarithmic decrement will not be the same in the two cases, unless C_0 and C′ are equal, for it is of the form $\lambda = a + bC/S$.

In § 4 of the *Phil. Trans.* Paper we stated, erroneously, that the ratio θ/ϕ is unaffected by the damping; in § 14, however, the point is correctly stated.

* *Phil. Trans.*, Vol. 176 (1885), p. 466.

† Ewing, "Magnetic Induction in Iron and other Metals." 3rd edition, revised, § 192.

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§ 4. If, instead of making the primary current go through a complete cycle, we make it go through a semi-cycle from $+C_0$ to $-C_0$, or *vice versa*, we can very conveniently combine the measurement of the hysteresis, by the dynamometer, with the measurement of the magnetic induction, by a ballistic galvanometer. For, if the galvanometer be connected with a second secondary coil wound upon the specimen, its throw gives the value of $B_1 - B_2$, where B_1 and B_2 are the *algebraical* values of B corresponding to $+C_0$ and $-C_0$. In the ideal case $B_2 = -B_1$, and then $B_1 = \frac{1}{2}(B_1 - B_2)$.

In any case, I denote $\frac{1}{2}(B_1 - B_2)$ by B_0, and call it the *mean maximum induction*. When the specimen is a ring, the ballistic galvanometer only enables us to find B_0; it gives no information as to B_1 or B_2.

Mr. Bedford and I each observed one instrument, and thus made simultaneous observations for W and B_0.

§ 5. To take the specimen through a complete cycle the current must go first through the semi-cycle $+C_0$ to $-C_0$, and then from $-C_0$ to $+C_0$. If the iron has reached a cyclic state the throws of the *galvanometer* will be equal and opposite for the two reversals. But it will often happen that, on account of the previous treatment of the iron, B_1 differs considerably from $-B_2$ in spite of very many reversals, and then the throws of the *dynamometer* differ in magnitude for the two reversals, though they are in the same direction.

A little consideration shows us how to proceed. Let $abca'b'c'a$ (Fig. 1) be a B-H loop, and let ad, $a'd'$ be drawn parallel to OH. By the reversal $+C_0$ to $-C_0$, let the iron be caused to go through the changes represented by the curve

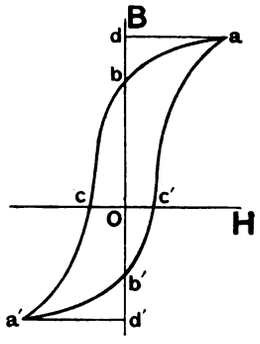

FIG. 1.

$abca'$. From a to b, H is positive and dB is negative, while from b to a' both H and dB are negative. Hence the value of $\int H dB$ for the semi-cycle $+C_0$ to $-C_0$ is given by (area $bca'd'$) − (area abd). Similarly, $\int H dB$ for the other semi-cycle is given by (area $b'c'ad$) − (area $a'b'd'$). The value of $\int H dB$ for the complete cycle is thus the area of the B-H loop $abca'b'c'a$.*

If θ_1 and θ_2 be the two throws of the dynamometer for the two semi-cycles, we have, by (8),

$$\frac{1}{4\pi}\int_{B_1}^{B_2} H dB = \frac{NC'P}{An\phi}\theta_1, \quad \frac{1}{4\pi}\int_{B_2}^{B_1} H dB = \frac{NC'P}{An\phi}\theta_2,$$

and hence, since W is the sum of the two quantities on the left sides of these equations,

$$W = \frac{NC'P}{An\phi}(\theta_1 + \theta_2). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Thus, to find W, we have simply to add together the two throws for the two semi-cycles, and then to multiply the result by $NC'P/An\phi$.

The expression (9) is the fundamental formula of the method employed by Mr. Bedford and myself in the measurement of hysteresis. From it we see that the only instruments of known numerical constants which are required are an ampere-meter, for the determination of C', and an earth-inductor or other means of producing a known change of induction (P) through the secondary circuit.

Complete Theory of the Method.

§ 6. I shall now show how to take account of the energy dissipated both by eddy currents in the specimen and by the current in the secondary circuit. Referring the reader to the *Phil. Trans.* Paper for a general account of the theory, I will here simplify the mathematics by supposing that the iron under test has a cross-section of at least 1 sq. cm., since with such a section, unless the experimenter wilfully arranges the secondary in a disadvantageous way, the only part of the flow of induction through the secondary, which is worth considering, is that which occurs in the iron itself.

In the primary circuit, let the magnetising coil and the fixed coil of the dynamometer be placed next each other, and let R be the resistance of the conductor so formed, and let E be the voltage between its ends. Then, denoting by L'C the part of the flow of induction through the primary due to the magnetic *force* in the air arising from C itself, and neglecting the part of the flow due to the magnetic *force* in the air due to c, the flow through the primary is $NlAB + L'C$. The flow of induction through the secondary, to the approximation just mentioned, is nAB. Hence the equations for C and c are

$$E = RC + NlA\frac{dB}{dt} + L'\frac{dC}{dt}, \quad . \quad . \quad . \quad . \quad (10)$$

$$Sc = nA\frac{dB}{dt}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

By the principle of the conservation of energy, the work done by the voltage E during a semi-cycle is equal to the energy dissipated by hysteresis and by eddy currents in the whole of the specimen, together with the heat produced in the resistances R and S, and the increase in the electromagnetic energy of the system and the kinetic energy acquired by the moving coil of the dynamometer.

The kinetic energy is quite negligible in the present case, where the volume of the specimen is several cubic centimetres. For, with the dynamometer which Mr. Bedford and I used, the kinetic energy due to a semi-cycle never amounted to one-tenth of an erg, while the energy dissipated in a single cubic centimetre of iron for a cycle between the limits ± 1,000 for B is counted by hundreds of ergs.

Now, let W_1, W_2 be the energy dissipated by hysteresis per cubic centimetre for two semi-cycles, so that the loss per cycle is $W = W_1 + W_2$. Further, let AX_1, AX_2 be the energy dissipated by eddy currents, per unit length of specimen, for the two semi-cycles.* Then the total energy dissipated in the specimen in the first semi-cycle is $Al(W_1 + X_1)$, ergs.

Thus, if T, T' be the electromagnetic energy at the beginning and end of the first semi-cycle, we have

$$\int EC dt = (W_1 + X_1)Al + R\int C^2 dt + S\int c^2 dt + T' - T. \quad . \quad (12)$$

But, from (10),

$$\int EC dt = R\int C^2 dt + NlA\int C\frac{dB}{dt}dt + L'\int C\frac{dC}{dt}dt. \quad . \quad (13)$$

Since the term involving L' vanishes for a cycle or a semi-cycle with the limits $\pm C_0$, we find, on comparing (12) with (13),

$$(W_1 + X_1)Al = NlA\int C\frac{dB}{dt}dt - S\int c^2 dt - T' + T.$$

Transforming the right side by (11), we have, after division by Al,

$$W_1 + X_1 = \frac{NS}{An}\int C c dt - \frac{n^2 A}{Sl}\int\left(\frac{dB}{dt}\right)^2 dt - T' + T. \quad . \quad (14)$$

§ 7. The first integral is proportional to the throw of the moving coil, for by (7)

$$\frac{NS}{An}\int C c dt = \frac{NC'P}{An\phi}\theta_1.$$

* Mr. T. G. Bedford, who has kindly read the proofs of this article, has pointed out to me that the inequality in the two dynamometer throws—amounting perhaps to 5 per cent. for freshly annealed soft iron even after 50 cycles or 100 reversals of H—cannot be accounted for by a mere shifting, parallel to the axis of B, in the manner indicated in Fig. 1, of a B-H loop, which is symmetrical with respect to the axis of B. It is no doubt true that, in some cases, $+B_1$ is not equal to $-B_2$, but this in itself does not explain the inequality. The effect must be attributed to a want of symmetry of the loop with respect to the axis of B, though, of course, the distances ad, $a'd'$ are always equal.

* The rate of heat production by eddy currents is not uniform over the cross-section of the specimen. When dB/dt is small, the rate at any point is proportional to the square of the distance from the centre, when the section is circular, and to the square of the distance from the line through the centre parallel to the two longer sides, when the section is a very narrow rectangle. The last is applicable to strips of transformer sheet.

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It is convenient to have a single symbol for this quantity and I use U_1 for this purpose, U_2 corresponding to θ_2, while $U = U_1 + U_2$. Thus U is the uncorrected value of the hysteresis loss which is given by the sum of the two throws of the dynamometer as in (9).

The second term on the right side is the heat produced in the secondary circuit during the first semi-cycle. It will be denoted by Y_1. For a complete cycle $Y = Y_1 + Y_2$.

§ 8. To obtain an expression for X_1—the space-average of the heat produced per cubic centimetre by eddy currents during the semi-cycle—we notice that, if the induction change slowly enough, the eddy currents may be calculated on the assumption that B has, at any instant, the same value at all points of the section. In this case the eddy current at any point is proportional to dB/dt, and inversely proportional to σ, the specific resistance of the iron. Thus, when the geometrical *form* of the section is given, $AldX/dt$, the rate at which heat is produced in the specimen, will be, by Joule's law, proportional to $l\sigma^{-1}(dB/dt)^2$ and can, besides, only depend upon the absolute *magnitude* of A. Employing the method of "Dimensions," we have

$$[L^3]\frac{dX}{dt} = \text{rate of working} = \frac{[E^2]}{[R]} = \left[L^2\frac{dB}{dt}\right]^2\left[\frac{L}{\sigma}\right],$$

so that

$$\frac{dX}{dt} = \frac{[L^2]}{\sigma}\left(\frac{dB}{dt}\right)^2.$$

Hence we can write

$$\frac{dX}{dt} = \frac{QA}{\sigma}\left(\frac{dB}{dt}\right)^2, \quad \ldots\ldots \quad (15)$$

where Q is a numerical constant depending upon the *form* of the section, its value being $\frac{1}{8}\pi$ or 0·03979 for a circle and 0·03512 for a square. For iron we may take $\sigma = 10^{-5}$ ohms per centimetre-cube or 10^4 C.G.S. units.

If the specimen be so laminated that it is built up out of p similar portions, each insulated from the others, and each of section A/p, the rate at which heat is produced per unit length of a *single* portion is, by (15),

$$\frac{A}{p}\cdot\frac{Q(A/p)}{\sigma}\left(\frac{dB}{dt}\right)^2$$

so that for the whole section,

$$\frac{dX}{dt} = \frac{QA}{p\sigma}\left(\frac{dB}{dt}\right)^2, \quad \ldots\ldots \quad (16)$$

where, of course, Q now refers to the form of each of the p portions.

§ 9. The equation (14) now becomes

$$W_1 = U_1 - X_1 - Y_1 - T' + T.$$

If we add together the results for a pair of semi-cycles, the quantities T′ and T disappear, when a cyclic state has been established. We thus obtain

$$W = U - X - Y = U - Z, \quad \ldots\ldots \quad (17)$$

where

$$Z = X + Y. \quad \ldots\ldots \quad (18)$$

From (14) and (16) we find

$$Z = A\left(\frac{Q}{p\sigma} + \frac{n^2}{8l}\right)\int\left(\frac{dB}{dt}\right)^2 dt, \quad \ldots\ldots \quad (19)$$

the integral now referring to a complete cycle. We notice that Z is always positive; thus U always exceeds W.

Now, since Z is merely a correcting term, it will suffice to use in it the value which H has when S is infinite and when c is, in consequence, zero. This value is $H = 4\pi NC$. We thus obtain

$$Z = 16\pi^2N^2A\left(\frac{Q}{p\sigma} + \frac{n^2}{8l}\right)\int\left(\frac{dB}{dH}\right)^2\cdot\frac{dC}{dt}dC. \quad \ldots \quad (20)$$

Now the quantity dB/dH is, for a given specimen, a nearly definite (double-valued) function of H, and therefore of C, for given limits $\pm C_0$, and hence the correction to be subtracted from U, in order to obtain W, will be increased k-fold, if for every value of C, which occurs during the cycle, dC/dt be increased k-fold. We may thus write

$$Z = \left(\frac{Q}{p\sigma} + \frac{n^2}{8l}\right)\int z\frac{dC}{dt}dC, \quad \ldots\ldots \quad (21)$$

where z depends upon C, N and A, but not upon dC/dt.

The form of Z is of great importance in the ballistic method. For, if dC/dt be made very small, as it may by the use of a proper choking coil in the primary circuit, Z will be very small, and also, if for every value of C, dC/dt can be increased in a known ratio, as it may by the use of a proper key, Z can be experimentally determined when appreciable.

(To be continued.)

PROCEEDINGS OF COMMITTEE ON ELECTRICAL LEGISLATION.

We have received the minutes of the proceedings of this Committee whose report and resolutions we published on page 46 of our last issue. The meetings were held on various occasions during last year. At the first meeting on April 29, 1901, the points for the consideration of witnesses were brought up, these being as follows :—

1. As to whether the electrical industry in the United Kingdom is in a backward condition as compared with other countries, and, if so, in what respects, and due to what causes.

2. As to the practical economy and public advantage of electrical power supply undertakings and of electrical traction undertakings dealing with areas of suitable character in regard to size, distribution of population and of trade, but without reference to local government boundaries.

3. As to the effect such undertakings are likely to have upon overcrowding difficulties in congested centres of trade.

4. Concerning the present state of legislation relating to the electrical industry, and as to the amendments which are desirable in the interests of the general community and of the manufacturing trades of the country. Reference to acts, reports, &c. :—

(*a*) Electric Lighting Acts, 1882-8, sec. 1: "Notwithstanding anything in the Electric Lighting Act, 1882, no provisional order authorising the supply of electricity by any within the district of any local authority shall be granted by the Board of Trade except with the consent of such local authority, unless the Board of Trade in any case in which the consent of such local authority is refused are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, and in such case they shall make a special report, stating the grounds upon which they have dispensed with such consent."

(*b*) Report of Joint Select Committee of Parliament, 1898, appointed to consider and report upon a reference in regard to "Electrical Energy—Generating Stations and Supply." Extract from Committee's report :—

"Where sufficient public advantage is shown, powers may be given for the supply of electrical energy over an area including districts of numerous local authorities, and involving plant of exceptional dimensions and high voltage. The Committee further think that undertakings of this character may properly be authorised on conditions differing in some respects from those imposed by and under the existing acts.

"The Committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order, should be amended. In their opinion the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto, only to be dispensed with in special cases by the Board of Trade."

(*c*) The Tramway Act, 1870, particularly sections in regard to "consent," "frontagers," and "purchase."

(*d*) The Light Railway Act in relation to the compulsory purchase section of the Land Clauses Act, running powers, competitive lines, &c.

(*e*) The Parliamentary Standing Orders, in relation to special Acts for tramways. Number 22 requires consent of local authorities as a condition precedent to such an Act being considered on its merits.

5. As to changes desirable in procedure with a view to reducing the time occupied and expense incurred in obtaining authority to carry out electrical undertakings.

6. As to the most suitable arrangements under which the scientific and practical knowledge of the Institution can be placed at the service of the Board of Trade so as to ensure questions concerning rules, regulations, and other administrative matters of a diverse character, being dealt with in the best informed manner.

7. As to the most promising means of giving effect to their recommendations.

Mr. MADGEN was, on May 7th, examined, and attributed the backward state of the electrical industry as principally due to restrictive legislation and the advantage taken of such by some legal representatives of the local authorities. It was often to the interest of these gentlemen to oppose any scheme brought forward in the districts to which they belonged, receiving legal fees from the local authority in respect to such opposition. In 1882 electricity could have competed with existing systems of lighting, the passage of the act being direct evidence of a demand at prices then possible. The lead which both America and Germany had obtained they had been able to maintain, as our Amendment Act of 1888 altered the tenure but in other respects did not improve matters. Until recently, no objection could have been taken to the action of the Local Government Board, but in the past few months the Local Government Board had come to the conclusion that, if the Board of Trade made

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a provisional order, the local authority must have its loan. A case at Hornsey was quoted. Here, the North Metropolitan Electric Power Co.'s area of supply included Hornsey, to whose Council a tariff of 3½d. per unit was proposed. This was not gone into by the local authority, who decided to equip its own works, and though the company applied for powers to lay down isolated works, the department granted the loan, on the assumption that the Board of Trade had satisfied themselves as to the suitability of the scheme before granting the provisional order. The stringency of the Act of 1882 was in great measure due to the wild statements made by certain engineers, who impressed people with the idea that gas as an illuminant would be superseded in a few years. It was his belief that the great social advantage of the distribution of electrical power would be to take the population more into the country. The over-speculation of the early days had undoubtedly a bad effect on the industry, but it did not seriously affect the present position. The industry felt very much the want of flexibility in the Board of Trade regulations and the power of altering them to the changed condition of the industry.

On May 21, 1901, Col. R. E. CROMPTON was examined, and attributed the loss of England's position in the industry chiefly to the speculative inflation and over-statements of engineers in the early days, when the Act of 1882 was drawn up, the act itself also placing onerous conditions upon the development of enterprise. The restrictions imposed by the Board of Trade as to the use of overhead conductors also greatly hampered development as compared with America, Germany and Switzerland, where the early undertakings were carried out by overhead conductors. This enabled experiments as to feed points, distributing networks, &c, to be made more easily than with underground cables. The carrying out of schemes by manufacturers, as opposed to consulting engineers acting as media between contractor and customer, was, in his opinion, more conducive to the rapid development of such an industry as electrical engineering, the example of foreign firms in this respect being direct proof of his statement. The power and influence of the Institution should be increased, and its oldest and best members should point out to the Board of Trade and Parliament that by consulting them the interests of the country will be best served in such matters. He thought that the industry had been retarded by municipalities undertaking a business which was a new one, and which conflicted to some extent with the interest they had before in gas, and further, that local authorities ought not to invest money in any enterprise which may possibly involve the scrapping of machinery.

On July 23, 1901, Ald. IVEY (West Ham) was examined, and gave evidence from his experience as chairman of Electric Lighting and Tramways committees. In his statement he remarked that if one half the sums spent on applications for provisional orders and the promotion of Power Bills had been utilised for laying down installations, our position in the industry would wear a different aspect to its present one. The history of electricity supply in West Ham extended over 10 years, eight years of which were taken up in discussions, theories, oppositions, &c., and only on compulsion was the work undertaken to keep out private enterprise. He thought amendments of sec. 1 of the 1882-8 Act should be made somewhat as follows :—

Upon application by company for provisional order, local authority may oppose, if prepared with a counter scheme and application. Work to be commenced within 12 months from date of order being granted, failing which, Board of Trade may transfer the provisional order to the company which applied in first instance. This would preserve to local authorities full powers for their own proper protection, but would prevent them from abusing those powers by getting them to sit on.

Upon any application by a company for a provisional order for the supply of electricity within the area of a local authority, such company shall have given not less than six months' notice to such authority of its intention to apply. The local authority shall have power to appear in support or opposition to the application when it is made, provided that, if determined to oppose, may do so only on condition that on the date fixed the local authority can show that its council has passed a resolution to apply for a provisional order on their own behalf. And that the application is made and accompanied with all the requisite plans, particulars, and details of the scheme showing area to be dealt with.

He thought it almost impossible to get several local authorities to agree on joint action, where large areas were concerned, and that the Government should be the general authority, to be above local suspicions and jealousies. He considered that if a local authority could get some consideration from a company to take over the whole work, the things would be done cheaper and more quickly. He deprecated the action of socialist candidates on the West Ham Council, who, he said, had gone into a scheme regardless of cost, to further their own views. He admitted willingly that 10 years' delay had given them the advantage of improvements, but it was not always a good thing to delay, as someone must do the work and initiate experiments.

At a meeting on October 23, 1901, Ald. PEARSON (Bristol) gave evidence, which was strongly in favour of municipal enterprise. Local authorities could not stop electrical progress, as the Board of Trade could and would pass over the objection of a local authority if necessary. He attributed the backward condition of electrical matters in early times as mainly due to the fraudulent company promoter. Large towns could, in his opinion, do their own electrical work more cheaply than a company, and in smaller places grouping could be effected, or, failing this, a national system of light railways would be preferable. Public companies having to obtain their capital at the present market price could not hope to compete with the municipally-owned tramway, and any system which would vary the present contracts existing between municipalities and companies, to the advantage of the companies, would be dishonest to the public. Public rights must, in his opinion, be protected by Parliamentary control, and he would not favour any arrangement which robbed a municipality of the right to appeal to Parliament for its protection.

On November 22, 1901, Mr. R. P. SELLON was examined, and stated that the backwardness of electrical enterprise was largely due to the policy of the Legislature in determining that its development shall be subject to State and municipal control. Municipal debt had reached the sum of £260,000,000, and in electric lighting it was noticeable that numerous local authorities had used their power either to block or to hang up the introduction of a supply, only about one-third of 300 provisional orders granted having been put into force. A grave defect in the early Act of 1882 remained in the Amendment Act of 1888—namely, the practical right of veto of local authorities to the introduction of electrical enterprise within their areas. There was no organised medium for consultation with the Board of Trade, Local Government Board or Government authorities generally, and this was a prejudicial feature of our system. He urged that the Institution should take the following steps forthwith :—

(1) To create an organisation from its own body, and representatives of Chambers of Commerce and other influential bodies and persons, for the purpose of safeguarding the welfare of the industry.

(2) Make representations to the Government, either directly or through the State departments concerned, that—

(*a*) Such organisation should receive recognition and a *locus* in questions of electrical legislation and regulations.

(*b*) Amendment of existing legislation, particularly that relating to electric traction, is urgently necessary.

(*c*) The future relations of local authorities towards electrical enterprise should be defined by Parliament.

Mr. A. C. CAMPBELL SWINTON was also examined, and said that all electrical legislation had been *restrictive* and none of it *enabling*, the prime error being to give to municipal authorities a priority over private enterprise. If private enterprise had been given free scope it would have begun in large towns and been successful. Investors would then have put their money into electrical manufacturing and traction and other developments as they came along. He thought a Royal Commission preferable to a Special Committee of the House of Parliament, as members had to consider their constituents too much.

Dr. ROBERT SPENCE WATSON gave evidence at a meeting held on December 20, 1901, and from practical knowledge of Germany, Italy and Switzerland he admitted that this country was behind others; as early as 1891 he found small towns in Spain almost entirely lighted by incandescent lamps. Local government boundaries had nothing

Some Comparative Approximate Figures of Electric Light, Power, and Traction Stations in European Countries and the United States of America at the present day.

Name of country.	Station kilowatts available for lighting and power.	Station kilowatts available for traction.	Miles of single track electrically equipped.	No. of motor cars running.	Total electrical station capacity available for all purposes in kilowatts.	Population of country.	Area of country in square miles.	Total approx. capital invested in pounds.
Great Britain	200,000	50,000	900	2,600	250,000	40,000,000	121,115	35,000,000
Germany	170,000	54,000	2,300	5,400	224,000	53,000,000	211,168	29,000,000
France	70,000	...	800	1,300	95,000	39,000,000	204,146	12,000,000
Switzerland	30,000	7,500	250	330	37,500	3,000,000	15,469	4,500,000
Belgium	15,000	3,000	120	200	18,000	6,600,000	11,373	2,100,000
The whole Continent of Europe	400,000	154,600	5,000	9,800	550,000	350,000,000	3,756,970	85,000,000
U.S.A.	1,200,000	800,000	21,000	68,000	2,000,000	70,000,000	3,581,885	200,000,000

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to do with electrical power undertakings, and so long as the area was one that could be supplied conveniently from a single station economy would result. The entrusting of large electrical undertakings to municipalities, he said, was not always attended with public benefit, and he drew comparisons between Newcastle Corporation tramways and the Gateshead Tramway Co. The estimates of the Corporation had been greatly exceeded, and the power station had taken a long time to build. He thought that the fact of a corporation having the rates at their back made them more reckless in their work than was the case with a private company.

Mr. PHILIP DAWSON gave evidence, in which he said that legislation had imposed serious drawbacks on electrical development in England, it being very difficult and costly to get bills through Parliament. Municipalities had kept back power transmission especially, such schemes necessarily connecting large areas; but the power of opening streets was brought forward in favour of municipal control, the authorities desiring to retain this power to the exclusion of all others. He put in the table given on the opposite page to show the position of the industry in this country, compared with the Continent and United States.

Mr. J. CLIFTON ROBINSON also made a statement, referring especially to the practice of local authorities in imposing exorbitant terms for their consent to tramway schemes.

PARLIAMENTARY INTELLIGENCE.

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL.

On Friday last week this bill was further considered.

Mr. BALFOUR BROWNE, K.C., on behalf of the companies he represented, submitted that the preamble so far as it affected the expediency of giving the powers in clauses 3, 5, 6, 7 and 8 was untrue. The first part of clause 3 would give power to the County Council to purchase the generating station of the Central Electric Supply Co., situated on Regent's Canal, and although this company had assented to the proposal, he held that that consent was contrary to public policy, the proposal being absolutely in the teeth of the findings of Lord Cross's Committee, one of which was, "The Committee think the provisions of the Electric Lighting Act, 1888, enabling the local authority to purchase an undertaking after a term of years, inapplicable, as a general rule, to the case of an undertaker supplying energy in bulk at high voltage, but there may be special cases where it is desirable that the local authorities should have the right to purchase reserved to them. To meet such cases they suggest that the Board of Trade should have power to insert the purchase clause in the provisional order if the local authorities concerned can, in the opinion of the Board, show good cause for such a course." Sub-sec. 1 of clause 3 sinned against that. Under the existing law Westminster had no right to purchase such an undertaking as the generating station; but the bill would enable the London County Council to effect the purchase without the consent of Westminster, although the station supplied electricity to the companies who were supplying Westminster. If the County Council were given power to purchase the central station at Regent's Park they would be purchasing the thing Westminster had a right to; if power were given to Westminster to purchase that station, it would be giving a power to Westminster to purchase a thing which was not only outside its district altogether, but which it had not now got power to purchase. And, moreover, this power on the part of Westminster to purchase had been refused by Parliament. The Central and Metropolitan companies took their bills and were expending their money on the faith of the refusal of a purchase clause. If it was right for the Committee now to insert a purchase clause, would it not have been right for the Committees which some years ago considered the bills of those companies to have inserted a similar clause then when they were asked to do so? The clause would also modify the Electric Lighting Acts, and it was a well established rule in private bill committees not to modify general acts by private bills. The second sub-section of clause 3 said: "If the authorised undertakers to whom such supply may be given are authorised to supply one district only, the said power of purchase may be exercised by the local authority of the district, or by the Council with the consent of the local authority." That again absolutely altered the general law for at present the County Council had no power whatever to purchase. It was also opposed to the best opinion and precedent. The Board of Trade had refused to give this power, stating that, although there might be something in the argument of the County Council that they should be the authority, it could only be given effect to by a general act; and it would be contrary to the decisions of Parliament in the Central and Metropolitan and other cases. Again, the proposal to insert a purchase clause on behalf of the London County Council was a downright breach of the parliamentary bargain of 1888, under which the undertakers were only subject to the risk of expropriation by the local authority at the end of 42 years. The most objectionable clause of all was No. 8, which enabled the London County Council to "purchase any such undertaking, by agreement with the undertakers, before the expiration of any period at which such undertaking would have become purchaseable by a local authority under the Electric Lighting Act, 1888, or the special act relating to such undertaking, or this act." So that in districts where there were three or four companies competing the London County Council could, by agreement, buy the weakest and thus compete with and kill the other companies. That they were in a position to do so was abundantly clear by the clause going before, and they, having the electric generating stations for the tramways, while the companies were only lighting concerns, would be able probably to produce electricity at a lower rate than the companies, and even if they did not they would always have the rates to fall back upon, which would enable them to beat the companies in competition. There was not a single instance in which a local authority had been allowed to compete with an electric light company. A company against a company could hold its own, but against the London County Council, with the rates behind them, the competition obviously would be unfair. What was to prevent the County Council from making a dead loss on their electricity undertaking for two or three years, and thus ruining the companies, who would then be only too glad to sell at the terms of the London County Council? In these circumstances he held that clause 8 ought to be struck out. In every way the bill seemed against precedent, and against common sense, and it was unjust to the companies and therefore he urged that it should not be passed.

Mr. PEMBER, K.C., said the bill would enormously enhance the chances of purchase, and the chance of a purchase damaged a commercial undertaking and the bill would clearly enhance the chance of the companies suffering damage. It permitted combination among several local authorities to buy an electric undertaking, and while he did not say that might not be a good thing, he did hold that each case of the kind should be judged on its merits as it arose, and that there should not be an enabling act saying it should be done whenever local authorities chose to combine, without any reference to the merits of the proposal. The report of Lord Cross's Committee supported this view, because they stated: "It is to be observed that the exemption from liability to compulsory purchase would not prevent local authorities, either alone or in combination with other authorities, from applying for powers to purchase. But each case would have to be judged on its merits, and such conditions imposed as might be thought fit." Moreover, it might be possible for the London County Council to purchase a company or companies, and that purchase would be effected, not under the Lands Clauses Act, but under the Electric Lighting Act—practically on old iron terms. The Committee were being asked to do in a hole-and-corner sort of way what, if it was done at all ought to be done on the broadest possible principles and after the most careful investigation by means of a general act. With reference to the Central Company, which had been brought into existence solely to supply two companies—the St. James' and Westminster—he understood a clause had been agreed, as follows: "Provided always that the undertaking of the Central Electric Supply Co. shall not be so purchased unless the authority so puchasing the same shall at the same time purchase the undertakings of the authorised undertakers supplied by that company, nor shall it be lawful for the local authority to purchase the undertaking of the authorised undertakers supplied by the company unless they at the same time purchase the undertaking of the Central Electric Supply Co." That, of course, did not affect the preamble question. The joint works of the Kensington and Notting Hill Company at Hammersmith were also started to supply two companies, and there was no distinction in equity between this undertaking and the Central, and, therefore, in the event of the preamble being found proved, which he hoped would not be the case, he should ask for the insertion, on behalf of the former, of a similar clause to the one he had just read.

Mr. BLENNERHASSETT, K.C., on behalf of the City of Westminster, said he understood it was the intention of the Committee that there should be no power given to the County Council or any other body to purchase an undertaking in the city of Westminster without the consent of the Corporation of Westminster. Westminster was supplied by several different companies, some of which supplied other areas. For instance, the Metropolitan Electric Supply Co. supplied a comparatively small portion of the City of Westminster, but they also supplied the very important areas of Holborn, Paddington and Marylebone, which had an aggregate population of about 350,000 and an aggregate rateable value of over £4,000,000. Thus the population and rateable value of the portion of Westminster was very small in comparison with the aggregate rateable value and population of the other three places, or even of two of them. Therefore, if the Committee were to adopt any principle of percentage, any of those two places would be able to compel a purchase of the undertaking in Westminster. He proposed that there should be inserted in the bill a provision that there should be no power to acquire any electrical undertaking in the City of Westminster without the consent of the local authority. The matter was very serious as regarded Westminster because if the County Council were to acquire one of the electrical undertakings authorised to supply there, they might ultimately be a competitor with the City of Westminster in the supply of electricity. He then referred to the clause which had been arranged between the promoters and the Central Electric Supply Co., and had been read out by Mr. Pember. This clause was a most serious invasion of the rights of Westminster, because it would compel Westminster, when they took over the two undertakings supplying in Westminster (as, under the present law, they would have power to do in 30 years), to take over another undertaking, the Central London Company, which was outside their area. He admitted that defects existed in the present law, but this bill was not the proper way to deal with them. There was no urgency, however, because for 30 years purchase could not take place under the Electric Lighting Acts. The remarks of the President of the Board of Trade on the second reading of this bill, showed that the Government recognised that the question would have to be dealt with and that they were prepared to deal with it.

The CHAIRMAN: Mr. Gerald Balfour expressly said he was not speaking from the Government point of view, but only for himself.

Mr. BLENNERHASSETT said he only referred to Mr. Gerald Balfour's speech to show that the Government recognised the importance of the matter, and that they thought it ought to be dealt with in a public bill hereafter, and deprecated dealing with it in a premature and ill-considered private bill. Westminster, he added, wished these matters to be dealt with after due consideration by a Government measure, and they therefore asked the Committee to reject the bill.

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Mr. MOON, for the Metropolitan Supply Lighting Co., dealt with the bill first as it affected the generating station of his company at Willesden, which station, under the existing acts, was not subject to purchase. The company had three distribution areas in London—one being Marylebone, one Paddington and one the mid-London area—and its total capital was £1,600,000, which included the expenses on the generating station. His learned friends had pointed out that the legislation now proposed was *ex post facto*; but in the case of the Metropolitan Company it was something more. The question was discussed before Committees, both of the Commons and Lords, before the Metropolitan Company obtained power to erect their generating station at Willesden, and the power now sought by the County Council was asked for then and refused by both Committees. Therefore, as regarded the Metropolitan Company, the County Council were not only asking the Committee to legislate *ex post facto*, but to reverse the considered decisions of Committees of the Commons and of the Lords. Surely a difference in opinion from the Committee which dealt with the case could not be enough to justify the Committee in reversing that decision, upon the faith of which the company had expended their capital. Therefore, unless some new circumstances could be shown, so far as regarded the Metropolitan Company, whatever the Committee might do in regard to the other company, they would not reverse legislation which was passed as recently as 1898. He maintained, however, that there were no new circumstances. The vice of the bill was that it gave power in general without any special application. That was contrary to the practice of Parliament under which, in private bills, power relating to special circumstances only was given. In effect the County Council asked the Committee to alter the provisions of the public general law—the law contained in the Electric Lighting Acts. Sec. 8 of the bill provided that the deficiency of income of a purchasing body necessary to pay its way might be raised by rates. That put as plainly as possible the position which a company might be in if one of the local authorities was able to purchase the concern of a decrepit company within its area, and then take advantage of its powers and compete in the supply of electricity in that area. The question they had to deal with in sec. 8 affected almost, if not quite, the whole of the electric lighting undertakings in London. The danger underlying the clause was that in the various areas there were companies supplying, or authorised to supply, which were not too prosperous, as was the case with the London Electric Supply Co., which had power to supply in a number of districts in London, and which had never paid a dividend except on its preference shares. The company which a local authority would purchase would be one which had large powers, which had not incurred much expense, and which had made little profit; because, obviously, if the local authority were going to compete with the supplying company their policy would not be to buy a rich company for which they would have to pay a large price, but a company which was either commencing or had just started operations. Supposing the Committee found it was undesirable that they should allow competition between a local authority and company to be introduced in an indirect manner, what was the use of the bill? The operation of the bill would be deferred for 29 years, because there would be nothing, if they eliminated the agreement clauses, which could operate *in presenti*. If the agreement clauses went, the sole question the Committee would decide would be that 29 years hence the Land Clauses Act with reference to purchase should apply. He asked the Committee not to give the County Council power to assert as a principle that they were the purchasing authority in London.

Mr. FITZGERALD said no witness having been called by the opponents, he was unable to reply; but he wished to correct Mr. Blennerhassett, who was mistaken as to what the intention of the promoters was in regard to the clause, the basis of which had been arranged with the Central Company. When that clause was read out he refused to agree to its terms till he had had time to consider it. If it would deprive the Westminster Council of their present right to purchase the Westminster undertaking alone, or the St. James' undertaking alone, or both, without taking the station of the Central Company, that was not what he intended to agree to. All he would agree to was that, if the powers of this act were to be authorised for the purchase of the Central Company, then those powers should only be exercised concurrently with the exercise of the power of purchase of the Westminster Company and of the St. James' Company.

After some discussion, the CHAIRMAN said he thought the matter might be left till they discussed clauses.

Mr. FITZGERALD, continuing, said Mr. Blennerhassett also said the proposal of the bill was not urgent, and that they might very well wait till 1931. If they did wait till then it would be said: "Here, you have allowed this thing to go on for 30 years, and now, just at the moment that these powers are coming into force, you seek to alter the position." Such an observation would have a great deal of force if the County Council had acquiesced in the arrangement for 30 years. Therefore, if the position was to be altered, it should be altered now, so that all the parties might know what the alteration was, and carry on their business with that knowledge.

The CHAIRMAN, after a short deliberation with his colleagues, said that the Committee decided to throw out the bill.

LONDON UNDERGROUND RAILWAYS.

Lord Windsor's Committee.

Lord Windsor's Committee continued its sittings on Friday last.

Friday, May 2.

BROMPTON AND PICCADILLY CIRCUS RAILWAY.

Sir JAMES SZLUMPER, continuing under cross-examination by Mr. Freeman, K.C., for the Gordon Hotels, which are along the route of the junction from Piccadilly-circus to Charing Cross, said that the tunnels round the two curves along this line would be constructed in short sections with straight shields. Such a method of construction had been adopted on the Central London Railway, and among other places at Shepherds Bush.

Mr. FREEMAN: The Central London Company's engineer informs me that this is absolutely not so?

WITNESS: It has been done on many railways.

But you told me specifically that it had been used on the Central London Railway. Do you still say so?—I have been informed to this effect.

You intend to increase the size of one of the curves on this line to 4½ chains. This will still come within the error mentioned by Col. Yorke that no curves should be less than 5 chains?—I do not think he put it forward as an error.

Will it not be necessary to slacken the speed of the train on these curves?—At the Charing Cross end it will be, for the reason that the station is just there, but in the ordinary way there would be no necessity for slowing.

Sir ALEXANDER BINNIE was next examined. He said he had given evidence before the Joint Committee last year as to the possibility of the Brompton-Piccadilly Railway forming a portion of a through route to the City. His evidence was not intended to recommend any particular route, but only to point out where the proposed lines appeared incompatible with each other in the public interest. The combination which Mr. Yerkes had now taken in hand constituted, in his opinion, a most economical way of providing communication east and west of London. The actual cost of the extensions now proposed, and which were necessary to give the completion of the scheme, including the Parsons Green branch, would be £1,678,000, or, excluding the Parsons Green line, £851,000.

Cross-examined by Mr. VESEY KNOX, for the Brompton and Piccadilly Railway, he agreed that a great portion of the Morgan group was compatible with the Yerkes group. As far as the North-East London Railway was concerned he still maintained his opinion, given last year, that it was a good one. The London County Council, for whom he then appeared, was faced with the difficulty that the District and Metropolitan Railways, and other lines, represented over £20,000,000 in capital, and their opinion was that this should be taken into consideration in connection with the sanction of any new lines from Hammersmith to the City. The extensions in the present bill were proposing to do for under a million what would cost others some three or four millions.

Mr. VESEY KNOX: What is your opinion now, as against last year, with regard to confluent junctions?—A good many things have changed since last year. Col. Yorke has stated that he has somewhat changed his on this question, and I have very much modified mine.

Viscount KNUTSFORD: I think you are mistaken as regards Col. Yorke. It was in the matter of through routes upon which Col. Yorke stated he had changed his views.

Mr. J. R. CHAPMAN, chief electrical engineer to the Underground Railway Company of London, the syndicate under which the Yerkes combination of lines will be worked, said the power station would have a capacity of 50,000kw. The generating pressure would be 11,000 volts, which would be transformed down to 550 volts for the running pressure. The negative rail would be near one of the track rails inside, and the positive near the track rail outside, and this latter would be protected by wood in such a way that the collecting shoes on the trains would collect the current, after the manner of a conduit tramway. This method of construction had been submitted to the Board of Trade jointly by the District and Metropolitan Railway Companies, and had been approved. The potential of the negative rail could not be, under ordinary operating conditions, anything above that of the track rails, and it could be walked upon with impunity. He objected to the proposals of the amalgamated lines of the Morgan house in respect of the position of the working conductors. Being so close together, there was the possibility of an arc forming across the two conductors, and the dust caused by the collecting shoes on the train would tend to sustain such an arc. The block system of signalling which it was intended to instal, automatically operated the trains through a compressed-air mechanism controlled by electricity.

Lord WINDSOR here interrupted, and said that all these details, being under the jurisdiction of the Board of Trade, it was unnecessary to go too fully into them.

Continuing, Mr. CHAPMAN said the speed of a train could only be carried to the limits of endurance of the passengers, and 2ft. per sec. per sec. acceleration had been found to be the one most suitable. Consequent on Mr. Balfour Browne's cross-examination of Mr. Yerkes on the previous Wednesday he had sent an engineer to Liverpool to ascertain the actual working speed on the Liverpool Overhead Railway, and it was found to be only between 13 and 14 miles per hour. The speed which was being proposed for the District Company's lines was the one which all operating companies had proved to be a success. As to the curves on the Piccadilly–Charing Cross line 3½ chains was very safe, and on American lines there were some with only half that radius—in fact, what were called right angle curves.

Cross-examined, he said the total cost of the electrical equipment of the tube railways was estimated at £460,642. On the District Company's lines they intended to use larger wheels in order that the motors did not cut into the carriage. The main objection to the larger tube in this connection was the difficulty of making them a commercial success. An undertaking must be a commercial success before it could be an engineering success.

Mr. MOON, K.C., for the London United Electric Railways: I put it to you that a train has been constructed at the Preston works, and is working successfully upon the Liverpool Overhead Railway at an average speed of 19½ miles per hour, including stoppages?—I must dispute that.

Viscount KNUTSFORD: Is it merely an experimental train?

Mr. MOON said that it was being worked as part of the schedule, and had been so successful that the existing rolling stock was being converted, and that all new stock would be built after this model.

Mr. CHAPMAN, continuing, said that on the Boston Elevated Road the speed had had to be reduced from 20 miles an hour to 16 because it was found impossible to maintain the service at the higher speed.

A number of local witnesses were then called in respect of the con-

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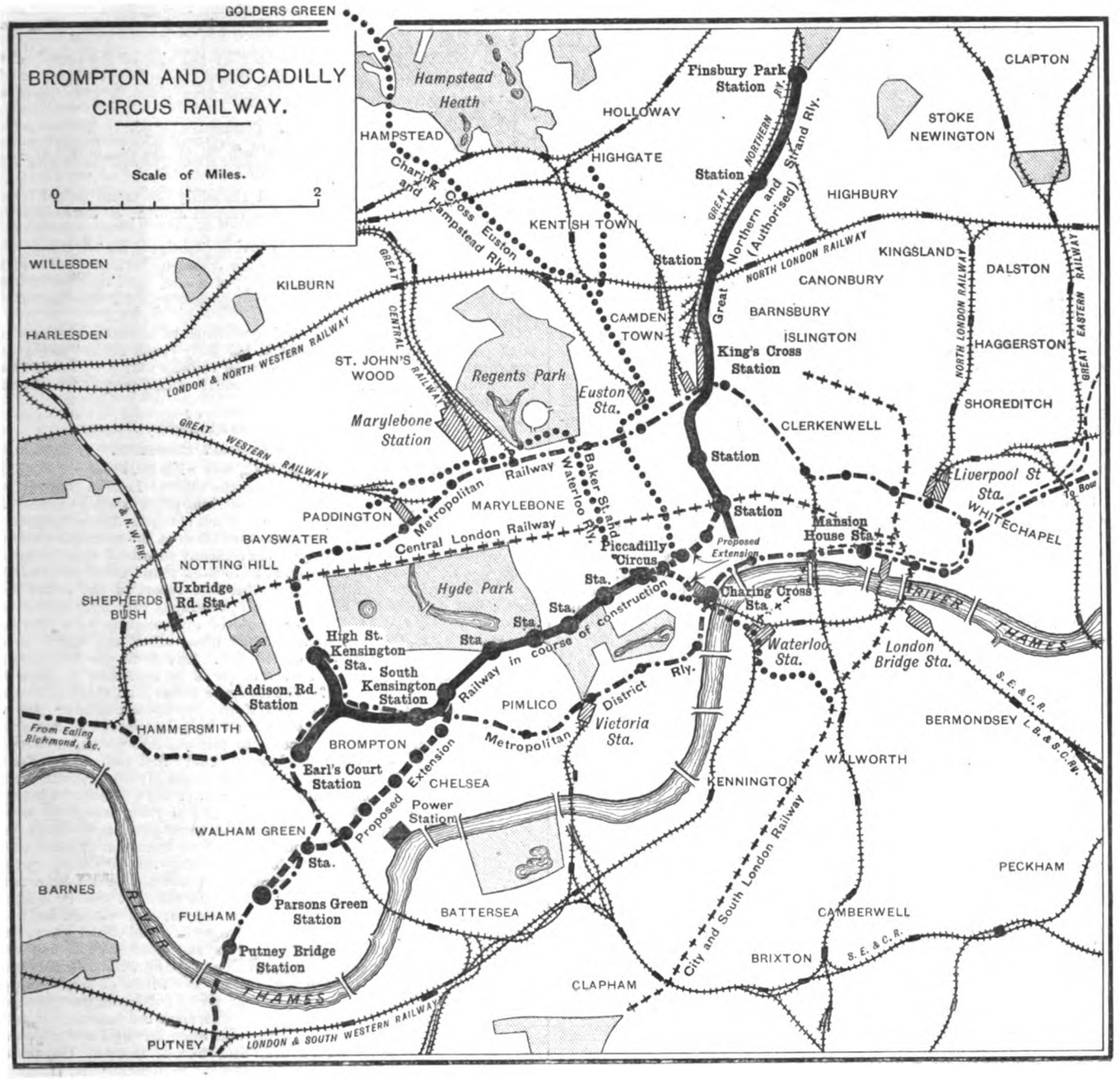

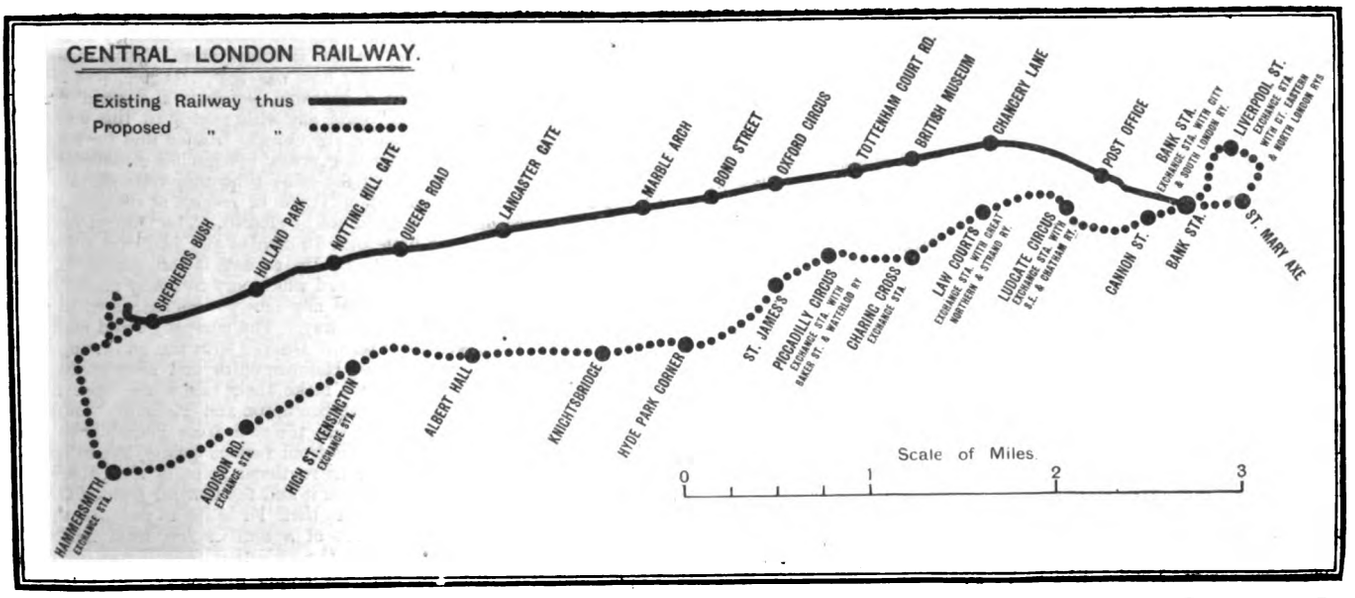

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nection between the Brompton–Piccadilly Railway and the northern lines of Mr. Yerkes's group.

Sir Henry Oakley, one of the promoters of the Great Northern and Strand Railway; Mr. George Spicer, a Hatfield resident; The Chairman of the Friern Barnet District Council; Mr. Allan Forbes, a member of the Middlesex County Council; Mr. W Grienling, chief traffic manager of the Great Northern Railway; Mr. Alex. Ross, engineer to the Great Northern Railway; as well as the Town Clerk and the Chairman of the Works committee of the Holborn Borough Council, all gave it as their opinion that this connection with the Great Northern and Strand Railway at Holborn would afford a much needed means of communication from the northern suburbs with the West End.

In favour of the South Kensington–Parsons Green branch were Mr. Hayes Fisher, M.P. for Fulham; Dr. C. Jackson, the medical officer to Fulham Borough Council; Mr. Chas. Botteril, formerly surveyor to the Fulham Borough Council, and Mr. Frank Boyton, a Fulham surveyor.

Mr. CHARLES PEARSON estimated the total cost of the various lands, buildings and easements for the necessary extensions of the Brompton–Piccadilly line as asked for by this year's bill at £212,930.

Mr. S. B. FORTENBAUGH, works engineer to the English Electric Manufacturing Co. (the Preston works alluded to above), then detailed his visit to Liverpool, where he timed three different trains, travelling as an ordinary passenger. One of the journeys worked out at 13 miles per hour and the other two at about 14 miles per hour.

Cross-examined, he said he knew all about the experimental train which was said to have run at 19½ miles an hour, as he was on the works at the time it was constructed. But, as a matter of fact, the train was not constructed for such a speed, although it could be run up to that speed on occasions, and he did not think 19 miles an hour could be economically maintained by any such train.

Monday, May 5

Sir JOHN WOLFE BARRY, K.C.B., considered the route served by the authorised Brompton and Piccadilly Railway and its connections with the District Railway was an ample and better one for accommodating third class neighbourhoods than any of the competing and parallel schemes now proposed. As a matter of fact, something like 90 per cent. of the Metropolitan Company's fares were third class. There would be several advantages offered by the District and Metropolitan lines from Hammersmith to the City over the tubes. The carriages would be larger, the stations were more commodious and airy, and there would be no necessity for lifts to get down to them. Generally speaking, he did not think there was any justification for any competition along the Hammersmith–City route. In connection with the tramway traffic at the Hammersmith end of the railway, if there was to be any monopoly of this for any one tube it would be disastrous for competing lines and also for the public. The distance between the District Railway running along the Embankment and a new line running down the Strand was so little that by the time a passenger had used the lift to get on to the tube railway he could have reached the already existing railway alongside the river. This fact brought out more strongly the lesser capital expenditure necessary to give practically the same facilities. The construction of a new railway entailed absorption of properties, and this absorption of property for commercial purposes was becoming most objectionable. With regard to the Central London Railway Co.'s proposals, he pointed out that, at Farringdon-street, the two sides of the ellipse would be under a quarter of a mile apart, and less at Chancery-lane. He did not think there was any engineering difficulty in constructing the curves which had been mentioned on the Piccadilly-circus–Charing Cross junction. The site for the generating station at Lots-road, was an extremely favourable one, which he had advised in 1900, one of the most important advantages being its proximity to a good water supply.

Cross-examined by Mr. RAM, K.C., for several opponents along the route of the Piccadilly–Charing Cross junction: Generally speaking he did not consider vibration depended upon curves. Lord Rayleigh's Committee, last year, of which he was a member, had thoroughly sifted this matter. There was, of course, more friction between the wheel and the outer rail, but this did not in any way increase the vibration. If the wheel base of the bogeys of the rolling stock was proportional to the radius of the curve, there was no reason to anticipate any more danger in taking a 3½-chain curve than with a 10-chain curve. He had constructed the curves at Cannon-street, which were 7½ chains radius, and the rolling stock running over these was not specially constructed for them; but there had never been any accidents through this. He admitted that the series of curves from Piccadilly to Charing Cross junction line would involve a slight leaning over of the train to one side, and a reverse leaning over on the opposite curve which came at once. This would amount to about 2in. or 2½in., but at all curves the tunnel would have a slightly larger diameter to permit of this.

Under further cross-examination, he said that before last year's Joint Committee he expressed the opinion that Parliament had made a great mistake in sanctioning the 11ft. 6in. tunnel of the Central London Railway, and he still adhered to that.

Re-examined by Mr. LITTLER, K.C.: His great objection to the size of the Central London Railway Co.'s tunnel was on the score of the impossibility of the interchange with ordinary rolling stock from existing steam lines, and not so much as between an 11ft. 6in. and 13ft. tunnel. On the question of vibration, Lord Rayleigh's Committee, as he had already mentioned, had practically settled the question that by motor coaches the vibration was unappreciable, at any rate to persons, if not to the very delicate instruments with which they experimented.

Lord WINDSOR: Do I understand that your objection to duplicate lines from Hammersmith to Hyde Park Corner is one of competition?—Yes.

On engineering grounds there is no objection?—I do not think that there s.

About the size of the tube, I understand that you prefer a larger one to that of the Central London Railway?—Yes.

Earl ZOUCHE: For what particular reason?—I think the reason is this. There is a very small amount of space between the rolling stock and the tube. If you make the tube larger and the rolling stock similarly larger the objection remains the same, but if you keep the same size rolling stock it disappears.

Lord WINDSOR: Do you consider that the size of the tunnel of the authorised Brompton and Piccadilly Railway is sufficiently large to give effect to the recommendations which have been made in your report last year?—Certainly.

When Col. Yorke came before this Committee he said he had formed the idea that a 13ft. 6in. tunnel would be a fair diameter. I conclude that your opinion is that the size of the tunnel should be such as to give a fair amount of clearance?—Yes.

And the size of the Brompton and Piccadilly line as authorised is sufficient?—Yes. The side platform is a certain amount of convenience for platelayers probably.

Viscount KNUTSFORD: But by giving passengers the advantage of an emergency platform they would have the additional advantage of walking along the permanent way as well?—Yes, of course, but I consider it would be a great danger to have these emergency platforms for the use of passengers.

Sir JOHN WOLFE BARRY having returned to correct a mis-statement in his previous evidence, said that in his early youth he had made some experiments in connection with the tube railway near Greenwich Observatory, and found that anything in the nature of clay propagated vibration more than gravel.

This was the case for the Brompton and Piccadilly Railway.

Central London Railway Extension.

The Hon. J. D. FITZGERALD, K.C., who with Mr. Freeman, K.C., Mr. Lloyd and Mr. Chapman, appeared for the Central London Railway, said that from the very commencement of the working of the existing Central London Railway, it was seen that, at the busy times of the day, there was need for a larger service, but that owing to the time taken at the terminal stations it was impossible to do this. Last year the company deposited a bill for loops at either end of the existing railway, so as to work round these and back into the station without shunting. But when the report of the Joint Committee was published it contained two paragraphs with reference to such loops, to which, of course, the directors of the company were bound to give the most careful consideration, but whose effect was really to condemn the loop at the City end of the line. The result was the proposal now made by the company in the shape of an extension of their line as seen in the map on p. 107. The line gave access to all existing means of communication along its route, and if the North-East London line was sanctioned it would be possible to have an interchange station at Cannon-street. Sir Douglas Fox's objection to this was that passengers arriving in the City from the north of London would find the carriages of the Central London full, and would not be able to get into them without much inconvenience. But a consideration of the matter put a different light upon it. The traffic on the Central London in the morning was from west to east, and at the City the large majority of their passengers would leave the line. The traffic from the north would be from east to west, and so the trains of the Central London Railway leaving the City along the proposed route for the Strand and Piccadilly would not be in that crowded state which was predicted. Another criticism was that the two sides of the line would be competing with each other, but this was not so, as the Committee would see. There were advantages in closed circuits, in as much as there were no junctions and no points and crossings, and the whole service would be continually going round and round without interruption from any outside sources. Further, around the whole of this circle the same fare would be charged as was at present charged for the shorter line—viz., 2d. This uniform fare gave an enormous convenience. It got rid of all looking at tickets when entering and when leaving the stations, and also all the expense connected with collection of tickets. He was surprised that Mr. Clifton Robinson had proposed to go back to the differential system of fares and the collection of tickets. The same system of workmen's tickets would hold good as at present, and the success of this warranted such a step. It had been said that such a line as that proposed did not admit of extension, but there was not the least difficulty in doing this, the extensions being worked on the shuttle system. With regard to the size of the tunnel, the suggestion now was that 13ft. 6in. was the proper size, the idea being to have a gangway alongside the train for use in cases of emergency. All he could say with regard to this was that no necessity had ever been found on the Central London line for such a platform, and those responsible for the Central London line considered it would be an unnecessary expense. At the same time they were quite willing to leave this matter to the Board of Trade in respect of the new lines. Of course, the existing tunnel could not be altered. The Central London line had only been working a little over 18 months and had paid a dividend of 4 per cent. on its ordinary shares. Up to date it had carried 41 millions of passengers, and this was a record which any company might be proud of, and which gave confidence that any new powers entrusted to it would be carried out in the best possible way. The company could raise its new capital on the most favourable terms. Dealing with the competing schemes, he passed by the Charing Cross, Hammersmith and District Railway, as nothing which he might say could make their case worse than their own evidence did. With regard to the Brompton and Piccadilly line, only one portion concerned him, and that was the spur from Piccadilly to Charing Cross, which seemed objectionable from various points, but in spite of its objectionable features from a constructional point of view, there seemed no physical incompatibility between it and the Central London Company's new lines, and it was quite open to their lordships to pass the two. The North-East London line, as part of a combination from north-east to south-west London, was open to the objection that it was partly in the open and thus liable to have its traffic disarranged by fogs, and the

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trains at Piccadilly or Hammersmith might be delayed through fog at Tottenham or Southgate. This large combination, which was opposing the Central London Company, had come into existence since the commencement of the sittings of this Committee. It really took in the London United Electric Tramways Co., because the gentlemen at the head of that company were promoting the lines to Hyde Park Corner. But it was practically certain that if this combination were sanctioned no lines beyond Hammersmith could ever be constructed, as this district was served by the tramway company. The combination between the tramway company and the through line was as clever a thing as ever anyone on the other side of the Atlantic could have imagined. At the same time it was not in the public interest that tramways and railways should be in the same hands. The City Corporation and the London County Council approved of the scheme of the Central London Company, and the City Corporation opposed the North-East London line coming further west than Cannon-street. In the report of the London County Council, which had just been published (*The Electrician*, April 25, p. 34), this body strongly supported the Central London Company with only one substantial modification—viz., that the company should be required to seek powers next session to construct an extension of their line from Hammersmith to Barnes, to be worked on the shuttle system, but this the Central London Company considered a premature proposal altogether.

Counsel for the combined scheme here pointed out that the amalgamation had not been arranged at the time of the publication of this report, and that, therefore, the advantages offered by it had not come before the notice of the London County Council.

Mr. FITZGERALD admitted this. Continuing, he said the position of Mr. Yerkes in the matter of London underground railways was entirely different to that of Messrs. Morgan. Mr. Yerkes had come into the field prepared to risk his money on constructing authorised lines, which no one hitherto had been inclined to do. Mr. Morgan was not proposing to do this, and he considered the proposals of these two gentlemen were only another step towards a Yerkes-Morgan combination, which would then form, on the one hand, a combination with practically all this class of communication in their control, and the public, on the other hand, helpless. The Central London Company had built up their undertaking by fair competition, and were quite willing to face all competition and risk their money in these new lines.

Sir HENRY OAKLEY, chairman of the Central London Railway Co., went at great length into the methods of working the Central London Company, the numbers of passengers carried and the financial position of the undertaking. The length of the new proposal was about 8½ miles, and there would then be five City stations supplying the very core of the City. At Broad-street lifts would be provided for interchange with the high level lines there to avoid any necessity for a passenger to come up into the street. They proposed a two-minute service running continuously. The main reason for putting this bill forward was the Joint Committee's recommendation last year that there should be a through route from Piccadilly to the City. Directly after the Liverpool Overhead Railway fire they took the precaution of lining all their motor carriages with steel, and packed them up with asbestos, and the Board of Trade were quite satisfied. The whole length of the existing railway was, and had been for months, fitted with electric lights, which could be switched on from any of the stations whenever required. On the matter of ventilation they were continually making experiments, but it was one of the details which they were quite willing to leave to the Board of Trade. With regard to the proposal of the Morgan combination, this did not suggest to him economical working. The loop at Hammersmith would only permit of a five-minute service to the City from there and Shepherds Bush. He considered the line had some undesirable difficulties at one end and a wasteful service at the other. Mr. Clifton Robinson's proposal as to fares was an impossible one, and was entirely different when applied to tramcars, where there would only be a comparatively small number of passengers delayed in case of any trouble in the collection of the fares. In a tube train there might be something like 300. With regard to through booking with the tramway company he said he could not entertain any such proposal which would involve a reduction of the 2d. fare.

Tuesday, May 6.

Sir HENRY OAKLEY, cross-examined by Mr. BALFOUR BROWNE, K.C., for the Piccadilly-City Railway, said the method of raising the capital for the new lines had not yet been settled. It would, of course, have to be raised under the obligation of the Central London Railway Co. The estimated capital was £4,151,000. Of this, works accounted for £2,110,000, land, &c., £873,000, electrical equipment, lifts, rolling stock, &c., £798,000, interest during construction £180,000, law and engineering expenses £190,000. This all came out at about £470,000 per mile.

Why can you make this line for £470,000 when you have to take so much valuable property in the City, whereas the existing Central London line cost £579,920 per mile?—This is principally because we know more about the construction of such a railway than was the case when the original line was built.

You say you have been advised by a very competent engineer: I suppose Sir Benjamin Baker?—Yes.

Do you know that Sir Benjamin Baker's estimate for the City and West End line was £620,000 per mile?—No, I do not.

Will you compete with the District Railway from Hammersmith to the City?—I suppose we shall in a way, but such competition will be a great advantage for the public.

Re-examined, Witness said that the fact of the Central London Railway Co. having some unexpended capital explained their proposed new capital not amounting to the estimated expenditure. This also had something to do with the capital cost per mile of the new lines being less than the original line. The line did not necessitate all the expenses consequent on the incorporation of a new company. As to the criticism on the distance between the lines, he said there was no doubt that along the two routes there were absolutely independent streams of traffic, which was emphasised by the promotion of other lines to serve the Piccadilly thoroughfare. He was perfectly open to arrange exchange stations between the Central London and both the North-East London and City and North-East Suburban Railways.

Viscount KNUTSFORD: Are we to understand that you are willing to arrange as many exchange stations as possible?—Certainly.

Sir BENJAMIN BAKER, the engineer to the Central London Railway, detailed the history of tube railways in London from the date of the passing of the City and South London Railway Bill. The idea of such railways was entirely British, and British investors had suffered considerably in allowing American finance to come so largely into the field. As a matter of fact, the present proposals of the Central London Company was the only absolutely through route from Hammersmith to the City which would be in the hands of one company. The Piccadilly-City did not run the full journey itself, and neither did the Hammersmith and Charing Cross line. Regarding the size of the tube it was his opinion that if the larger size had been enforced for the original line, the increased cost would have precluded it ever being constructed at all, and in this connection it was noteworthy that no accident had ever occurred by which the directors had felt the necessity of the larger tube. He confirmed Sir Henry Oakley's figures for the estimates, and he also was in agreement with the same witness that capital can be more easily raised, and on better terms, by an existing company in good credit than by a company that had to be created. Criticising the proposed loop from Hammersmith to Shepherds Bush on the London United Electric Railways, he said this was safe enough while everything went right, but if a man made a mistake the chances were all in favour of his sliding into another train. A closed circuit with interchange stations with other systems was much safer than having a line with crossover roads and junctions.

Under cross-examination, Witness expressed a disinclination to insert in the new bill the same clause for the benefit of the Bank of England as was inserted in the Central London Railway Bill of 1891, and did not propose to do so unless compelled to by the Committee. The line throughout its length in the City was in the London clay, and although he admitted that subsidences had occurred to buildings over tunnels in the clay, they had for the most part occurred near the points where shafts for the construction of the station tunnels came, and he did not anticipate any extraordinary subsidences in connection with the heavy City buildings, consequent on the construction of these extra lines. If the loop line round St. Mary-axe, Liverpool-street, and then back to the Bank were rejected, he considered it would spoil the whole scheme. In answer to Mr. Lewis Coward on behalf of the Thames Conservancy, as to the reason why this bill was asking for compulsory powers to erect a staging in the river for the purpose of disposing of the soil, and as to why he was not content to take a licence under the Thames Conservancy Act of 1894, he said all he wanted was some statutory power to effect his purpose.

Lord WINDSOR: Have such compulsory powers ever been inserted in a bill before?

Mr. LEWIS COWARD: Never in an authorised bill. The same powers are being sought in another tube bill now before Parliament, and which is being strenuously opposed. If the promoters will drop their attempt at compulsory powers, I am with them.

Mr. LLOYD, for the Central London Railway Co., said the promoters would consider the matter.

Continuing under further cross-examination, on behalf of various public buildings, churches, hospitals, &c., along the proposed route, Witness agreed that subsidence might take place years after a railway was constructed. Several counsel asked for the "Bank of England" clause, and others for clauses specifying that the company shall be liable for any subsidence for a reasonable number of years, but Sir Benjamin Baker would not pledge himself.

Mr. MOON, K.C., for the Piccadilly-City and North-East London Railways: Why is that in 1900 you estimated £620,000 per mile for the City and West End, and in 1901 only £470,000 for the present lines?—The two lines are entirely different. Then, again, we have laid out the present lines as economically as possible. Further, there is no generating station to be allowed for.

What would be the extra cost of using the 13ft. 6in. tunnel?—Roughly, £30,000.

Wednesday, May 7.

Sir Benjamin Baker's cross-examination having been concluded,

Lord WINDSOR announced that this Committee, in conjunction with Lord Ribblesdale's Committee, were inclined to consider the advisability of inserting a general compensation clause giving a limit of possibly two years after the opening of the railway during which all questions of damage arising from construction or working should be referred to a special tribunal or to an arbitrator. If the promoting companies agreed to such a clause the proceedings might be materially shortened, but the Committee reserved to themselves the right to impose on the promoters such special clauses as in their opinion might be necessary for the protection of particular buildings. The particular terms of the period were left open, and the Committee only suggested two years as the limit. Further, the Committee had not in their minds any intention of referring these matters to a court of law and a jury. If counsel for the opponents would consider this matter and draw up a clause with which the promoters agreed, the Committee would be very pleased to consider it.

Mr. PEMBER, K.C., said this ought to be a very simple matter. If once such a clause could be determined upon on behalf of all the promoters, and acceded to by opponents generally, then there would be no difficulty for two competent Parliamentary agents to settle upon the form of words. Possibly, also, if a clause for special buildings could be arranged at the same time and submitted to the Committee, the only question then would

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be to determine what buildings should come into this category. The onus rested upon the opponents who, no doubt, would consider the matter.

Mr. H. F. PARSHALL, the electrical adviser to the Central London Railway Co., said that the working of the present line had suggested no modifications for the new lines. There had never been a failure of the electrical supply since the line was opened. They proposed to extend the power house buildings, and the additional power thus provided would admit of a 1½-minute service. Consequent on the recommendations of the Vibration Committee, the directors were changing from locomotives to motor coaches, and final plans had been submitted to the Board of Trade which had expressed an unofficial approval. All the estimates for the new lines included the new motor equipments. These latter were seven coach trains with a motor car at either end, and upon these trains there would be no power circuit under the passenger coaches, the switches being worked on the relay principle. His total estimate for the equipment of the new lines, including extension of generating plant, lifts, rolling stock, &c., was £798,000. On the question of speed, he confirmed the previous evidence as to the impracticability of 16 miles per hour both from a financial and engineering point of view. He considered the fact of the line being a continuous circuit made the electrical working much more secure.

Mr. LESLIE VIGERS, surveyor and land valuer to the Central London Company, estimated the cost of the various sites for stations, easements, &c., at £873,000.

Sir FREDERICK HARRISON, general manager of the London and North-Western Railway, supported the scheme. His view for some years had been that a series of circular railway lines around London would better serve the needs of the traffic than the present system of straight lines with dead ends.

Mr. C. G. MOTT, chairman of the City and South London Railway, also gave evidence in favour of the scheme. The Bank was recognised as the great point of concentration of the London traffic, and this fact had been forced upon the City and South London Railway Co., which had been obliged to transfer their Monument station into the City. On the question of the experiment with a 2d. uniform fare on the City and South London Railway, he said this had had to be dropped because the London County Council, when they took over the South London Tramways, greatly reduced the fares, which naturally precluded any intermediate traffic without differential fares.

Mr. J. JENKIN, general manager to the City and South London Railway Co., gave it as his opinion that there practically very little intermediate traffic on tube railways, and from this it followed, he admitted under cross-examination for various opponents against the loop from the Bank to Liverpool-street and back, it was not likely to pick up a very heavy traffic.

Evidence in favour of the Central London Railway new lines was also given by the general managers of the Great Eastern and the South-Eastern Railway Companies, which was followed by similar testimony by a number of local witnesses.

This closed the case for the promoters of the Central London Railway Co.

The case for the opponents to the **North-East London** and **City and North-East Suburban Railways** was then taken.

For the Great Eastern Railway Co.,

Lord CLAUDE HAMILTON the chairman of the company, referring to the lines which last year they proposed to build under their existing railway, said that, on going into the cost of these new lines, it was found that it would be very heavy, and offered very little chance of being remunerative. They were, therefore, abandoned. At present, however, the heads of the various departments were seriously considering the question of electrifying the existing railway, and a report was to be made to the directors.

Cross-examined by Mr. BALFOUR BROWNE, he said the Great Eastern Company considered they would be making a mistake in constructing any new lines, and it was with the idea of preventing anyone else making a similar mistake that he was opposing.

Viscount KNUTSFORD: Has the electrification of the Great Eastern been decided upon.

Lord CLAUDE HAMILTON: No.

The Committee adjourned till to day (Friday).

Lord Ribblesdale's Committee.

CHARING CROSS, EUSTON AND HAMPSTEAD RAILWAY AND EDGWARE AND HAMPSTEAD RAILWAY.

The House of Lords Committee presided over by Lord Ribblesdale, which was appointed in order to relieve Lord Windsor's Committee of certain of the bills for underground railways on the tube system now before Parliament, sat for the first time on Thursday last week.

Thursday, May 1.

The first scheme under considersation was that of the Charing Cross, Euston and Hampstead Railway, which was presented in three bills, dealing with railways 1, 2 and 3.

Mr. LITTLER, K.C., on behalf of the promoters, after giving the history of the inception of the schemes springing out of the requirements of the northern and north-western suburban populations, said that the proposed line had been authorised in 1893, and an extension of time had been granted. The object was to couple up the whole of central London from the Strand, past Euston station, through Camden Town to Hampstead, and also on the other side to Kentish Town. He then described the gradual formation of the Yerkes group of proposed lines to combine the Metropolitan-District, Brompton-Piccadilly Circus, Great Northern and Strand, Baker Street and Waterloo, and the Charing Cross, Euston and Hampstead Railways, as summarised in our issue of April 11 (p. 998), and described in our report of the Parliamentary proceedings with respect to the Metropolitan-District and Brompton and Piccadilly Circus lines in our last two issues. The routes of all these lines are set out in the map on p. 107 of this issue, and in his opening statement, counsel repeated the clear outline of the scheme reported in our issue of May 2 (pp. 53 and 54) in connection with the Brompton and Piccadilly Circus Railway. The present bill proposed an extension from an interchange station to Highgate Hill, where the line would join the now authorised light railway of the Middlesex County Council. As population was rapidly increasing north of Hampstead towards Hendon it was proposed to extend the communication to Golders Green. That would also couple up with the proposals of the Middlesex County Council for tramways.

In reply to the Chairman,

Mr. LITTLER said that in the bill of last year the diameter of the tube was 11ft. 6in. wide, because a great many people thought that vibration was much lessened by small tubes. Now it was proposed not to exceed 13ft. The promoters were willing to make it such a size as the Board of Trade approved, not being more than 13ft. Making the tube larger added very greatly to the expense. There were to be two separate tubes, one for each line, as in the Central London. The main station would be at Adelaide-street, just behind St. Martin's Church, and opposite the courtyard of the South-Eastern station, and there would be a subway into that station with every convenience for interchange. The other scheme before the Committee was that of the Edgware and Hampstead line, which was to some extent competitive. They proposed to go under Hampstead Heath by a different route, though in the same direction, and it was quite clear that both tubes could not be made. That line proposed to go on to Edgware, some 6 miles further out, as an open-air railway, and if the Committee preferred the Edgware and Hampstead's route under the Heath he would be quite satisfied. But it was a *sine qud non* that his company should have the control of the whole tube from end to end, and to that the Edgware and Hampstead agreed. The learned counsel proceeded to point out the immense convenience of the proposed line, stating that there might be a subway connecting Gower-street station with Euston-square. At Kentish Town there would be an interchange of traffic with the Midland Railway, and communication would be made at King's Cross with the passengers of the Great Northern, at Uxbridge-road with the London United Tramway system, and at Oxford-street with the Central London Railway. A passenger would even be able to go from Hampstead to Southend. It would be seen that the possibilities of traffic were enormous. There was no petition attacking directly the area proposed to be supplied, and the convenience was admitted. The promoters had power, under the Act of 1893, to raise £1,416,000 by shares and £472,000 by debentures, and under the 1899 Act to raise a further sum of £360,000 by shares and £120,000 by debentures. The present bills proposed further capital powers as follows:—Bill No. 1: Ordinary shares, £1,800,000; debentures, £600,000. Bill No. 2: Shares, £450,000; debentures, £150,000. Bill No. 3: Shares, £300,000; debentures, £100,000. £138,000 was deducted for the Craven-street abandonment, leaving a total of £5,630,000. The estimated expenditure was as follows:—Works and land, £3,512,205; cost of power-house and land, electrical equipment, rolling stock, accumulators, lifts, sub-stations, cables, &c., £868,000; Parliamentary, law, engineering and administration £438,000; interest during construction £264,000; financial expenses, £346,080; total, £5,428,285, leaving a balance of £201,715 to cover contingencies. £5,000,000 was provided for the proposed schemes. With regard to petitions against the bill, he submitted that as the line would pass 260ft. below the surface, in London clay, near Lord Iveagh's residence, no injury would be caused to him. A large amount of alarm had very rightly been created amongst owners of property by reason of what took place on the Central London Railway, and a great deal of knowledge had been gained from the experience of that railway. On the Central London the permanent way was exceedingly shallow and fixed to the inside of the hard steel tube. The outer side of the tube was very heavily grouted, so as to prevent any percolation of water or any mischief being done to the surface, and in consequence was very solid and heavy. On those rails the Central London placed an engine weighing 42 tons, which was practically without any springs, in order to get the maximum of electrical power, and it went pounding along, and wherever there was any inequality in the rails it was a very serious matter indeed. The result of the conclusions of Lord Rayleigh's Committee was that the whole of that might practically be avoided. They said, in the first place, the road should be deeper, and, in the second, that it was very undesirable to have the whole of the traction placed on a springless engine. What the promoters proposed was the method which had been adopted on all the Chicago railways—viz., to have a certain number of cars made motor-cars. On the main line there would probably be seven cars, one at the head, which would be a motor, one in the centre, a motor, and one at the rear, a motor, working the whole seven cars. The springless load necessary for securing the electrical contact and traction would be only 1¾ tons on any one wheel. Experiments had been made with that method of traction by Lord Rayleigh's Committee, which was perfectly independent and appointed by the Board of Trade, and it was found impossible, even with an instrument, still less by the observation, to find that there was any vibration at all.

The CHAIRMAN asked if the practical recommendations of that Committee, which the Board were insisting upon, were carried out by the bill.

Mr. LITTLER: We are going further. We are going to put ourselves absolutely in the hands of the Board of Trade, so that if there should be any further discovery before the railway is finished as to the best method to adopt we shall adopt that method. Of course, it is to our interest to do so.

Continuing, the learned counsel said there was a petition of Messrs. Shoolbred, in Tottenham Court-road, who feared the railway would injuriously affect the foundations and stability of their premises, and another petition from the Hampstead Heath Protection Society. He briefly explained the nature of the latter petition, and submitted they had no *locus standi*.

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The CHAIRMAN, having elicited from Mr. Pulling, who represented the society, that they had no property abutting on the line of route, said the Committee could not admit a *locus*.

Mr. W. R. GALBRAITH was then called. He gave the engineering details of the proposal, and stated that Lord Iveagh's property and the premises of Messrs. Shoolbred would not be injured in any way. Even if water were abstracted the foundations of premises were not affected, as was proved in the case of the Waterloo and City Railway.

Mr. Arnold White, member of the Hampstead Borough Council and chairman of the Housing committee, and Mr. Arthur P. Johnson, town clerk of Hampstead, gave evidence in favour of the scheme. The extension to Golders Green would give opportunities for the housing of the working classes. Expert opinion had been taken on the bill, and it was decided that no harm whatever could arise to the surface of the Heath, in which the Council naturally took a keen interest.

Mr. R. W. PERKS, M.P., chairman of the District Railway, said the scheme was an integral portion of the larger scheme contemplated by Mr. Yerkes. The financial proposals before the Committee were satisfactory, adequate and secured.

Mr. CHARLES TYSAN YERKES, in answer to Mr. ROSKILL, said he had built and controlled in Chicago alone 47 miles of cable tramway, 432 miles of electric tramway, and 40 miles of electric elevated railway. The number of passengers carried was upwards of 300 millions a year. He then sketched the financial arrangements which had been made, and supported the capital powers asked for by the bill, which he considered were not excessive. Particular attention was being paid to the construction of the cars. There would be nothing inflammable about them. They would be made partly of steel, partly of asbestos, and partly of non-inflammable wood. The permanent way would also be rendered uninflammable. There would be no inflammable wood in the tunnel. Extensive investigations and experiments had been made with regard to ventilation, and a system was now adopted which would change the air in every mile of tunnel once in every 45 minutes. The generating station would be in Lots-road, Chelsea, and would cost, with the ground, £1,250,000 or thereabouts. There would be a power of 50,000kw., and it would be the largest traction station in the world.

Mr. SHAW, on behalf of the Edgware and Hampstead Railway, said that practically an arrangement had been come to with the promoters of the bill now before the Committee, by which an end-on junction at Golders Green would be constructed. A further statement on the matter would be made on the following day.

Friday, May 2.

Mr. W. R. GALBRAITH was re-called and gave further evidence with regard to the non-injurious effect upon Messrs. Shoolbred's premises by the proposed line.

The CHAIRMAN said the whole question of frontages along any line of tube railway was raised by the petition of Messrs. Shoolbred. As he understood, frontagers were affected by the passage of a tube, first, by the nearness of their premises to the line of railway, secondly, by the depth of the tunnel below that line, and, thirdly, having regard to foundations, by the soil. The first two concerned vibration and the third would concern foundations, but he supposed the foundations might also be affected to some extent by vibration.

The WITNESS said that his experience was that when the railway was once made structural injury was not caused by vibration. The tunnel would be about 24ft. from Messrs. Shoolbred's frontage, although in one place it was within 16ft. The depth of the tunnel to the rails was 60ft., and the top of the tunnel was about 12ft. above that, so that the latter would be 48ft. below the road. As to the limits of deviation, it was not proposed to take advantage of them, and he would advise the company to guarantee that the top of the tunnel should not be less than 48ft. below the surface of the road. No irreducible minimum had been laid down with regard to the depth or nearness with reference to the effect of vibration on foundations, and that remained a matter of opinion and experience. At present they were liable for damage arising by construction, and he thought if there were any failure in the works afterwards they would be bound to make that good.

The CHAIRMAN: Speaking generally, I suppose you would not see any objection to protective clauses of some uniform character being inserted in these bills where it seems reasonable to suppose that frontagers would be adversely affected?—If we had always to deal with reasonable men. But you have to take into account that we shall probably affect 1,500 frontagers, and I think the consequences of a vibration clause, which might possibly lead to proceedings by a very great number of persons, who may not be so scrupulous as Messrs. Shoolbred, might be very detrimental to the construction of the tubes.

I am assuming a model clause for these bills which would be arrived at by agreement more or less between promoters and opponents?—The danger is of a great number of claims being made, and possibly going before juries, which would lead to endless trouble and litigation.

In cross-examination by Lord ROBERT CECIL for Messrs. Schoolbred, the Witness said that the decision whether compensation should be granted rested with the tribunal before whom they had to appear. He had a wholesome dread of juries as against railway companies.

We should have no objection to an arbitrator appointed by any impartial person you like to mention?—I have been thinking the matter over, and it is very important, I think, that there should be some special court to try these cases.

The CHAIRMAN: I do not want anybody to draw the inference from what I said, that trial by jury was in my mind; nothing was more remote from it.

Lord ROBERT CECIL then addressed the Committee on behalf of Messrs. Shoolbred. He said that his clients wished a definite obligation to be put upon the promoters, that they should take all necessary precautions to prevent the leakage of water, which, by disturbing the soil, might affect the foundations of their premises.

The decision with regard to this bill was held over in order to consider the Edgware and Hampstead Railway, with regard to which an agreement had been arrived at.

Mr. JOSEPH SHAW said there was now no opposition to this scheme, an arrangement having been come to with the promoters of the Charing Cross, Euston, and Hampstead Railway, by which an end-on line was agreed upon, so that it should be worked as one complete scheme out to Edgware. All he had to do, therefore, was to put a witness into the box and prove the estimates.

Mr. DAVIDSON having been called for this purpose, the Committee deliberated in private for a short time, after which,

The CHAIRMAN announced that the preambles of the Charing Cross, Euston, and Hampstead Railway Bills, Nos. 1, 2 and 3, and also of the Edgware and Hampstead Bill were proved, and that the Committee were not prepared to put the special clause asked for by Messrs. Shoolbred upon the promoters.

Monday, May 5.

The clauses of the Edgware and Hampstead Bill having been adjusted on Friday, the clauses in the Charing Cross, Euston and Hampstead Railway Bill were now considered.

Counsel for the City of Westminster stated that all clauses had been agreed to with the exception of the vibration clause.

Mr. FREEMAN said that was so. The question of vibration would be discussed before Lord Windsor's Committee, and it was obviously desirable to have uniformity in all the bills. If the matter were to be argued before the other Committees, he would undertake that the City of Westminster should not be prejudiced in any way by not now arguing it.

It was agreed that this course should be followed.

It was also stated, on behalf of Messrs. Coutts, that all clauses were agreed with the exception of vibration, which was in like manner reserved.

Mr. WOOD, on behalf of the proprietors of the Hippodrome, stated that that building stood in the angle between the Charing Cross and Hampstead line and the Brompton and Piccadilly line. He asked for a special protective clause, which would render both lines jointly liable for any damage done to the Hippodrome, as it would be impossible to prove which line caused the damage.

The CHAIRMAN: My impression is that there will be a protection clause of some sort drafted for the benefit of all interests supposed to be affected by these lines, and you will probably find that sufficient.

After some discussion, it was agreed that the clause should stand over to be considered by the other House.

Mr. TALBOT then opened the petition of the London County Council. In answer to the Chairman, he said that on the whole they were in favour of the bill, but there were certain matters which they wished adjusted.

The proposal of the Council that the company should be compelled to give up the frontage of a piece of land in the Strand in order that that thoroughfare might be widened, was rejected by the Committee. A clause providing that all hoardings erected should be approved by the County Council, and another clause providing that the company should not have power to take, use, or interfere with any part of the surface of Hampstead Heath without the consent of the County Council, were both agreed to.

A clause was also inserted in the bill to the effect that the powers conferred by the act should be conditional on the company obtaining within 12 months of the passing of the act a certificate from the Board of Trade that there had been a bona fide commencement of the undertaking.

With regard to cheap trains for the working classes,

Mr. TALBOT said this was the decision of the Joint Committee upon the matter last year:—"The Committee finding a want of uniformity in the obligations on companies to run trains in the early hours of the morning at certain specified fares, recommend that every act should contain a clause imposing this obligation, and the clauses in the Central London Railway Act, with some modifications suggested by the representatives of the Corporation of London and the London County Council, appear well adapted to secure the desired object." The clause now brought forward by the London County Council was the Central London Railway Act, 1900, modified in the way suggested to the Joint Committee last year, and, therefore, came within their recommendation. The most important modification was that the employers could get tickets in bulk for distribution among their workmen, and that the workmen should be able to get their tickets for use on the following day.

Mr. FREEMAN said the promoters would accept that.

On the question of workmen's tickets, the Committee decided that words should be inserted to make it clear that the penny fare for the 11 miles extended to the Charing Cross and Edgware Railways, which they looked upon as one system. The London County Council desired that there should be no limitation of the company's liability to £100 in respect of workmen injured by an accident on the lines, but the Committee decided that this clause should stand.

Islington and Euston Railway.

Mr. FREEMAN, in opening the case for the promoters, on Friday last week, said that this was an extension line of the City and South London Railway from the Angel at Islington along the Pentonville-road, past the Midland Station at King's Cross, and up to Euston, and was promoted by that company. The line was 1 mile 5 furlongs long, and was important because it gave connection with several of the big railway companies. The bill was drawn upon the ordinary lines of tube railways. The line was to be constructed in two tunnels not exceeding 11ft. 6in. internal diameter, and was to be worked by electrical power, and to be in all respects subject to the regulations of the Board of Trade. The amount of capital powers was £420,000, to be obtained by the issue of ordinary or preference shares or stock, and the borrowing powers amounted to £140,000. The estimate for the works was £387,653, leaving only just over £30,000 for contingencies. The

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City and South London was an established company, and was, therefore, not like the promoters of some new lines, who had to get credit. The number of passengers carried on the City and South London was 80 millions, exclusive of season-ticket holders, and the company was very proud of the fact that there had not been a single fatal accident on the line. There would be two stations—one under the Great Northern Company's property between King's Cross and St. Pancras, with easy access by subways, &c., to the Great Northern station, St. Pancras station, to Euston station and the Charing Cross and Hampstead line. The rail level would be 109ft. below the surface at the Angel and gradually go up on a rising gradient till it was only 70ft. below the surface, but it would all be in the London clay and perfectly safe. A footway had always been provided for passengers in case they had to leave the train. In accordance with the suggestion of Col. Yorke, on behalf of the Board of Trade, provision would be made for lighting the tunnels, in case of accident, in the new extension on the old line. He thought no one would suggest that any question of vibration would arise, because there would be very light carriages drawn by independent motors, with a total weight of 13 tons 13 cwt. The total weight of the train, which would consist of engine and four carriages, would not amount to more than 40 tons, which was less than the weight of one of the engines running on the Central London Railway. The first train started on the existing line just before six o'clock, and the last one at 11:15. There was a 2¼ to 2½-minute service in the busy time and a four-minute service at other times. The line would be worked from the company's generating station at Stockwell, so that there would not be the inconvenience of taking land and putting new generating stations in the busy parts of London.

Mr. CHARLES MOTT, chairman of the City and South London Railway and of the present scheme, confirmed the opening statement of counsel.

Mr. FREDERICK HARRISON, general manager of the London and North-Western Railway, said that additional communication between the northern and southern lines was wanted, and would be provided by the proposed line.

In cross-examination he denied that more than 50 per cent. of passengers arriving at Euston had luggage. The majority had no luggage at all.

Mr. WM. FORBES, general manager of the London, Brighton and South Coast Railway, said that over 22 million passengers passed annually in and out of London Bridge station. The line would be a very great advantage for passengers who wished to go to or come from the Great Northern Railway stations. It was proposed to take passengers from London Bridge to Euston in 16 minutes.

In cross-examination he denied that people travelling on the London Brighton and South Coast Railway generally had luggage. There were 40,000 persons arrived the other day without any.

Mr. BALFOUR BROWNE: Yes, and you made them draw the match and come back again the next Saturday.

In answer to the CHAIRMAN, Mr. BALFOUR BROWNE said that the Metropolitan Railway allowed luggage the same as an ordinary railway.

Lord DONOUGHMORE, a member of the Committee, said that it was his experience that a porter could never be found to carry luggage.

Mr. BALFOUR BROWNE said the noble lord had been unfortunate. There were transfer porters to the Great Western at Paddington and also at Victoria. By section 62 of the bill the proposed line would not carry luggage beyond 28lb. in weight, and that the passenger had to carry himself, and it must not be of a nature to inconvenience other passengers, or occupy any part of a seat.

Mr. FREEMAN said that was so. People who had such luggage would have opportunities of travelling by the Metropolitan Railway.

Sir Benjamin Baker, who is one of the consulting engineers of the City and South London Railway, Mr. Blair, engineer and surveyor to the Borough of St. Pancras, Mr. A. C. Morton, on behalf of the Corporation of the City of London, and Mr. Grinling, traffic manager of the Great Northern Railway, also gave evidence in support of the bill.

The consideration of the bill was continued on Monday and Tuesday.

Mr. J. MATHIESON, general manager of the Midland Railway, said that he approved of the scheme of the Islington and Euston Bill as giving additional facilities to passengers travelling by his company to and from St. Pancras. In cross-examination he stated that his company could only run about 55 to 60 trains per day into Moorgate-street station. They were looking upon this line as an additional assistance to dispose of their London passengers on their arrival in London, and did not think it would materially affect the Metropolitan Railway.

This concluded the case for the promoters, and the petition of the Metropolitan Railway Co. was proceeded with.

Mr. ELLIS, general manager of the Metropolitan Company, gave evidence in opposition to the bill. He said that as a result of observations the company had found that very few passengers coming out of Euston Station turned Citywards, and he expressed the opinion that there was very little need for a railway between the Angel and Euston. On the other hand, to sanction such a railway would result in passengers who otherwise would travel from Gower-street to Moorgate-street travelling by the new line from Euston to Moorgate-street. He thought it would be a great injustice to authorise anything of that kind, particularly at a moment when the Metropolitan were expending large sums in the electrification of their system.

Sir J. WOLFE BARRY, consulting engineer to the Metropolitan Railway, gave similar evidence.

Mr. LITTLER having summed up the case for the Metropolitan Railway,

The CHAIRMAN announced that the Committee found the preamble of the bill not proved, and the bill is therefore thrown out.

The City and Crystal Palace Railway.

This bill was considered by the Committee on Tuesday and Wednesday.

Mr. BALFOUR BROWNE opened the case on behalf of the promoters. He said the proposal was to construct a tube railway from Cannon-street to Penge, where it would get into connection with a great system of tramways which would be in the hands of the British Electric Traction Co. The chief opponents to the bill were the London, Brighton and South Coast Railway Co. and the London, Chatham and South-Eastern Railway Co., who opposed on the ground of competition. This tube railway would give people an opportunity of getting from London to the Crystal Palace more expeditiously than they had been able hitherto. The proposed line would be 7 miles long, and there would be stations at Borough High-street, New Kent-road, Trafalgar-road, Peckham High-street, Rye Common, Dulwich Park, Lordship-lane, Sydenham and Penge (the terminus). The capital, although mentioned in the bill at five millions would not exceed £4,600,000. The public authority most interested was that of the Borough of Camberwell, and they were in favour of the scheme.

Mr. DALRYMPLE HAY was the first witness, and he gave evidence as to the general design and construction of the line. He said the railway would be almost wholly under streets, and they would only run under private property in a few places where on curves, &c.

Cross-examined by Mr. FREEMAN (for the London, Brighton and South Coast Railway): The scheme might involve risk to warehouses at the Bricklayers' Arms station, but there was always risk with an underground railway. He was aware that it was understood that a railway company should keep so many feet of London clay between the top of their arch and the soil above, but he did not think that was at all necessary.

The CHAIRMAN, at the commencement of Wednesday's proceedings, made a similar announcement as Lord Windsor in his Committee (see above) as to their inclination to consider the advisability of inserting a general clause fixing a two years' limit during which compensation for damage done by the construction of the railway might be claimed.

Mr. GALBRAITH said he was the engineer to the scheme, and he explained the manner in which he became acquainted with it. It was out of friendship to Mr. Hay. It was without his knowledge that his name was on the prospectus.

Mr. SHAW (for the promoters): But the prospectus has never been issued.

The CHAIRMAN: One who allows his name to appear on a prospectus makes himself liable for everything in that prospectus. It is strange that your friend, Mr. Hay, should not have told you that your name was put on the prospectus. You are put on as being the consulting engineer, and yet you know nothing about it.

Mr. CLODE: Do you know what is to be the capital of this undertaking?—I do not.

It is £4,600,000. Have you satisfied yourself as to the financial position of those who are going to handle the money?—I have not.

Do you know a single one of the promoters?—I do not.

Surely it is important to you whether you give your name to a sound undertaking or an unsound undertaking?—It is not my business to ascertain how the money is to be raised.

Then you wash your hands of all responsibility as to the financial side of the scheme?—I have no responsibility in that way at all.

In answer to the CHAIRMAN, Witness said he thought the promoters should have communicated with him as to the statements in the prospectus before it was issued, publicly or privately.

The CHAIRMAN: I think it will be better for the promoters to put in their financial people. It is of little use for us to go into the construction of the scheme until we have had the financial evidence.

Mr. GLUCKSTEIN, a director of Lyons & Co. (Ltd.), refreshment contractors, and a director of Salmon & Gluckstein (Ltd.), tobacco merchants, said Lyons & Co. had gone to considerable expenditure in connection with the Crystal Palace, and they were prepared to take a financial interest in the scheme, which they were satisfied was financially sound.

The CHAIRMAN: You do not know whether this is over-capitalised or not?—No, I do not.

The CHAIRMAN; You know nothing about the prospectus?—No; up to the present time he had not put any money into the scheme. He had only just heard what the capital was to be.

Mr. EMILE GARCKE said he had advised his directors to take a large participation in the financial part of the scheme. He did not know anything about the promoters, and he had had nothing to do with the inception of the scheme. He had not considered how many millions of passengers would be required to make the railway pay; his expert officers had done so, and they had advised him that the scheme was sound in that respect.

By the CHAIRMAN; He would recommend his board to practically take the promotion of the undertaking.

Mr. GEORGE RILEY spoke as to the proposed route, which he said would provide considerable traffic. He had no doubt that the capital could be raised. He had subscribed to the scheme to a large extent himself, and he was prepared to go further and subscribe more. As to the prospectus, it was never issued; it was a proof. It was abandoned, and not acted upon at all; and no copies were issued.

Mr. LITTLER, (for the Corporation of London): You found the Parliamentary deposit?—Through my own bank or Parr's Bank, or the London Joint Stock Bank.

And have they the control of the bill? Have they not got a clause that if they do not approve of the bill as passed by the Committee they can withdraw their money?—I do not think so.

What security did you give?—I do not think I gave any.

How many million passengers will you have to carry to make the line pay?—I am afraid that is too much for me.

Mr. BARTLETT (Messrs. Perry & Co.) said his firm were joint contractors for the line with Messrs. Mowlem and Birt. He was satisfied that the scheme was a good one. His firm had subscribed to its promotion to the extent of £1,000. If the bill passed, and the work was carried out, his firm would be prepared to invest £50,000 if they got the contract or a portion of it.

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Sir CHARLES RIVERS WILSON, Chairman of the British Electric Traction Co., said he had considered the scheme, and he thought it was likely to be a financial success. Certainly, his company would not go into an undertaking of this sort unless they thought it would conduce to the advantage of their system of tramways.

Lord ROBERT CECIL: Will you say what your company are prepared to do in the financial part of the scheme?—I am not prepared to answer that.

Mr. S. P. SELLON said he had looked into the scheme. He came to the conclusion that the estimate proposed was reasonably within the mark, and he advised the last witness to take some interest in the matter, as the scheme would materially assist their tramway system. He should think they would want to carry 100,000,000 people a year to make the line pay.

Mr. SCHENCK, chairman of the Crystal Palace Co., said he had given £1,000 for preliminary expenses, and had no doubt that if the bill passed all the money required would be found, and that the line would be remunerative. He believed the number of people carried to the Crystal Palace by the two existing railways every year was about two millions, but the line would not depend on visitors to the Crystal Palace. If this line was constructed the number of people going to the Palace will be doubled.

The Committee adjourned till to-day (Friday).

NORTH METROPOLITAN ELECTRIC LIGHTING AREAS.

On Tuesday a Select Committee of the House of Commons, presided over by Mr. Fison, had before them the Electric Lighting Provisional Orders (No. 1) Bill and the North Metropolitan Electric Supply Bill as competing measures. The former proposes to confirm electric lighting orders made by the Board of Trade with respect to Edmonton, Tottenham and Wood Green in favour of the local authorities, and in regard to Enfield in favour of the North Metropolitan Electric Power Supply Co., which company by its bill seeks power to supply in retail within the districts of Tottenham, Wood Green, Southgate and Edmonton.

Mr. BAGGALLAY, K.C., in opening for the Edmonton order, said that the North Metropolitan Company's bill before the Committee was a bill in competition with the order for which he appeared. When in 1900 power was being sought by the North Metropolitan Company to supply in bulk, a letter was written to the local authorities pointing out that the bill would confer no powers on the company to supply retail to the general public, but only to authorised distributors desiring a wholesale supply. The company were, however, to-day asking for what they said then they would not propose. The proposals of the North Metropolitan Company's bill were absolutely unprecedented—to give to a bulk company the power to become a distributing company. The matter had been fought only this session in the case of the Northumberland and Tyneside Power bills. The Tyneside Company were seeking to supply in retail, and the Northumberland Company were seeking to supply the same district in bulk. The latter company said they ought to have a priority, but the Tyneside Company argued that if that were granted the advantage of competition would be done away with, as the bulk supply and distributing supply would be in the same hands. The Committee passed the Tyneside Bill and refused the Northumberland. If the Provisional Order Bill were passed, the local authorities would have an opportunity of generating for themselves if they so desired, or they might take their supply from the company, if able to supply at a cheaper rate. What he asked was that the Committee should confirm the Edmonton order and refuse the bill of the North Metropolitan Company in regard to that place, as a dual system could do no good.

Evidence of local witnesses in support of the order was taken, and Mr. Robert Hammond gave evidence for the local authority. The case for the Edmonton Order having been closed, the Tottenham order was next considered.

On Wednesday Mr. E. NEILD addressed the Committee in favour of the Wood Green order. He said the present population of the district was 32,000, and there were schemes afoot which would probably lead to an increase in the next 10 years to 60,000 or 65,000. The district was a compact one, and could be worked from one centre for supply of electricity. Notwithstanding the company got their powers in 1900, the company had not attempted even to negotiate a site for a generating station, and there was no chance of getting a supply in the near future.

Evidence in support having been taken, the case for the local orders was closed, and

Mr. BALFOUR BROWNE, K.C., opened the case for the North Metropolitan Electric Power Supply Co.'s bill. He said it was true that two years ago the company had said they desired to supply only authorised distributors, and if things had remained as they were, then they would not now have come to Parliament for fresh powers. His argument was that in a district like the one in question—the company's district covered 325 sq. miles—the fat should go with the lean, and that the poorer districts who could not supply themselves would be able to be supplied. They must have a large district, and they relied upon the local authorities coming to them, but they had not succeeded, as each of these local authorities had a small municipal desire to supply themselves.

Evidence of local witnesses was taken against the provisional orders and in support of the bill of the North Metropolitan Company. Mr. Howard, vice-president of the London Chamber of Commerce, also gave evidence in favour of the principle of the scheme.

Mr. FERRANTI said the company proposed to have a large generating station at Enfield. It was proposed to instal plant for 8,000kw., or rather over 10,000 H.P., to give as a maximum load 6,000kw., and that power house would be capable of extension to meet the needs of the district. He had considered the estimates, and thought them fair and reasonable. It was desired that the total authorised capital of the company should be £750,000; that was an addition of £250,000 over the capital authorised in 1900. The borrowing powers would now amount to £250,000, which was an addition of £84,000 to amount of 1900. That meant that the total capital would be £1,000,000. The estimates for the bulk supply in 1900 were £390,000. An additional capital was now sought to be authorised of £180,000. There was £120,000 for an additional generating station, and a further £60,000 for working capital. He might put down the generating station at close on £196,000, and transmission, &c., £160,000.

Yesterday the examination of Mr. Ferranti was continued. He said the company would be able to supply electricity at a lower rate from a large generating station than these local authorities could possibly do from several small ones. The capital was better used in a large station. There were economies in the cost of staff and in the handling of coal, and in the expenditure of coal per unit of electricity.

At the conclusion of witnesses examination-in-chief, the Committee deliberated, and on the re-admission of the public,

The CHAIRMAN said the Committee were not prepared to refuse the confirmation of the provisional orders, first as to distribution, and secondly, as to generation. There must be modifications made.

In the course of a long conversation between counsel and the Committee,

The CHAIRMAN further said the decision of the Committee did not imply that the local authorities should, of necessity, erect their stations. It was, as witnesses had pointed out, a great mistake to have these small stations multiplied. The Committee had in mind that the stations erected might be so small as to be unable to supply any large manufactories that might come into their district, and the Committee did not want to prevent such large works from, under such circumstances, getting a supply from the company. They had decided that the company might not distribute without the consent of the local authorities. If the local authorities wanted to buy in bulk they could do so; if they wanted the company to distribute, the company should be able to do so. Some provision might be made that the company, with the consent of the Board of Trade, might give a supply to large consumers where the local authority could not do so.

Further consideration was postponed for clauses to be prepared and submitted to the Committee.

The Willesden portion of the North Metropolitan Electric Power Supply Co.'s Bill was then proceeded with, and

Mr. LITTLER, K.C., said that the company wished to have the same power of supply in Willesden as they had by their Act of 1900 in the Hendon Union. Owing to an error of description in the act the present application was rendered necessary. The company thought that Willesden was included in the Hendon Union, but just at that time Willesden was constituted a separate union in consequence of its growth, and the company, therefore, now asked for the powers they thought they were then taking.

The CHAIRMAN: It is practically an extension of the company's limit.

Mr. LITTLER: It is to correct an error.

Mr. SIDNEY MORSE, solicitor to the company, gave evidence in support. They were, he said, merely asking for what had been given by Parliament in the case of Middlesbrough and other towns. The principle Parliament proceeded upon was to enable the big consumers to have a supply even if they took a prospective customer from an existing concern.

The company's case was closed for this part of their bill, and local evidence against the inclusion of Willesden was taken.

Mr. PINKHAM, ex-chairman of Willesden Urban District Council, said, personally, he should be satisfied if the company were restricted to supplying the power for the authorised North-West London tube railway.

Mr. E. T. RUTHVEN-MURRAY, electrical engineer to the Willesden Urban District Council, said at the present time they were erecting a power house and a sub-station, the power house building being designed to accommodate 4,200kw., and the sub-station about 3,000kw. They had entered into contracts for buildings, plant and mains altogether amounting to £120,000. The Local Government Board had sanctioned an expenditure of £143,600, which included generators having a total capacity of 2,000 H.P. They could supply the tube railway, if a bargain could be made with the company, since their generators were arranged originally, and might yet be used, to supply tramways.

After hearing counsel, the Committee decided to give the North Metropolitan Electric Supply Co. power to take over, by agreement, the authorised site in Willesden from the North-West London Railway Co. for the purpose of supplying that railway and districts outside Willesden, but not to supply in Willesden itself in competition with the Willesden District Council.

The Committee then adjourned.

THE LONDON COUNTY COUNCIL TRAMWAYS AND IMPROVEMENT BILL.

This bill came before the Court of Referees of the House of Commons on Friday last week, presided over by the Chairman of Ways and Means, Mr. J. W. Lowther, on objection taken by the promoters to the *locus standi* of various petitioners.

Mr. BLENNERHASSETT, K.C., for the Westminster Corporation, claimed a *locus standi* on the ground that a large section of the proposed Thames Embankment tramway of the London County Council (which was part of the scheme of the bill) would be within the Borough of Westminster.

The *locus* was disallowed, on the ground that it was not raised in the petition.

Mr. BLENNERHASSETT said he also claimed a *locus standi* under Standing Order 134, which said, "It shall be competent to the referees on private bills to admit the petitioners, being the municipal or other authority having the local management of the metropolis or of any town, or the inhabitants of any town or district alleged to be injuriously affected by a bill, to be heard against such bill, if they shall think fit." His clients were the road authority of the district abutting upon the Embankment and as the traffic in their streets would be injuriously affected by the tram

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way they had a right to be heard before the Committee to whom the bill would be sent for consideration.

The CHAIRMAN : The *locus* will be allowed under Standing Order 134.

Mr. MOON, K.C., then addressed the Court on behalf of frontagers along the Embankment, and, after some discussion,

The Committee ultimately decided to disallow the *locus standi* of the following petitioners:—

1. Owners, lessees and occupiers (except such of the petitioners as are entitled to be heard under Standing Order 135 on the grounds specified therein, and such of the petitioners as are owners, lessees or occupiers of property which may be compulsorily taken under the powers sought by the bill).

2. Owners, lessees, and occupiers, being frontagers (except such of the petitioners as are entitled to be heard under Standing Order 135 on the grounds specified therein).

3. Owners, lessees, and occupiers, and frontagers (except such of the petitioners as are owners, lessees, or occupiers of property which may be compulsorily taken under the powers sought by the bill).

4. Gordon Hotels Company.

The bill came on for consideration on Monday, May 5, before a Select Committee consisting of Mr. H. Hobhouse (Chairman), Mr. G. White, Mr. Morrell and Mr. Horniman.

Mr. POLLOCK, in opening the case for the London County Council, said there were 115 miles of tramway in the County of London, of which 74 or 75 miles belonged to the London County Council, about 16 were under notice of purchase, and the remainder would become their property by 1910. The present bill originally included a much larger number of tramways than were now proposed, but many of them had been omitted for the reason that the assent of the local authorities over two-thirds of the routes had not been secured. One of the tramways now proposed would run from Queen-street, Hammersmith, to Putney, and in connection with it there would be street widenings in Fulham-road, part of the cost of which would be defrayed by the local authority. The chief opponents to this were the Hammersmith and Wandsworth local authorities. The line would join the system of the London United Tramway Co., and there could be little doubt as to its usefulness. Another of the tramways, and one which had evoked considerable opposition, would start at Westminster Bridge and run along Victoria Embankment, terminating at Blackfriars Bridge. The roadway of the Embankment belonged to the London County Council, who were the road authorities, but other authorities interested in the termini and approaches were the Corporation of the City, at Blackfriars, and the Westminster Borough Council, at Westminster. As to the suitability of the roadway of the Embankment to carry a tramway there could be no doubt. It was 94ft. wide at the Westminster end and 80ft. wide at the Blackfriars end, and at the narrowest point it would be 64ft. wide. The tramway would occupy no more than 13ft. of the road. There would not be the customary nuisance consequent on the use of horses, for the reason that the tramway would be electric—on the conduit system. Another of the tramways would run from Plumstead-road to Eltham, and the remaining lines would start at Camberwell Green and join the Crystal Palace tramway at Lordship-lane. The learned counsel then dealt in detail with the petitions against the bill, submitting, in reply to the City Corporation especially, that the tramways along the Embankment would be greatly to the advantage of the public, would practically give a much wanted communication between the north and south of London, and would have convenient gradients.

On Tuesday, Mr. FITZMAURICE, engineer to the London County Council, was examined in support of the bill. In regard to the Victoria Embankment tramway, witness said that at the narrowest point there would be on each side of the lines 24ft. of roadway, sufficient to accommodate three lines of vehicles. In fact, the tramway would serve to regulate the traffic. If any damage were done, as feared, to the roof of the District Railway, the County Council would pay for reconstruction if necessary, and if the damage were proved to be due to the tramway only. As to the length of time the County Council were taking for purposes of the electrification of their system—namely, seven years, witness said that in a huge town like London the change of traction could not be made in a hurry. It might be possible to effect the conversion in six years, but it was necessary to have the margin provided in the bill. So far as the objections of the Wandsworth local authority were concerned, the County Council would be willing to assent to street widenings, which probably would satisfy them.

Mr. POLLOCK said the Borough of Hammersmith would no longer oppose the bill, as a clause would be inserted to meet their desires.

Cross-examined by Mr. BLENNERHASSETT, Witness said it was true the Thames Embankment North Act said that locomotives propelled by steam should not pass along that thoroughfare, but he would certainly draw a distinction between a locomotive propelled by steam and a tramcar propelled by electricity. He did not think the recommendation of the Committee on Underground Railways, which sat last year, that the best method of conducting passenger traffic through London was by means of underground tramways applied to the Embankment. He believed an enormous number of people would use the tramway.

On Wednesday, Mr. J. ALLEN BAKER, vice-chairman of the Highways committee of the London County Council, said he had recommended the conduit system as the most suitable for use in the metropolis. That recommendation had been approved by Dr. Kennedy. The Council had purchased 74 miles of tramway in London out of the total of 115, and were about to purchase another 16 miles. The Embankment tramway had been several times rejected by Parliament, but the Council regarded it as an important one, because it would relieve traffic between Westminster and Blackfriars, and provide a link between the northern and southern lines. It would in no way spoil the thoroughfare. Nearly all the leading cities of the Continent and America had tramways running along the public boulevards. He could not see how a comfortable electric tramway could depreciate the value of property on the Embankment; if it did, it would be contrary to experience all over the world. The Council's generating station at Charing Cross would be used for the tramway in conjunction with electric lighting. That station was worked by gas engine, so that there was no smoke. The tramway would be worked on the conduit system, and there would be no noise, or poles, or wires, to offend the æsthetic mind.

Cross-examined, Witness said the owners of carriages would use the wood pavement, and would not object to the metal of the tramway. The cars would be 30ft. long, and 8ft. or 9ft. high.

Mr. JOHN BURNS, M.P. and L.C.C., next gave evidence. He said he took great interest in the tramway question as affecting the working classes, who required to be carried to and from their work. The Embankment tramway would pay, especially if it were linked up through the subway cars with the tramways running to Holloway and Hampstead. If the Committee were to lay it upon the Council to take the tramway over Westminster Bridge he should regard it as a distinct improvement.

Mr. ALFRED BAKER, manager of the London County Council tramways, also gave evidence in favour of the bill.

On Thursday Mr. M. FITZMAURICE, C.E., engineer to the London County Council, was re-called by the Chairman and said there would be ten cars running on the Embankment tramway.

The CHAIRMAN : Have you further considered the construction of a junction at the entrance to the proposed subway ?

WITNESS : I have not looked carefully into it, and though we have not shown the junction on the deposited plans we find we can put one on of 40ft. radius.

Mr. DEW, alderman of the London County Council, endorsed the evidence of Mr. John Burns, M.P. There were a large number of people who wished to go to the central West End—working people and others—who would be only too glad to use the tramway if it were constructed. If the tramway terminated at Waterloo Bridge, that would not meet the needs of the large mass of people who arrive at St. Paul's and Ludgate Hill, and also the great number of people who come on the Great Northern and Midland and get off at Farringdon-street station. The tram along the Embankment would be a great help to them. It would be a great advantage to have a tramway along the Embankment also to link up communication with the shallow subway of the London County Council, which would enable people to get right away up to the central district and the north.

Mr. BLENNERHASSET : Do not you think the network of tube railways which it is proposed to construct all over London will meet the wants you put before the Committee ?—No ; people will not use the railways for short distances.

Would it not be reasonable to wait, before constructing the tramway along the Embankment, to see the effect of the tube railways ?—No.

Mr. READER HARRIS : Do you think this proposal quite fair towards the District Railway ?—Quite fair.

Would you think it quite fair, Mr. Dew, if, after constructing your shallow subway at a cost of £900,000 a mile, and paying £150,000 a mile in addition for wayleaves, someone put a tramway on the top of you ?—Well, perhaps I should not, if I were a party to it myself. From the public point of view I think it quite fair.

Mr. TIMOTHY DAVIES, Mayor of Fulham, gave evidence with regard to the proposed line from Hammersmith Broadway to the Lower Richmond-road on the south side of Putney Bridge, which he thought would be beneficial to a large number of the inhabitants of Fulham. Fulham was one of the most rapidly-growing areas in London, it having increased by over 200 per cent. in the last 20 years ; but they had no more travelling facilities, except omnibuses, than they had in Fulham 20 years ago. There was no tramway whatever in Fulham.

Mr. ANDREW YOUNG, valuer to the London County Council, said his estimates of the cost of acquiring property and lands in connection with the bill was as follows : Tramway from Hammersmith to Putney, £120,026 ; the Denmark Hill and Lordship-lane line, £78,900 ; the widening of Hampstead-road, £240,000 ; widening of Queen's-road, Peckham, £31,000 ; sites at New Cross, Clapham and Greenwich, £67,500—making a total of £537,426. It is expected that £63,000 would be realised by the sale of surplus lands, reducing the net estimated cost to £474,426. In regard to most of the properties required for widenings, it was proposed to acquire the forecourts only, which could be done without material detriment to the portion not taken. Only 483 persons would be dishoused. In witness' opinion there were really only a few frontagers to the Embankment—De Keyser's Hotel, the City of London School, Hamilton House and the St. Stephen's Club—and none would be detrimentally affected by the construction of the tramway along the Embankment.

The Committee then adjourned.

PRESS TELEGRAMS IN INDIA.

In the House of Commons on Wednesday, Lord GEORGE HAMILTON replying to a request by Mr. Weir, said he was not prepared to ask for a reduction of the Indian Press telegram charges. Considering the very great difference in the distances over which such telegrams were transmitted in India and the distances in Great Britain, no comparison could be drawn.

OTHER ELECTRICAL BILLS.

In the House of Commons, on Friday last, the Lords amendments to the Derbyshire and Nottinghamshire Electric Power Bill were considered and agreed to. On the same day the Cavehill and Whitewell Tramways and Salford Corporation Bills were read a third time.

On Monday the Brighton and Rottingdean Seashore Electric Tramroad Bill was read the third time in the House of Lords and passed. In the House of Commons the Belfast Corporation Bill was read the third time,

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and the following bills were considered and ordered for third reading: Norwich Corporation (Electricity, &c.), Scarborough Tramways, Halifax Corporation and the Metropolitan District Railway. The following were read a second time: Metropolitan Railway and Rhondda Urban District Council Tramways.

On Tuesday, in the House of Lords, the Bradford Corporation Bill was read a third time, and in the House of Commons the Preston Corporation Bill was ordered for third reading.

On Tuesday last the Court of Referees rejected the applications of the Middlesex County Council and the Wimbledon and Putney Commons Conservators for a *locus standi* to appear by counsel against the London United Tramways Bill. A limited *locus*, however, was allowed to the Public Elementary Schools in Wimbledon.

Yesterday, in the House of Commons, the Whitechapel and Bow Railway Bill was read a third time.

Last evening, in the House of Commons, the Metropolitan District Railway Bill was read a third time.

LEGAL INTELLIGENCE.

Attorney-General and Bray v. Hastings Corporation.

In the Chancery Division on Saturday, before Mr. Justice Buckley, plaintiffs sought a declaration that an agreement between the Hastings Tramways Co., the defendant Corporation, and Mr. W. M. Murphy, dated June, 1901, was illegal and *ultra vires*. An injunction was also sought to restrain defendants from carrying the agreement into effect, and so rendering plaintiff liable to be injured through the alleged illegal expenditure of moneys paid to defendants in respect of rates. Plaintiff is a large ratepayer in Hastings, and is also an alderman of the borough. At a meeting of Council in October, 1899, the Tramways committee reported in favour of supporting Mr. Murphy's proposed bill for the construction of electric tramways in the borough provided the Corporation entered into an agreement to consent to an application by the promoters to obtain powers for the construction of a tramway between the eastern terminus of the proposed Bexhill and St. Leonard's light railway and the Albert Memorial whenever the Corporation deemed it expedient to give such consent on terms. The promoters were to pay a wayleave rent of £325 per mile per annum for the first five years, and £400 per mile afterwards, and the particular system of traction was to be such as the Corporation should determine. The recommendation was adopted by the Council. The bill was opposed by plaintiff and other ratepayers, but finally became law under the title of the Hastings Tramway Act, 1900. The act, however, contained no reference to the terms upon which the Council's consent was given, although an agreement embodying the conditions was scheduled with the bill as deposited, and struck out, together with all clauses relating thereto. The altered conditions were never brought before the Corporation nor adopted by them, and no opportunity of discussing them was given. In this state of things, an agreement between the Corporation, the Hastings, Bexhill and District Light Railway Electric Co. and Mr. Murphy was executed in April, 1900, in terms similar to the agreement scheduled with the bill but rejected by Parliament. The agreement was never brought before the Corporation nor adopted by them. Plaintiff alleged that it was at a meeting of the Corporation in April, 1901, at which he was present, that they were told for the first time that soon after the rejection of the scheduled agreement in Parliament a similar agreement had been entered into by the Corporation, and the Tramways committee proposed that their report thereon should be adopted. The Corporation were at once notified that the agreement was illegal and the proceedings of the Corporation illegal, but a motion to that effect was lost by a small majority, and the the Corporation then adopted the committee's report by 18 votes to 14. The agreement contained clauses as to widening of streets and the working of the Old Town tramways. The terms contained in it were not authorised by the act, and should not be binding upon the ratepayers.

Mr. ASTBURY, K.C., for plaintiff, submitted that the April resolution was invalid because the members of the Council were asked to direct an agreement to be executed which they had never seen or considered. If 50 years hence the Corporation wanted a tramway down the promenade, and somebody other than Mr. Murphy was willing to give them £1,000 per mile, they could not promote a bill to enable that person to do it. As road authorities they would be bound to call upon Mr. Murphy to construct the line on agreed terms. Their assent as road authorities involved a large number of circumstances which they ought to take into consideration and exercise their discretion upon. All this the Corporation tied up. The Corporation of to-day could not bind the Corporation of 50 years hence.

Mr. H. TERRELL, K.C., for defendants, said his clients had communicated with the solicitors who acted for both Mr. Murphy and the tramway company, and they said that they had no instructions from either of the parties in the matter. He was told that neither Mr. Murphy nor the company were prepared to assist the Corporation or the plaintiff. In those circumstances it was impossible to decide the case in the absence of these parties.

Mr. ASTBURY asked his lordship to amend the writ and statement of claim by joining the parties named, and allow the case to stand over, with liberty to apply as soon as it was ready for hearing.

His lordship granted the application.

Heap v. Blackpool Electric Tramways (South) (Ltd.) and others.

In the Chancery Division on Friday, before Mr. Justice Buckley, Mr. Astbury, K.C., moved, on behalf of the Electric Tramways Construction and Maintenance Co., for an order to strike out the statement of claim in this action, in which the Electric Tramways Construction Co. is second defendant, or that the action might be stayed.

Mr. ASTBURT, K.C., said the Blackpool Company was the successor of a former horse tramway company, the new company having been formed for electrifying the system. The plaintiffs were trustees for debenture-holders of the new company, who employed the Electric Tramways Construction Co. to convert the tramways. By agreement the contractors were entitled to purchase about three-fourths of the ordinary and preference shares. The new company was to issue £150,000 debentures, £100,000 preference and £150,000 ordinary shares for the purpose of buying up the old company. The contractors were to have the debentures as fully paid up, issue them to the public, and so obtain a sufficient amount for constructing and electrically equipping the line, the moneys received for the shares to be paid into the account of plaintiffs. The statement of claim alleged that debentures had to a large extent been placed with the public, but the Tramways Construction Company refused to pay over the proceeds, and this action was brought for specific performance.

Mr. BUCKMASTER, K.C., did not object to the action being heard with the action of the Tramway Company against the Tramways Construction Company if proper application was made.

His Lordship declined to make the order, and dismissed the motion with costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Board of Management of the East London Hospital for Children and Dispensary for Women, Shadwell, require an officer for the electrical department. Applications to secretary by May 17.

The trustees of the Victoria Jubilee Technical Institute (Bombay) invite applications for the professorship of physics and electrical engineering. Applications should be sent to Prof. Ayrton, City and Guilds Central Technical College, Exhibition-road, London, S.W. An advertisement contains additional particulars.

York Corporation require a junior assistant engineer and a managing clerk for the electricity department. Applications to Mr. C. A. Midgley, electricity works, York, by May 12.

Marconi's Wireless Telegraph Co. (Ltd.) require junior electricians to train at their private school for staff appointments. Applications to the secretary, 18, Finch-lane, London, E.C. See advertisement.

The Marconi International Marine Communications Co. (Ltd.) require a number of first-class operators for service on board ship and at shore stations. Applications to the secretary, 18, Finch-lane, E.C. See advertisement.

A science master is required for the Tunbridge Wells Technical Institute. Applications by June 3.

St. Anne's-on-the-Sea District Council require a resident electrical engineer. Applications by 20th inst.

The following appointments and re-arrangement of the staff of Glasgow electric tramways department have been made: —Mr. James Dalrymple, accountant and chief of office staff to be deputy manager at £550 per annum; Mr. L. McKinnon, of the purchasing department, and formerly chief traffic clerk, to be traffic superintendent at £350; D. I. Liddel to continue outside superintendent of traffic department at £300. Mr. Wm. Smeaton, assistant in purchasing department, to attend to that department under Mr. Dalrymple at £125.

Mr. W. T. Stamp, of Wimbledon, has been appointed chief assistant electrical engineer at the Devonport electricity works. There were 92 applicants, but this number was reduced to three—viz., Messrs. Stamp, E. E. Allen (Llandudno) and A. J. Banfield (Hertford).

Mr. H. S. May has been appointed assistant tramway engineer at Blackpool.

Mr. S. G. Leech, engineer of the Weston-super-Mare Electric Light Co., has been appointed manager also of the tramways.

Aston.—Application has been made by the District Council for sanction to a loan of £24,516 for the electrical equipment of tramways in the district.

Bath.—An inquiry was held here last week into the application of the Corporation to borrow £25,000 for electricity supply. The application was supported by Mr. J. A. Simon, who gave the history of the municipal electricity undertaking.

The CITY ELECTRICAL ENGINEER (Mr. Francis Teague) said he had had 20 years' experience in electric lighting. As soon as he came to Bath he was instructed to report as to necessary extensions. Unfortunately, his appointment was confirmed too late in the year to admit of anything being done last year. Of £11,195. 17s. 4d. spent, £9,417. 19s. 6d. was incurred by additions to mains, transformers, &c.

The INSPECTOR asked for details and a map indicating the transformers and sub-stations. He was not aware, and he did not know, why the Corporation should have thought the Local Government Board would not have sanctioned borrowing for plant that was to provide for future require-

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ments. He was surprised when he heard one of the reasons given was that the Board had refused to sanction anything to work upon, and was responsible for the Corporation getting into debt. For future guidance he would suggest to the Corporation to get their electrical engineer to look ahead and give them year by year the probable requirements, cables, meters, &c.

Mr. TEAGUE said that since 1898 the number of lamps actually connected had more than doubled. He anticipated that 8,000 or 9,000 new lamps would be connected this year. He estimated that they lost £700 in the Christmas quarter by people using gas instead of electric light, in consequence of breakdowns, but they did not affect the influx of new connections.

The INSPECTOR said the Board did not sanction loans for incandescent lamps of any sort.

Mr. SIMON explained that it was more economical to change customers' lamps than to lay down new mains. They could borrow for the mains, and it was hard that they should be penalised for adopting a more economical method.

Mr. TEAGUE said the new dynamos would carry them safely through the coming winter and possibly the winter following. They might probably have to make a further application within a year. With everything running they could supply 33,000 8 c.p. lamps, and the new plant would supply another 16,500. They had now about 37,000 lamps connected.

The CONSULTING ENGINEER (Mr. E. Manville) endorsed Mr. Teague's remarks. He was entirely satisfied with regard to the figures in the estimate. The estimates were based on the present prices of machines. Electric tramways were to be constructed and the plant would be more suitable to supplying current than was the old. Their idea was to supply the whole of the centre of the city with continuous current, and to meet extensions in suburban areas with the alternating current.

The Bath Chamber of Commerce, through their assistant secretary (Mr. W. Jeffery), approved the present proposal. Members of the Chamber represented a rateable value of £25,000. There was some opposition by ratepayers.

The City Council have adopted the recommendation of their Electric Light Works sub-committee, and have rejected both the offers received for the purchase of the electricity undertaking.

Birkenhead.—During the year ended March the electricity department supplied 391,516 units of electric current to 352 consumers, increases of 102,492 units and 79 customers in 12 months.

Birmingham.—An inquiry was held on Tuesday into the application of the Corporation to borrow £251,974 for extensions of the electricity works. The town clerk (Mr. E. O. Smith) said the money would be applied in making additions to existing works and for a new generating station. Some of the extensions had been commenced. A site had been purchased and the ground cleared for the new station. By a clause in the Birmingham Corporation Act of 1899, they were entitled to borrow, in addition to the £500,000 named in the act, such further sums as they might from time to time require for their electric supply undertaking. The sum mentioned had been expended mainly in the purchase of the undertaking and in developing existing works. The area of supply of the old company was limited, but now it extended over the whole city. The cost of the site was £23,174 and the area about 4 acres. The amount proposed to be expended upon machinery, buildings, and additions to existing power stations was £41,909. 3s. 2d., and upon the erection of the new generating station £128,890. The estimated cost of laying new mains, erecting and equipping a sub-station, providing meters, &c., was £58,000. The present generating stations, it was anticipated, would be working at their full capacity in 1903 and there was not sufficient land for extension. The city electrical engineer (Mr. J. C. Vaudrey) supplied technical details.

Blackburn.—Prof. Kennedy, who was recently appointed to decide the question of the type of engine for the extensions at the electricity works, has presented his report, and recommends the use of a moderate speed engine of 180 revs. per min. The tenders were for engines varying from 90 to between 300 and 400 revolutions, and the recommendations of the Corporation's own engineers was in favour of 180 revs. The three firms who had tendered for this class of engine and accompanying dynamo would not be disclosed, as it was possible their tenders might be revised owing to alterations in prices during the last six months.

Blackpool.—The past year's accounts of the electric tramways and lighting departments have been issued. Receipts from the tramways were £41,825. The expenditure was £28,259. 11s. 7d., leaving a gross profit of £13,558. 5s. 7d. £6.648. 14s. 6d. was allowed for interest and sinking fund, leaving a net profit of £6,909. 11s. 1d.

Although the trams had been running 17 years the Chairman of the Electric Lighting and Tramways committee (Ald. Brodie) said that they had not had a single accident electrically. In the electric lighting department the receipts amounted to £27,912, against £23,531 for 1901. There was an increase of £1,091 for private lighting, £3,000 for extra current for the Marton trams, and £209 for public lighting. The gross profit was £9,192, but after providing £9,135 for interest and sinking fund, there was a net profit of only £57. Considering all the circumstances, he thought they had done very well.

Bury (Lancs.).—The Council have entered into an agreement with the Johnson-Lundell Electric Traction Co. for equipping an experimental length of tramway on their surface-contact system.

Camberwell (London).—The Borough Council have definitely decided to drop their application for a provisional electric lighting order owing to what they consider the onerous conditions of purchase of the undertakings of the companies already supplying current in the district, which the Board of Trade insist upon. At the last meeting of the Council

Ald. SETH COWARD said he was sorry they had to abandon their scheme when they were on the eve of introducing it. It was perfectly impossible for them to pay the extravagant prices asked for the purchase of the undertakings of the electric lighting companies operating within their area.

Councillor TAYLOR moved, as an addendum to the resolution to abandon the application, that the Council express a strong protest against the action of the Board of Trade. The Council ought to show its strong condemnation of the conduct of the Board of Trade in treating Camberwell differently to other Councils.

Councillor M. WALLACE supported the addendum. The Board of Trade was, he said, simply an official sitting behind a pen, and if that official thought he was going to teach the mayor, aldermen and councillors of the Borough of Camberwell how to do their business he was mistaken.

Councillor PHILLIPS suggested that perhaps, by approaching the Board with some solidity of support, they might get the clauses to which the Council objected eliminated.

The resolution, with the addendum, was carried.

Cheltenham.—The salary of the borough electrical engineer (Mr. Hamilton Kilgour) has been increased to £450 per annum, as from Dec. 31 last, with a further increase to £500 on June 30 next.

The County Council recently inquired whether the Corporation would supply electric current to work a light railway between Brockworth and the boundary of Gloucester, and the Corporation have agreed to give a supply if they can legally do so, and subject to terms being arranged.

In reply to a communication from the National Telephone Co., complaining of interference with the telephone service, due to leakage and induction, it was resolved to inform the company that the electrical engineer (Mr. Kilgour) "had done a good deal of work on the arc lighting mains both as regards testing and renewals of some slightly faulty parts, the insulation to earth had been considerably improved and was very good, and if further testing should indicate the possibility of further improvement the necessary steps would be taken at once to secure it."

Cheshunt (Herts.).—A report on electric lighting is to be prepared for the District Council by Mr. H. Wall Wilkinson, M.I.E.E., A.M Inst.C.E.

Darlington.—The consulting engineers (Messrs. Kennedy and Jenkin) have been instructed to prepare plans, &c., in connection with the Council's proposed electric tramways and also to report as to extensions of the plant at the electricity station.

Darwen.—Last year there was a profit of £126 on the electricity supply department, and on the tramways a loss of over £1,300 on the Darwen and Hoddlesden electric sections.

Dudley.—The Chairman of the Electric Lighting committee (Ald. Dunn) made a statement at the Council meeting this week as to the working of the electricity undertaking during the past 12 months. He said they had been greatly deceived as to the accuracy of the meters used throughout the borough, the result being that much electricity had been supplied for private lighting for which they had had no return, and the company supplying the meters would have to make good the loss. The estimated revenue for the 12 months ended March 31 had been £6,117. 13s. 3d., and £636. 7s. 4d. was put down in respect of the loss sustained with the meters, making, with one or two small items, a total of £6,816. 6s. 7d. The expenditure had been £6,648, leaving a net profit, after paying interest and sinking fund, of £168. 7s. The units generated had been 688,678 for traction, 238,292 for private lighting, 37,335 for street lighting, 10,148 for lighting station, and 3,126 for testing. The average price received had only been 1½d. per unit. He was convinced that the town would ultimately derive great benefit from the electrical undertaking.

Dumfries.—Prof. D. S. Capper has been appointed consulting electrical engineer to the Council.

Ealing.—It is announced that there was a profit of £420 on the working of the electricity department last year.

Edinburgh.—The Corporation have decided to supply electric current for Coronation illuminations at 2½d. per unit.

Exhibition.—The Laundry Exhibition now being held at Agricultural Hall, London, which remains open till to-morrow (Saturday), has proved very successful and shows a great development in this branch of industry since the previous exhibition two years ago. The electric driving of laundry machinery, and the application of electricity to many smaller details of laundry work, is gradually becoming manifest, and in this, as in many other industries, the advent of cheap bulk supply will assuredly bring electricity into general use in the increasing number of large and medium-sized laundries throughout the country. The efficiency of the electric iron has improved, and in this direction especially the electrically-heated apparatus will shortly come into increased demand.

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Exhibition Lighting.—Some 300–350 Brockie-Pell arc lamps are employed for lighting the buildings and grounds of the Wolverhampton exhibition.

Frome.—The Council are proceeding with the scheme for electricity works, and application has been made for sanction to a loan.

Glasgow.—Last week Bailie Stevenson proposed that a special committee be formed to report upon the advisability of appointing a general manager to co-ordinate and supervise the whole of the work of the Corporation. The work of the Corporation, he said, was growing at such a rate that unless a change were made they would come to a deadlock. They had converted their tramways to electric traction, electric lighting had been introduced and the objectionable placing of electric lighting and tramway poles in close proximity to each other would never have happened had there been a general manager who had charge of the operations of the Corporation. No doubt the salary of the official would be saved many times over if a suitable man could be found and appointed. The motion was defeated.

Hastings.—The accounts of the electricity department were discussed by the Council last week. Criticising the accounts,

Councillor BOUTWOOD said they had had an example of municipal trading in one of its most regrettable and unfortunate aspects. They had invested £123,405, with few hindrances as regards the enlargement of the amount, for the Council had been generous in advancing money for extensions, yet they had to regret a loss last year of £1,949. 14s. 11d., against £1,741 the year before. They had a debit balance of £1,488. 3s. 5d., which, with the previous one of £1,949. 14s. 11d., made £3,437. 18s. 4d., almost a 2d. rate, which produced £3,470. That experience should make them pause in any further developments of municipal trading, for it seemed impossible for the Corporation to show efficient and economical working in any undertaking they had in hand. The electric light company, although working on borrowed capital, paying interest at 5 or 6 per cent., were enabled to pay, he thought, 7½ per cent. dividend during the last year of their existence. Some of them felt that there must be something radically wrong in the administration of the undertaking. The Council ought to engage a business man as manager, and pay him salary upon results.

The MAYOR denied that there had been a loss on the undertaking. On the contrary, there had been a large balance in hand in favour of the working, out of which a large amount had been paid for interest and sinking fund. There was a gross profit of £5,600 on the trading, and he thought they had done well considering all things. They were in a state of transition; they had to prepare for the future claims in the way of lighting, and they had to be in advance of their work. He believed that in the electric light works they had good property, but it was not property that would develop in a day. If it had been a company, that £5,000 would have been divided amongst the shareholders, as they would not be compelled to pay off their capital, and they would have said, "What a splendid dividend!"

Leeds.—Mr. J. B. Hamilton, the newly-appointed manager of the tramways, has taken up his position.

Leek.—Application has been made to the Local Government Board to carry out the electric lighting scheme prepared by the Council's consulting engineers (Messrs. Burstall and Monkhouse), at an estimated cost of £10,061.

Light Railways.—An important point in light railway law was raised on Monday, when the Poole and District Light Railway Order came up for confirmation by the Board of Trade.

For the South-Western Railway Co., who opposed the order, Mr. PAGE, K.C., argued that, where an existing railway company would be seriously injured by a light railway or tramway, the scheme must go before Parliament, and could not be sanctioned by the Light Railway Commissioners or by the Board of Trade. The railway companies had allowed these light railways to be promoted without opposition, and were only now beginning to find out what formidable competitors they might become in the future. There seemed no reason why, by a series of extensions, these light railways should not go parallel to the existing big companies all over the country. But Parliament, when it originally gave powers to the existing railway companies, did so on the distinct understanding that no rival schemes should be promoted without coming before Parliament for sanction. If it were otherwise, then the qualified monopoly granted by Parliament at great cost to the railway companies would be done away with, and railway shareholders would suffer. The promoters of light railways were now extending their lines everywhere, and were becoming serious competitors to railways, and in this case the proposed extension would compete seriously with the South-Western, and the existing light railway had already seriously diminished their income.

Mr. S. MORSE, for the promoters, submitted that Parliament had delegated the sanction of light railways to the Light Railway Commissioners and the Board of Trade, and they were to decide what was best for the public convenience.

Sir HERBERT JEKYLL said the Board of Trade would consider the point raised.

The Midland Railway Co. have withdrawn their opposition to the Ashby, Swadlincote and Burton light railway project.

Little Woolton.—The Council have approved the scheme of electric lighting, and a loan of £6,000 is being applied for.

London County Council.—At Tuesday's meeting it was agreed to loan the Poplar and Stepney Sick Asylum District Managers £2,200 for an installation of the electric light.

Tramways.—It was agreed to allow the engineer's department four additional assistants in connection with the survey of the Council's tramways on the north side of the Thames with a view to re-construction.

The Highways committee reported having secured the Pimlico Gas Works, at a cost of £80,000, for a tramway power station. The tramway manager and the electrical engineer approve the site as eminently suitable for the purpose. The price paid is £10,000 more than the estimate approved by the Council. Further property will have to be purchased. The net cost of the whole of the property required for the station is estimated at £120,000.

On the subject of the tenders received for the supply to the Council of high-tension and low-tension cables for the tramways (these tenders are set out on another page of this issue)

Mr. TORRANCE called attention to the fact that there was a difference of £2,400 between the lowest tender and that recommended for acceptance. He believed the St. Helens Cable Co. had done work for the Council satisfactorily.

Mr. BAKER said the samples sent by the the St. Helens Company were not so satisfactory for the particular purpose for which they were required as were those of the other firms recommended. The St. Helens Company had certainly done certain work for the Council for electric lighting satisfactorily, but, on the advice of Dr. Kennedy, they recommended the other tenders, and in addition, the tender form of the St. Helens Company was not properly filled up.

The recommendation was agreed to.

Estimates.—The Council passed in detail the estimates of expenditure for the year 1902-3. The estimates of the Fire Brigade committee included £1,800 for electric lighting of stations; £500 for electric bell work, and £9,000 for telephones and fire alarms. The Highways committee estimated that £1,545 would be required for expenses under the Electric Lighting Acts, while against that the fees for inspecting and testing electricity meters and for testing electric pressure would be £425. Last year the actual receipts from this source were £430. Dealing with the tramway system, it was stated that last year the estimated surplus on the southern system was £13,716, but the actual surplus was £8,792. The estimated surplus for 1902-3 was £10,220, and that might be that the traffic receipts would suffer through dislocation arising from the re-construction of parts of the system for electric traction, but it was expected that any loss would be compensated for by extra traffic during the Coronation.

Mansfield.—The foundation stone of the electricity supply station buildings was laid on Tuesday. The consulting engineer is Mr. Robert Hammond.

Middlesbrough.—Particulars of the financial position of the electricity undertaking were given at the meeting of the Electric Lighting committee on Wednesday. The income from the sale of current was £4,677. 1s. 6d. net, gross profit £2,126. 3s. 3d. After paying interest and sinking fund instalment there was a deficiency of £971. 8s. 2d. The charge for current for private lighting has been reduced from 7d. to 6d. per unit, with 5 per cent. discount for cash. The following scale of charges for motors was adopted:—Up to 250 hours' use per quarter, 2d. per unit; between 250 and 500, 1¾d.; between 500 and 750, 1½d.; between 750 and 1,000, 1¼d.; and above 1,000, 1d.

Middleton.—The Board of Trade have sanctioned the construction of an electric tramway, affording through connection from Manchester to Chadderton.

Municipal Telephony.—The Scarborough Town Council have resolved to apply for a licence to establish a municipal telephone exchange.

A statement was made at Manchester Corporation meeting on Wednesday in regard to the withdrawal of the bill for the constitution of a joint telephone board for the Manchester area. Ald. Southern said the bill was withdrawn because, after an interview with the Post Office authorities, another and better mode of procedure had been suggested. It was pointed out that the bill was entirely unnecessary, as licences could be given to the three authorities of Manchester, Salford and Stockport to effect the same purpose. By adopting that course the cost of a poll would be saved, they would save the cost of a Parliamentary contest, they could stop the National Telephone Co. from obtaining the Parliamentary powers sought by a bill now before the House, which would encroach on their interests in the future, and, by reducing the number of authorities, they would simplify the administration of the proposed telephone board.

Grantham Town Council have received sanction for a loan of £1,500, out of £2,000 applied for, to establish a municipal telephone exchange. The Board are of opinion that the area of the Council's licence should be extended to include Buckminster and Belvoir, and the balance of the loan will be sanctioned when the licensed area has been so extended. The committee, accordingly, applied for authority to include Buckminster, Sproxton, Knipton, Harston and Belvoir in their scheme, and the Postmaster-General has agreed.

Mansfield Woodhouse District Council are supporting the application of the Mansfield Town Council for a licence for a municipal exchange for the Mansfield area.

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At a meeting of the Glasgow Telephone committee on Tuesday, the general manager (Mr. A. R. Bennett) reported that there are now 7,066 orders on hand, of which 5,055 had been executed, leaving 2,011 connections to be made. Subscribers at Clydebank are now connected with the system, and the contract with the Clyde Trust has been completed. Mr. Bennett further reported that, after paying all working expenses, Post Office royalty and interest and sinking fund on the whole of the capital expended to date, there remained a balance for the month of April. The committee authorised the ordering of relief cables for Bridgeton and St. George's Cross, the wires originally laid down having been already taken up.

New Cable Steamer.—The s.s. "Colonia," built and engined by Messrs. Wigham, Richards & Co., of Newcastle, to the order of the Telegraph Construction and Maintenance Co., had its trial trip off the Tyne on Tuesday. The vessel is constructed with four large tanks, and has a capacity of 4,000 nauts of cable. The "Colonia" is about 500ft. in length by 56ft. in breadth and 39ft. in depth, of 11,000 tons register, and is built for a speed of 11½ knots. The "Colonia" is the largest telegraph ship afloat, and has a carrying capacity double that of the "Great Eastern."

Newhaven.—The Newhaven Electric Lighting Syndicate have intimated to the Board of Trade that they do not propose to proceed with the provisional electric lighting order obtained by them in 1900.

Nottingham.—The official inspection of the Woodborough-road electric tramway route took place on Tuesday.

Oldham.—Three additional sections of the electric tramways were officially inspected last week, and have been opened for traffic.

Paddington (London).—At the Borough Council meeting on Tuesday the Electric and Gas committee reported the receipt of a letter from the Metropolitan Electric Supply Co., concerning the charge made by the company for the public lamps for lighting Westbourne-terrace. The charge made is £30 per arc lamp per annum. There are 14 lamps, and the company, having regard to this small number, were unable to reduce their charges. The surveyor has consequently prepared a scheme for installing a system of gas lighting by incandescent burners at an initial charge of about £200, and a maintenance charge of about £169 per annum. The committee recommended that this scheme be adopted, and that three months' notice be given to the Metropolitan Company of the termination of their contract. The chairman of the committee (Col. Barchard), in reply to a question, said he did not think Westbourne-terrace would be so brilliantly lighted by gas as by electricity, but the surveyor was of opinion that it would be sufficiently lighted by gas. Mr. Blair considered the borough was badly lighted at present, and urged that the Council should put mantles on all the gas lamps, leaving the lighting of Westbourne-terrace as at present until this work was carried out. This view commended itself to the members, and the further consideration of the committee's report was adjourned for six months.

Personal.—Mr. F. Harrison, M.I.E.E., has resigned the position of works manager to Cryselco (Ltd.), Kempston Works, Bedford.

For the important appointment of town clerk of the City of London a very large number of applications was received. This number was reduced to six, one of whom subsequently withdrew, and on May 1 the final selection was made. The City Council's choice fell on Mr. James Bell, town clerk and solicitor to the borough of Leicester, and clerk and solicitor to the Derwent Valley Water Board. Mr. Bell is aged 36, and has had a quite exceptional municipal career for so young a man. He was originally assistant town clerk at Birmingham, and was subsequently appointed town clerk to Leicester, and now gains the highest civic appointment in the kingdom. He has been at Leicester over seven years, having previously served Birmingham for three years. He succeeds a very able man, the late Sir John B. Monckton, and will find in the City of London great scope for his undoubted abilities.

Plymouth.—The electricity supply undertaking has now reached the profit-earning stage. For the year ended March the gross profit was nearly £5,000, and after paying all expenses (including interest and sinking fund) there was a small net profit. The income included £5,650 from the Tramways committee, £1,000 from the Plymouth, Stonehouse and Devonport Tramways Co., £4,876 for private lighting and £1,215 for public lighting.

Police.—At the Guildhall, on Friday, Charles Bright, electrical engineer, of Buenos Ayres, was committed for trial on a charge of concealing from his creditors 10,202 shares in Charles Bright & Co. (Ltd.) and 13,183 shares in Bright's Light and Power Co. (Ltd.), with intent to defraud. Jouquin Fermin Moreno and Robert George Fudge were also committed on a charge of conspiring with Bright to commit the alleged frauds.

Ramsgate.—Electric lighting was discussed by the Council last week. It was decided to apply to the Board of Trade for an extension of two years in which to comply with the terms of the Ramsgate Provisional Order, obtained in 1900.

Salford.—The Lower Broughton electric tramway route was opened for traffic on Friday last, and the Weaste–Eccles Cross section will be opened to-day.

Judge Parry has been appointed to hold an inquiry into the administration, &c., of the electricity department of the Council.

Shipley.—The electric tramways were opened for traffic on Monday, and a four-minute service of cars from Bradford boundary to Shipley was inaugurated. A line to Saltaire will be completed by Whitsuntide. Shipley Council provide the equipment and supply current, the cars being run by Bradford Corporation. The question of wayleave rent has yet to be arranged.

Stockton-on-Tees.—The Council have voted a grant of £200 to Mr. W. Ford, the gas manager, in recognition of his services in connection with the introduction of the electric light.

Southampton.—An inquiry was held here on Thursday last into the application of the Corporation to borrow £30,000 for electric lighting.

The TOWN CLERK (Mr. R. R. Linthorne) supplied particulars of previous loans, assessable value, &c, and explained that it was proposed to erect a new generating station.

Ald. BONE (chairman of the Electricity committee) said the demand for current had increased during the last two or three years. The works had not been remunerative, but the committee had provided for repayment of principal and interest, after which there had been a charge of between £4,000 and £5,000 upon the rates. This year, however, there was a profit on the undertaking.

THE BOROUGH ELECTRICAL ENGINEER (Mr. H. F. Street) said the maximum output last winter was 1,143kw. The capacity of the generating plant was 1,030kw., the balancebeing supplied by accumulators. The boiler power was barely sufficient to work the present plant, and on two or three occasions they had had to stop the trams during the heavy load at night. There was no room at the present station for extension. It was proposed to provide two new 500kw. machines at the new station. They would want 1,400kw. next winter, which would mean using all the present plant and one of the new 500kw. machines; £1,600 would be wanted to provide new mains to couple up the new station to existing mains. The top load of the trams now was 400kw., and it was expected that another 100kw. would be wanted in the immediate future. There would be a sub-station at the Clock Tower, but there would be no high-tension work in connection with it.

Swansea.—During the past 12 months 278,640 units of electric current were supplied, the average price being 3·542d. per unit.

Warrington.—Sanction is sought to a loan of £27,000 for the construction of electric tramways.

Weston-Super-Mare.—The inauguration of the electric tramway service took place on Monday.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week*]

TENDERS INVITED.

Halesowen Rural District Council, having obtained authority to erect electricity works and to construct light railways, invite communications from companies willing to take over their powers, and to carry out the works authorised and obligations imposed by the orders. Further information from the clerk (Mr. E. H. Grove), to whom communications are to be sent by May 21. Plans may be seen at the offices of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. See advertisement.

Ipswich Corporation invite tenders for the supply, delivery and erection of engines and dynamos, storage battery and overhead hand travelling crane. Specifications, &c., of the town clerk (Mr. Will Bantoft), and can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Further particulars are contained in an advertisement. Tenders to Mr. Bantoft by noon May 27.

Oldham Corporation Electricity committee invite tenders for cables, troughing, bitumen and insulators. Specifications, &c., from the superintendent (Mr. Arthur Andrew), gas and water offices, Oldham, or of the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to Mr. Andrew by May 20. See advertisement.

The Guardians of the *Poplar* (London) Union invite tenders for electric wiring and fittings at the Union offices. An advertisement contains further particulars. Specifications, &c, after 12th inst., of of the consulting engineer (Mr. F. J. Warden-Stevens), 34, Victoria-street, Westminster. Tenders addressed to clerk (Mr. G. Herbert Lough), Guardians offices, 45, Upper North-street, Poplar, E., by 6 p.m. May 28.

Worthing Corporation invite tenders for the supply and erection of a 250k.w. steam dynamo and a dryback marine-type boiler with

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fittings. Specifications, &c., from the consulting engineers, Messrs. Burstall & Monkhouse, 14, Old Queen-street, Westminster, S.W. Tenders to town clerk (Mr. W. Verrall), municipal offices, Worthing, by noon May 26. See advertisement.

Bray Urban District Council announce in an advertisement that they will, on May 19, at 10:30 a.m., receive and consider tenders for electricity meters, transformers, batteries, voltmeters, balances, demand indicators, &c. Tenders to the clerk (Mr. P. Macdonnell) by the date mentioned.

Coventry Electric Light committee invite tenders for the supply and erection of steam and water pipes and accessories. Specifications, &c., of the electrical engineer (Mr. Joseph A. Jeckell), and tenders to the town clerk (Mr. Lewis Beard), 10, Hay-lane, Coventry, by 10 a.m. 26th inst.

Tenders are invited for wiring and fittings at the Parc Gwyllt and Angleton Asylums, near *Bridgend*, Glam. Applications for specifications by May 14, and tenders by May 31. Mr. W. E. Allen is clerk to the Committee of Visitors. See advertisement.

Dudley Electric Lighting committee invite tenders for motors. Specifications from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, and tenders (addressed to chairman of Electric Lighting and Tramways committee) by noon May 20. An advertisement contains further particulars.

Govan Town Council invite tenders for the supply of stores for their electricity department for 12 months from June 1, including fuse-boxes, meters, demand indicators, manhole boxes and connections and joint boxes for armoured cables. Full particulars from the resident engineer (Mr. James Brown) and tenders to the town clerk (Mr. A. Macdonald), town hall, Govan, by May 27. See advertisement.

Stockport Gas and Electricity committee invite tenders for a water-tube boiler for their electricity works. Specifications from the engineer (Mr. S. Meunier), gas and water offices, Portwood. Tenders (addressed to the chairman) by May 21. See advertisement.

Messrs. W. T. Glover & Co. (Ltd), Trafford Park, Manchester, are desirous of receiving estimates from makers of electrical transformers for a transformer of 150,000 for cable testing. See advertisement.

West Ham Corporation invite tenders for two steel chimneys, four fans and engines for induced draught, brickwork in connection with the flues and economisers. Tenders to Mr. Fred. E. Hilleary by 4 p.m. of May 13.

The *War Office* invite tenders for the manufacture of a self-propelled lorry for military purposes. Specifications, &c., from Director of Army Contracts (Mr. A. Major), War Office, London, S.W., to whom tenders by noon July 31.

Brighton Town Council invite tenders for points, crossings, tie-bars, bolts, &c., also about 300 tons of steel girder tram rails. Tenders by noon June 9.

Brighton Town Council also invite tenders for extensions to tramway, car sheds, &c. Tenders by noon May 12.

Manchester Electricity committee invite tenders for the erection of sub-stations at Cheetham Hill, Harpurhey, Openshaw and Sherbourne-street, Cheetham. Tenders by May 12.

Glasgow Corporation invite tenders for the supply of motor-driven boosters and relative switching apparatus. Tenders to town clerk (Sir J. D. Marwick) by May 5.

Dublin Lighting committee invite tenders for the construction of a cast-iron subway under the Grand Canal Dock. Tenders to chairman by noon May 13.

The Great Northern Railway Co. (of Ireland), *Belfast*, require a dynamo and a 41-H.P. Crossley high-speed gas engine. Tenders by May 12.

Swindon Corporation invite tenders for the supply, delivery and erection of a storage battery of 252 cells, and accessories. Tenders to town clerk (Mr. Robert Hilton) by May 19.

Bury (Lancs.) Electricity committee invite tenders for jet condenser and pumps. Tenders by May 20.

Swindon Corporation invite tenders for wiring premises on hire-purchase system. Tenders by 14th inst.

Swansea Public Library committee invite tenders for wiring the free library, art schools and art gallery. Tenders by 10th inst.

Bedford Electricity committee invite tenders for economisers. Tenders to chairman by May 19.

Dewsbury Electricity committee invite tenders for a traction switchboard. Tenders by May 12.

Woolwich Borough Council require 10,000 pairs of arc lamp carbons and a 70 H.P. motor. Tenders by May 15.

Ilford District Council invite tenders for the supply of three 10 H.P. electric motors. Tenders to clerk by noon May 13.

The *Chilian Government* invite tenders for laying a submarine telegraph cable from Talcahuano to the Straits of Magellan.

Tenders are invited until 15th inst. by the *French Post and Telegraph* authorities for 550 tons of copper wire. Tenders to Le Sous-Secretariat d'Etat des Postes et des Télégraphes, 103, Rue de Grenelle, Paris.

TENDERS RECEIVED AND ACCEPTED.

The Highways committee of the London County Council have received eight tenders for the 48 miles of high-tension and ten for the 100 miles of low-tension cables recently advertised. Of the first list one tender, and of the second two, were not in accordance with specification. Following are particulars of the tenders sent in :—

High-tension cables.		*Low-tension cables.*	
Land und See Kabelwerke (Cologne)	£40,464 19 4	Land und See Kabelwerke	£61,478 5 4
W. T. Henley's Co.	34,799 17 8	Johnson & Phillips	56,518 8 3
Callender's Co.	34,782 6 8	W. T. Henley's Co.	54,303 6 8
B.I.W. Co.	33,371 17 6	Callender's Co.	54,293 11 8
Western Electric Co.	31,849 18 6	Siemens Bros. & Co.	50,523 5 0
Siemens Bros. & Co.	31,743 17 6	Western Electric Co.	49,964 6 8
St. Helens Cable Co.	31,454 12 6	B.I.W. Co.	49,499 12 6
		St. Helens Cable Co.	47,228 5 0

The committee's report on these tenders states :—We are advised that the most satisfactory are Messrs. Siemens Bros. & Co. for the high-tension and the British Insulated Wire Co. for the low-tension cables. The total amount of these is £81,243. 10s., or £2,490. 12s. 6d. in excess of the two lowest tenders. The times for delivery specified by the British Insulated Wire Co. and Messrs. Siemens are satisfactory, and the amounts of their respective tenders are within the estimates submitted by the Council's officers. The committee recommended that the tenders of Messrs. Siemens Bros. & Co. and the British Insulated Wire Co. be accepted, and this was agreed to at Tuesday's meeting of the Council.

On April 28 Grimsby Town Council accepted the following tenders for extensions of the electricity works, to the plans and specifications prepared by the borough electrical engineer (Mr. W. A. Vignoles) :—

British Westinghouse Co. (220kw. dynamo, direct-coupled to Belliss engine), £2,377 (98 tenders).
Britannia Co. (extension of switchboard and supply of motor boosters), £596 (12 tenders).
Tudor Accumulator Co. (battery), £905 (nine tenders).
W. H. Allen, Son & Co. (condensing plant, cooling tower, &c.), £1,748 (24 tenders).
Sir Hiram Maxim Electrical and Engineering Co. (pipework), £585.
Stirling Boiler Co. (water-tube boiler), £1,151 (seven tenders).
The total of the tenders accepted amounts to £7,362. The plant is required to meet next winter's load.

Grimsby Corporation have also accepted the tender of the Horsfall Destructor Co. for the erection of a refuse destructor for £8,507.

Bermondsey (London) Borough Council have accepted the following tenders for supplies for their electricity department :—

Chamberlain and Hookham, meters.
Reason Manufacturing Co., demand indicators and main fuses.
Veritys Ltd., incandescent lamps.
William Rickard, indiarubber cable and jointing material.
G. Hatch, ironmongery and engine room stores.
Johnson and Phillips, lead-covered cables, boxes, &c.
British Thomson-Houston Co., meter-boards.

Heckmondwike District Council have accepted the following tenders in connection with their electricity supply undertaking :—

Thornton and Crebbin, steam piping, condenser and oil separator.
Dick, Kerr & Co., steam generator (Howden engine).
Chloride Electrical Storage Syndicate, storage battery, &c.
Bertram Thomas, extensions to main switchboard.
Worthington Pumping Co., cooling tower.
W. T. Henley's Telegraph Works Co., underground cables.

The Electrical Co., 122 and 124, Charing Cross-road, W.C., have received an order from the Holwell Iron Works, Ashfordby, Lincs., for the supply and erection of a power transmission plant at their works.

Salford Corporation have placed the contract for 12 months' supply of asphalt troughing with the Howard Conduit Co., Trafford-park, Manchester.

Warrington Corporation have accepted the tender of Messrs. Bennie & Thompson for steel rails, paving, &c., in connection with their electric tramways scheme at £16,857. 14s. 6d., and that of Messrs. R. W. Blackwell & Co. for steel poles, brackets, trolley wire, insulators, &c., at £2,736. 19s. 2d.

Dundee Town Council have accepted the tender of Messrs. Dick, Kerr & Co. for a steam dynamo at £6,215.

The Admiralty have again placed a contract for 200,000yds. of rubber cable with the St. Helens Cable Co.

The St. Helens Cable Co. has received an order from the British Thomson-Houston Co. for dialite non-fibrous cables for the Hamilton-Motherwell tramways.

Falkirk Town Council have accepted the tender of Messrs. Belliss and Morcom for steam engines for their electricity works.

Blackburn Corporation have accepted the tender of Messrs. Yates and Thom for two boilers for the electricity works.

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Islington (London) Borough Council have placed with Messrs. Rowland Carr & Co., London, an order for the supply of 72 arc lamp columns for the Highbury arc lighting extensions.

BUSINESS NOTICE.

Mr. A. H. Hunt, whose business premises in Gresham-street, London, it will be remembered, were destroyed by fire a short time back, has started afresh in more commodious premises at 115–117, Cannon-street, London, E.C. Mr. Hunt, in addition to representing several British firms and a leading American house, has been appointed sole representative here for Messrs. Geoffroy and Delore. Samples and stocks of a large variety of apparatus and materials are available for supply to the trade only.

BANKRUPTCIES, LIQUIDATIONS, &c.

It has been resolved to wind up voluntarily Electric Fog Signal (Ltd.) Mr. G. H. Carter, 1, Queen-street, Cheapside, London, E.C., is liquidator.

Claims against Howell's Simplex Anti-Inductive Telephone Syndicate (Ltd.) must be in by June 14 to Mr. D. F. Basden, 33, St. Swithin's-lane, London, E.C.

Claims against G. F. Rogers, electrical engineer, 5, Great Winchester-street, London, E.C., must be in by 24th inst., to Mr. E. S. Grey, Bankruptcy-buildings, London, W.C.

Plant, &c., for Sale.—50,000 new incandescent lamps (Ediswan and other types) are for sale. Applications to Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C. See advertisement.

Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

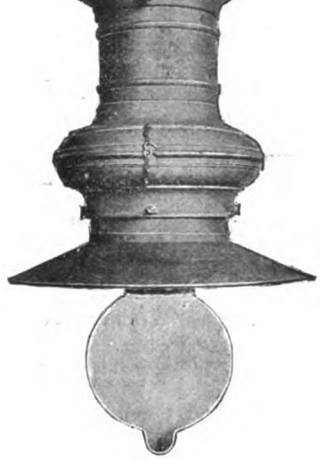
A compound engine and Crompton dynamo are for sale. See advertisement.

Factory Sites.—Messrs. Humbert and Flint, Watford, Herts., and 11, Serle-street, Lincoln's Inn, London, W.C., announce in another column some convenient factory sites in the Watford district for disposal.

Mr. J. H. Osborne, 15, Charterhouse-street, London, E.C., has for disposal convenient freehold sites for factories, under 11 miles from City, and adjoining railway and navigable river.

The Journal.—Part No. 156 of the *Journal* of the Institution of Electrical Engineers is now ready, price 6s. Particulars of contents are set out in an advertisement.

Flame "Ark" Lamp.—The accompanying illustration shows the flame "Ark" lamp now being placed upon the market by Messrs. Johnson and Phillips. The provision of a coloured light by means of electric arc lamps is one which is just now attracting much attention. In the flame "Ark" lamp the light is of a rich golden colour, and has high penetrating power. The mechanism of the lamp is of a simple character, enabling its manufacture to be accomplished at moderate cost. It is economical in consumption of current and carbon, and attendance for cleaning and trimming is reduced to a minimum. It is claimed that for Coronation illuminations the flame "Ark" lamp is peculiarly suited.



Mail Motor Carts.—A motor mail service between Liverpool and Manchester has been inaugurated. The contract was given to the British Electric Traction Co., which sublet to the Electric Haulage Co., Manchester. The highest speed of the cart, which weighs under 2 tons, is, of course, 8 miles an hour, the total journey being 38 miles. The new car can carry a load of 30 cwt., against a load of 18 cwt. borne by the old horse vehicles.

Coronation Illuminations.—Messrs. A. J. Beaumont & Co., of 16, Stonegate, York, are issuing a coloured set of illustrations showing some excellent designs of plain and electric Coronation devices to suit both public and private requirements. Installation contractors will find several useful designs in the group.

Westminster City Council have resolved to expend £10,000 in decorations in connection with the Coronation festivities, including illumination by incandescent electric lights of various colours, estimated to cost £4,850.

Catalogues.—The Westminster Engineering Co. have ready a new list of enclosed motors and enclosed arc lamps.

A pamphlet is issued illustrating and describing electric traction apparatus supplied by the International Electrical Engineering Co., Clun House, Surrey-street, London, W.C. The company's operations in connection with the manufacture and supply of electric tramway plant and material commenced as long ago as 1892.

"Slow and Moderate Speed Motors" and "Direct and Alternating-Current Fan Motors" are the subjects treated respectively in pamphlets Nos. 122 and 123, issued by the British Thomson-Houston Co.

The 1902 price list of "Armorduct" conduit wiring material has now been prepared, and gives particulars of a wide range of specially-designed high-grade material for use in installation work for electric lighting, &c. A good variety of tools for use in conduit fitting is also listed.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 30 to May 6, with the ports of destination :—

Africa—Alexandria, £91; Cape Town, £863; Delagoa Bay, £508; Durban, £3,090; East London, £675. *Argentina*—Buenos Ayres, £343 (telegraph material). *Australasia*—Adelaide, £78; Fremantle, £55; Lyttleton, £20; Melbourne, £120; Wellington, £467. *Ceylon*—Colombo, £338. *Denmark*—Copenhagen, £129 (including £42 telegraph wire). *France*—Boulogne, £65. *Germany*—Hamburg, £209. *Gibraltar*, £10. *Holland*—Amsterdam, £75. *India*—Bombay, £72; Calcutta, £891. *Straits Settlements*—Singapore, £290. *Sweden*—Gothenburg, £11; Stockholm, £196. Total, £8,596, against £23,463 in the corresponding week last year (May 1 to 7).

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia and China Telegraph Co. (Ltd.).

The fifty-seventh half-yearly ordinary general meeting of this Company was held on Wednesday at River Plate House, Finsbury-circus, Sir J. WOLFE BARRY, K.C.B., presiding.

The MANAGER and SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting, and other formal business having been disposed of, the report of the Directors was taken as read.

The CHAIRMAN: It now becomes my duty to offer a few of the general remarks which chairmen make at these meetings on the accounts as presented and other matters connected with the operations of the Company. You will notice from the accounts that the gross revenue for the half-year has been £324,000—I am using round figures—against £360,000 in the corresponding period of 1900. This shows a decrease of £36,000, of which nearly £20,000 is due to traffic with Australasia and the remainder to traffic with China, Japan and the Philippines. The shareholders, however, should bear in mind that the traffic of 1900 was abnormally large in consequence of the troubles in China and elsewhere, and this naturally makes the traffic for last year compare somewhat unfavourably. As a matter of fact, however, it was not unsatisfactory as far as China and Japan were concerned, but the Australasian traffic has certainly been very disappointing, for the number of words transmitted has remained almost stationary, in spite of the very large reductions that have been made in the cost of telegrams. This unsatisfactory condition of things may possibly be due to the uncertainty which has been prevailing in Australasian circles with respect to the new Federal tariffs. That bill is now settled, and possibly we shall see the effects of it in increased traffic; but while it was in debate there is no doubt that there was a disinclination in commercial circles to embark on new ventures, and as, of course, we depend on commerce for our revenue, and if business is interrupted or thrown back in any way, the telegraph companies suffer. Unfortunately, working and other expenses show an increase of £15,600 for the past half-year as compared with the corresponding period of 1900. Of this amount £6,000 is due to increased cost of maintenance of cables due to circumstances over which we have no control, and the balance is accounted for by the opening of new stations in consequence of our new cables to Australia, and matters of that kind. When we come to compare the figures for the whole year, we find that there has been a decrease in the past year's revenue of £3,500 as compared with that for 1900, but the expenses, of course, still remain heavy, because, as I have said, they are due to causes not connected with the forwarding of traffic, and the increase for the whole year in the working expenses as compared with those for 1900 was £22,000. The usual quarterly interim dividends of 2s. 6d. a share have been paid in the past year, and we now recommend a final dividend of 2s. 6d., which will make the total dividend 5 per cent. In addition to this, the Board propose to pay a bonus of 4s. a share, or 2 per cent., making a total distribution to the shareholders of 7 per cent. for the year 1901, which I hope will not be considered unsatisfactory, considering all the circumstances of the case (applause). After crediting the subsidiary reserve funds with the usual contributions, we have a revenue balance of £69,560, which we propose to carry to the general reserve fund, making, with the £125,000 contributed for the first half-year, a total contribution from revenue of £194,560 for the year 1901. On the other hand, we have had to debit the general reserve fund during the whole year with £497,000 for expenditure on account of the Cape-Australian cable, and in carrying out partial renewals of other portions of our system. The general reserve fund now stands at £969,800. Since the close of the half-year the last section of our great enterprise connecting the Cape and Australia—the section between Perth and Adelaide—has been successfully laid, and the whole line has been

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opened for traffic. The line is, roundly speaking, 7,600 nautical miles in length, and it passes in places at a depth of 3,400 fathoms, which is some 700 fathoms deeper than the waters in which the Atlantic cables are submerged. But everything has been carried out in record time, and without any hitch whatever, and the Directors think that great credit is due to the contractors (the Telegraph Construction and Maintenance Company) for the excellent manner in which this very important work has been carried out (cheers). With respect to tariffs, the rate for telegrams exchanged with the contracting states—South Australia, Western Australia, Tasmania and New South Wales—was further reduced on January 1 last from 3s. 6d. to 3s. a word for ordinary messages, with proportionate reductions for Government and Press telegrams. If the standard revenue is maintained in the current year the tariff will be further reduced next January to 2s. 6d., but in order to realise this reduction, I am bound to say that the Australasian traffic will have to show much more vitality than it has done in the past few years. We have also been in a position to make substantial reductions in the tariffs for telegrams exchanged between the Straits Settlements and Netherlands-India. We have reduced the rate for the Straits Settlements from 4s. 6d. to 3s. 6d. a word, for Java from 5s. to 4s., and for the other islands in Netherlands-India from 5s. 5d. to 4s. 5d. These are substantial reductions, and I think they are likely to give great satisfaction (hear, hear). The next most important matter which I should allude to, perhaps, is the fact that the first section—that is to say, the section between Australia and New Zealand—of the Pacific cable, belonging to the British and Colonial Governments, was opened for traffic last month, when competition was started with the Company's cables between Australia and New Zealand. I am sorry to say—and it was to our very great surprise—that the Federal Government announced a reduced uniform terminal rate for the Pacific route while maintaining the higher differential terminal rates for the Company's traffic between New Zealand and Australia. This is opposed to the terms of the special contract made between the Company and the New Zealand and New South Wales governors when the cable was laid, and it is also contrary, in our view, to the International Telegraph Convention. Negotiations are in progress on this subject—it is impossible to let the matter stand as it does—and we have every hope that when the injustice of the differential rates is pointed out to the Federal Government, they will retreat from what I cannot help thinking is an untenable position—certainly untenable in view of the special agreement between the Company and the Government of New South Wales, and, I cannot help thinking, untenable in view of those principles of free trade which we have been told will be applied to the competition between a Government cable subsidised by public money and a cable supported by private resources which has done so very much good for Australasia in the past. I will not say any more on this subject at the present time except to express the hope that the Federal Government will see that it is neither to their interest nor in common justice that this matter should proceed (hear, hear). The negotiations between the Federal Government and the Company for substituting an uniform agreement for the whole Commonwealth in place of the agreements with the four contracting States have not yet had any practical result, but we are told that when Mr. Barton, the Prime Minister of Australasia, is in London next month, he will be empowered and will wish to discuss the matter further with us. Meanwhile, the higher rates are maintained in Victoria and Queensland, and the merchants in those States are agitating, and have been agitating for some time past, for their assimilation with the rates charged to the rest of the Commonwealth. All we can say is that we desire very earnestly to bring that assimilation about, but at the same time we feel that we have a right to ask that in those two States which still hold out, we shall have the same rights of dealing directly with the public that have been given to us under the arrangements with the other four contracting States who enjoy the lower tariff. I think it is a most important question that the right of directly dealing with the public at our own offices in the leading States of Australasia should be insisted upon (hear, hear), and I think that what we have already seen in regard to the action of the Federal Government with respect to the New Zealand traffic indicates that the Board were only protecting your interests when they insisted upon that as one of the conditions of granting the reduced tariff. A matter of very considerable importance to the telegraph world has occurred since I last had the pleasure of addressing the shareholders, and that is that a very important Blue Book has been issued containing the report of the inter-departmental committee which was appointed to inquire into the cable communications, tariffs and general matters connected with cable communications generally. I welcome the report as very important to this Company, and, in fact, to all cable companies; and I think it is very satisfactory that the matter was referred by the Government to a committee which must command, from its constitution, universal respect. The committee consisted of Lord Balfour of Burleigh (chairman), the Marquis of Londonderry (Postmaster-General), the Right Hon. R. W. Hanbury (President of the Board of Agriculture, who will be remembered as lately Secretary to the Treasury), the Earl of Hardwicke (Under Secretary of State for India), the Earl of Onslow (Under Secretary of State for the Colonies), Major-Gen. Sir J. C. Ardagh, K.C.I.E. (Director of Military Intelligence), Rear-Admiral R. N. Custance, R.N. (Director of Naval Intelligence), No one can avoid seeing that a more powerful committee could not have been suggested, or one on which the national interests could have been more completely represented; and I think it is interesting to know what the terms of reference were, because one sees then that the committee was, as it were, seized with the whole subject of cable communications. The terms of the reference were—

"*To inquire into the present system of telegraphic communication between different parts of the empire, and to consider in what respects it requires to be supplemented.*"

"*To investigate the relations between private cable companies and the Imperial and Colonial Governments (including the Government of India), the amount of control at present exercised by these Governments, and the policy which should be pursued by them in future, especially when new concessions are sought.*"

"*To examine existing rates, to report how far they are fair and reasonable; and, if not, how any reduction should be effected.*"

Those are very wide-reaching enquiries, and from the knowledge we have of the proceedings of the committee, we are fully aware that they left no matter uninvestigated which was referred to them for consideration and report. It is very satisfactory, I think, at the very outset to find that the committee, in the following words, acknowledge—

"*that there is no widespread feeling of dissatisfaction with the present state of British cable enterprise, and that such dissatisfaction as exists is of a somewhat vague and unpractical character. Some of the proposals laid before us were based on insufficient acquaintance with the facts and difficulties of the case; and the views expressed on such objects as the desirability of all-British cables or the possibilities of reductions in rates were in many cases not such as would stand cross-examination.*" (Cheers.)

After recognising the assistance rendered to the enquiry by the representatives of the Associated Companies, and referring to the companies' history, the committee state—

"*we think that they (the Associated Companies) have rendered great service commercially and strategically to British interests. With a view, primarily, to their own revenue, but to the great incidental advantage of this country, they built up a vast system of cable communication under British management.*"

The committee, I am glad to say, also add that—

"*it is of paramount importance to this country so to direct its telegraphic policy that the great network of British-owned submarine cables which extends over the world shall continue to be remunerative to those whose enterprise has created it.*"

Further—

"*that the time is fast approaching when private enterprise in certain cables, hitherto a profitable monopoly, may require support rather than control in cases where it is exposed to the unlimited competition of landlines.*"

I will not, of course, go completely through the report, but I merely take passages from it which appear to me of interest for the shareholders to consider. The committee then deal with the vexed question of State purchase of cables, and, after expressing strong opposition to the principle of purchase, point out—

"*that the State does not obtain favourable terms for the transfer of property to itself, and that when the transfer is made there is constant pressure for an increase of the wages of the working staff and for an indefinite reduction in rates. These objections would not be fatal if it were established that submarine cables would be more efficiently managed by the State than by private companies, but no serious attempt has been made to prove this point, and we ourselves are decidedly of a contrary opinion.*"

A great many proposals were submitted to the committee, some of them, I am bound to say, of the wildest nature; but, after giving consideration to all the proposals laid before them, the committee found themselves in the position of only wishing to recommend three extensions, two of which affect this Company, and one only very slightly. The latter recommendation was that there should be a landline between Burmah and the Straits Settlements. That will certainly not have any effect upon us, and we shall not view it with any disatisfaction. The other recommendation is a much more important one—namely, their proposal that, for strategic purposes, there should be an extension of our cable—I should say a linking up rather than an extension—with the island of Cocos to Ceylon, so as to give an alternate route to India. This they regard as of great strategic interest and of importance to the country. I think that anyone who studies the map will see what an important link of communication, from a military and naval point of view, such a linking up with the island of Cocos, where our new cable is landed on its road between the Cape and Australia, would be. The Board have not taken any steps with respect to the report generally, but I may say, speaking, I think, for my brother Directors—that we shall be very happy to consider with the Government how such a strategical cable could be laid and be utilised for the public interests, provided, of course, the interests of the shareholders are properly safeguarded. It is not a link of communication which we think is necessary for the commercial purposes of the Company, but, of course, a second cable is not to be despised from that point of view. The need for it for commercial purposes is, however, not such that at the present time we should think of recommending you to undertake it except with very considerable assistance from the Government. Subject, however, to this condition I think that the Board are not only willing, but are even anxious to serve the general interests of the public by coming into line with the Government in linking up that important gap, which would be, I have no doubt, for the general benefit of the whole empire. The distance from Cocos to Colombo is 1,714 knots. I do not know that there is very much more that I have to say on the matter, excepting this—that I ought not to leave the report of the committee without saying something about their concluding paragraph, which relates to tariffs. It is very remarkable, in view of the extraordinary ideas that have been put forward by people like Mr. Henniker Heaton and Sir Edward Sassoon as to rates, that the committee, after weighing all that was said, and hearing those gentlemen at great length, should remark that they are not prepared to say that any of the rates were excessive, with one exception—viz., to the Gold Coast and Nigeria, which they considered ought to be further reduced; and they indicate that, in 1904, when the Eastern Company applies for a renewal of its landing rights at Porthcurnow, that company might reasonably be asked to obtain some concession in this direction from the African Direct and West African Companies. I will not say any more on that subject at present. It is not a burning or a very important one, but I will only point out

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that the traffic in question is very small and is carried at great cost. I have very little doubt that when we come to talk about this matter in 1904, or even before that date, we shall be able to show the Government very good reason for the charge which has been in existence, and we shall receive, with every respect, any suggestions from the Government which would tend towards a reduction of the charge, if it can be made with fair and reasonable conditions, having regard to the interests of the shareholders. The committee say that Mr. Henniker Heaton's suggestion of a penny rate to America and Australia broke down completely under cross-examination as quite impossible on a commercial basis, and I should have thought that it was scarcely necessary even to discuss such a question. They also dissent in terms from Sir Edward Sassoon's criticism in estimating the fairness of rates—namely, that this should be by mileage. The committee say:—"We do not think that mileage taken alone furnishes an adequate test; the conditions of different cables vary very widely. The unhealthiness of the stations, the cost of working, the character of the sea bottom in its effect upon the life of the cable itself, must all be taken into account; and no fair conclusion can be arrived at without considering the profit which would be shown on the particular cable if separate accounts were kept of the expenditure and receipts upon it. Nor can we accept as conclusive, comparisons between the rates of ordinary commercial companies and those charged on subsidised cables or State cables worked at a loss by foreign governments."

Speaking generally, all I can say is that I think we may congratulate ourselves that the Government appointed this committee, who, after hearing all the opponents of cable enterprise, and having heard and studied the whole subject, have abundantly justified the position of the companies *vis-à-vis* the public. I think it is a matter of great gratification to us that we have had an an independent tribunal, and that we have emerged from their investigations with only one solitary recommendation for amendment—namely, the almost insignificant question of the communications between the Gold Coast and Nigeria (cheers). I think that that is all I have to say about the cable committee's report, and I have now only one or two things to draw your attention to. One is that the meeting of the International Telegraph Conference which was proposed to take place in London this year has been further postponed until the summer of next year. Then, perhaps, meeting the shareholders of a cable company, I should not be thought wise unless I said a few words about wireless telegraphy, which has been bulking so largely, and in a sort of balloon-like way, before the eyes of the public. I had to address the Eastern Telegraph Company's shareholders last January on the subject, and the remarks I made obtained somewhat wide circulation. All I can say now is, that since those remarks were made there has been no new development of any practical nature. I myself, with the knowledge we have at the present time, have no words to withdraw from the statements I then made, which are, generally speaking, I think those which an honoured name, Lord Kelvin, used lately in America—that he thought, as I ventured to think last January, that wireless telegraphy might be a useful adjunct to cable enterprise, but that I did not think—and Lord Kelvin did not think—it would interfere with the legitimate work of submarine cables. I do not think I can say any more now. I think that that is the position of affairs. Prof. Oliver Lodge and Sir William Preece said, in the report they made last January, that they saw nothing at the time, unless something should arise which they might say would be in the nature of a new physical discovery—they saw nothing that would tend to disturb the predominance of cable enterprise in the international communications of the world (cheers). I have only one thing more to say and to report to you—that, as stated in the printed report, the vacancy in the directorate caused by the lamented death of Mr. Colvin has been filled up by the appointment of the Hon. A. G. Brodrick to the Board, where we welcome him most cordially. I now move—

"*That the report and accounts of the Directors, now submitted, be received and adopted, and that a dividend be now declared of 3s. 6d. per share, together with a bonus of 4s. per share, both free of income tax, payable on the 8th inst., making, with the previous distributions, a total payment of 7 per cent. for the year 1901.*"

Sir J. DENISON-PENDER, K.C.M.G., seconded the motion, which was carried unanimously, and the retiring Directors—Sir J. Denison-Pender and the Hon. G. Peel—were afterwards re-elected, as were also the retiring auditors.

Mr. J. NEWTON then proposed a cordial vote of thanks to the Chairman and Directors. What the Chairman had told them on that occasion was only a commentary on the very able management of the Company for the past 30 years, and the shareholders could safely leave their affairs in the hands of the present Board.

Mr. HOBBS seconded the resolution, which was carried unanimously.

The CHAIRMAN: Mr. Newton and gentlemen, on behalf of the Board I beg to express our thanks for your renewed expression of confidence in us. There is nothing which gives a board of directors so much confidence and enables the business of a company to be transacted so well as feeling that we have the whole body of shareholders behind us. That, I think, is the case with this company, and I hope that it may long continue.

The proceedings then terminated.

Cuba Submarine Telegraph Co. (Ltd.).

The sixty-first ordinary general meeting was held on Wednesday, Mr. CHARLES W. PARISH presiding.

The SECRETARY (Mr. James Scott) read the notice calling the meeting, and the report of the auditors.

The CHAIRMAN said: Gentlemen, I will first refer to our traffics, and call your attention to the comparative statement for the years 1900 and 1901, as given in the report. In reviewing the last six months of 1901 with those of 1900, we have two periods working under the same conditions, and I am glad to point out to you that July to December, 1901, gave us a traffic of £9,270 against £8,903 for the same six months of 1900, thus showing an increase of £367, which, although a small amount, is a satisfactory sign. Adding to the traffic of £9,270 the £2,093 received as interest from our investments, &c., we have a total of £11,363 to deal with, while our expenses have been £5,334. In the second half of 1900, the expenses were £5,502, or £168 more, which is a very small variation on such a large business, and which confirms the opinion I have expressed before that we have no elastic accounts to cut down and economise upon. Both in Cuba and in London the officials of the company thoroughly understand that we have to work as economically as possible, and will do their best in that direction. As regards the dividends, the preference shares on which the dividend is, as you know, at the rate of 10 per cent. per annum, will absorb £3,000, and we propose to pay at the rate of 4 per cent. per annum on the ordinary shares, which will need £3,200, and enable us to carry forward £4,590 to the next half-year, as compared with £4,761 brought forward from June, 1901. The broken cable which we had between Cape Cruz and Santiago has been successfully repaired. The steamship "Newington" was hired for the purpose, and went out from here with the necessary cable on board. Mr. Keith kindly consented to take charge of the expedition and met the "Newington" at Jamaica. The cable was found to be broken in pretty deep water, and considerable skill and patience were required to repair the damage; however, Mr. Keith was able to telegraph to us, on March 31, that the cable was in order again. The cost of the hire of the steamer and the cable used will not fall far short of £6,000 to £7,000, which we shall have to meet out of our reserve fund during the present half-year. I regret exceedingly that we are still unable to report the settlement of the claim for the damage done to our cables during the Spanish-American war, but, as mentioned in the report, we understand that the bill in connection with the same is now pending in the House of Representatives. Our Foreign Office have been helping us as much as possible, and we know that the late President McKinley recommended the House of Representatives to pass our claim. The appeal of the West India and Panama Telegraph Co. to the House of Lords in our suit has not yet come up for decision, but we are now informed that it will probably do so during the autumn. I now move the adoption of the report and accounts.

Mr. ROBERT KAYE GRAY seconded.

Mr. NEVILLE: Can you give us any information as to what effect the Marconi system is likely to have on our Company—what effect it may have on our property?

The CHAIRMAN: As far as we understand the system it is in such a very early state that I do not think, so far as our pockets are concerned, it is likely to affect us in any degree. I daresay you have seen how the highest experts are fighting over it. One says it is a good system and another that it is not suitable to take the place of cable property.

The resolution was then carried unanimously.

Resolutions approving the dividends were then passed, and a vote of thanks to the chairman, directors and staff terminated the proceedings.

West Coast of America Telegraph Co. (Ltd.).

The fifth ordinary general meeting of the shareholders of this Company was held on Tuesday, under the presidency of Sir JOHN DENISON-PENDER, K.C.M.G.

The SECRETARY (Mr. Frederick L. Robinson) having read the notice calling the meeting and the Auditors' report to the shareholders,

The CHAIRMAN said: The report gives pretty nearly all the figures, but I will make a few comments upon them in order to enable you to judge how the Company is going on. The gross receipts during the year ended Dec. 31 last amounted to £32,106, compared with £30,883 in 1900, an increase of £1,218. In 1898 they were £25,080, in 1899 £28,347, in 1900 £30,888. You will, therefore, see that there has been a steady increase in the gross receipts. The improvement between the 1900 and 1901 accounts has not been in the same ratio as was shown in the previous years, but that is not owing to any loss of traffic; it is accounted for by the tariff reductions which were made in April of last year, which, of course, told against the revenue of the Company. However, we still maintain an increase in 1901 over 1900 of £1,218. With respect to the working expenses, they amounted to £23,022 last year as compared with £23,046 in 1900, so you will see that the two amounts were very similar, there being a small decrease of £24. As I say, the amount is practically the same as in the previous year, but it is something if expenses do not increase, because I am sorry to say that that is the general rule. The interruptions that have taken place during the year we are considering were two in number. The Chorrillos-Mollendo cable was down from June 3 to 9, and the Mollendo-Arica cable was down from November 14 to 29. The cost of cable repairs has been pretty much the same, but in the one case we spent more on coal, for the distance was longer, while in the other case we spent more on cable, which is better for the company, because, after all, if you get new cable in you may consider that it will work longer. The amount of cable we had to put into the last repair—to the Mollendo-Arica cable in November—was 14 knots. In order to keep expenses down, we work pretty well from hand to mouth. As we took out of our cable stock 14 knots, we necessarily had to send out this year stock to replace it, and we sent out something like 30 knots. That stock, which cost about £3,000, does not come into these accounts; but it will come into the accounts to be presented to you next year. I was in hopes that I should be able to report that the ship had not been called upon up to the present for any work this year, but I am sorry to say that a message came in this morning to say that the Mollendo-Arica cable is interrupted, and the ship has already left to effect the repair. The amount we have to deal with—namely, the difference between the receipts and expenditure, together with the sum brought forward—is £9,672. The debenture interest takes £6,000, and the income bond interest £800; and we have put to a general reserve fund £1,500, and also placed £1,000 to maintenance ship's fund. These two latter amounts open up again, I am glad to

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say, reserves which we have been forced for some years to do without. Your ship stands in the books of the Company at £10,000, and we consider that a full value for her. Instead, however, of writing that amount down, we have put £1,000 aside to reduce the value of the ship, and also to be used, in case of any special expenditure, for maintenance. The £1,500 is for the starting of a general reserve, to which I hope we shall be able to add every year in order to replace the cables as they become too old to work. I do not think there is anything else to which I need call your attention. I now move the adoption of the report and accounts.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded, and it was carried unanimously.

Sir J. Denison-Pender was re-elected a director, and the auditors (Messrs. Deloitte, Dever, Griffiths & Co.) having been re-appointed, a cordial vote of thanks to the chairman, directors, and staff terminated the proceedings.

Submarine Cables Trust.

The thirty-first ordinary annual meeting of the certificate-holders was held on Tuesday, the Most Hon. the MARQUIS OF TWEEDDALE, K.T., presiding.

The SECRETARY (Mr. Sidney Collett) having read the notice convening the meeting,

The CHAIRMAN said: The revenue, including interest on deposits for the past year, amounted to £24,615, against £24,901 in 1901, a decrease of £286. Of this decrease £81 is due to additional income tax deducted from the dividends on the various stocks and shares held by the Trust, while, included in the revenue last year, were five quarterly dividends on our holdings in the shares of the Commercial Cable Co. against four dividends during the present year. These items, together with the reduction of £113 in the amount received for interest on deposit, account for the decrease. A full statement is given in the accounts as to the redemption of certificates, shewing that out of the surplus funds, during the year now under review, we have been able to redeem a further 31 certificates (exclusive of the coupons of reversion) by purchase in the market, at a cost to the Trust of £3,611. 19s. These certificates bring the total number of certificates cancelled to 928. We have paid the usual two coupons of £3 each, and, after transferring the sum of £3,611. 19s. to the Redemption Fund, there is a balance of £71. 11s. 5d. to carry forward to the next account. I now move the adoption of the report and accounts.

Sir J. DENISON-PENDER, K.C.M.G., seconded the motion.

Mr. FULLER said in the report the cost price of the investments was given, and he thought that it would be satisfactory to most of the certificate-holders if their market price, at the date of the report, could also be given in the future.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., said he thought that this would be a very doubtful proceeding.

Sir J. DENISON-PENDER remarked that the Chairman could always give the information at the meeting.

The CHAIRMAN: The present market value is £433,389. The present surplus over the capital, which is really interesting to the certificate-holders, is £92,963. These figures make our certificates considerably above their market value. Their present market price is about 115, but their real value is about 128. He then put the motion, which was carried unanimously.

The retiring auditors, Messrs. Deloitte, Dever, Griffiths & Co. and Messrs. Gane, Jackson, Jeffreys and Wells, were then re-elected, and a hearty vote of thanks to the Chairman and his co-Trustees and the staff was proposed by a shareholder.

The CHAIRMAN, in returning thanks, said he was glad to find the certificate-holders took an optimistic view of the future. When the present scare had passed away, he had no doubt Submarine Cables Trust certificates would recover their price, which was a little depreciated at present.

The proceedings then terminated.

Great Northern Telegraph Co. (Ltd.).

At the meeting, at Copenhagen, on April 30, Mr. F. ZAHLE presided, but as he was prevented by illness from rendering the report himself Mr. Melchior read the following: After a graceful reference to the death of the hon. chairman (Mr. C. F. Tietgen, the principal founder of the company), Mr. MELCHIOR said: With regard to the ordinary events of the year, the number of interruptions in Europe amounted to 15 on seven of the cables, while in the Far East there were 14 on five cables. The c.s. "H. C. Örsted" had been on active service for 132 days, of which 14 were for the account of others (repair of the cable between Germany and Norway), and the "Store Nordieke" for 226 days, of which 81 were for the account of others. Amongst the works undertaken for others was the laying of the Chefoo–Taku duplicate cable, which was opened for traffic on May 31 last, and had already become very useful. The Wladiwostock route was improving, but it should not be overlooked that the line ran very close to the borders of Manchuria, where matters had not yet settled down to normal conditions. That was an additional reason for pushing forward with energy the contemplated duplication of the Wladiwostock route by means of a Taku–Tientsin–Pekin–Kiachta line, and they hoped that the negotiations which they had begun with the Governments interested would soon lead to a successful issue. They had assisted, as far as their interests permitted, and as far as was compatible with their engagements and duties to other Governments, in the landing at Amoy of a cable belonging to the French Government, connecting that town with Tourane (Indo-China).

Although their receipts for 1901 had not quite reached the exceptionally large amount of the preceding year, they had been sufficiently large to allow them to propose once more to distribute a final dividend of 10 per cent., making a total of 15 per cent. for the year. At the same time they had had to provide for a substantial augmentation of the different reserve funds. Although their receipts had reached so high a total, that result was solely due to temporary causes. Not only did the political and military events in the Far East which caused the exceptional increase in their revenue in 1900 extend over a great part of 1901, the peace treaty not being signed at Peking until Sept. 8, and the withdrawal of the troops being effected later and more slowly than was expected, but the favourable result was also due, to a great extent to the postponement until 1903 of the International Telegraph Conference, at which they were prepared to make large tariff reductions for the Far East traffic. In those circumstances the board considered it their duty to lay their views of the company's position clearly before the shareholders. In reference to the heavy fall in the value of the shares which occurred at the beginning of the year, that was exclusively due to the panic which seized the shareholders of all telegraph enterprises when the transmission by means of wireless telegraphy of the signal "S" between Europe and America became known; but unless fresh extraordinary developments should take place in wireless telegraphy in the near future, they considered that fall in price to be much exaggerated. At the same time they fully acknowledge the great use of the new invention within certain limits and under certain conditions.

In the revenue account, salaries and wages had increased by £6,010. 11s. 3d. and expenses of stations, offices and agencies by £2,494. 15s. 9d., owing to a considerable increase of staff, and to the large amount of material used by their stations in the East during the two last exceptional years. Ordinary supervision of sea and land lines and repairing steamers had increased by £3,190. 16s. 11d. owing to the steamers having been so largely employed for account of others. The amount under sundries on the credit side amply counterbalanced the increase. Rates and taxes were higher by £1,541. 16s., due to the increased revenue in 1900. The net traffic receipts had decreased by £33,740. 8s. 4d., which was exclusively due to the return to a more normal state of affairs in China after the peace of Pekin. Loss on exchange had increased by about £11,256, due to depreciation in value of dollar in China and elsewhere. Sundries had increased by £5,247. 6s. 4d., principally on account of profit from cable steamers. The balance-sheet included a fresh item—viz., participation in other telegraph enterprises (£129,000), their proportion of the amount advanced to China at 5 per cent. interest for the cables laid by this company in 1900 and 1901, which amount would be amortised in 30 years. The interest would be credited to reserve. Investments had increased by £177,601. 18s. 7d., and advances guaranteed by banks by £147,222. 4s. 5d., whilst sundry debtors had been reduced by £78,803. 4s. 1d. The reserve and renewal fund had been increased by the interest on investments, including interest for more than a year on the capital expended on the Chinese cables; sundry creditors had increased by £82,203. 18s. 5d., but that was only apparently, the company not yet having been able to settle the accounts in connection with the laying of cables in China. The profit on reserve cable sold represented part of the profit from reserve cable sold during 1900 and 1901.

West India and Panama Telegraph Co. (Ltd.)

The report of the directors for the six months to Dec. 31 states that the amount to credit of revenue is £25,243. 16s., against £24,300. 0s. 1d. for the corresponding half-year of 1900. The expenses have been £19,836. 14s. 8d., against £20,962. 14s. 1d., leaving £5,407. 1s. 4d., to which is added £2,529. 5s. 5d. interest on investments, and £6,512. 6s. brought from last account, making £14,448. 12s. 9d. It is proposed to pay 6s. per share on account of arrears of dividend on the first preference shares (£10,368. 18s.), the balance being put to current half-year's account (£4,079. 14s. 9d.). This will leave in arrear the first preference dividend for the six months to Dec. 31, and 18 months' second preference dividend to same date.

The International Conference recently held in Brussels has decided, subject to ratification by the powers concerned, to abolish foreign sugar bounties on Sept. 1, 1903. The abolition of these bounties is calculated to be very beneficial to all West India interests.

The company's appeal to the House of Lords in the action brought against it by the Cuba Submarine Telegraph Co. is expected to be heard this year.

The Western Telegraph Co. (Ltd).

The report of the directors for the half-year to Dec. 31 last states that the revenue amounted to £221,512. 9s. 1d., and the working expenses to £101,002. 19s. 4d. After providing £9,576. 3s. 10d. for debenture interest and sinking fund, and £4,391. 19s. 2d. for income tax, there remains £106,541. 6s. 9d. To this is added £3,368. 14s. 9d. brought forward, making £109,910. 1s. 6d. First and second interim dividends (£62,379) have been paid, and, after transferring £40,000 to general reserve and £2,000 to maintenance ships' reserve, there remains £3,531. 1s. 6d. to be carried forward. The revenue includes £11,336. 11s. 6d. dividends on the company's investments in other telegraph companies.

Important renewals of the Para–Maranham and Pernambuco–Rio No. 1 cables were arranged for last autumn, and have been completed during the current half-year. The cost of the new cable (£52,398) for these purposes is charged against general reserve.

CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.)—Col. A. J. Filgate, at the meeting on Thursday last, said the company's business continued to grow at a rapid rate and was likely to continue to expand for a considerable time. This expansion entailed considerable expenditure. During the past year they had spent £63,372, and the total capital outlay at the close of the year was £180,639. The total length of mains laid was 46 miles, compared with 26 in 1900. Further mains material was being sent out. It seemed probable that growth of business would involve the building of a third generating station, and if the company obtained the contract for supplying Howrah, it might entail the erection of a fourth station. There were frequent demands for extensions of mains. The

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board had confidence that the additional outlay would prove remunerative and help to pay satisfactory dividends. During the year 10,000 new shares were issued at £6 each, and the premium (£10,000) had been added to reserve, which now stood at £15,000. £5,590 at credit of renewal fund would be charged with expenditure on repairs and maintenance. The gross revenue amounted to £23,248, compared with £11,147 in 1900, and the expenditure £14,602, compared with £8,252. There was £9,016 available for dividend, and the board proposed a final dividend for the half-year at the rate of 7 per cent. per annum, making with the interim, 6 per cent. for the year. From Jan. 1 to the April 4 the lamps and motors on the system showed an increase equivalent to 8,020 8 c.p. lamps, while the increase in the same period of 1901 was 7,106. The motion was carried.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.)—At the meeting on Wednesday the chairman (Mr. John MacFarlan) moved the adoption of the report, abstracted in our last issue. He said the loss on the year's trading was due entirely to circumstances over which they had no control. The work done at the factory, even so far as November last, showed a considerable profit, and although Germany was passing through an industrial and financial crisis, the amount of orders received showed considerable increase. Turning to the finances of the company, he said it was absurd that they, occupying an important position amongst the manufacturers of Germany, should pay 8 per cent. for their debenture stock; and were it not for the fact that so many debenture stockholders were shareholders, he thought they should make any sacrifice to reduce the rate of interest paid, if only for their credit's sake; but, under the circumstances, what the shareholders received less by way of dividends they received by way of interest, and at the same time they got a fixed sum regularly. They found that they could not profitably underwrite the new issue of stock, and therefore the directors considered there was no alternative but to ask for an extension of three years for the redemption of the stock, when the preference shareholders would cease to take nine-tenths of the profits, and when the whole question of a re-arrangement of the company's finances could be taken up without interfering with the rights of one or other of the shareholders. There was an increase in their sales compared with the same period last year, and they had at present a list of orders which was larger than anything they had had previously. They had again secured the German Government contract for three years. The report was adopted.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LTD.)—At the meeting last week the chairman (Mr. W. L. Madgen) said substantial progress had been made in both lighting and tramways departments during the past 12 months. In the electricity supply department the receipts amounted to £2,747, compared with £182 for the four months of 1900 during which supply was available. Private consumers represented the equivalent of 7,628 8 c.p. lamps connected, compared with 5,760 a year ago. Expenditure for the year on capital account, £15,148, included £9,893 on new machinery. Of the total capital of £77,000, £56,000 was invested in the Kidderminster and Stourbridge Electric Tramways Co., from which the company received £2,240 in dividends, compared with £1,540 in 1900. The gross receipts from all sources amounted to £5,889, against £2,924 in 1900, and the net profit to £2,339 compared with £2,157.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 23⅞d. per oz. (May 8). Consols (2¾ per cent.) 94 1/16—95 1/16 for money, 95⅛—95¼ for account; 2½ per cent. 95—95½ (May 8). Consols Pay Day June 2; Stocks and Shares Continuation Days, May 13 and 27; Ticket Days, May 13 and 27; Pay Days, May 14 and 28; Mining Share Carry-over Days, May 12 and 26.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The numbers are given in an advertisement of the 152 debentures of £100 each of this company which have been drawn for payment on July 1 at Parr's Bank, Bartholomew-lane, London, E.C.

CASTNER-KELLNER ALKALI CO. (LTD.)—The directors' report for the year ended March 31 states that the net profit, after liberal expenditure in keeping up the works and machinery to the highest state of efficiency, is £68,319. 8s. 1d., and, with £2,266. 19s. 9d. from last account, there is a total of £70,586. 7s. 10d. Interim dividend at the rate of 4 per cent. per annum for the six months ended Sept. 30 absorbed £9,000, and debenture interest £10,956. 12s. 5d., leaving £50,629. 15s. 5d., out of which the directors recommend that £15,000 be appropriated to depreciation (increasing this to £40,000); that the whole of the amount standing to suspense account (lawsuits), and expenses and costs of amalgamation (£11,039. 18s. 10d.) be written off; and that a dividend at the rate of 8 per cent. per annum be paid for the six months to March 31, amounting to £18,000, making, with the interim, 6 per cent. for the year, leaving £6,589. 16s. 7d. to be carried forward.

MOTOR MANUFACTURING CO. (LTD.)—At a recent meeting of this company, presided over by Mr. Roger W. Wallace, K.C., it was decided to adopt a scheme of reconstruction presented by the directors.

MUNICIPAL LOANS.—The Hyde, Stalybridge, Mossley and Dukinfield Joint Tramways and Electricity Board is prepared to receive loans in sums of not less than £100, at 3½ per cent., for three years.

NEW GENERAL TRACTION CO. (LTD.)—The gross profits for the past year were £53,064. 8s. 7d., after deducting £7,385. 7s. 3d. for general expenses, salaries, directors' fees, interest on loans and legal expenses; 5 per cent. interest on the company's outstanding mortgage debentures up to March 23 amounted to £5,677. 15s. 8d., leaving £47,386. 12s. 11d. It is proposed to write off £6,693. 15s. (expenses of debenture issue) and £166. 8s. 5d. (loss on Consols sold during the year), leaving £40,526. 9s. 6d., and, after adding £41,135. 14s. 3d. from last year, there is a total profit of £81,662. 3s. 9d. The directors recommend (*a*) that £70,000 be applied to write off balance of goodwill, and (*b*) that the balance (£11,662. 3s. 9d.) be carried forward. During the year the directors offered for subscription £200,000 5 per cent. mortgage debentures, of which £181,300 were subscribed. The company's tramway system at Philadelphia, which has been increased from 20 to 25 miles, has still only 9 miles in operation. The delay in completing has been due to still pending litigation. So far the various suits brought against the Philadelphia system have been decided in its favour. The only case which their opponents had carried to the Supreme Court was recently heard, and the decision is awaited from day to day.

PRIMITIVA GAS AND ELECTRIC LIGHTING CO. OF BUENOS AIRES (LTD.)—For 1901 the balance of revenue account amounted to £80,444. 10s. 3d., and after deducting interest, London expenses, &c., there is a net profit of £67,305. 11s. 10d., which, after paying debenture interest (£14,533. 16s. 8d.), leaves £52,771. 15s. 2d. available for dividend. Two dividends, of 2s. 6d. each, were paid on the preference shares (absorbing £40,000), and it is proposed to carry forward the balance (£12,771. 15s. 2d.). During the year £45,191. 3s. 3d. was expended on improvements and extensions of mains, cables, &c., and on new plant and machinery, rendered necessary by the increasing demand for electric current for lighting.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has been asked to allow the further issue of 50,000 £5 fully-paid 6 per cent. preference shares of the *British Westinghouse Electric and Mfg Co. (Ltd.)*, and the further issue of 10,000 £5 fully-paid six per cent. cumulative preference shares of *Edmundson's Electricity Corporation (Ltd.)*, to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (*a*)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (*a*)
		£	£		£	£
Aberdeen Corporation...	Apl. 26	698	+ 63	47	33,294	+ 2,106
Ayr Corporation	May 3	180	...	32	4,521	...
*Birmingham Tramways.	,, 3	4,834	+ 363	17	78,615	+27,896
*Blackburn Corporation..	,, 2	724	+ 76	18	11,371	+ 1,416
Blackpool Corporation...	,, 1	475	+ 129	5	2,172	- 87
Blackpool and Fleetwood	,, 3	357	- 3	18	4,246	+ 296
Bolton Corporation	,, 4	1,536	+ 138	5	7,261	- 249
Bradford Corporation ...	,, 4	2,786	+1,856	5	15,537	+10,662
Brighton Corporation ...	,, 4	710	...	23	13,143	...
Brisbane Tramways.....	Mar. 19	2,457	+ 332	12	27,795	+ 2,821
*Bristol Trams & Carriage	May 2	4,157	- 337	17	69,836	+ 4,383
Burnley Corporation ...	,, 3	687	+ 236	‡5	3,266	+ 969
*Buenos Ayres & Belgrano	Apl. 6	2,778	- 223	14	37,760	- 951
Calcutta Tramways Co...	May 3	R21,763	+R2,9 7	18	R398,221	+R35,556
Carlisle Tramways Co....	,, 3	150	- 14	†18	2,362	+ 44
Central London Railway	,, 3	6,937	+ 559	18	119,796	+ 8,772
City & South London Ry.	,, 4	2,920	+1,058	18	53,457	+17,621
Cork Elec. Tramways Co.	,, 1	580	+ 50	§17	6,712	+ 192
Devonport & Dist. Trams	Apl. 25	398	...	16½	6,337	...
Dover Corporation	May 3	184	- 15	5	923	+ 148
Dublin & Lucan Railway	,, 4	107	- 8	18	1,648	+ 139
Dublin Southern Dist....	,, 2	793	- 56	¶17	12,830	+ 3,498
Dublin United	,, 2	3,692	+ 46	¶17	59,587	
Dudley—Stourbridge ...	Apl. 25	683	+ 36	16½	10,737	+ 2,003
*Dundee Corporation ...	,, 30	673	+ 70	...	...	...
East Ham Council	May 3	392	...	45	16,206	...
Gateshead & Dist. Trams	Apl. 25	691	...	16½	10,482	...
*Glasgow Corporation ...	May 3	11,687	- 70	21	227,427	+ 80,167
Greenock & Port Glasgow	Apl. 25	450	+ 245	16½	6,518	+ 3,644
Hartlepool Tramways ..	,, 25	252	+ 35	16½	3,198	+ 237
Hull Corporation	May 3	1,603	+ 23	5	8,206	+ 61
Isle of Thanet Co.	,, 3	409	+ 83	...	...	...
Kidderminster & Dist....	Apl. 25	103	- 13	16½	1,620	+ 141
*Liverpool Corporation...	,, 26	9,258	+ 34	17	151,502	+15,223
Liverpool Overhead Rly.	May 4	1,399	- 233	‡18	25,238	- 2,313
Manchester Corporation	,, 3	2,586	...	§47	96,913	...
Merthyr.....	Apl. 25	169	- 73	16½	3,132	- 367
Middleton	,, 25	261	...	4½	1,306	...
Newcastle-on-Tyne Corp	May 3	2,451	...	...	...	...
Oldham, Ashton & Hyde.	Apl. 25	499	- 30	16½	7,715	- 1
Perth (W.A.) Elec. Trams	May 2	1,100	+ 226	‡44	42,952	+14,080
Poole & Dist.....	Apl. 25	260	+ 11	16½	3,374	+ 39
Portsmouth Corporation	May 3	1,318	+ 727	...	...	...
Potteries	Apl. 25	1,469	+ 67	16½	22,590	+ 896
*Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ..	May 4	3,875	+ 337	18	66,327	+13,414
Southampton Corporat'n	,, 1	844	+ 132	17	13,732	+ 2,721
Southport Tramways ...	Apl. 25	229	+ 78	16½	2,632	+ 704
*S. Staffordshire Trams...	,, 25	765	- 8	16½	11,984	+ 595
Swansea Trams.....	,, 25	426	+ 35	16½	6,774	+ 649
Taunton Trams.....	,, 25	59	...	16½	904	...
Tynemouth & Dist.	,, 25	221	- 15	16½	3,262	+ 144
Wolverhampton District	.. 25	143	+ 88	16½	2,183*	+ 1,401

(*a*) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, Apr. 30.	Price Wednesday, May 7.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 7. Highest	Lowest
			ELECTRICITY SUPPLY.			£ s. d.			
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½ ¼	½ ¼		...	..	
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)..	103 104	104 104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11 12	11 12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103 106	103 106	6 5 2	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9 9¼	9 9¼	4 4 8	...	4⅛	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9¼	9 9¼	3 13 8	March and September	...	...
10,000	5	2/6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8½ 9½	8½ 9½	2 7 4	...	...	...
10,000	5	...	Do (Nos. 20,001-30,000)	8 9	8 9		...	...	...
£250,000	Stock	...	Central Electric Supply Co. 4% Guar. Deb. Stock	106 108	106 108	3 14 9	...	...	...
£0,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9 10	9 10	5 0 0	February and August	9⅛	9⅝
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...		..	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6¾	5½ 6¾	3 18 3	,, ,,	...	...
£250,000	Stock	4/0	Do. 4% Deb. Stock Red.	105 107	105 107	3 15 6	...	...	...
44,456	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	6¾ 6¾	5¾ 5¾	3 9 7	March	5½	...
£140,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 113	110 113	4 0 2	June and December...	...	...
70,579	10	10/0	City of London Electric Lighting Ord.	8 9	8 9	5 5 7	February and August	8⅛	8
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 123	123 128	3 18 10	June and December ...	125¾	123
£300,000	Stock	4¼%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103 106	103 106	4 6 0	...	104½	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8 9	8 9	4 8 11	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	12½	12⅞
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	107 110	107 110	4 3 0	...	109½	109
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	6¾ 6¾	6¾ 6¾	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6¾ 6¾	6¾ 6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...	...
£115,000	Stock	4%	Kenstn. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104 107	104 107	3 14 11	...	104¾	...
110,000	3	...	London Electric Supply Ordinary	1¼ 1⅜	1¼ 1⅜	...	...	...	...
42,840	5	3/0	Do. 6 per Cent. Preference	4¼ 4¾	4 4½	6 13 4	...	4⅜	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95 100	95 100	4 0 4	Mar., June, Sept., Dec.	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15½ 16½	15½ 16½	3 18 8	April and October	17⅛	15⅞
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 115	111 115	3 18 2	June and December ...	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 100	97 100	3 10 8	...	98	...
8,652	10	6/0	Notting Hill Electric Ordinary	14 15	14 15	4 0 0	March	14½	14⅛
12,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	98 101	93 101	3 19 3	...	...	...
300,000	1	...	Rand Electric	1/16 1/16	1/16 1/16	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	65 70	65 70	...	January and July	70	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	102 104	102 104	4 3 4	April and October	102¾	...
40,000	5	9.6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15	14¾
20,000	5	3/6	Do. 7 per Cent. Preference	8¾ 9¼	8½ 9¼	3 13 8	,, ,,	9⅛	9
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98 101	98 101	3 9 6	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1¾ 2¼	1¾ 2¼	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	...	...
65,000	5	..	South London Electric Supply Ordinary	2¾ 3¼	2¾ 3¼	...	...	3⅞	3
109,518	5	5 6	Westminster Electric Supply Ordinary	11 12	11 12	4 7 6	March and September	...	...
28,141	5	...	Do. 5 per Cent. Cumulative Preference	3½ 4	3¼ 4	...	...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007) xd	3⅞ 4⅛	3⅞ 4⅛	4 17 0	April and October	4	3⅞
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125 130	155 30	4 13 9	...	...	...
20,000	10	...	Barcelona Tramways Ordinary	7½ 8½	7½ 8½	...	...	8½	8
10,000	10	5/0	Do. 5% Cumulative Preference	8 9	8 9	5 11 1	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	94 99	95 100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13 14	13 14	4 12 10	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3 3½	3 3½	...	...	3½	3⅜
75,000	5	2/8	Do. 5% Cum. Pref.	4½ 5	4½ 5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	104 107	104 107	4 4 1	...	104½	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	109 111	109 111	3 12 1	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	6¾ 7	6½ 7	2 16 1	...	6⅞	...
20,000	10	5/0	Do. 5% Preference xd	9½ 9⅝	9¼ 9⅝	5 2 7	May and November	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	100% 102%	102% 104%	4 6 9	...	...	...
100,000	10	6/0	British Electric Traction Ordinary	13¾ 14¼	13½ 14½	6 4 2	...	14½	14¼
100,000	10	6/0	Do. 6% Cum. Pref.	12½ 12⅝	12½ 12⅝	4 14 1	February and August	12⅝	12½
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	128	128
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1¼ 1⅜	1¼ 1⅜	...	...	1⅜	...
40,000	5	3/0	Do. 6% "A" Cum. Pref. xd	4⅜ 5¼	4⅜ 5¼	5 14 3	...	5	...
27,500	5	10/0	Do. "B" xd 3s. and 7s. on a/c of arrears	4⅜ 5¼	4⅜ 5¼	5 1 3	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 4	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	97 100	97 100	5 0 0	...	99	98½
34,440	10	6/0	Calcutta Tramways (Nos. 1 to 34,440) xd	14 15	14½ 15½	1 18 3	...	16⅛	14⅞
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	106 108	107 109	4 3 7	...	107½	107½
440,000	1	1/2½	Cape Electric Tramways Shares	2⅛ 2⅜	2⅛ 2⅜	4 4 2	...	2⅛	...
£1,810,014	Stock	4%	Central London Ordinary Stock	103 106	103 106	3 15 11	June and December...	105½	104½
£494,093	Stock	4%	Do. 4% Preferred Stock	103 106	103 106	3 15 11	...	106⅜	...
£494,993	Stock	4%	Do. Deferred Stock	100 103	100 103	3 17 1	...	...	...
£698,201	100	4%	Do. 4% Deb.	116 118	116 118	3 8 0	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5⅛	5 5⅛	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...	...
£330,000	Stock	2½%	City and South London Railway Con. Ordinary	69 71	70 72	2 15 7	February and August	72½	70
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	.. ..	.. ..	...		..	..
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 15 5	,, ,,	130	...
£200,000	Stock	5%	Do. (1898)	124 127	124 127	3 18 10	...	126½	...
£150,000	Stock	...	Do. (1901)	120 124	120 124	...	...	122½	...
£416,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	112 116	113 117	3 8 7	May and November	...	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11½ 12⅛	11⅝ 12⅝	4 0 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½ 15⅛	14½ 15⅛	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4 4⅛	4 4⅛	6 13 4	...	...	...
£70,000	Stock	40/8	Do. 5 per Cent. Debenture Stock (red.) ...xd	101 104	1 1 104	4 13 2	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%) xd	8 9	8 9	3 6 8	...	8⅛	8½
20,000	10	8%	†Imperial Tramways Ordinary	26½ 27½	26½ 27½	3 18 6	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14 14½	13¾ 14¼	4 0 0	...	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110 112	110 112	4 0 6	January and July	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4⅞ 5	4⅞ 5	3 0 0	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅜ 11	10¼ 11	4 11 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98 99	98 99	4 0 10	January and July	...	...
£350,000	Stock	4%	Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd)	102 104	103 105	3 16 4	...	104	...
$5,103,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	111 115	111 115	4 6 11	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	103 105	103 105	4 15 3	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	102 104	102 104	4 6 7	...	103	...
24,000	5	4/0	New General Traction Ordinary	2½ 3½	2 3	6 13 4	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4 5	3½ 4½	6 13 4	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96 100	96 100	5 0 0	...	...	...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stck.	99 102	99 102	4 13 2	...	101	...
13,334	10	8/0	Potteries Electric Traction Ordinary	9½ 10½	9½ 10½	3 16 2	...	...	...
30,000	10	5 0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	106 109	106 109	4 2 9	...	108½	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	... ...	... ...	...			...
51,132	1	...	Do. 6% Preference (10/0 paid)	... ...	... ...	...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	... ...	... ...	...	,, ,,	...	...
£500,000	Stock	...	Do. 4½% Debenture Stock (50% paid)	... ...	... ...	...	January and July	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	91	91 94	3 4 0	June and December	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 30.		Price Wednesday, May 7.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 7.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅜	4⅛	3⅜	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...		...	...
£7?8,840	Stock	12/6	Anglo-American	44	47	44	47	5 19 5	Feb., May, Aug., Nov.	44½	...
£3,097,640	Stock	25/0	Do. Preferred	88	90	89	91	6 6 4	" "	90½	89
£3,097,640	Stock	2/0	Do. Deferred	7	7½	7	7⅛	1 6 8	" "	7⅜	...
$13,333,300	$100	$1⅓	Commercial Cable Capital Stock	150	160	150	160	5 0 0	Jan., Apr., July, Oct.	...	...
1,341,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	93	96	93	96	4 3 4	" "	93½	...
16,000	10	4/0	Cuba Submarine Ordinary	4	5	4	5	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 10	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	3	4	2⅛	3⅛	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8½	9½	8½	9½	5 5 3	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	98⅞	102⅞	98⅞	102⅞	4 8 3	January and July	...	...
60,710	20	3/0	Direct United States Cable	9½	10½	9½	10½	6 3 10	Jan., Apr., July, Oct.	9⅝	...
£101,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200] (red.)	128	132	129	130	5 7 8	Jan., Apr., July, Oct.	125	120½
£1,930,807	Stock	17/6	Do. 3½ per Cent. Preference Stock	83	86	83	86	4 1 5	" "	85½	83½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	105	109	107	111	3 13 5	May and November	1 0	103
300,000	10	2/6	Eastern Extension	12½	13½	12½	13½	5 3 8	Jan., Apr., July, Oct.	12⅞	...
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	112	107	112	3 11 10	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	98	101	99	102	3 17 4	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red. xd	100⅞	103⅞	99⅞	102⅞	3 18 5	May and November	...	...
150,000	10	20/0	Great Northern of Copenhagen	27	29	26	28	5 7 2	January and July	...	...
£75,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos	99	103	99	103	4 8 3	June and December	...	...
17,000	25	12/6	Indo-European [1 to 1,200] (red.	36	40	37	41	6 1 11	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 7	June and December	...	...
15,609	...	...	*West African Telegraph Shares	1⅛	2⅛	1½	2½	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99	101	99	101	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	⅛	⅜	⅛	⅜	...		...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅛	⅜	⅛	⅜	...	May and November	⅝	...
34,563	10	£/0	Do. 6 per Cent. 1st Preference	5	5½	5½	6	10 0 0	" "	5⅝	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅝	4⅜	3⅝	4⅜	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	100	103	101	104	4 16 8	January and July	1 3	...
207,930	10	3/0	Western Telegraph (late Br xll'n Submarine)	11⅛	12⅛	11⅛	12⅛	5 16 4	Mar., June, Oct., Dec.	12⅛	11⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 8	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 18 5	...	...	...
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3½	4	3½	4	6 5 0	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	⅝	½	⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	95½	...
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	3⅜	3⅝	3⅜	3⅝	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	56	60	56	60	7 10 0	...	53	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	14	12	14	4 5 9	February and August	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	12	14	4 5 9	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅛	5⅛	4⅛	5⅛	4 17 7	" "	5	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	93	96	94	97	3 12 5	June and December	94⅜	94½
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	104	105	103	107	3 15 8	...	...	...
171,504	1	0/6	Oriental	1/16	1 1/16	1/16	1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	4½	5½	4½	5½	6 13 4	July	...	...
140,000	5	2/6	Do. 5% Cumulative Pref.	4½	5	4½	5	5 0 0	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	105	103	106	4 14 8	June and December	...	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛	¼	⅛	¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	1/16	3/16	...	...	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜	⅝	⅜	⅝	9 12 0	March and September	⅝	...
70,000	5	5/0	British Insulated Wire Ordinary xd	8	9	8	9	8 6 8	July and February	8 9/16	8½
70,000	5	3/0	Do. 6 per Cent. Preference	5½	5⅞	5½	5⅞	5 4 0	January and July	5⅞	5⅝
£250,000	Stock	50/3	Do. 4½% 1st Mort. Deb. Red.	102	105	102	105	4 5 11	...	103	...
150,000	5	3/0	British Westinghouse 6% Preference	5½	6	5⅛	5⅝	5 0 0	...	5 1/16	...
105,731	2	...	Brush Electrical Engineering	¾	1⅛	¾	1⅛	...	March	...	...
150,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	¾	1	1⅛	2	4 13 0	March and September	1⅛	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	101	104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	95	100	95	100	4 10 0	January and July	...	...
80,000	5	5/0	Callender's Cable Construction Ord.	17	18	17	18	4 3 4	" "	1 7/8	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	" "	5 1/16	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111	115	111	115	3 18 4	November and May	...	...
450,000	1	0/4½	Castner-Kellner Alkali Co. (fully paid)	¾	1	¾	1	3 0 0	...	1 1/16	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	87	92	87	92	4 17 10	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞	1⅛	⅞	1	8 0 0	March	...	...
185,000	3	1/9⅜	Crompton and Co. (Nos. 1 to 54,000)	3	3½	3	3½	6 8 6	January and July	...	...
2100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103⅜	108⅜	103⅜	108⅜	4 12 8	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅛	⅜	⅛	⅜	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	2	3	2	3	...	" "	...	...
2344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	73	83	75	80	5 1 3	June and December	...	...
£100,000	Stock	5%	Do. 5% 2nd Deb. Standing Prv. Cts. (all pd)	82	87	...	...	...	...	...	...
35,500	5	2/6	Edmundson's Electricity Corporation Ord.	6½	6¾	6½	6¾	5 3 8	Half-yearly	6 3/16	6 1/16
20,000	5	3/0	Do. 6% Cumulative Preference xd	6	6⅛	6	6⅛	4 12 4	...	6 1/16	...
£120,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	108	109	107	110	4 2 7	...	...	...
112,100	2	1/2½	Electric Construction Co.	1½	1⅝	1½	1⅝	6 17 2	January and July	1⅝	1⅝
31,390	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2½	3	2⅝	3	4 13 4	July	2 1/16	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97	101	97	101	3 19 3	January and July	10⅜	...
122,685	1	...	Electrolytic Alkali Ordinary	...	...	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	...	...	¼	1½	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	9½	10½	9½	10½	4 17 7	...	10	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98	101	98	101	3 19 3	...	...	...
35,000	5	10 0	Henley's Telegraph Works Ordinary	17	18	17	18	4 3 4	February and August	...	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	115	111	115	3 18 3	" "	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21 1/16	2 ⅜
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34	37	34	37	6 9 8	March and July	37	35
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	106	3 15 5	January and July	...	...
25,000	5	4/0	Do. Manufacturing Ordinary	10⅜	11⅛	10⅜	11⅛	5 4 4	...	11⅛	1 1/16
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅜	6	5⅜	6	4 3 4	...	...	...
66,666	5	5/0	Willans and Robinson Ordinary	8½	9⅛	...	...	...	April and October	...	...
63,666	5	3/0	Do. 6 per Cent. Cumulative Pref.	6½	6⅝	...	...	...	" "	...	...
£ 60,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105	107	...	...	...	May and November	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	5⅜	5⅛	5⅜	5 9 1	...	5⅛	...
180,237	10	2/6	Globe Telegraph and Trust xd	8⅛	9⅛	8	9	5 16 8	Jan., Apr., July, Oct.	8⅛	8⅛
180,042	10	3/0	Do. 6 per Cent. Preference xd	12½	13⅛	12½	13⅛	4 8 11	" "	12 1/16	12⅜
11,839	8	4/0	Reuter's	6½	7½	7	8	5 0 0	April and October	...	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE annual conversazione of the Royal Society was held on Wednesday evening, when the rooms of the Society were set out with interesting exhibits of recent discoveries and improvements in all branches of science. In passing through the various rooms the crackle of induction coils came from every side, there being a great number of experiments on Röntgen rays, ultra-violet radiation, and the spectra of the new gases. Among the electrical exhibits of direct practical interest, Dr. MUIRHEAD'S demonstration of re-transmission on submarine cables (cable relaying) and the new electricity meter of Messrs. MORDEY and FRICKER were especially noteworthy. The cable relay was shown in operation between two circuits of artificial cable, each representing 1,250 nautical miles, with an automatic transmitter at the sending end of one circuit and a siphon recorder at the receiving end of the other circuit. In the relay the local contacts are made between a metallic arm, which is connected by fibres to the signal coil, and a vibrating body whose metallic surface is divided by thin insulating partitions into three sections, to constitute the two terminals of a local line or re-transmitting battery with a zero section between. The new meter of Messrs. MORDEY and FRICKER (which we illustrate and describe more fully in an article) is based on a suggestion made by Prof. BOYS many years ago.

PROF. E. WILSON exhibited, with diagrams, the solid iron cylinder in which he has studied the distribution of currents induced by rotation of the cylinder in magnetic fields. Prof. FLEMING gave an illustration of ZICKLER'S proposed method of wireless telegraphy, which utilises the fact that ultra-violet light promotes electric discharge. As here arranged, one—the larger—of two spark-gaps in parallel was made to spark more easily than the other by exposing it to the feeble ultra-violet glow of a Leyden jar; but when, on the shorter gap, a distant naked arc light was focussed by means of a concave mirror, the sparking action was transferred from the long gap to the shorter. Interruption of the arm beam by a glass plate, which robs it of its ultra-violet rays, restores the original state of things, which would thus be set up and maintained for long or short periods. Thus we have dots and dashes carried along the light beam and recorded on moving paper submitted to the burning action associated with the longer spark-gap.

THE new thermometry recently foreshadowed in our columns is in a fair way of being realised. In this week's "Contemporary Science Notes" will be found an account of an instrument devised by M. FERY for measuring temperature in terms of radiation. The two quantities are connected by an exceedingly simple relation called STEFAN'S law, which says that the radiation of a body is proportional to the fourth power of its absolute temperature. Thus, a temperature may be measured in the same manner as a brightness. But it must be remembered that the "body" in question is supposed to be absolutely black; in other words, that it absorbs all the heat it receives and gives it out again by radiation, and not by reflection. If the body is not absolutely black, STEFAN'S beautifully simple law does not apply. Fortunately, we know from KIRCHHOFF that the interior of an enclosure whose walls are at a uniform temperature behaves as an ideally black body. Now, a furnace with a small opening is practically such an enclosure, and, since it is usually a furnace whose temperature is the important element we want to get at, the application of STEFAN'S law becomes at once a matter of great value. The device of a fluorspar lens is a happy one, and is specially applicable to the lower temperatures, where infra-red radiation plays the most important part. The chief attraction of the new instrument is its enormous range. At temperatures at which platinum melts and all thermo-couples forsake us, and even air thermometers lack a fireproof enclosure, the radiation thermometer only needs a re-adjustment of sensitiveness to make it perfectly correct. This assumes, of course, the universal applicability of STEFAN'S law; but as that appears to be based upon sound thermo-dynamics, the only limit we can assign to its range is the capacity of the ether to convey

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electromagnetic waves of high amplitude in accordance with the law of inverse squares.

Of the germicide properties of bright sunshine and kindred radiations there can be no longer reasonable doubt. Evidence, moreover, is rapidly accumulating which tends to show that pathogenic germs active upon the human organism can be exterminated, if only they can be reached and persistently acted upon by intense actinic radiation. Herein lies the supreme obstacle, at present, to the application of radiation cures to the most virulent among the thousand ills into the inheritance of which flesh has long since entered. Only when the seats of the disease—the colonies of active bacilli—are upon the surface of the organism can this remedy be found effective. Many terrible scourges are, doubtless, thus capable of being treated, as, for example, lupus and cancerous disease of the skin; but a far greater number are so deep-seated in the human frame that by no known means can sufficiently powerful rays be thrown upon their centres. In the early days of the glow lamp it used to be a popular experiment to light up a tiny lamp inside the stomach of a fish. Possibly in this harmless experiment lay the beginning of a new and now only partially-developed method of treatment of organic disease. If the ingenuity of inventors can devise means by which vital organs within the body can be safely maintained in the sunshine of healing rays, what an infinite blessing will have been conferred on mankind! Meanwhile rapid progress is being made in the construction of apparatus for skin treatment, and in an article this week we give some account of the light cure equipments of the Sanitas Electrical Co.

Our attention has been directed to the following correspondence between the Clerk of the London County Council and the Secretary of the National Electrical Manufacturers' Association. The letters relate to an invitation for tenders for lamps for the Council, stipulation being that the goods were to be "of English make." In the result, the tender of the Brush Electrical Engineering Co., whose lamp works are in Vienna, was accepted, an unlooked-for climax, which evoked the following letter:—

The National Electrical Manufacturers' Association,
Ridler-place, Holland-street, Blackfriars, London, S.E.
April 16, 1902.

Dear Sir: Your letter of January 9th last, asking for tenders for electric lamps, together with your specification for same, is before me. In this specification you stipulate that the lamps shall be of English make, and you further bind those who tender to certain labour requirements, which can only apply to goods made in this country.

We are informed that you have accepted the tender of the Brush Electrical Engineering Co., whose lamp works are in Vienna.

I am instructed to draw your attention to this, and to ask your assurance that English made lamps only will be accepted.—Yours faithfully,

(Signed) W. Davenport, Secretary.

G. Gomme, Esq., Clerk of the London County Council,
Spring Gardens, S.W.

The reply of the London County Council is one of the coolest pieces of haughty unconcern which we have met with for a long time. It ignores *in toto* the stipulation with regard to English manufacture, neither denying nor admitting this stipulation; and it merely observes that it was quite aware of what it had done, adding that "on the next occasion" it would invite two quotations, one for British, the other for foreign goods:—

London County Council,
County Hall, Spring Gardens, S.W., April 23, 1902.

Sir: I am directed to thank you for your letter of the 16th inst., and to say that the Council were aware that the lamps supplied by the Brush Electrical Engineering Co. would be foreign made. On the next occasion of inviting tenders for electric lamps firms will be asked to send in two quotations, one for English-made lamps and the other for foreign-made lamps.—I am, Sir, your obedient servant,

(Signed) G. Gomme, Clerk of the Council.

The Secretary of the National Electrical Manufacturers' Association,
Ridler-place, Holland-street, Blackfriars, S.E.

If the London County Council imagines that British manufacturers are going to put up with this sort of supercilious treatment it is decidedly mistaken.

Oldham Municipal Electric Tramways.—The inauguration of the municipal electric tramway will take place on Whit Monday.

Rhosllanerchrugog Tramway.—A local paper states that a tramway has been extended from Wrexham to Rhosllanerchrugog, "so as to carry passengers further."

Electric Pulse in Plants.—On Monday afternoon last, in the Jehanghir Hall, Imperial Institute-road, S.W., Prof. J. Chunder Bose, M.A., read a Paper before the National Indian Association on "Electric Pulse in Plants, with Experiments." The chair was taken by Prof. G. B. Howes, LL.D., F.R.S.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Bolama	April 19, 1902
Puerto Plata—Martinique	May 6, 1902
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902

The Royal Society.—At yesterday's meeting the following were among the Papers to be read:—Capt. H. B. Jackson R.N., F.R.S., on "Some Phenomena affecting the Transmission of Electric Waves over the Surface of the Sea and Earth"; T. Andrews, F.R.S., and C. R. Andrews, "Microscopic Effects of Stress on Platinum"; W. Rosenhain, "A Note on the Re-Crystallisation of Platinum," and Prof. J. C. Bose, on "Electromotive Wave accompanying Mechanical Disturbance in Metal immersed in Electrolyte."

Physical Papers of Prof. A. Rowland.—A volume containing these Papers is now in preparation, and will contain Prof. Rowland's articles and memoirs on physical subjects, among these being "Fundamental Researches on Magnetisation," the "Magnetic Effect of Electrical Convection," the "Value of the Ohm," and the "Theory and Use of Alternating Currents," &c. The volume will be printed on royal octavo, and contain between 600 and 700 pages. The price is fixed at a guinea for orders sent in advance of publication.

University College, Liverpool.—Mrs. George Holt has offered a sum of £2,650 to endow a scholarship, to be known as the Lodge Scholarship, in commemoration of the professorship of Dr. Lodge, now principal of Birmingham University. A donation of £25,000 from Mr. William Johnston is also recorded, for a pathological research laboratory, the endowment of a chair of pathological chemistry and two scholarships for colonial and international research. The Lancashire Council has also given a grant of £1,000 towards the equipment of the new botanical gardens.

Electricity and Plant Growth.—Dr. Lemström, of Helsinfors, has recently carried out some experiments, in which the growth of vegetable and other crops was stimulated by means of electricity. The crops obtainable from arable land of medium quality showed an increase of 45 per cent., while on poor soil the effect was trifling. Peas, cabbages and turnips among certain plants were only affected after being watered, but most plants were injured, if submitted to the influence of

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electricity during hot sunshine. It is estimated that the method can be made to pay when applied to agricultural purposes.

Reduction in Telegraph Rates.—The Eastern Extension, Australasia and China Telegraph Co. announces that a tentative arrangement has been come to with the Federal Government of Australia by which the reduced tariffs now in force in the four Contracting States—viz., 3s. per word for ordinary, 2s. for Government and 1s. for Press telegrams—will be applied to the States of Victoria and Queensland, pending the negotiations which the Prime Minister (Mr. Barton) proposes to conduct with the company's directors in London for an uniform agreement for the whole Commonwealth. The reduced rates will come into force on June 1.

Carnegie Research Scholarships.—The Andrew Carnegie gold medal for 1902 has been awarded by the Council of the Iron and Steel Institute to Dr. J. A. Mathews, of New York, for the research carried out by him as a holder of an Andrew Carnegie Research Scholarship during the past year. The medal has been designed by Mr. G. W. de Saulles, of the Royal Mint. The first recipient, Dr. Mathews, has previously received a Fellowship for the encouragement of scientific research from Columbia College, New York, where he has been working under the guidance of Prof. H. M. Howe. For the present year the Council of the Iron and Steel Institute has awarded six Andrew Carnegie Research Scholarships, each of the value of £100.

Obituary.—We have to record with much regret, the sudden death of Mr. George Griffith, who has been intimately connected with the British Association for the last 40 years. He first came into contact with this institution in 1859, when he acted as local secretary for the Oxford meeting, and was shortly afterwards chosen by Prof. John Phillips, then secretary of the Association, as his assistant, subsequently succeeding him as secretary and editor of the *Transactions*. He filled this last-named post for 16 years, retired for three years, and resumed the duties again for a year at the request of the Council, in order to officiate at the jubilee meeting held at York in 1881. In 1890 he again took up his old position, which he occupied until the day of his death.

Technical Education.—From the annual report of the Technical Education Board of the London County Council we learn that considerable progress has been made during the year. Electrical engineering and lighting are dealt with in 13 centres. Electrical fitting at six centres and electro-metallurgy at one centre. The number of student-hours for electrical engineering has increased from 24,600 to 31,300, but in chemistry the number has fallen from 56,000 to 52,100 student-hours. Aid is rendered to a number of polytechnic institutions in London, and the re-organisation of the London University is having a marked effect on these and other institutions. The advanced classes in science and engineering are being revised and brought up to a higher standard, and students will be induced to enter upon systematic courses of study extending over three or four years instead of attending isolated classes.

Message Rate Telephone Service.—The effect which the introduction of the message rate system of charging for telephone service in New York is well brought up by Mr. H. L. Webb in a recent number of the *Electrical World* of New York. At the beginning of 1894 less than 10,000 subscribers were connected to the telephone system, while in January, 1902, the numbers had increased to 72,189 for the same area covered. Previous to 1894 the growth of the service had been very slow, and there were also great changes necessary in the plant, the system being altered from overhead wires and grounded circuit to underground metallic circuit. The message rate plan, introduced in 1894, was regarded somewhat with suspicion, but it soon found favour, and by the end of 1895 the system gained 8,000 subscribers—a number equal to the total gain of the previous six years. The success of the new method was assured practically from the start, and within a short time the flat rates were displaced entirely from the companies' tariff.

Electricity in Greece.—According to *Cassier's Magazine*, there are prospects of considerable further electrical engineering developments in Greece. The resources of the country, as far as fuel is concerned, are very poor, and as there is little or no prospect of the use of water power, the costs of production must remain high where steam is employed for generating purposes. As long ago as 15 years a few dynamos were introduced at Athens to provide light for the Royal palace, the university and a few public buildings. Subsequently the formation of small competitive companies led up to their consolidation as the Greek Electric Co., which has established electricity supply undertakings in most of the large Greek cities. A tramway has been laid down at Patras, and a large generating station for the supply of Athens and adjacent cities with light and power is under construction at Phaleron. This will cover some 2½ acres and contain nine engines, seven of which will be 1,200 H.P. each and two of 110 H.P. each.

The Institution Building Fund.—At the meeting of the Institution, on Thursday last week, the president announced that the building fund had now reached £10,000. The Institution was naturally very anxious to secure liberal support to this fund. The provision of an Institution building would be of immense advantage, in addition to being a place of convenience to the members, and although the progress with the fund had been satisfactory so far, it was necessary that it should be increased at a more rapid rate in the future. The Institution had been in existence for 30 years, and the membership was now nearly 4,500, and if every member were to contribute annually, say 10s., some £2,000 or £3,000 would be added to the fund each year. But no doubt there were many members willing to contribute larger sums. He therefore appealed to every member to mention the matter to their friends, and also to every member, to subscribe, whether resident in London, the provinces or abroad. In tendering these remarks, the great services which had been rendered by the Institution of Civil Engineers during past years were not forgotten, whose kindness and courtesy were beyond thanks.

Personal.—Mr. Ch. Gerhardi, for 30 years manager and secretary of the Direct Spanish Telegraph Co, retired from active service on the 14th inst. with a liberal retiring allowance. Mr. Gerhardi was born in 1837, and commenced his connection with telegraphy in 1853 in Belgium. In 1856 he entered the service of the Electric and International Telegraph Co., and in 1857 joined the Atlantic Telegraph Co. He was on board the U.S. steamer "Niagara" during the attempts to lay the first Atlantic cable, and was at the company's Newfoundland station till 1859, when the cable was abandoned. In 1860 he became superintendent at the Channel Islands for the Submarine Telegraph Co., and, later, took charge in London of the Belgian, Dutch and German cables of that company. In 1872 he was appointed manager of the Direct Spanish Company, then just formed, and has continued to hold that position ever since. In October, 1898, the Queen Regent of Spain appointed Mr. Gerhardi a Commander of the Order of Isabel la Catolica. Mr. Gerhardi will be followed in his retirement by the cordial esteem and hearty good wishes of all who have so long worked with him.

Magnetic Traction.—According to the *Street Railway Review*, recent tests have been made at Seattle, Washington, with a device for increasing the adhesion between the driving wheels and the rails on locomotives and street cars. A 35ft. car, equipped with 40 H.P. motors, was fitted with the apparatus, which comprised a coil of wire round the axle of each wheel and switches for controlling currents to the coils. The tractive power of the car was registered on a dynamometer, and tests were made with and without the magnetic device. The pull of the car was less than half a ton in one instance without the device, and with it the pull was increased to 2 and 2¼ tons. Improvements have already been effected, in which an independent helix is constructed, with small wheels about 1ft. in diameter, running on the rails as close to the driving wheels as possible. This arrangement gives a magnetic circuit through the rails, driving wheels and axles, and any number of these magnets can be used in connection with the train. The energy required for the purpose is not stated.

The Rhodin Process.—The Rhodin process for the manufacture of alkali and chlorine by electrolysis is attracting

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attention in chemical circles. In our issue of May 2nd we drew attention to the efficiency figures for the Rhodin cell given in a Paper read by Mr. B. F. Rhodin before the Canadian Section of the Society of Chemical Industry. The April number of the *Electrochemische Zeitschrift* contains an abstract of another Paper on the Rhodin process, read recently by Mr. John Rhodin before the Swedish Society of Technologists, and printed in the *Teknisk Tidschrift*. After pointing out that, in spite of the increased output of caustic soda and bleaching powder in recent years, the price of these commodities has been advanced, Mr. Rhodin describes the construction of his cell for decomposing brine by electrolysis with a moving mercury cathode. This has already been dealt with in our columns, and the only portion of Mr. Rhodin's paper new to our readers, will be that dealing with the cost of running his cell and the profits to be derived from an installation of 3,000 H.P. Assuming that this power will produce the equivalent of 2,000kw. with modern turbines and dynamos, Mr. Rhodin calculates that the output with his type of mercury cell will be 15·1 tons of caustic soda and 30 tons bleach per 24 hours, the current efficiency of the cell being taken as 85 per cent. with an E.M.F. of 4 volts. Taking the cost of power as equal to 0·0945d. per kilowatt hour, the total cost for the above quantities of caustic soda and bleaching powder works out to £206, while the selling value with caustic at £11 per ton and bleaching powder at £6. 17s. 6d. per ton is £377. The net profits, therefore, on a capital outlay of £202,500, and a working year of 300 days, are estimated to amount to the very respectable return of 25·4 per cent. Even should the selling value of caustic soda and bleach fall to £9 and £5 per ton respectively, the estimated profits for the Rhodin process and cell will still represent 12·4 per cent. interest on the capital outlay.

University of London.—On Friday last a meeting was held at the Mansion House in support of the Fund for Higher University Education and Research (see *The Electrician*, Vol. XLVIII., p. 1001). The chair was taken by the Lord Mayor of London (Sir Joseph Dimsdale), who was supported on the platform by the Duke of Devonshire, Lord Reay, Lord Avebury, Lord Brassey, Sir Michael Foster and others. The Duke of Devonshire moved, "That this meeting is of opinion that the incorporation of University College, London, in the University of London, will materially promote higher education and research in London, and that, with this object, a fund shouid be raised to equip and endow the college adequately for such education and research," and further supported the resolution by drawing attention to the importance of incorporation of the universities in London and to the changes in conducting our methods of teaching in such institutions, which the discoveries of science had rendered necessary. Oxford and Cambridge had attempted to alter their standards in this direction, but had been hampered by lack of funds, though there seemed to be no reason why these old-established universities should not continue to send out men who would become leaders in scientific research. The United States of America could expend 12 millions on the promotion of research in universities, and it was essential that this country should not be any longer in the rear. The requirements of the University were then detailed by his grace, who concluded by heartily recommending the scheme for support. Sir Michael Foster seconded the resolution, which was supported by Prof. Rücker and carried unanimously. Lord Brassey then moved, "That this meeting urges on the citizens of London the importance of giving a generous response to the appeal now made for a million pounds to equip and endow University College, London," a resolution which was seconded by Lord Avebury and carried unanimously. The treasurer stated that the subscriptions at present received amounted to over £110,000.

The Catastrophe in the West Indies.—The international telegraph service has been a severe sufferer by the disasters which have overtaken St. Pierre (Martinique) and St. Vincent, and we deeply regret to announce that Mr. W. J. Murphy, M.I.E.E., a well-known and respected member of the telegraph service, was a victim of the disaster. Mr. Murphy was born at Dublin in 1864, and educated at Heriot-Watt College, Edinburgh. He was the son of Mr. C. J. Murphy, a member of the original Mediterranean Telegraph Co., stationed at Modica (Sicily), who was afterwards, for many years, superintendent at Vigo in the Eastern Telegraph Co.'s service, and died at Panama. Mr. W. J. Murphy entered the Eastern Telegraph Co.'s service in 1880, at Alexandria, and afterwards joined the company's ships as assistant electrician, and was, in 1888, appointed chief electrician to the "Great Northern." After service in various parts of the world, he resigned in June, 1901, to start in business as a consulting telegraph engineer. However, in March, 1902, he rejoined the active list of the telegraph service with the West India and Panama Telegraph Co. as chief electrician of the cs. "Grappler," the unfortunate vessel which was one of the first to be destroyed by the molten lava from Mont Pelée. The ship, upon which eight other English officers were serving at the time, was engaged in the repair of two sections of the above-named company's cables off St. Pierre. Mr. Murphy sailed from England on April 2nd, and this was his first work in his new service. He succeeded Mr. C. B. Cruickshank, who has returned home, his term of service having expired. Capt. Boreham, of the "Grappler," had been in the telegraph service for 11 years, and Mr. Marshall, the chief engineer, for 12 years. The West India and Panama Company also lost in the disaster their staff of four persons at St. Pierre, including Mr. Miller, the clerk-in-charge, who had been in their service for over 20 years.

No less mournful is the tale to be told by the Compagnie Française des Cables Télégraphiques, who have lost M. Jallebert, their general manager in the West Indies, who was at Fort de France at the time of the early disturbances of Mont Pelée. The company received the first intimation that the volcano was unduly active on May 5th, with a notification that the cables had broken on the northern side of the island. No serious notice was taken of this, but on May 7th M. Jallebert left to repair the broken cables (two), arrived at St. Pierre that day, and proceeded to test for the fault. He was actually giving instructions for the repair of what was considered to be only a temporary interruption at the moment when St. Pierre was overwhelmed. Information received by the company shows that within 25 minutes the entire city was wiped out. The company's cable ship "Pouyer-Quertier" was standing off at the time, and subsequently came round to Precheur and succeeded in taking off 450 persons who had congregated on the higher lands in the neighbourhood of St. Pierre. The vessel returned to the scene of the disaster and fetched a further large number of survivors, and, in company with the French cruiser "Suchet," was instrumental in saving between 3,000 and 4,000 lives. The vessel is, we are glad to learn, uninjured, and has now left to repair the company's two broken cables. The French company had a superintendent and eight native operators at St. Pierre, and these have all been killed. The services of the "Pouyer-Quertier" are much appreciated, both in the West Indies and in France.

The dreadful story of disaster is continued in the news from the British island of St. Vincent, where Mont Souffrière has been in eruption, destroying nearly 2,000 lives. Here also, two cables have been broken, and, there being no repairing ship on the spot, some delay is experienced in the delivery of messages.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

WEDNESDAY, May 21st.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Students' Meeting at 28, Victoria-street, S.W. Paper to be read: "Some Notes on Recent Continuous-Current Dynamo Design," by F. J. Hiss, jun.

THURSDAY, May 22nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Annual General Meeting at the Society of Arts, John-street, Adelphi. To receive the report of the Council and statement of accounts and balance-sheet for the year ended December 31, 1901. The announcement of the election of the new Council will also be made.

FRIDAY, May 23rd. PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "On the Ebullition of Rotating Water," a Lecture Experiment, by T. C. Porter. (2) "The Conservation of Entropy," by J. A. Erskine. (3) "Rational Units of Electromagnetism," by Signor G. Giorgi.

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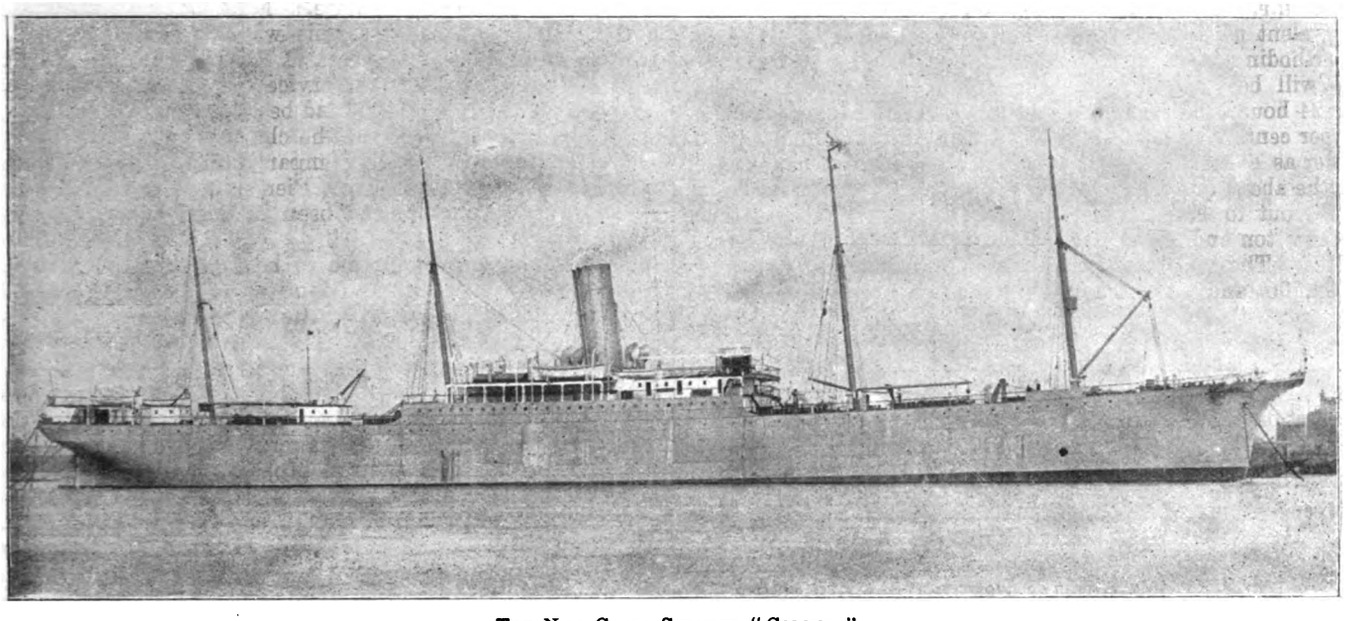
THE NEW TWIN-SCREW CABLE STEAMER "COLONIA."

The trial trip of the new cable steamer "Colonia," which has been built to the order of the Telegraph Construction and Maintenance Co., by Messrs. Wigham, Richardson & Co, of Newcastle-on-Tyne, took place on May 6th, off St. Mary's island. The average speed on a series of trials was 14·4 knots on an I.H.P. of over 5,000. The builders were represented by Mr. John Tweedy, while Capt. W. R. Cato, Capt. H. Woodcock and Mr. C. Slater were present on behalf of the Telegraph Construction and Maintenance Co., together with Mr. G. Scott, the naval architect of the ship.



THE NEW CABLE STEAMER "COLONIA."

The principal dimensions of the vessel are as follows:—Length over all, 500ft.; breadth, moulded, 56ft.; depth, moulded, 39ft. She has a double bottom, 4ft. 6in. high, and when fully loaded will carry a dead weight of 11,000 tons. There are four cable tanks built into the ship, with a total capacity of about 150,000 cubic ft. On the spar deck, which is flush fore and aft, is a midship bridge-house, containing the saloon and rooms for the officers and staff, together with galley, pantry, bathrooms, &c. On the same deck, further aft, is the chart-room, drum-room, &c. The engines, which were also constructed by Messrs. Wigham, Richardson & Co., are of triple expansion, inverted direct-acting type, having cylinders 24in., 40½in. and 67in. diameter, with a stroke of 48in. There are three double-ended steel boilers, with six furnaces in each, and also a horizontal winch boiler.

After the trial trip, which was in every way satisfactory, the "Colonia" was handed over to the charge of Capt. Woodcock, who brought her round to the company's works at East Greenwich, where she will be fitted with picking up and paying-out machinery of the most modern type. Her first voyage will be to lay the Vancouver and Fanning Island section of the Pacific cable, and for this purpose she will be loaded with 3,505 nautical miles of cable, weighing 7,595 tons.

The "Colonia" carries nearly 11,000 tons deadweight at a speed of 11½ knots. The ventilating arrangements on board are of the most up-to-date character. Heating is effected by steam and the lighting throughout the vessel is by electricity. She is the largest cable ship afloat, and has a carrying capacity of 4,000 nautical miles of cable in her four tanks. The telegraph equipment on board, and the installation of Brown's telemotor gear for the navigation of the vessel is of the most complete character. In her trial trip, extending over six hours, the "Colonia" developed a speed of 14½ knots.

THE MORDEY-FRICKER ELECTRICITY METER.

The Mordey-Fricker meter, exhibited at the Royal Society conversazione on Wednesday, is the invention of Mr. W. M. Mordey and Mr. G. C. Fricker, and is intended for either continuous or alternating current. It may be described as a combination of an ordinary clock with a galvanometer coil surrounding a soft iron needle. Its construction will be readily understood from the illustrations. Fig. 1 shows the meter complete in its case. Figs. 2 and 3 are back and front views, with the cover removed. Fig. 4 shows one coil of the winding removed, revealing the "armature." Fig. 5 gives curves from tests taken by the makers with both continuous and alternating current. Two examples were shown on Wednesday, a 20-light and a 10-light meter. The illustrations are from photographs of the former.

The meter consists of a clock deprived of its hair-spring, and carrying on its balance-wheel shaft a disc of slate on which a few pieces of iron wire or iron strip are fixed in the manner of a compass card. This disc is surrounded by a fixed coil of wire, conveying the current to be metered. The disc acts as a variable hair-spring. The iron which it carries is magnetised more or less strongly by the current, a directive action being exerted in an opposite sense to that acting on a galvanometer needle—that is to say, tending to bring the iron needle to a central or axial position in the coil. This action, in conjunction with the ordinary action of the driving spring of the clock, causes the disc to oscillate at a rate directly proportional to the current. The meter does not go at all when no current is passing, for there then being no directive action on the iron, the disc comes to rest at one or other extreme of its arc of oscillation.

The balance-wheel shaft is carried on a footstep jewel, but in order to relieve that jewel of pressure and prevent risk of injury to it, a tortionless silk fibre suspension is used attached to the shaft by a bent wire spring—thus practically the whole weight of the shaft and disc is taken off the jewel. This suspension is not essential—the meter works quite well without it. It is used simply as a safeguard against damage to the jewel and consequent interference with the running of the meter, such as might otherwise result from long-continued use.

The meter is an ampere-hour meter, but for use on constant-pressure circuits the counter, which is geared to the clock, is arranged to indicate the consumption directly in kilowatt-

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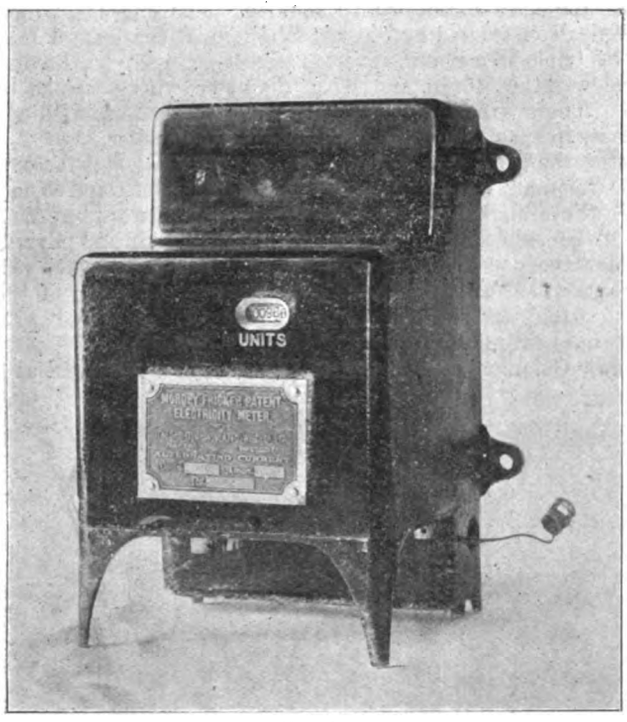

FIG. 1.

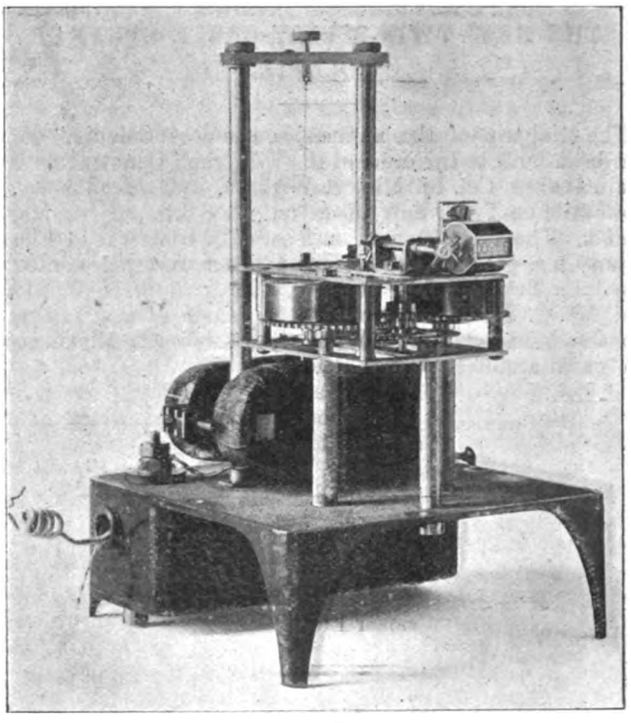

FIG. 3.

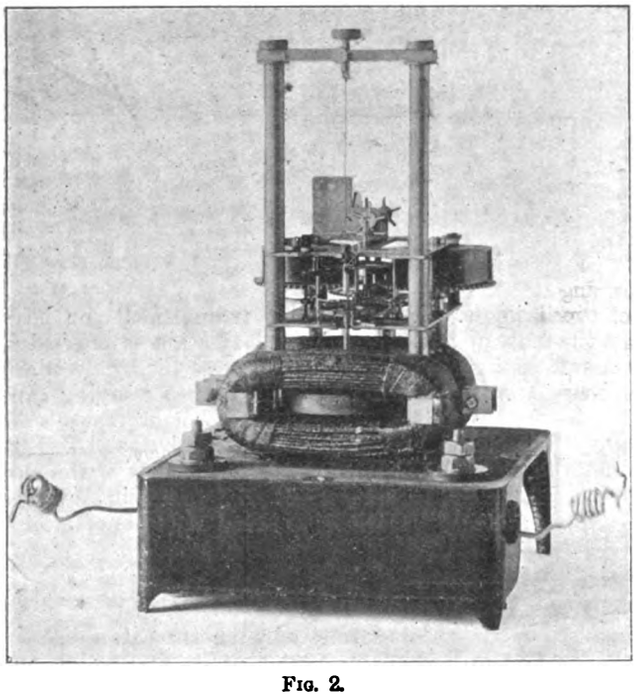

FIG. 2.

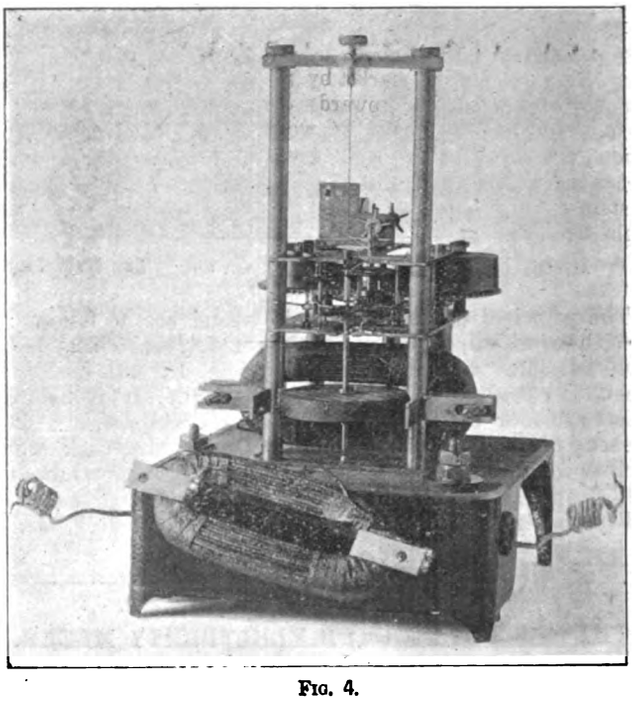

FIG. 4.

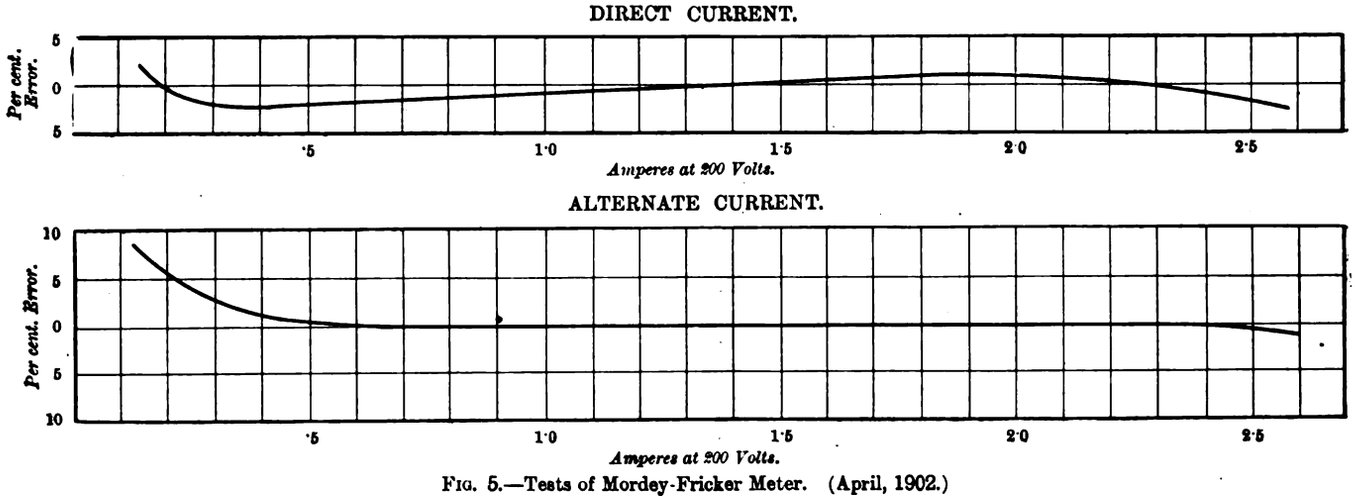

FIG. 5.—Tests of Mordey-Fricker Meter. (April, 1902.)

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hours or Board of Trade units. The base of the instrument is provided on one side with a sealing chamber, to which access is obtained by a movable plate at the bottom, the wires passing through holes at the sides. The meters may be wound for any pressure, and, moreover, it is asserted that with alternating currents there is no frequency error, the constant being the same for all practical frequencies. It is also stated that the starting current is extremely small, corresponding to a single 5 c.p. or 8 c.p. lamp. The pressure drop due to the resistance of the coil is about 0·7 per cent. at full load. One winding of the clock-work is enough to last for about three months on installations of the kind for which the instrument is intended. As the clock does not go at all when no current is passing, the running down of the spring is very slow. For this reason it has not been thought necessary to introduce the complication of an automatic self-winding gear. An ordinary eight-day clock movement is used. These instruments are intended especially for small installations, say of 12 to 30 lamps. Assuming the same proportion between the smallest recorded load and full load, however, they may be used equally well for much larger loads, such as, for example, motors of 10 H.P. to 20 H.P., on which the minimum load is not less than 1 H.P.

The meters are being made by the British Insulated Wire Co. for the Mordey-Fricker Electricity Meter Co. (Ltd.).

A NEW SELECTOR SYSTEM.

A "selector" system, whose primary application is the control of sub-station and arc circuit switches from the station, has recently been developed by Mr. Louis N. Bruner, and is now being put on the market by Messrs. Venner & Co. It has already been in use for upwards of nine months in connection with the Croydon electricity works, and its employment is under consideration in other towns, in several instances the necessary wires having already been laid. The object of the system is as follows:—Taking, first, the example of an arc lighting system in which the arcs are connected nine in series across the 440-volt distributing mains. To switch these circuits of nine on or off it is ordinarily necessary either to send a man out to switch boxes placed on each circuit, or else to bring a switching wire back to the works from each series of nine lamps. In this system one wire only need be employed, and a "selector" is placed in series on this wire at each of the switching points. A transmitter is employed at the works to send different series of electrical impulses to line corresponding with each of the selectors, and the latter are so designed that they only close the switch of the arc circuit they control when the particular series of impulses to which they are designed to respond is received. Obviously this is not confined to arc circuits, but can also be employed for other purposes, such as in connection with individual transformers banked at sub-stations. By suitable arrangements it should be possible to save a considerable waste in magnetising current at light loads.

The transmitter which is placed at the electricity works is illustrated in Fig. 1. A number of brass discs, D, are mounted on the spindle S, which rotates one revolution when the handle H is pulled forward and released. The spring P, pulling the lever back, furnishes the necessary energy for driving the spindle through an ordinary train of wheels, and the vane V equalises the speed. It takes about 10 seconds for the spindle to rotate once. There are 10 pairs of discs, and each of the discs has a number of projections on it, which make contact with one of the flat springs FF as they pass round. Each time one of these projections passes the spring a current is closed through one of the electromagnet coils EE, one corresponding to the left-hand and the other to the right-hand disc of each pair. A resistance, R, is included in this circuit, so that it can be connected up to the same battery or exciter 'bus bars as the main selector circuit. The transmitter at present in use is designed for 120 volts. The electromagnets EE act as relays, and when their armatures are attracted, close the contacts CC of the selector circuit, sending a positive or negative current to line, the connections being similar to those of an ordinary reversing key. The connections mentioned above are shown in Fig. 2, which is lettered to correspond with Fig. 1.

The slider on which the two springs FF are fixed is placed at the point corresponding to the station or circuit which is to be actuated, and a number of impulses are sent (22 in one direction and seven in the reverse direction). For each one of the 10 "selectors" at these stations, the moments at which the reverse impulses are sent, between two ordinary impulses, differs, and the selector in question is so designed that the corresponding switch (for the transformer or arc circuit) is only actuated when this particular series of impulses is received

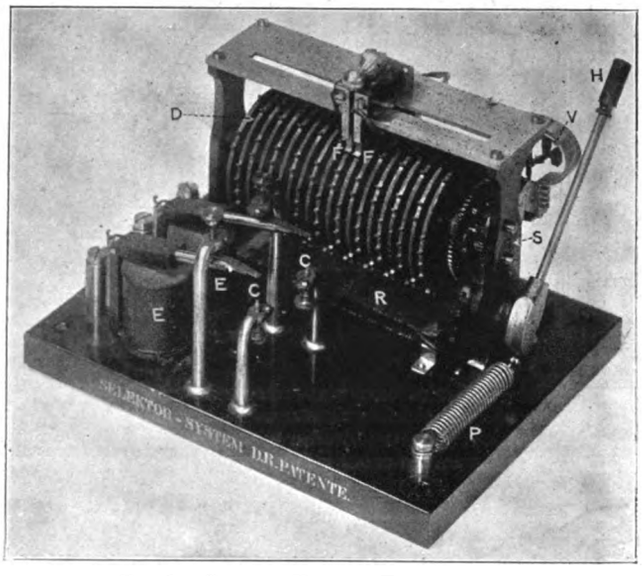

FIG. 1.—GENERAL VIEW OF TRANSMITTER.

A general view of the selector is shown in Fig. 3, and a diagrammatic sketch of the arrangement in Fig. 4. An electromagnet, A, is placed between the two poles of a horse-shoe magnet, and it is free to move either to the left or right, according to the direction of the current passed through it. Each time it is attracted to the left it pulls with it the link B, and the pawl G pushes the ratchet wheel H one tooth forward against the action of a spring. The detent J, which is also kept bearing on the ratchet wheel by a light helical spring,

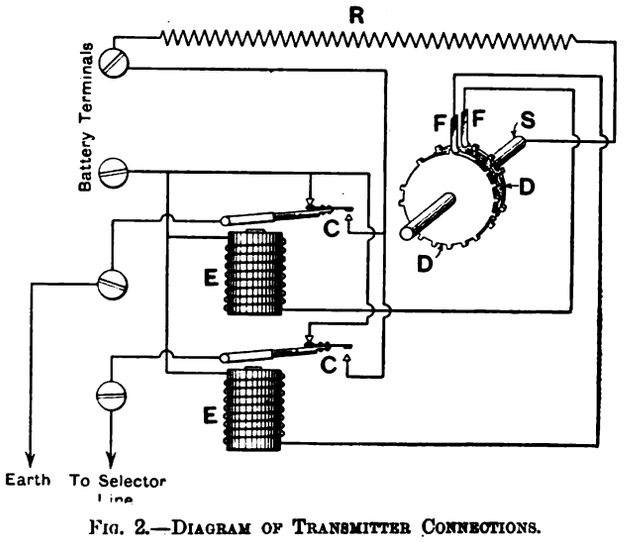

FIG. 2.—DIAGRAM OF TRANSMITTER CONNECTIONS.

prevents the wheel turning back. After a number of impulses attracting A and B to the left, a reverse current is received from the transmitter, as already explained. The arm B then moving to the right, G comes in contact with the pin K and is lifted, and the pin L engages with the detent J and releases the ratchet wheel. This is what happens if the transmitter slider is not adjusted to the selector in question. If, on the other hand, the series impulses received are those for

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which the particular selector is intended, a second detent, M, is engaged in one of the notches in the plate N (which is fixed to the wheel H) at that moment, and prevents the wheel from returning to its initial position. On the same spindle, but loose on it, is a small barrel of vulcanised fibre, W, to which is fixed a small brass plate, P, and a snail, U, with two notches at opposite diameters. A pawl, T, fixed on the larger snail wheel N engages in one of the notches in U after the wheels H and N have made a half revolution forward, and the next impulse being a reverse one, the barrel W revolves back with the other wheels. In rotating, the plate P makes contact with one of the flat springs Y or Z; this closes the circuit of either the switching on or switching off coil of an electromagnetic switch on the circuit or transformer which the particular selector controls.

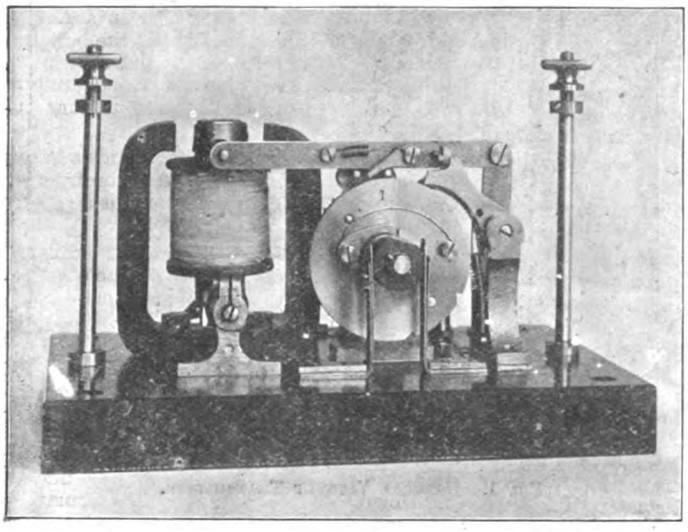

FIG. 3.—GENERAL VIEW OF SELECTOR WITHOUT COVER.

A photographic view of one pattern of these automatic switches is shown in Fig. 5. The coil is in two parts, and there are two plungers, one for each pole of the switch, which are pulled up or down according as the top or bottom coil is energised. These plungers are attached to the switch-bars on either side. This automatic switch may receive its energy from the network itself, or a switch wire may be run from the

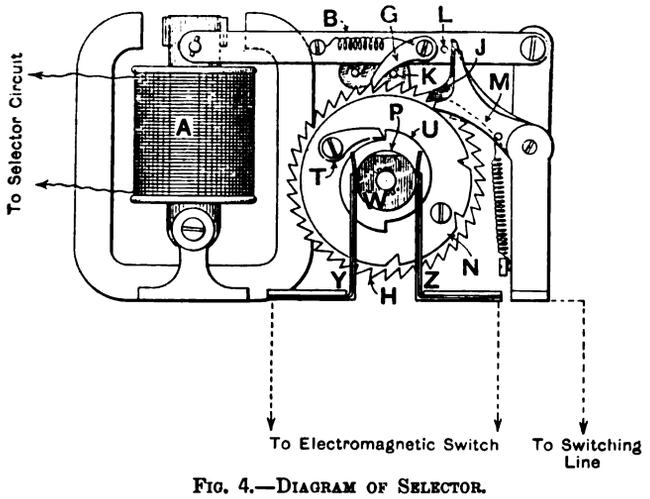

FIG. 4.—DIAGRAM OF SELECTOR.

station, a single switch-wire serving for all the points just as a single wire with earth return suffices for 10 selectors. A diagram of the connections of the circuit in this case is given in Fig. 6. A twin wire may be employed, as shown, one of whose wires connects up the selectors in series, and the other being tapped for the switching connection at every point, the earth being employed as return in both cases. The resistance of the selectors is about 6 ohms, and with 10 in a circuit 120 volts is required, so that 2 amperes flows. At Croydon, where the selector system is employed for the arc circuits, current from the station battery is employed for the selector circuit, the connection being made through fuses and a rheostat to compensate for increase in the battery voltage during or soon after charging. There are four selector circuits, but only one transmitter, switches being provided so that it can be switched on to any one of the four circuits. Current for the automatic switches is not conveyed by a separate wire,

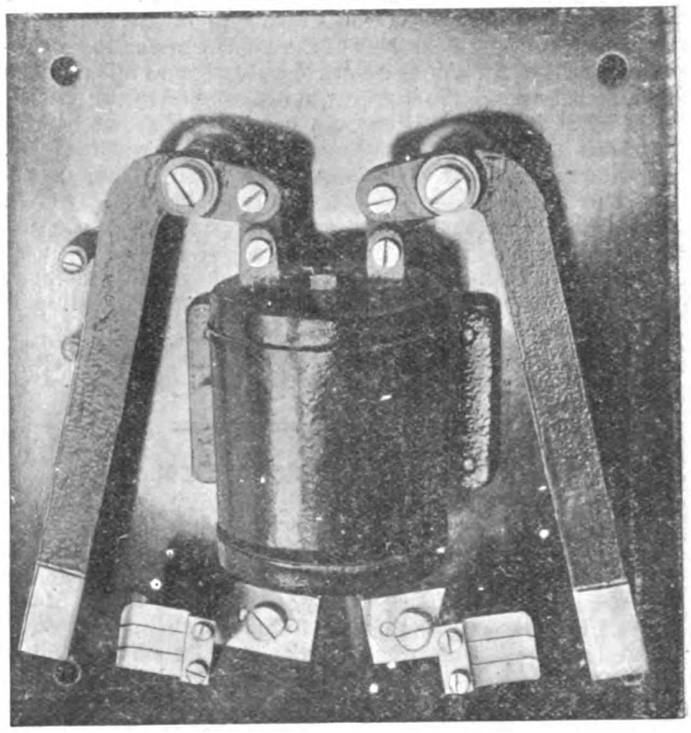

FIG. 5.—AUTOMATIC SWITCH.

but is taken from the private lighting network, which is on the alternating current system, and is fed through transformers in sub-stations.

When employed for switching transformers in and out, a more complicated switch is needed than that shown in Fig. 5, as there must be an arrangement for switching both primary and secondary windings of the transformer on and off, and in such a manner that the primary is switched on before the

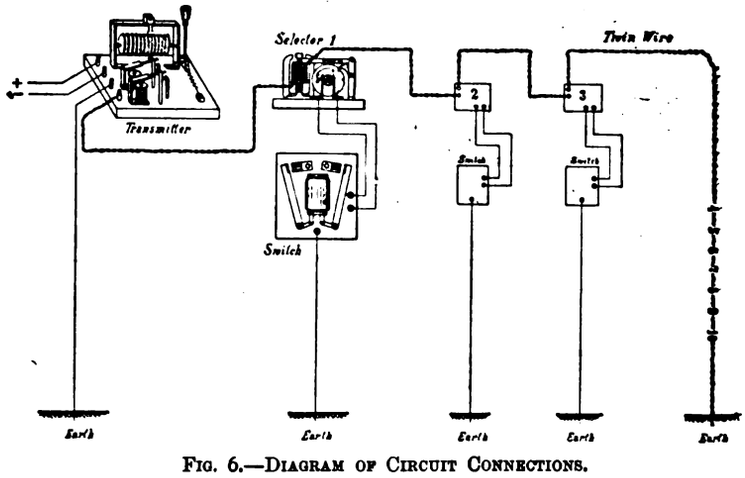

FIG. 6.—DIAGRAM OF CIRCUIT CONNECTIONS.

secondary, and in switching off the secondary circuit is broken first. This is done by employing two switches, each very similar to the one in Fig. 5, but with an extra contact. One of these switches is for the primary of the transformer and the other for the secondary. In switching on, the selector closes the switching circuit of the primary, and as soon as this is effected the extra contacts closed at the same time by the automatic switch close the secondary switching circuit. In switching off, the reverse takes place.

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THE WOLVERHAMPTON EXHIBITION.—II.

One of the few novel things shown at the Wolverhampton Exhibition is the Cahall water-tube boiler, two of which have been erected by Messrs. Edwin Danks & Co., and supply part of the steam required for the exhibition electrical generating plant. Besides having an opportunity of seeing one of these under steam, visitors can inspect one of these boilers without its casing in the grounds. The boiler is vertical, and its general arrangement is seen in section in Fig. 1. It consists of a water drum and mud drum of Siemens-Martin mild steel arranged one above the other and connected by a number of 4in. straight seamless tubes, which are expanded into them. The position of the furnace is shown in the illustration, and it is seen that the gases pass around the tubes to a flue which passes through

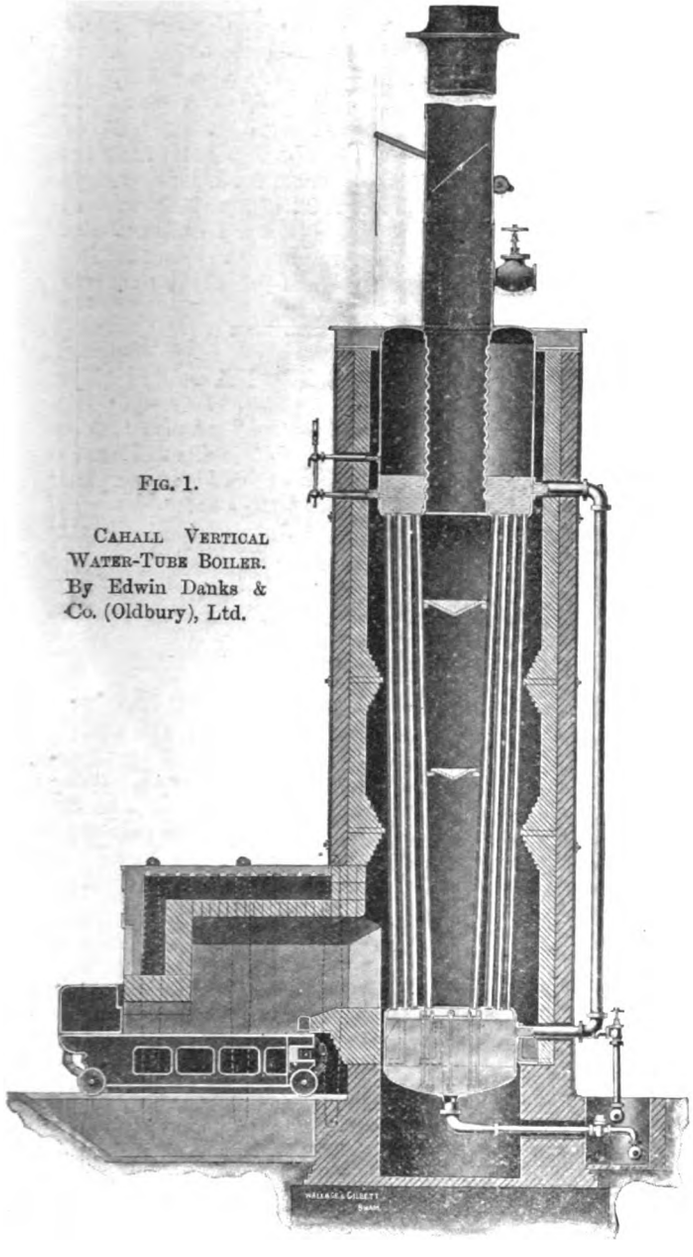

FIG. 1.

CAHALL VERTICAL WATER-TUBE BOILER. By Edwin Danks & Co. (Oldbury), Ltd.

the centre of the water drum and thence to the iron chimney. Two cast-iron deflecting plates (seen white in the figure) in conjunction with baffle tiling of the brick lining, prevent the gases from going straight up the centre without coming in contact with all the tubes, and it is claimed that this results in considerable economy in fuel. This space is lined with fire brick, around which is ordinary brick, shown by different shading in Fig. 1. Outside this brickwork is a cylinder of $\frac{5}{16}$in. steel boiler plate, a slight air space being left between. There are three 6in. circulating pipes, one of which is seen to the extreme right in the illustration, and the feed takes place at the top end of one of these. It is claimed that the circulation is perfect, the water ascending the 4in. tubes, and descending by the external circulating pipes. The boilers are fitted with Mansfield chain grates, which are very similar to the Babcock-Wilcox type, the feed of fuel and the motion of the grate being controlled by ratchet and pawl and worm gear.

The boilers shown at the exhibition are intended to evaporate 10,000lb. to 12,000lb. of water per hour, and are the largest size that have been constructed hitherto. In these the height of the top of the stack above the ground is 50ft., and the sizes of the steam and mud drums are 6ft. 9in. diameter × 8ft. 9in. deep, and 5ft. 9in. diameter × 2ft. 9in. deep respectively. The vertical seams of these drums are butt-jointed, with inside and outside cover plates secured with six rows of rivets, and the circular joints are lapped and double rivetted. The diameter of the flue passing through the water drum is 2ft. 10in. Brackets rivetted to the mud drum support the entire boiler. In addition to the dimensions and data already given, we may add the following: Heating surface in the tubes 2,500 sq. ft., grate area 48 sq. ft., maximum working pressure 200lb. per sq. in. (the pressure at the exhibition is considerably lower), number of tubes 108, length of tubes 22ft. Each boiler has an independent iron chimney, but if desired these can, of course, all be led to a common chimney. Although the height of this is only 50ft., it is asserted that the draught is amply sufficient. A great advantage claimed for the boiler is that it is suitable for impure water, for, the heating surfaces being practically vertical, it is stated that there is no accumulation of scale, the dirt dropping to the mud drum at the bottom, where it can easily be removed. The makers state that several of these boilers have been in use in the United States with good results; and a few have already been erected in this country, but none at electricity works.

Messrs. Edwin Danks & Co. also exhibit in the grounds a large marine type of boiler 14ft. long by 11ft. 6in. diameter, constructed for 180lb. per square inch working pressure. This boiler is destined for the Ipswich Corporation.

The Babcock and Wilcox boiler exhibited is of this firm's ordinary water-tube pattern. It has a total heating surface of 2,255 sq. ft., and is constructed for a working pressure of 200lb. per square inch. It is composed of 10 sections of 10 tubes each, these being 4in. diameter and 18ft. long, and the diameter of the steam and water drum being 54in. The boiler has a Babcock and Wilcox chain grate stoker. It is also fitted with the firm's feed-water purifier, whose construction is based on the principle that the heating of water containing the carbonates and sulphates of lime and magnesia to a temperature of upwards of 300°F. causes these salts to become insoluble and to be thrown down as sludge—the former almost instantly, the latter more slowly. It consists of a steel drum or cylinder, fitted with dished ends, one having a manhole in it, a steel dome fitted with sprayer, and removable diaphragms or obstacle plates. Under working conditions the lower half of the purifier is filled with water and the upper portion with steam, the steam and the water connection between the purifier shell and the main steam and water drum of the boiler being made by expanded connections. The boiler feed check valve is mounted on the top of the spraying dome, and the water entering the purifier is divided into a fine stream, and, passing through the steam space, becomes raised to practically boiler temperature. The majority of the scale-forming matter is deposited in the two front chambers of the purifier, but, in order to intercept any scum, the water is caused to pass alternately over and under obstacle plates before it enters the boiler proper, freed from nearly all scale-forming matter. On opening the blow-off cocks attached to the purifier the majority of the sludge can be expelled, any deposit left in the purifier drum can be taken out from time to time by removing the front manhole and the obstacle plates, which are only secured in position by snecks. There is no necessity to empty the water from the boiler when cleaning the purifier, so that the latter can, in case of very bad water, be cleaned two or three times before the boiler itself requires to be laid off. In connection with this boiler there is a wrought steel chimney 42in. in diameter by 80ft. high, also manufactured by Messrs. Babcock and Wilcox.

The two Dürr boilers, supplied by Mr. John Thompson of Wolverhampton, combine two principles which have been used also in the Niclausse and the Babcock-Wilcox boiler respectively. A group or nest of 137 water-tubes 4¼in. diameter and 17ft. 3in. long are fixed in an inclined position, the upper end being at the front of the boiler above the furnace, and each of these tubes contains an internal circulating pipe. At the front end of the boiler is a wrought steel header or water chamber divided into two parts by a division plate. The outer tubes terminate in the back part of this chamber, but the inner tubes pass straight into the partition so as to terminate at the front side of the chamber. The back end of the tubes is simply supported on a framework of cast iron. Above the tubes are two steam and water drums running the whole length of the boiler, and slightly inclined. The feed water enters at the back end of the right hand one of these drums, into which the steam and also the water carrying steam are discharged, and then flows along it to the front partition of the header, thence into the internal circulating pipes. The steam generated in the outer tubes rises in the back partition of the header to the water and steam drum where the feed water is admitted, passes along this drum, through a connecting passage into the

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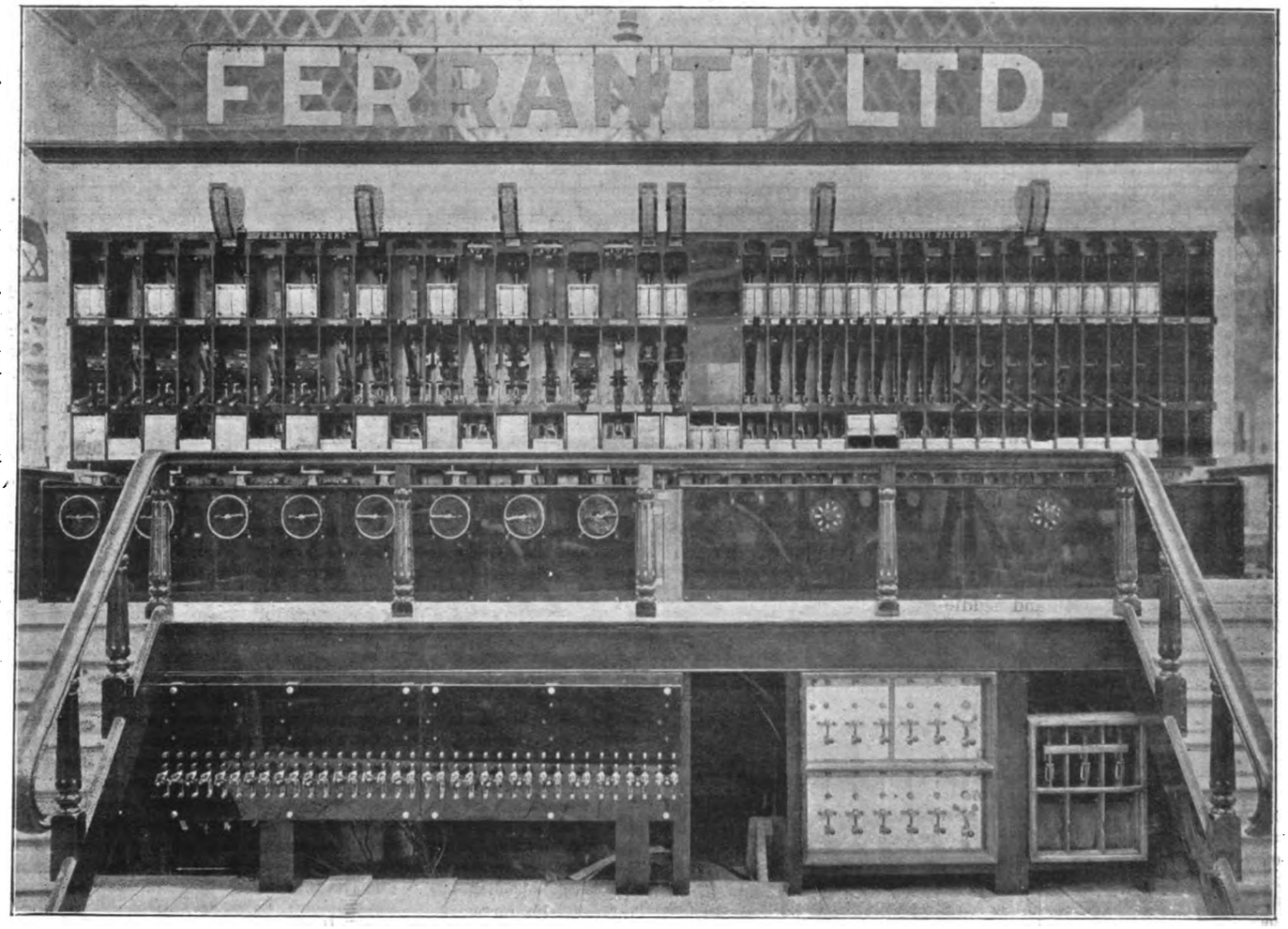

FIG. 2.—THE FERRANTI SWITCHBOARD.

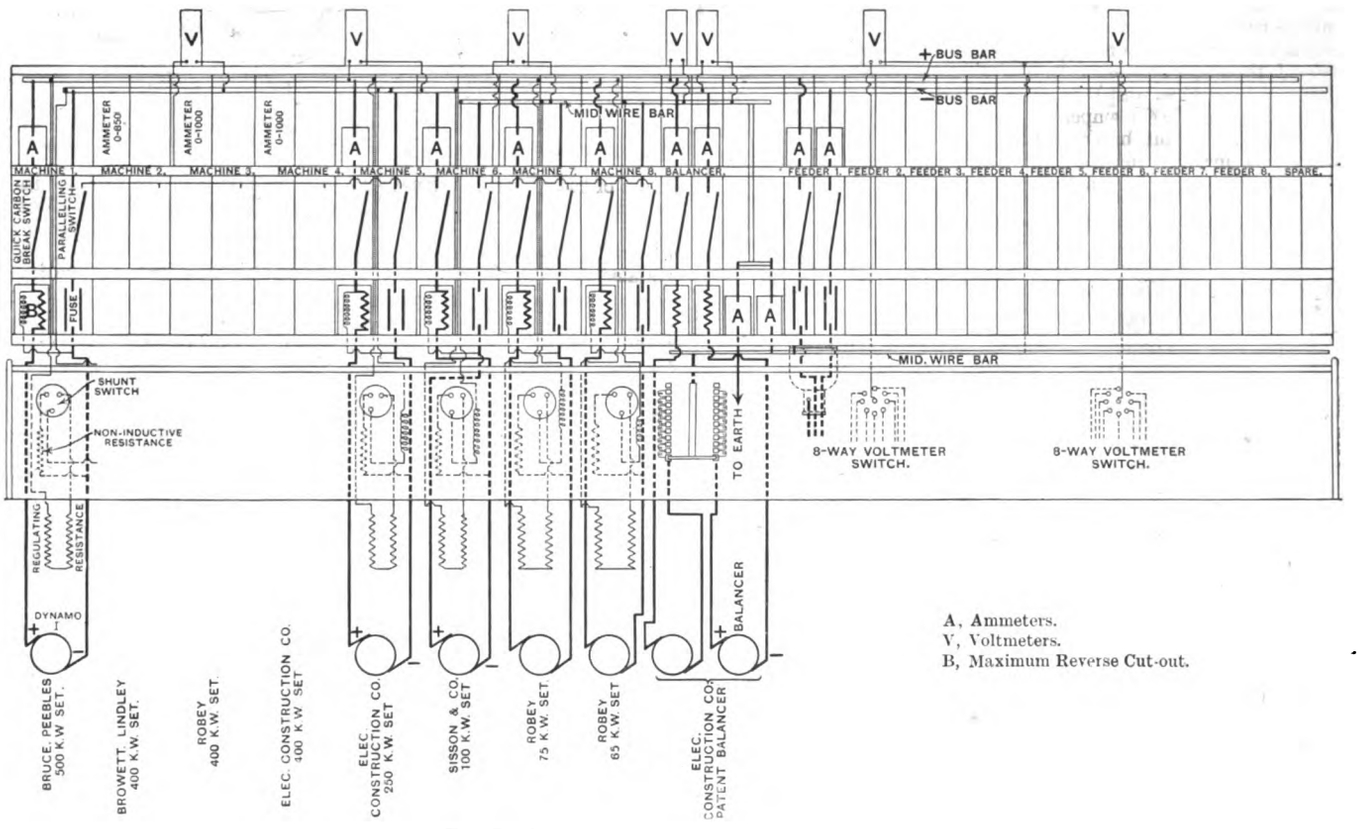

FIG. 3.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

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second drum, and thence to the steam dome. The makers of the boilers claim particular advantages for the method of fixing the tubes into the header at the front end. Instead of doing this with an expander, the end of the tube is thickened either by welding on a ring or by thickening up the tube itself under hydraulic pressure. This extra thickness is made sufficient for turning down to a taper which fits into tapered holes machined into the water chamber. The tubes are pressed home into the header, the joint being simply metal to metal, and the pressure of the steam helps to make the joint tight.

The two Dürr boilers at the exhibition are rated at 500 H.P. The two steam and water drums of each measure 4ft. 6in. diameter by 22ft. 6in. long. They are built for a working pressure of 200lb. per square inch, and have been tested up to 350lb.

The Stirling Boiler Co. exhibit an excellent and interesting model of their Stirling boiler—a type which was fully described in *The Electrician* at the time of the Glasgow Exhibition (Vol. XLVII., p. 477).

As has been stated in our previous article, a fine Ferranti switchboard controls the whole of the lighting and power distribution by electricity in the exhibition. A photographic view of this board is given in Fig. 2, and a diagram of the connections in Fig. 3. All the connections come to the bottom of the board, and the 'bus bars are at the top. It is divided into two sections, eight pairs of generator panels on the left, and eight pairs of feeder panels on the right. The 'bus bars connected to the outers of the three-wire system run the whole length of the board, and the middle wire 'bus bar extends over the panels to which the balancer and the 250-volt generators are connected. On the feeder panels there is an ammeter, single-pole switch and fuse on each pole. Two feeder voltmeters are mounted on the top slate and coupled up to the voltmeter switches on the regulating table. The earth and middle-wire ammeters are mounted to the left of the feeders. To the left of this, between the feeder and dynamo panels, is the switch-gear for the balancer. The balancer starting switch will be seen under the regulating table in front of the board. In the generator panels the positive side is arranged with an automatic cut-out, the negative having fuses. Each pair of generator panels contains an ammeter and a quick-break switch, with the automatic release fixed in the recess under the switch, a quick-break knife switch, and a fuse with duplicate contacts. The switch with the automatic release is on the positive pole, and the break takes place between carbon blocks. Switching off takes place here always, and in running up a new machine this switch is closed first. The switch on the negative side has a paralleling contact connected to a zero voltmeter. The arm of the switch makes contact with this first, and, when the voltmeter returns to zero, it is pushed home. Edgewise voltmeters for paralleling and showing 'bus bar volts are mounted on the top slate. The regulating table in the front contains the usual switch and rheostat in the field circuit of the dynamos, the rheostat being of the compact and yet most substantial design which Messrs. Ferranti have been supplying of late for both continuous-current machines and alternators.

Besides this main switchboard, Messrs. Ferranti are exhibiting a number of their specialities, including a rectifier, two transformers of 30kw. and 62·5kw. respectively, a number of oil-break fuses, including one for 1,000 amperes, three-phase extra high-tension switches fitted with oil break, continuous-current meters, junction boxes, &c. It may be mentioned also that the firm have supplied the electric meters in use in the exhibition.

AUTOMATIC RELAY TRANSLATION FOR LONG SUBMARINE CABLES.*

BY S. G. BROWN.

The system of relay working for long submarine telegraph cables here described must not be looked upon as being in an experimental stage. It is in everyday use on some of the lines of the largest cable companies, notably of those of the Eastern Telegraph Co., their station at Gibraltar having been the first to be fitted up for automatically translating cable messages between Porthcurnow in England and Alexandria in Egypt. The usual methods employed on cables at the present time is to receive signals on a strip of paper, written by a siphon recorder, as a dotted ink line. The message at an intermediate station is then punched by hand on another strip of paper, which strip is passed through an automatic transmitter for re-transmission over the next line. Or, if the speed of signalling and the conditions of the circuit will allow of it, the message is read off the siphon recorder strip by the clerk, direct, as it flows from the instrument, and sent on by a hand-key, signal by signal. This latter system is termed "human translation," the speed being necessarily limited by the possible rate of hand transmission, and it is slow, laborious, and permissible at only one station. A cable relay is, therefore, valuable in that it replaces the clerk in all these operations, receiving and sending on the traffic automatically, whatever may be the speed of transmission. I believe the provision of a submarine cable relay has been one of the problems to the solution of which the attention of telegraph engineers has been turned for some years. The requirements in such an instrument are great sensitiveness, combined with the capability of being worked at a high speed by the feeble forces available at the receiving end of a long cable and the absolute assurance of perfect contact. With the exceedingly feeble current obtainable at the end of cables, when operated at their present working speed on the siphon recorder, it is useless to bring two pieces of metal into "butt" contact with the view of closing the circuit of a battery, so as to work, say, a Post Office relay, since the resistance of such a contact may be normally many thousands of ohms, whilst, if the local battery is increased so as to break down this resistance, the contact on passing a current coheres or sticks together and prevents the cable current from opening the circuit. This disturbing force, although a great drawback in sensitive relays, has been effectually made use of for purposes of wireless telegraphy.

Varley, in his patent No. 3,456 of 1862, proposes to get over the difficulty of the relay contact sticking after the passage of the current by revolving the contact pieces; but I have found by actual experiment that such a movement actually increases the trouble of making contact, so that, on the whole, the remedy is as bad as the disease. I have found, however, that with such a form of relay the resistance of the contact could be reduced by the use of a suitable short-circuiting condenser. About the early part of the year 1899 I discovered that good electrical contact could be made and maintained by keeping the end of the relay tongue pressed upon the surface of a divided plate, and that frictional resistance to side motion of the tongue could be reduced and almost eliminated by moving the plate under the tongue, or, what amounts to the same thing, by moving the tongue over the

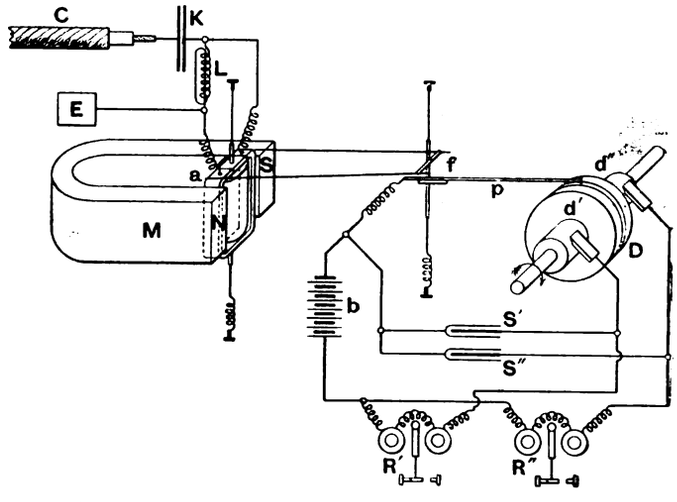

FIG. 1.

surface of the plate, the movement in each case being maintained in the direction of the length of the tongue. To obtain the best effect and greatest sensitiveness the relay tongue is arranged in practice to move across the surface of a rotary drum, the drum is divided into insulated sections, and the sections joined to Post Office or similar relays. This relay is called the "drum cable relay."

In Fig. 1, *a* is a recorder coil suspended in the field of a permanent magnet, M; *f* is a light suspended frame to carry the relay tongue *p*; the frame is joined to the suspended coil *a* by two silk or quartz fibres. The pointer *p* is a fine syphon glass tube carrying through its bore a phosphor-bronze wire. This wire is soldered to an iridium tip, which tip is shellacked to the extreme end of the siphon tube. The iridium tip bears lightly upon the surface of the drum D, which is kept revolving at about 150 revs. per min. The drum D is made in three parts: the two outer ones, *d' d''*, constitute the "dot" and "dash"-marking surfaces, and the middle one, upon and in the centre of which the pointer normally rests when no signal or current passes, is insulated. When the tongue is deflected by the movement of the coil to form, say, a dot, a circuit is made through the battery *b*, the tongue *p*, and the Post Office relay R'. A movement of the tongue in the opposite direction would close the circuit of the Post Office relay R''.

The relay depends for its efficiency upon the reduction of frictional resistance to the lateral movements of the tongue, and it is easy to prove that this effect is due to the tangential motion of the surface, for if the drum is stopped when signals are being received, the tongue also comes at once to rest, since the currents leaving the cable are of insufficient strength to overcome the statical friction between tongue and surface. This principle is somewhat ignored, I am afraid, in most treatises on friction; might there not be a

* Paper read before the Institution of Electrical Engineers, May 1st.

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parallelogram of friction corresponding to that which we use in dealing with force and motion?

S′ S″ are condensers of 2 microfarads capacity each, used to short-circuit the sliding contact between the tongue *p* and the drum *d*. Without them, good electrical contact can only be maintained when the surfaces of the drum and the tongue are very much cleaner than they can possibly be kept in practice. Why these condensers do improve the contact, making the contact practically perfect, I am not prepared to say. One eminent electrician maintains that this proves the existence of a vibratory contact. We all know why a condenser improves a vibratory contact, but I hardly think this touches the root of the matter, because I find that when the surface of the drum is exceptionally smooth the value of the condenser is usually more pronounced.

K is the receiving condenser. This condenser is placed in the circuit to act as a curb to the signals and to block out earth currents. The current from the cable *c* passes through this condenser before flowing round the suspended coil *a* to the earth plate E. The placing of the condenser K in the circuit introduces a difficulty due to its becoming charged under a succession of signals of the same polarity, producing what is termed "variable zero." This variability of zero which, unless special means are provided for its elimination, always occurs in cable signals when receiving condensers are employed, is of little or no importance if the siphon recorder is used as the receiving instrument, but is fatal to the working of a relay of any form.

Whilst experimenting with Mr. A. L. Dearlove at Porthcurnow on the Gilbraltar-Porthcurnow cable of the Eastern Telegraph Co., the variability was got rid of by placing a high-resistance shunt across the receiving and transmitting condensers, but this method was not found quite practical, owing to the fact that earth currents were not entirely excluded by the shunted condensers. The consequence was that the earth current temporarily upset the adjustment of the relay, and this mode of working was objected to by the company. For this reason I devised another method, which in practice has been found entirely satisfactory. I shall explain it here as briefly as possible.

"Variable zero" may be got rid of by means of "local correction"—that is to say, a current from a local battery and the relay R′ R″ is sent through a circuit having considerable retardation made up of a condenser placed between two high resistances, condenser and resistances being capable of minute adjustment. The relays R′ R″ produce the same order or combination of signal as that charging up the condenser K. As the current from the cable, due to this choking action of the condenser, dies away, so at exactly the same rate does the current from the local-correction circuit increase. The correction current flows through a separate winding on the suspended coil *a* in the same direction as the signals, so as to compensate for the loss of current from the cable, thus eliminating "variable zero" disturbances entirely from the working of the relay.

L is a magnetic or inductive shunt of 30 ohms resistance, joined across the terminals of the suspended coil *a*. The shunt can be adjusted to suit cables of from 1 to 10 K.R.; the largest size at present used has a very high self-induction. I am not at present prepared to say what the value is. It is secured by the use of many thousands of turns of copper wire, and a heavy closed magnetic circuit. The mechanical arrangement of this shunt is on the lines of the well-known "Mordey" transformer. Roughly speaking, to get high inductance to deal with the slow changes of current from a cable, we must have weight. Our largest shunt turns the balance at something like 3 cwt. When operated by the cable currents from the end of a line, the iron of the shunt must be magnetised only in its initial stage, the molecules being magnetically strained well within their elastic limit. In support of this statement, I shall refer you to Prof. Ewing's book on "Magnetic Induction in Iron and other Metals," Chap. VI., from which the following is more or less a quotation.

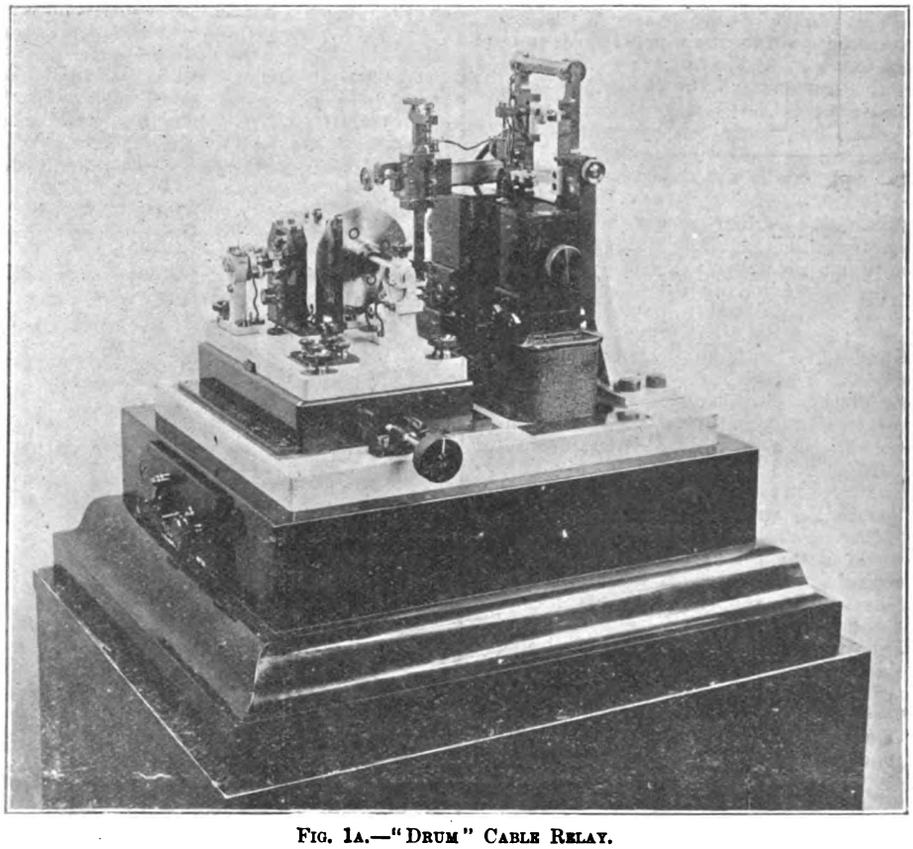

FIG. 1A.—"DRUM" CABLE RELAY.

Lord Rayleigh, in testing magnetometrically a bar of iron, one end of the iron being very near the magnetometer, and with a compensating coil adjusted to balance the magnetism, which a feeble magnetising current induced in the bar, found that the compensation remained perfect if the magnetic force fell below 0·00004 C.G.S. Within this range of force there is no retentiveness. The magnetising process begins like the straining of a solid body with an elastic stage, within which there is no permanent set. Some electricians have thought that there must be a drawback to the use of iron in these shunts, especially as the iron forms a closed circuit. They have suggested air as being a more perfect material, but I think the above well meets their objection. The permeability of the iron of these inductive shunts when used for cable work is probably somewhere about 150 as against 1,200, or thereabouts, when used as transformers for alternating-current lighting work, the permeability of air being 1.

Magnetic shunts have been designed so that the molecules of iron may be shaken up by an alternating-current excitation. This alternating-current circuit is disposed so that there shall be no interaction between it and the shunt-winding. The permeability of the iron may thus be greatly increased. The method has been tried with satisfactory results. These magnetic shunts are of very great value in cable work, for they steady and curb the action of the relay coil, and without them relay working would be well-nigh impossible. Their action on a siphon recorder is no less marked: using a "plain"

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automatic or hand-key as sender, they produce curbed signals, and this with an increase of speed.

The drum cable relay apparatus, so far as I have described it, is all that is necessary for simple translation on short cables, a hand-key being used at the first station, the relays R′ R″ being connected

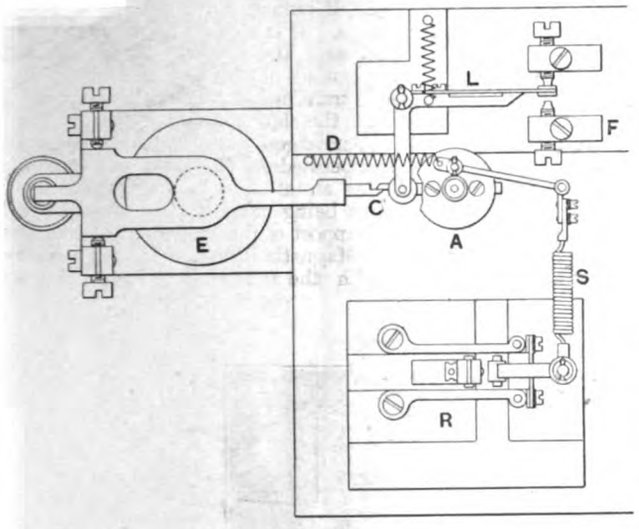

FIG. 2.

to work two sounders, which sounders are joined up with a battery, in the same way as a hand-key, to transmit the messages over the second line; but in what follows I shall assume that at the originating station an "automatic transmitter" is employed.

movements of its transmitting levers, instead of being governed by the peforations in the punched tape or strip, are governed by the motions of the relay tongue. The interpolator sends into the second cable impulses similar to those entering the first cable, and these may be either "curbed" or "plain" as required. To use this instrument to the best advantage, it is necessary that it should run in approximate synchronism with the automatic transmitter, and that the speed of the last-named instrument should be nearly uniform.

The interpolator consists of two sets of signalling levers, similar to each other but mechanically distinct. One set sends on the "dot" signals and the other the "dashes." Fig. 2 shows the mechanism of one-half of the interpolator, which acts as an automatic transmitter, forwarding the "dot" signals received by the drum relay from the first into the second cable. The electromagnet E is worked from the relay R′ of Fig. 1. The other set of mechanism, or "dash" side, not shown, is worked from the relay R″. When the electromagnet E is energised it pulls down its armature, removing the catch C from holding the clutch-sleeve A, allowing it to revolve. The clutch-sleeve as it revolves moves the lever L so as to make contact with the lower contact point F, this putting battery to line. S is a spring lever worked from a crank pin on top of the clutch sleeve; the crank pin revolving, rocks the lever and operates the reverser R to which the battery is connected, and this, at stated times in the revolution, reverses the battery, which acts as a curb to the first battery current or cutting off the battery and putting the line to earth, to act as "plain" automatic as the case may be. By moving the reverser R, relatively to the crank pin, a bias may be given the spring of the lever S. Such a motion will allow of the duration of the curb or earthing period being adjusted. D is a spiral spring to help the clutch-sleeve to ride over its lifting rollers. The clutch mechanism is driven by a small governed electromotor. The clutch is more particularly shown in Fig 3. S is a rotating spindle to which the collar G is fixed. The clutch-sleeve, loose on the spindle, carries at its end the cam plate A, is provided at its lower end with teeth, which are adjusted to gear with similar teeth on the collar. A spring B tends to force the clutch-sleeve into engagement

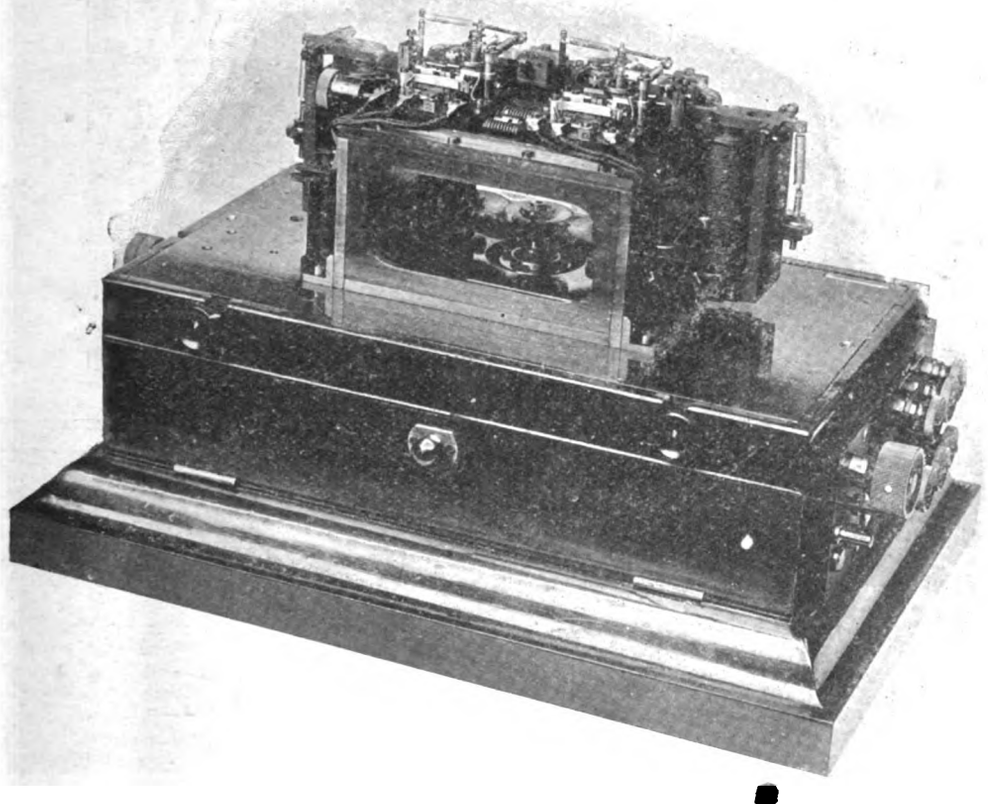

FIG. 2A.—INTERPOLATOR.

Although scarcely necessary, it may be well here to call attention to the fact that when a cable is worked at its highest practicable speed, many of the originating impulses are obliterated from the received signals whenever successive impulses of the same polarity or sign occur. It is, therefore, evident that if the impulses sent by the relay apparatus into the second cable are to be identical in character with those sent into the first, it is necessary to reproduce the missing "beats." The instrument used for this purpose is called an "interpolator." Its action resembles that of the automatic transmitter at the originating station, with this difference, that the with the collar. The sleeve is provided with pins or projections, one of which, C, engages with the arresting device, and these ride upon fixed lifting rollers L L (which are shown dotted) when the sleeve is at rest, and thereby raises it out of engagement with the rotary spindle. When the arresting device is removed by the magnet E, the clutch-sleeve is pulled off the rollers L L by a spring pulling at the crank-pin D, and thus thrown into gear with the spindle, operating the transmitting levers as previously described.

When an *h* is received from a long cable on the drum of the relay, the tongue remains in contact with the dot side throughout the four

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beats of the letter, simply producing one long contact on the "dot" Post Office relay. This long signal is split up by the interpolator and is transmitted as four dots.

In place of the interpolator, an "automatic perforator" (see Fig. 4) may be employed. The automatic perforator is constructed very much like the interpolator, with this difference, that in place of two there are three clutches adapted to operate punches, by means of cams, for perforating the signals on a paper tape, such as is employed when using the automatic transmitter. To prevent waste of paper, a stopping device is brought into action after the machine has fed out, say 5in. of blank strip, this after the last signal has been received. The perforator reproduces on punched tape a facsimile of the message on the punched tape used at the originating station, and the copy is immediately available for sending on by the usual automatic transmitter. By the use of this auto-perforator it is possible for a single short cable to feed two long ones, or vice versa, with a minimum of delay.

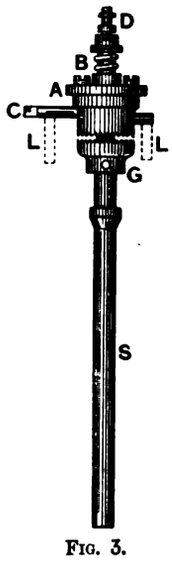

FIG. 3.

In order that slight failures in the relay apparatus may be instantly seen, it is necessary to have two local registers at the transmitting station, one showing the drum and tongue contacts, the other the signals actually sent into the second cable. The register for showing the drum and tongue contacts of the cable relay has been found to be most valuable and efficient, and automatic translation cannot very well be maintained without it, for it gives a record of what takes place in the most delicate part of the apparatus undisguised by defects of the Post Office relays, or the defects and corrective effects of the interpolator. Such a record is seen in slip A of Fig. 5. These signals were recorded by a direct writer, worked straight off the drum cable relay. It shows the quality of the contact, and gives an outline of the signals as they arrange themselves on the drum when everything is in correct adjustment. By observing such a record, the relay may be kept in adjustment, and faults in transmission easily detected.

Slip A is a record of signals received from a cable relay direct at 140 letters per minute over a duplexed cable of 3·2 K.R. under actual traffic conditions. It will be observed that there are no "beats" in the signals when the same follow each other on the same side of the line, the tongue of the relay having held over in these cases without breaking contact. On the other hand, slip B shows signals recorded by a direct writer worked off local circuit with the interpolar; here we have all the signals clearly recorded. Such a record was received from a relay over a cable of 2·8 K.R., simplex working at 210 letters per minute under actual traffic conditions.

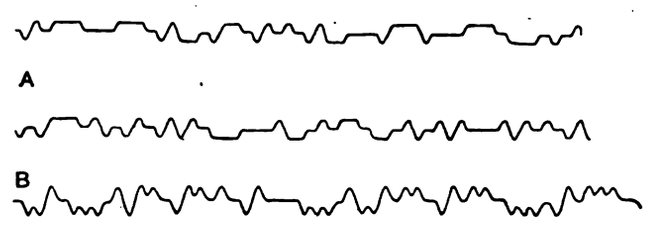

FIG. 5.

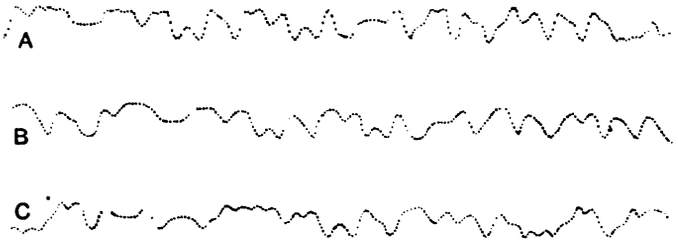

FIG. 6.

In Fig. 6, slips A and B show records of signals received on the drum cable relay apparatus, worked from a duplexed cable of 2·8 K.R. at 150 letters per minute; the sending battery was 60 volts. The signals were translated by the relay apparatus through an artificial line of 3·5 K.R., the signals being written by a siphon recorder. Slip A shows signals as received the siphon recorder when an automatic transmitter was used at the originating station; the message was sent on from the relay by a "curb" interpolator. Slip B shows signals as received when a couple of sounders were joined up like a hand-key to be worked by the relay in place of the interpolator. Slip C shows signals transmitted under similar conditions as slip B, but a hand-key was used in place of the automatic transmitter at the originating station.

(To be concluded.)

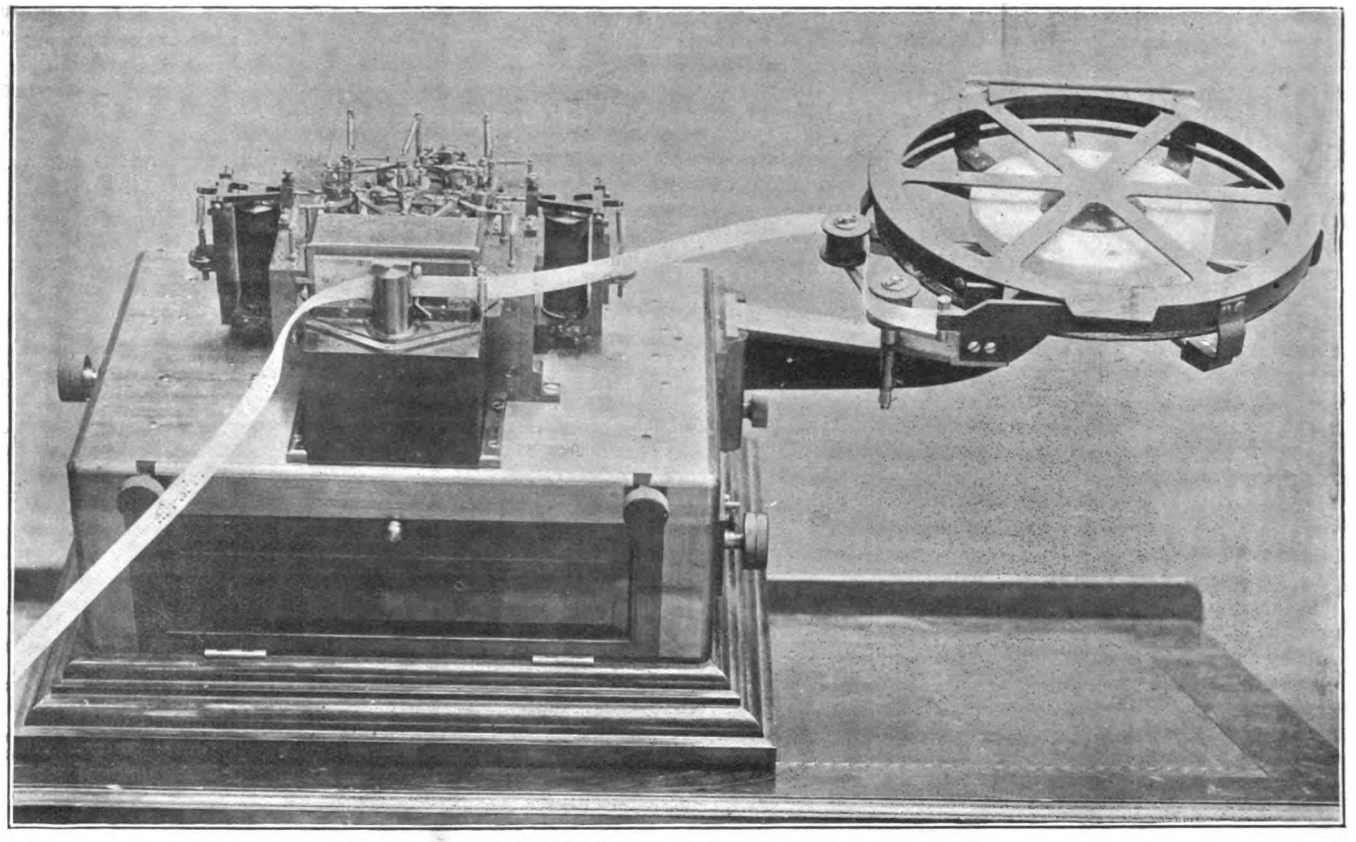
FIG. 4.—AUTOMATIC PERFORATOR.

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LIGHT BATHS AND LIGHT CURE APPARATUS.

Since the introduction of the Finsen light cure a few years ago, the method has received wider attention, and there are now on the market various kinds of apparatus in which the treatment can be applied to many forms of disease. We have inspected the showroom of the Sanitas Electrical Co. this week and were shown a number of light baths which are now being supplied to various medical institutions. We illustrate herewith some of the lamps and cabinets made use of, that in Fig. 1 being a combined arc light and incandescent

FIG. 1.—COMBINED ARC AND INCANDESCENT LIGHT BATH.

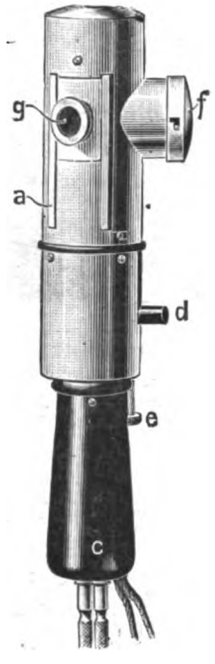

FIG. 2.—DERMO LAMP.

bath. A cabinet, finished in various styles is lined with vertical rows of incandescent lamps and four arc lamps are placed at diametrically opposite corners, whence their rays are reflected to the patient, who sits on the revolving chair in the centre of the cabinet. The head only is exposed to view, this projecting through doors at the top of the cabinet. Various rows of lamps can be turned on, or if all are used, their rays can be lowered by the insertion of resistance in the circuit. Cabinets employing incandescents alone are also used, and in one case three sets of coloured lamps are fitted for the treatment of nervous and skin diseases. Another form, also made

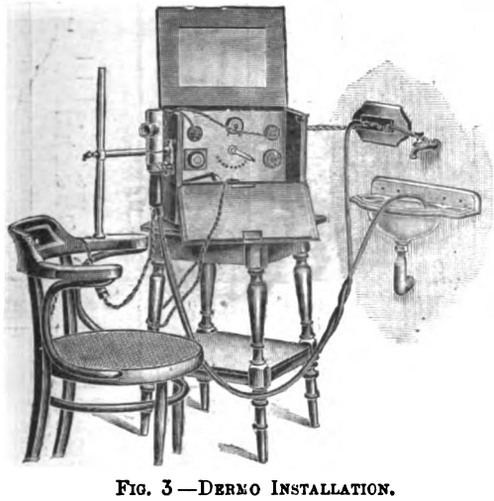

FIG. 3.—DERMO INSTALLATION.

with a hinged and folding front, allows of the application of heat and light rays from an external source, it being possible to concentrate the rays on every portion of the body.

The original Finsen lamp has been replaced by a new form of light known as the "Dermo," which takes but 5 amperes, as against the 80 of the older lamp. Iron electrodes are used for the points of the arc, and a water circulation is laid on, which keeps the entire lamp cool. Referring to the illustration Fig. 2, *a* is a hollow cylinder to which a handle, *c*, is screwed, the water-circulating tubes and current-conducting wires being brought in here. The lamp is switched on at *d*, and *g* is a sight hole for observing the arc, which is kept constant by revolving the handle *c*. The rays issue from the tube *f*, which is closed by a lens of rock crystal, this serving as a pressure glass, as employed by Prof. Finsen, in addition to the light cure proper. A complete installation is shown in Fig. 3.

Among other apparatus are portable baths, which can be applied to the legs, arms or body as required. A reclining light bath is also manufactured, it being possible to direct the rays from incandescent lamps to all portions of the body. The treatment, we are informed, is being very widely used, chiefly on account of its great cleanliness and ease of manipulation.

FACTORY AND WORKSHOPS ACT.

A conference of members of the Institution of Electrical Engineers was held on Monday last at the Society of Arts to consider what steps should be taken towards relieving the industry of the impediments which the Factory and Workshops Act presents in certain of its clauses. The chair was taken by the president of the Institution (Mr. W. E. Langdon), who referred in his opening remarks to the importance of removing all obstacles to the progress of the industry and placing it in a position which would enable competition with other countries to be successfully carried on. The secretary then read a statement which embodied the replies of 50 engineers of municipal and company stations to questions relative to the amendment of the act, the majority of these being in favour of such amendment as would relieve the industry from these burdens. The members present were asked to speak on the clauses which they thought needed amendment.

Major-Gen. WEBBER referred to the clause which included sub-stations under the act, and was of the opinion that the power stations now springing up would be hampered in the matter of attendants, and that the act generally was likely to greatly interfere with the industry. As representing the Chamber of Commerce, he said that that body was quite prepared to strengthen the hands of the Institution in whatever steps it took in the matter.

Mr. P. STILL (Chelsea Company) referred to the employment of young persons in sub-stations, and said that whereas they found a man suitable for a certain period, it became necessary, as the station was enlarged, to increase the number of attendants. For this work youths were of great value, and also were glad of the opportunity thereby afforded for taking up electrical work. A skilled hand was not necessary for this kind of work, and if the clauses of the act referring to such employés were enforced as to meal hours, Sunday work, &c., there would be a great scarcity of attendants. He then proposed the following resolution:—"That in the opinion of this conference there are clauses in the Factory and Workshops Act of 1901 that are prejudicial to the industry of electricity supply."

Sir H. MANCE seconded the resolution, and referred to the attendants in sub-stations at Oxford, who had to be employed above a certain age and paid more money.

Mr. A. GAY (Islington) remarked on the clause which classed stations as dangerous, and to the use of rubber gloves being strictly enforced by the management.

Mr. HARMAN LEWIS referred to the clause which enforced white-washing of works.

Mr. PATCHELL said that stations were now exempt from this.

Councillor IRVING (Dublin) also supported the resolution, which was carried unanimously.

Mr. RAWORTH then proposed, "That the Institution of Electrical Engineers be requested to take steps to approach the Home Secretary in order to lay before him the views expressed at this conference as to the prejudicial effect of the incidence of certain provisions of the Factory and Workshops Act of 1901 on the industry of electricity supply, and to pray him to allow the Institution to confer with him when he is framing regulations under the act." Supporting this resolution, he said that the Home Office were evidently unaware of the safety and beauty of an electricity works, which were far from being the dangerous places they once were when belt-driving was in vogue. He also referred to the use of young men in sub-stations and the difficulty which obtained in providing suitable attendants.

Mr. HAMMOND seconded the resolution, though he thought it rather late to take steps in the matter. Misconceptions were certainly afoot at the Home Office as to the nature of a central station, and he thought that it would do good if some modern German stations were inspected by that department. Switchboards were now built which could not be dangerous, and no one but a fool would use that portion of the station as a leaning post. The inspector who had been appointed was certainly a practical engineer, but he was, nevertheless, confined to the act in the performance of his duties.

Mr. CHAMEN and Mr. J. GRAY also supported the resolution.

Major-General WEBBER remarked that the conference was not a final one, and members would have another opportunity of speaking on the subject.

The resolution was then carried unanimously.

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	SOUTH LONDON.		BROMLEY (KENT).	
Undertaking Worked by	South London Electric Supply Corporation (Ltd.).		The Bromley Electric Light and Power Co. (Ltd.)	
Date of Commencement of Supply	October, 1899.		January, 1899.	
System of Supply	2-w. alternate-current with transformers in pits.		3-w. low-pressure and 2-w. high-pressure current.	
Chief Engineer	H. W. Sprunt.		R. L. Gamlen.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	1,508,682	1,288,657	—	—
„ **SOLD (TOTAL)**	**1,250,441**[a]	**921,867**	**209,348**	**306,000**
„ sold to consumers	928,131	854,217	209,348	306,000
„ sold for public lighting, &c.	—	67,650	nil	nil
„ sold for traction	—	—	—	—
„ used on works	322,310[a]	89,030	—	—
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	—	936	14·2	16·3
Actual maximum supply demanded	950 kilowatts	841 kilowatts	223 kilowatts	300 kilowatts
Load factor	—	12·5%	10·7%	11·6%
Number of public lamps	25 (15 amp.) arc	25 arc	nil	nil
Number of consumers	660	990	236	386
Connections to mains in 8-c.p. lamps at end of year	43,322	57,010	18,382[e]	26,816[e]
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	3,000	3,300	600	600
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	**£487,500 / £163**	**£487,500 / £148**	**£70,000 / £117**	**£70,000 / £117**
Share	325,000 / 108	325,000 / 98·5	50,000 / 83·4	50,000 / 83·4
Loan (including Debenture charges)	162,500 / 54·2	162,500 / 49·2	20,000 / 33·3	20,000 / 33·3
RECEIVED (TOTAL)	**324,980 / 108**	**324,980 / 98·5**	**29,608 / 49·4**	**36,797 / 61·4**
Share	324,980 / 108	324,980 / 98·5	9,608 / 16·0	16,797 / 28·0
Loan (including Debenture charges)	— / —	— / —	20,000 / 33·3	20,000 / 33·3
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**162,520 / 54·2**	**162,520 / 49·2**	**40,392 / 67·4**	**33,203 / 55·4**
Share (unissued)	nil / —	nil / —	40,365 / 67·4	33,195 / 55·4
Share (uncalled)	20 / —	20 / —	27 / 0·045	8 / 0·013
Loan (including Debentures)	162,500 / 54·2	162,500 / 49·2	nil / —	nil / —
REPAID (TOTAL)	— / —	— / —	nil / —	nil / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	— / —
DEPRECIATION FUND	— / —	2,033 / 0·62	400 / 0·67	400 / 0·67
EXPENDED (TOTAL)	**255,497 / 85·2**	**280,291 / 85·0**	**56,935 / 94·8**	**66,821 / 111**
Lands and buildings	76,538[b] / 25·5	77,896[b] / 23·6	9,505 / 15·8	9,736 / 16·2
Plant	98,505[c] / 32·8	113,974[l] / 34·5	23,496 / 39·2	28,776 / 48·0
Mains	78,504 / 26·2	86,342 / 26·1	22,944 / 38·3	26,132 / 43·5
Miscellaneous	1,951 / 0·6	2,079 / 0·63	990 / 1·65	2,177 / 3·63
BALANCE OF CAPITAL ACCOUNT	**69,483 / 23·2**	**44,689 / 13·5**	**−27,327**[a] **/ 45·5**	**−30,024**[a] **/ −50·0**
REVENUE—	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.
TOTAL	**£17,721 / 3·402d.**	**£17,572 / 4·575d.**	**£4,185 / 4·800d.**	**£5,980 / 4·690d.**
Revenue from supply	16,058 / 3·085d.	16,919 / 4·405d.	4,045 / 4·639d.	5,756 / 4·512d.
„ meters, &c.	372 / 0·071d.	569 / 0·148d.	139 / 0·159d.	201 / 0·158d.
„ public lighting	— / —	— / —	— / —	— / —
„ supply for traction	— / —	— / —	— / —	— / —
„ miscellaneous sources	1,281[d] / 0·246d.	84 / 0·022d.	1 / —	22 / 0·017d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£18,611 / 3·571d.**	**£15,880 / 4·134d.**	**£2,372 / 2·720d.**	**£2,813 / 2·205d.**
TOTAL WORKS COSTS	**14,875 / 2·853d.**	**11,304 / 2·942d.**	**1,756 / 2·013d.**	**2,036 / 1·596d.**
Generation of electricity	*14,091*[e] */ 2·704d.*	*10,537 / 2·743d.*	*1,745 / 2·000d.*	*2,022 / 1·586d.*
Fuel (including cartage, &c.)	10,279 / 1·972d.	6,432 / 1·674d.	1,197 / 1·373d.	1,286 / 1·009d.
Oil, waste, water, stores	1,005 / 0·193d.	745 / 0·194d.	81 / 0·093d.	111 / 0·087d.
Wages at station	5,027[m] / 0·965d.	1,957[m] / 0·510d.	426[f] / 0·489d.	515[f] / 0·404d.
Repairs and maintenance at station	780 / 0·150d.	1,246 / 0·325d.	41 / 0·047d.	110 / 0·086d.
Distribution of electricity	*317 / 0·061d.*	*496 / 0·129d.*	*11 / 0·012d.*	*14 / 0·011d.*
Wages, &c.	117 / 0·022d.	252[n] / 0·066d.	11 / 0·012d.	14 / 0·011d.
Repairs, renewals of mains, &c.	200 / 0·038d.	244 / 0·064d.		
Public lighting	*77 / 0·015d.*	*271 / 0·071d.*	— / —	— / —
Attendance	77 / 0·015d.	271 / 0·071d.	— / —	— / —
Renewals			— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	**3,737 / 0·718d.**	**4,576 / 1·191d.**	**617 / 0·707d**	**777 / 0·610d.**
Net rents	*18 / 0·004d.*	*— / —*	*42 / 0·048d.*	*42 / 0·033d.*
Rates and taxes	*69 / 0·013d.*	*810 / 0·211d.*	*82 / 0·094d.*	*220 / 0·173d.*
Management	*3,650 / 0·701d.*	*3,766 / 0·981d.*	*493 / 0·565d.*	*515 / 0·404d.*
Salaries	2,286[f] / 0·439d.	2,024[o] / 0·527d.	284 / 0·326d.	284 / 0·223d.
Stationery, &c.	387 / 0·074d.	307 / 0·080d.	91 / 0·104d.	56 / 0·044d.
Establishment charges	389 / 0·075d.	344 / 0·090d.	91 / 0·104d.	118 / 0·093d.
Law charges &c.	588[g] / 0·113d.	1,091[p] / 0·284d.	27[b] / 0·031d.	56[g] / 0·044d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	**−£890**[h] **/ −0·375%**	**£1,691 / 0·631%**	**£1,813 / 3·62%**	**£3,167 / 5·12%**
Sum carried to Depreciation Fund	— / —	2,033 / 0·759%	400 / 0·800%	400 / 0·647%
Sum carried to Reserve Fund	— / —	— / —	— / —	— / —
Net interest on loans (incl. Debenture charges)	1,373[i] / 0·578%	408[i] / 0·152%	1,946 / 3·88%	2,525 / 4·08%
Net profit for the year	483 / 0·203%	67 / 0·025%	— / —	414[h] / 0·669%
BALANCE FROM LAST ACCOUNT	— / —	— / —	1,021 / 2·04%	122 / 0·197%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	483 / 0·203%	67[j] / 0·025%	435[c] / 0·869%	536[h] / 0·866%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	4% / —	4½% / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	105%	90·4%	56·7%	47·1%
Expenditure per mean kilowatt capacity	£8. 5s. 6d.	£5. 0s. 10d.	£5. 1s. 0d.	£4. 13s. 10d.
REVENUE PER MEAN KILOWATT CAPACITY	**£7. 17s. 7d.**	**£5. 11s. 7d.**	**£8. 18s. 0d.**	**£9. 19s. 5d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**10s. 3d.**	**7s. 0d.**	**5s. 10d.**	**5s. 3d.**
Price charged for lighting, per unit	5½d.	5½d.	7d. (1 hr.) to 4d.[d]	7d. (1 hr.) to 4d.
Price charged for power, per unit	2d.	2d.	4d. (1 hr.) to 1d.[d]	4d. (1 hr.) to 1d.
Price charged for public lighting	—[k]	—[k]	—	—
Receipts per unit for private supply	—	—	4·64d.	4·51d.
„ „ public lighting	—	—	—	—
„ „ traction	—	—	—	—

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ELECTRICITY WORKS ACCOUNTS.

South London Electric Supply Corporation (Ltd.).

Seldom have our tables to record a diminished output for an undertaking as we have to this week in our record of the operations of the Lambeth company for 1901. The explanation is that the company's output in 1900 included 330,753 units sold to a neighbouring supply concern who were not customers last year. The difference in the output figures, as shown in our table for the two years, is not wholly due to the above fact, but also in consequence of the units used on the works being included in the output figure for 1900. The official returns for that year grouped together the output for public lighting and the units used on the works under one figure. The foregoing explanations will show how it is that the costs and revenue of last year appear so much higher than those of 1900. It is probable that there was actually an improvement of between 0·3d. to 0·4d. in the total costs per unit sold. This marks a good move in the right direction, and is the more creditable because it was made with a lower output and with some unusual expenses under management and property charges. It may be noticed that rates and taxes increased from £69 to £810. £263 in costs were incurred in obtaining a more reasonable assessment, which at first was on the basis of a rateable value of £5,667. This was reduced to £3,000. Other law costs were also heavy.

About the only item of works costs which is reasonable is that of repairs and maintenance. The fuel costs stand at the high figure of 1·67d., chiefly through the very high coal prices ruling at the beginning of 1901.

An agreement has been entered into to supply steam to the London County Council, to the extent of about 5,000, H.P. for the driving of power plant for the Council's tramways.

Bromley (Kent) Electric Light and Power Co. (Ltd).

With an improved load in quality and magnitude, this company has again reduced its costs, and the several values in our analysis are highly satisfactory considering the situation of the station in respect to fuel supply.

At 2·2d. per unit the total costs are about 0·6d. under the average of similar sized concerns, and with a total revenue also below the average, it was found possible to distribute 4½ per cent. on the ordinary shares after paying about 4·65 per cent. of the mean capital for interest and depreciation.

REMARKS.

SOUTH LONDON.—*a* Includes electricity used on works for lighting, meter testing, motors and public arc lighting, also 330,753 units sold to London Electric Supply Company for £3,710. *b* Includes expenditure on ironwork and masonry of destructor and £794 on artesian well. *c* £1,810 on battery and £3,642 on transformers and transformer tanks. *d* £1,261 for destruction of refuse and from sales of clinker. *e* After deducting £3,000 paid by contractors in respect of coal and oil expenses. *f* Directors £1,200. *g* Law £142, provisional order £152, insurance £189, auditing £102. *h* Working deficit. *i* Received for money on deposit. *j* Used in reduction of preliminary expenses. *k* By contract with disposal of refuse. *l* Loose plant and trucks of destructor £5,305, economiser plant £2,153, thermal storage plant £2,592. *m* Proportion of salaries of engineers and officers £771 in 1900 and £633 in 1901. *n* Proportion of salaries of engineers and officers £120. *o* Directors £1,200, secretary, clerks, &c., £814. *p* Auditing £123, law £306, costs in obtaining revised assessment £263, insurance £246.

BROMLEY (KENT).—*a* Over-expended. *b* Insurance £15, auditing £12. *c* Including £195 profit on wiring and after deducting £248 preliminary expenses written off. *d* Maximum demand system. *e* Inclusive of 4,087 at end of 1900 and 6,691 at end of 1901 in Chislehurst. *f* Includes proportion of salaries, £64 in 1900 and £71 in 1901. *g* Law £11, auditing £24, insurance £21. *h* Including £171 profit on wiring.

NATIONAL TELEPHONE COMPANY.

Mr. Wm. E. L. Gaine (general manager) occupied the chair at the ninth annual staff dinner of this company on Friday evening last. He was supported by Sir Henry Fowler, M.P., Lord Harris, Sir James Fergusson, M.P., Sir Albert Rollit, M.P., Sir James Woodhouse, M.P., Prof. S. P. Thompson, F.R.S., Mr. E. Forbes Lankester, Mr. D. Sinclair (engineer-in-chief), Mr. Albert Anns (secretary), Mr. S. J. Goddard, Mr. A. E. Cotterell, Mr. W. A. Valentine, Mr. J. W. F. Ashwin, Mr. J. C. Chambers, Mr. C. B. Clay, Mr. R. H. Claxton, Mr. F. D. Watson, Mr. F. Gill, and about 150 of the principal members of the London and provincial staffs.

After the loyal toasts the CHAIRMAN, who was very cordially received, gave the toast of "The President, Vice-President and Board of Directors." He said that since their last staff dinner they had lost their old and esteemed president, Mr. James Staats Forbes. But they thought the company were highly privileged in having secured as Mr. Forbes' successor a statesman of the capacity and renown of Sir Henry Fowler, and on behalf of the staff he offered to the right honourable gentleman a hearty welcome and the assurance of their loyalty and devotion (cheers). They had also had a change in the vice-chair, Mr. Franklin having taken the place of Lord Harris, whose other important engagements made it necessary for him to resign that position. He concluded by remarking that they had a new face in Sir James Woodhouse, M.P., who had recently joined the Board.

Sir HENRY FOWLER, who was accorded a hearty reception, said he fully concurred in the appreciative terms in which Mr. Gaine had alluded to the valuable services rendered by Mr. Forbes. When the history of the company came to be written by a candid and impartial pen, full justice would have to be done to Mr. Forbes for the admirable manner in which he presided over its interests, for the remarkable courage and ability with which he fought its battles, and for the loyalty both to the company and to all connected with it which characterised his presidency for so many years (cheers). The board of the company had been exposed to much unjust and unfair criticism, but they had pursued the even tenour of their way amid it all, doing their best for the shareholders and for the public. It was no easy task to superintend the affairs of such a concern as theirs. The services of the directors would be of little value if they were not supported, not only by the loyalty of which Mr. Gaine had spoken, but by the competency, ability and industry of those by whom the work was really carried on. Coming to the presidency with some experience of business and public life, he might claim to have some qualifications for forming an opinion of the permanent staff of the company, and he had no hesitation in saying that they did their work in a most able manner. Referring to competition with Government and municipal telephone services, he thought in London it would be conducted on fair and honourable terms between the Postmaster-General and the company. It would be a competition of efficiency and not one of cutting rates. He was not at all afraid of competition. In his opinion the work of telephony in this country had only just begun. If the company were to win they must aim at giving the best, the quickest and the most convenient service, and he felt sure that the board could depend on the assistance of the staff in doing all that was possible to that end (Cheers).

The CHAIRMAN next proposed, "the National Telephone Company." He said they now had 1,025 exchanges working in Great Britain and Ireland. Last year they had just one short of a thousand, but they had not only made up the thousand but added another 25. Then they had increased their clientele by over 20,000 in the 12 months, making the number of subscribers up to 226,000. A great deal had been heard of the inadequacy of the telephone service in this country, but, in spite of their little troubles, they had now a telephone for one out of every 183 of the population (cheers). The number of messages sent in the year was 787,000,000, an increase of 75,000,000, comparing with 89,000,000 telegrams sent by the Post Office, which showed a decrease of 838,000 in the year. During the past year a great deal had been done to develop the cheaper form of service, and they now had 30,000 subscribers in Great Britain getting all they required in the way of telephonic communication for £4. 18s. a year on the average. Something like a fifth of that number were having service at a little over £3 per annum. Competition in London, as they knew, was to be conducted on sensible lines; but they had another competing service—in the great northern city of Glasgow. He had a much lighter heart that night respecting Glasgow than he had 12 months ago. He did not want to offend the susceptibilities of the Glasgow Corporation, but they had started there with a system which, thank God, the National Telephone Co. were leaving off (laughter and cheers). Last year he ventured to prophesy that the competition in London with the Post Office would be nothing more than a competition to do the best that both could in the interests of the public. Events had shown that he was a true prophet. The agreement which had been made with the Post Office was an extremely favourable one for that department, but it was also in the interests of all parties—the public, perhaps, most of all. The conditions prevailing at the present time, having regard to the company's tenure from the Post Office, and so on, made it extremely difficult for them to develop and extend the telephone service in Great Britain as they would wish. He really wanted for capital expenditure another £2,000,000 a year. The telephone service had now become important to the commercial and social life of the country, and he felt certain that some arrangement would have to be made before long to enable the company to go on and develop their service with the zeal and energy which they were prepared to do. When that time came he felt sure that he could rely on every member of the staff to use their best energies and goodwill to aid in the work (cheers).

Lord HARRIS, in responding, said that he thought that a Government department was not calculated to compete successfully with a great concern like the National Company (hear, hear).

Mr. J. W. F. ASHWIN gave the toast of "Our Guests," coupled with the names of Sir James Fergusson, M.P., and Prof. S. P. Thompson.

Prof. THOMPSON, in reply, said that he was not one of those who thought that science was degraded by being associated with industrial applications. It was true there were those—the pioneers and investigators—who must have the quiet of the laboratory to perform their work efficiently; and he would not undervalue the preciousness to them of that detachment from money-making which they regarded as so important. On the other hand, he could not but acknowledge that many of the applications of science pursued solely for commercial purposes had resulted, and always would result, in great developments of science; for, so soon as any invention became of commercial value, from that moment money was available to pursue scientific investigation, and science progressed because of the fact of its having become of commercial use to mankind. He thought that they were standing on the threshold of large developments in telephony. Certainly, the telephone had not come to the end of its possible domains. This week he had received from Italy, which had so long been in the forefront of electrical discovery, details of an exceedingly remarkable application of the telephone

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for the extension of wireless telegraphy. A certain petty officer in the Italian navy, of the name of Castella, had discovered a new telephonic appliance, by the aid of which it is possible to receive wireless signals at considerably greater distances than was possible with the coherer apparatus such as they knew under the system patented by Mr. Marconi. For six months that new apparatus had in the Italian navy superseded the older form of apparatus for taking wireless messages. That was an important discovery, the end of which none could foresee.

Sir ALBERT ROLLIT, M.P., afterwards proposed, in a humorous speech, the health of "The Chairman."

The CHAIRMAN, having briefly replied, the company separated.

PARLIAMENTARY INTELLIGENCE.

NORTH METROPOLITAN ELECTRIC LIGHTING AREAS.

On Friday the Select Committee of the House of Commons, presided over by Mr. Fison, continued the consideration of the bills relating to electricity supply in the northern suburbs. As reported in our last issue, the Committee had decided to confirm the Edmonton, Tottenham and Wood Green provisional orders, and had refused to permit the company to come in without the consent of the local authorities. They now met to consider clauses carrying out their decision.

Mr. MOON, K.C., for the North Metropolitan Company, said they had crossed out, in conformity with the decision of the Committee, from their bill the words extending the power of their Act of 1900 to Willesden.

The Committee decided that the following words should be added:—"The company may use the electrical energy generated by them upon the said land for the purpose of supplying within the limits of supply defined in sec. 5 of the Act of 1900, and also for the purpose of supplying to the North-West London Railway Co.; but the company shall not use the supply of energy generated upon such lands or any part thereof for any other purpose in the urban district of Willesden without the consent of the local authority."

The other clauses were then discussed, and it was decided to limit the absolute veto of the local authority in each case to three years, and then, only if their consent is unreasonably withheld, the company may come in, in the same way as in the Cleveland case for the supply, for power purposes only, to manufacturers and authorised distributors.

The preamble of the local authorities' Provisional Orders Bill was then declared proved, so far as Edmonton, Wood Green and Tottenham were concerned.

In regard to the outside district of Southgate, which has not yet applied for a provisional order, but is about to do so, counsel for the company accepted the proposal of the Committee to apply uniform treatment to this area also.

On Monday, Mr. BAGGALLAY K.C., for the local authorities, asked for an additional proviso that where the Board of Trade decided that the local authority was unreasonably withholding its consent, and the North Metropolitan Company were allowed to supply one manufacturer, it should not give the company the right to supply the whole of the manufacturers in that district.

The CHAIRMAN said the Committee had decided not to insert the additional sub-section. They wanted to see what the local authorities would do. They would not be so foolish as to let one particular person bring the company in if they were properly doing their work.

The preamble of the bill having been passed, the Committee went through the clauses, and the bill was, together with the Electrical Lighting Provisional Orders (No. 1) Bill, ordered for report.

MIDDLESEX COUNTY COUNCIL TRAMWAYS.

The Select Committee of the House of Lords, the Duke of Northumberland in the chair, last week considered the Tramways Bill promoted by the Middlesex County Council. The House of Commons Committee stage of this bill was reported in our issue of March 14, p. 826, and the objects of the bill were then set forth.

Lord R. CECIL, K.C., in opening for the bill, said that Parliament had on more than one occasion considered it desirable to deal in a special manner with the county of Middlesex, which went some way to justify the proposal of the bill to empower the County Council to acquire, by agreement, the rights of the various local authorities for the purchase of the tramway and light railway undertakings in the county. That was an arrangement to which it was desirable Parliament should consent, because some of the undertakings ran through the districts of several local authorities, each of whom would have the right to purchase only so much of the tramway or light railway as ran through its area. Only eight out of 33 local authorities were opposing. In regard to the opposition of the London United Tramways Co., he contested the *locus standi*.

Mr. J. Bigwood, M.P. for the Brentford Division and an alderman of the Middlesex County Council, and Sir Alexander Binnie were then examined in support of the bill.

After opposition by the Hester and Isleworth District Council, the Committee proved the preamble of the bill, the chairman at the same time making a few remarks upon certain points which he thought needed clearing up. It was not intended that, if the County Council were to purchase a tramway under this Act, any district council could re-purchase from the County Council. Neither would the County Council, having purchased by agreement before the expiration of 21 years, be bound by any obligation entered into by the district council.

A MINISTER OF COMMERCE.

Mr. SINCLAIR, in the House of Commons last week, called attention to the fact that the increasing volume of trade of this country with all the world renders it imperative that a Minister for Commerce be appointed, and moved "That the present constitution of the Board of Trade is obsolete, and that, in the opinion of this House, the paramount importance of industry and commerce to the well-being of the empire requires that these interests shall be administered by a department in no respect inferior to other departments of State, and to which should be entrusted every function of the executive Government especially relating to industry and commerce." He contrasted the methods of Continental countries and our own. The appointment of consuls abroad was, he said, an absolute farce, both foreign countries and the colonies being better organised in this respect than we were, and it would be impossible to maintain our pre-eminence in commerce unless reforms were made in the way in which trade and commerce were administered in this country. He hoped that the cry for a Minister of Commerce would be listened to, for he was quite convinced that had there been such a Minister at the present time such an assault on our trade as the shipping combine would not have been made so easily.

Mr. HELME seconded and Mr. FIELD supported the motion.

Mr. HOULT said a business man, who was Minister of Commerce, would regard with serious attention the growing excess of imports over exports, and the importation into this country from America of steel plates for shipbuilding. Our trade was attacked not only by bounties, but by "combines" as well, and it might be necessary for us to take a different line from that which had been taken in the past when British trade was exposed to unfair competition.

Mr. BANBURY, who followed, was speaking at 12 o'clock, when the debate stood adjourned.

SCOTTISH PROVISIONAL ORDERS.

The public inquiry at Edinburgh by a Parliamentary Commission into provisional orders lodged under the Private Legislation Procedure (Scotland) Act has been concluded.

The order promoted by the Aberdeen Suburban Tramways Co. (see *The Electrician*, May 2, p. 68) was found proved after a deal of opposition by the Great North of Scotland Railway Co.

The Greenock and Port Glasgow Tramway Co. asked authority for an extension of their lines in Port Glasgow—viz., a double line 1 furlong 5 chains in length as a continuation from the present terminus. Powers were also sought to provide and run a service of omnibuses and motor cars, and to raise additional capital. The Glasgow and South-Western Railway Co. were the chief opponents; but, on the imposing of a limit within which the motor cars would be allowed to carry passengers, the opposition was overcome and the order proved.

An order lodged by the Rothesay Tramways Co. also asked for powers to construct additional tramways, and for land upon which to erect a generating station, and, as no appearance was put in by the opposition, the preamble was declared proved.

CROYDON AND DISTRICT ELECTRIC TRAMWAYS BILL.

The Select Committee of the House of Commons, of which Mr. Compton Rickett was chairman, considered this bill last week and this week.

Mr. BALFOUR BROWNE, K.C., in opening for the bill, explained that it was to authorise the construction of certain important tramways in the district south of London contiguous to Croydon. Croydon already possessed certain tramways, and the change that took place when electricity was introduced on those tramways as the motive power read almost like a fairy tale. Since January last something like three millions of people had been carried on those tramways in excess of those carried on the old horse tramway in the same period. He might mention that at Glasgow the year before last its population was carried 71 times over on its electrical tramways. In the Croydon district the want of tramways had been considerably felt, and the British Electric Traction Co., who were the lessees of the existing lines in Croydon, now sought to construct the lines before the Committee. They proposed to join up by a new line the existing tramway from Selhurst towards Penge in the north; a line to run from Penge to one of the entrances of the Crystal Palace at Penge station, and then round the Palace grounds up to almost the high-level station of the Crystal Palace. This would afford, by means of the Crystal Palace and City Railway (if passed), communication with the City, and would carry out the recommendation of Lord Windsor's Committee of last year that the tramways should be joined up with the tube railways, so as to carry people right in and out from the suburbs. Other tramways proposed would run through Waddon and Wallington to Sutton. Tramway No. 11 went up to Beddington where it joined the Mitcham Light Railway. The Mitcham Light Railway had been sanctioned, and the promoters were seeking to acquire the interests in that line, and then there would be an absolutely continuous line through Mitcham to Tooting, where they would join the system of the London County Council. Another important tramway proposed would run from Mitcham Station to Belmont Station. Mitcham, with a population of 16,000, and Sutton, with a population of 17,000, would be joined up by these tramways. All the local authorities, together with Croydon, were in their favour, and the only opponents were the Surrey County Council, the London, Brighton and South Coast Railway, and certain frontagers. The opposition of the Surrey County Council was based on two grounds. First it had reference to the widening of Mitcham bridge, and secondly, the County Council desired to become the purchasing authority in regard to these tramways. The railway company's opposition had regard to competition and engineering matters.

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Counsel for the Surrey County Council intimated that the point as to purchase would not be pressed, and counsel for the railway company said the question of competition would not be raised.

A number of local witnesses gave evidence in favour of the bill.

Mr. STEPHEN SELLON, engineer to the British Electric Traction Co., said he had had a census taken of the number of pedestrians passing certain points near Mitcham station, which showed a total of 55,588 for one week, or 2,890,596 for a year. There were a very large number of people who were not served by the present railway service. Witness gave evidence in detail as to the proposals of the bill and the various points of opposition. With regard to stopping places for the cars, he said that electrical cars did not stop, like horse cars, every time an umbrella was put up, but had regular stopping places, chosen in consultation with the local authorities. Cross-examined for the Surrey County Council, Witness said he could not agree to re-metal the whole of the roads passed over, but would agree to do so where the road was widened by taking in the waste.

The principal opposition coming from the owners and frontagers in the neighbourhood of Carshalton and Wallington, several days were occupied in hearing local witnesses against those portions of the scheme. Afterwards evidence was taken on behalf of the London, Brighton and South Coast Railway, especially against the adoption of the route which took the tramway under the London, Brighton Company's bridge at Wallington.

The Committee decided unanimously to pass the preamble of the bill, with the exception of the part relating to the tramway from West Croydon to Sutton and the middle portion running through Wallington and Carshalton, and to refuse to the London Brighton Company the control asked for by them over the working of the connection at West Croydon Junction, this connection to be worked under the control of the Corporation.

SOUTH SHIELDS AND SUNDERLAND TRAMWAYS.

The bill of the South Shields, Sunderland and District Tramways Co. came last week before the Select Committee of the House of Lords, presided over by the Duke of Northumberland.

Mr. BALFOUR BROWNE, K.C., in opening the case, said the bill was to authorise the British Electric Traction Co. to construct tramways for South Shields and Sunderland and other places. The tramways begin in South Shields and proceed through Barton to Whitburn. From Whitburn the line would proceed to the east and then south to Sunderland, whilst the main line proceeded due north to Sunderland. At that point they joined the lines of the Sunderland Corporation. The lines would be in length 8 miles and 1 furlong, and would be on a 4ft. 8in. gauge, by electricity and the overhead system. The tramways had been proposed in 1891, and the scheme came before the Light Railway Commissioners, who decided that there was competition, and the promoters must go to Parliament. In 1901 the Corporation of South Shields promoted the bill to enable them to re-construct and work the tramways, but the ratepayers refused to sanction the promotion of the bill, and the borough was obliged to be dependent upon some other way.

Evidence on behalf of the promoters was given by Mr. J. W. Coulson, clerk of the Rural District Council of South Shields; Mr. E. J. J. Browell, J.P., of East Boldon House, and chairman of the Rural District Council of South Shields; Mr. J. C. Wilson, assistant clerk to the Rural District Council of Sunderland; Capt. H. C. Streatfield, vice-chairman of the Rural District Council of Sunderland; Mr. J. C. Ridley, solicitor, of Newcastle-upon-Tyne, and residing at Fulwell; Mr. H. M. Waite, brick manufacturer, of Fulwell; Mr. Tom Glover, estate agent, of South Shields; Mr. R. H. Irvine, of Cleadud; and Mr. Jas. Watson, chairman of the Parish Council of Whitburn.

Mr. EDWARD CLARKSON, district surveyor of the rural district of South Shields, gave particulars of the census taken of the traffic between South Shields and Sunderland. The total at Harton Village for the week was—pedestrians, 50,145; brakes, cabs and traps, 3,692; passengers in brakes and traps, 5,495; carts, drays and waggons, 10,701; traction engines, 26; bicycles, 17,698; and various, 1,642.

Mr. JOHN BARLOW, clerk of the Parish Council of Fulwell, said the Council had passed a resolution approving of the proposed tramway.

Mr. H. E. Taylor, assistant secretary of the South Shields Property Owners' and Ratepayers' Association; Mr. S. Finn, draper, of South Shields; Mr. Henry Chapman, accountant, of South Shields; and Mr. Wm. Bainbridge, clerk of the Harton Parish Council, were also examined.

Ald. REDHEAD, chairman of the Finance committee of the South Shields Corporation, said he was opposed and had always been opposed to the Council undertaking the tramway enterprise, on the grounds that the town should not be saddled with the cost and risk of working such a tramway, and that it did not afford facilities for communication with the outside districts. He supported the proposals of the present bill because it gave better facilities than the Corporation could ever hope to give.

Mr. W. H. Scott, and Mr. J. H. Rennoldson, both solicitors, and members of the South Shields Corporation, gave evidence in favour of the bill.

Mr. STEPHEN SELLON, engineer of the British Electric Traction Co., gave details as to the proposed line, and said the Parliamentary estimate was £98,000. He corroborated the opening statement made by Mr. Balfour Browne, and said that whilst the North-Eastern Railway Co. suggested that the value of the traffic taken by the tramway from their company would be £25,000 per annum, investigations which they (the promoters) had made showed that in a week the passengers dealt with at intermediate stations was only at the rate of £242 per annum. The British Electric Traction Co. had, at the present time, either working or authorised, about 60 undertakings, and they were promoting new schemes in the present session.

This closed the case for the promoters, and Mr. ERNEST MOON, K.C., addressed the Committee on behalf of the North-Eastern Railway Co. The primary object of the tramway, he said, was to carry passengers between Sunderland and South Shields. That was the direct competition with the existing line of the North-Eastern Company. That company had had a bitter experience of the competition of electric tramways. They had not at first opposed their construction, but the effect had been in some cases to deprive them of 75 per cent. of their old traffic.

The CHAIRMAN said he had not consulted the Committee, but they might take it for granted that, where the tramway only duplicated an existing line without affording special facilities to other districts not served by the railway, the Committee would not authorise it.

Mr. W. J. Watson, general superintendent of the North-Eastern Railway Co., and Mr. Bowman, chairman of the Whitburn Parish Council, gave evidence as to the passenger traffic between South Shields and Sunderland and the facilities afforded by the railway. Mr. Watson said, in his experience, he had found the tramways suckers and not feeders of the railway.

Ald. J. R LAWSON, chairman of the Parliamentary committee of the South Shields Corporation, gave evidence in opposition to the bill. The Corporation's bill, above referred to, had been decided on in the Council by 27 to 6 votes, but had been rejected by the ratepayers. They had recently decided to promote another bill next session to construct and work additional tramways in the borough. They did not want a company to lay tramways in their streets. They did not desire to prevent a tramway connection between South Shields and Sunderland, and they were willing to make the tramway along Westerlane to the borough boundary as quickly as possible. Referring to a clause in the bill to the effect that if the Corporation did not complete the line in Wester-lane before July, 1903, the company could do the work themselves, he maintained that the Council had a right to ask that this time should be extended, say, to 1905. It was the unanimous wish of the Corporation ratepayers that, in any circumstances, the Council should possess the tramways within the borough, though there was a small minority opposed to the municipal working of the lines.

Mr. S. E. Burgess, the borough surveyor, and Mr. Beattie, the mayor of the borough, corroborated the evidence as to the views of the Corporation and the ratepayers on the question.

This concluded the evidence, and Mr. LLOYD having replied on behalf of the promoters,

After a brief consultation, the CHAIRMAN said the Committee considered that the preamble of the bill had not been proved.

SADDLEWORTH, SPRINGHEAD AND LEES TRAMWAY BILL.

The consideration of this bill was before the Select Committee of the House of Lords, of which Lord Glenesk is chairman, last Friday.

The bill was to incorporate a company to make tramways in the urban districts of Saddleworth and Springhead. There was no opposition, save respecting one tramway, a portion of which ran through the parish of Crossbank. The projected Lees tramways had been dropped because the Lees Urban District Council now proposed to apply for a Provisional Order to construct tramways of its own. The districts of Saddleworth and Springhead were situated in the West Riding of Yorkshire, and the object of the tramway proposed was to connect those districts with the Borough of Oldham and with Mossley. Oldham was not far from Manchester, and opportunity would consequently be provided by the bill to connect with that city.

The Committee declared the preamble of the bill proved. If required, however, the company must sell on Board of Trade terms so much of the line as was in Crossbank. The Board of Trade were also to be the body to determine as to working the tramway on the main road between Crossbank and Oldham. And if the portion of the tramway in the Crossbank district was sold to the Crossbank local authority, the latter would be compelled to act fairly with the tramway company as to running powers.

TRADES UNIONS AND PICKETING.

In the House of Commons on Wednesday, Mr. BEAUMONT moved "That legislation is necessary to prevent workmen being placed by judge-made law in a position inferior to that intended by Parliament in 1875." The hon. member quoted instances of the operation of the law, and said that from the Taff Vale result, a trade union could be sued in its corporate capacity, and its funds made attachable, even if picketing be practised peacefully.

Mr. BELL seconded the motion, and remarked that he did not encourage strikes, but several recent decisions of the House of Lords had placed the trade unions and workmen below the employers, and as he desired that they should be on an equal footing he supported the motion.

Mr. RENSHAW moved, as an amendment, "That this House declines to commit itself to fresh legislation on the subject of trade disputes until it is shown that the existing law does not sufficiently protect workmen in the exercise of their lawful rights." He took exception to the reference to judge-made law in the resolution, and maintained that the motion was a reflection on the law courts of the country.

Mr. WOLFF seconded the amendment, which was supported by the Attorney-General and the Home Secretary, and opposed by Mr. Asquith and Sir Henry Campbell-Bannerman.

The amendment was carried by a majority of 29.

(Parliamentary Intelligence continued on page 149.)

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THROUGH COMMUNICATION.

Our pages this week are largely filled, as they have been for some weeks past, with reports of the progress of electrical Bills in Parliament. Prominent among these Bills are the various groups which relate to railway and tramway traffic in London. These may be classified as the Morgan group, the Yerkes group, and the London County Council group, besides a number of minor and independent schemes. It is too early yet to paint a picture of what the ultimate provision for London's traffic will be; but the outlines are gradually taking shape, as one by one the unfavoured projects are dismissed or the possibly favoured ones are given another chance of surviving the Parliamentary ordeal. We do not intend, therefore, at present to discuss the matter in detail. But there are certain immediate considerations, contingent upon the past week's work, which present themselves for notice; and one of these is the question as to the provision of through communication. We suppose that few would challenge the general statement that through communication is to be preferred to a number of detached and independent lines. The north should be in direct communication with the south, the east with the west; and exchange stations should be provided between the two lines of communication. Yet it is surprising to what an extent London has suffered in the past through the neglect of this obvious necessity. From the arrangements for the great main line railways down to small local railways and tramways, through routes have been studiously avoided, practically without exception. London, in fact, has been regarded in the light of a social organism with a vital centre—the City—into and from out of which humanity needs to fluctuate daily along radii. This may or may not have been the problem in earlier days—say, 20 years ago—but it emphatically is not so to-day. There is not merely one, there are a dozen or more centres of traffic-movement in this great metropolis; and if the neighbourhood of the Bank is still regarded as chief amongst these, it is simply from its honourable antiquity, and not because of any great preponderance in the number of people it daily attracts and ejects. We do not deny that this type of traffic movement forms a very large proportion of the daily traffic; what we maintain is that there are numerous centres, and that, except in the hours before and after business, the traffic movement is more diffuse and far less radial. Railway and tramway managers are well aware that it is this steady diffusion of traffic in all directions throughout the day which is the most profitable part of their business. On the other hand, the majority of Londoners are painfully conscious that though it may be comparatively easy to travel between home and business, it is another matter altogether to have to do an occasional journey across London in another direction. This is more particularly the case as between the northern and southern districts. A *rapprochement* between railway or

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tramway managers and the travelling public, if it would tend to facilitate the long-hour diffusion of traffic, would be greatly to the advantage of both parties.

With regard to the two large railway groups, associated respectively with the names of YERKES and MORGAN, it may be said that in their original planning they offered competitive through lines from the west to the east and north-east through the City. During the past week, however, a Committee of the House of Lords has seen fit to disallow a short section of railway forming the central connecting link of the Morgan system, with the result that the important branch extending from the City north-eastward, and known as the City and North-East Suburban Railway, is abandoned altogether. We do not, of course, condemn the Committee for their decision. Admirable as the broad scheme for this through communication undoubtedly was, it is the promoters who must bear the blame if there lay hidden in it a defect that justified Parliament in rejecting it. But we cannot ignore the result incident upon the decision—viz., that the provision of a through route from west to north-east now rests upon the sanctioning of the remaining branch or of YERKES' scheme. By its decision to form its railway into a "circle," the Central London Railway Co. has removed itself from this field of competition. It is greatly to be hoped, therefore, that Parliament will deal leniently, and in as broad-minded a manner as the proper consideration of details will permit, with the short but vitally important link on the Yerkes system, for which alone Parliamentary powers have not yet been acquired. It would be a thousand pities—nay, a calamity to London—if, not through any defect in principle, but purely because of technical flaws, the metropolis should be left unprovided with these two much-needed lines of through routes.

While dealing with this subject we may allude to the sanctioning, by a Parliamentary Committee, of a tramway to be built by the London County Council along a portion of the Thames Embankment. We have always opposed the introduction of tramways of any sort or kind into this beautiful boulevard; but if fate decrees that they are to be there, we hope that something more serviceable than the one at present sanctioned will ere long be realised. On the ground that it will form a connection with the subway tramways already authorised, the Committee have sanctioned the section of the proposed line which extends from Westminster Bridge to Waterloo Bridge; but they have rejected the section from this last-named place eastward to Blackfriars Bridge. Does the Committee really believe the tramway public wants communication from the north to Westminster, but not to Blackfriars and the City? Further, taking up again the question of through communication, the only plausible ground for permitting a tramway in any part of the Embankment must be because it would ultimately, if not immediately, lead to through communication between the north and south, across the Thames bridges. That being so, why should the tramcars coming to Westminster be allowed to cross the river and proceed northwards, while the equally useful cars at Blackfriars are to be stopped inconveniently in the middle of the road at the southern end of the bridge? It all seems very ridiculous—as shallow a solution of the problem as the Council's own subways. Happily, we can still hope that the Bill will be thrown out *in toto* at a later stage; tramways on the Embankment would be an unnecessary evil. But if *this is not to be* the fate of the Bill, we hope that at any rate it will be moulded into a form more serviceable to the general requirements of London's tramway traffic.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Interference Tubes for Electric Waves.—A. Becker has made experiments with a view to determine the relative utility of two forms of Quincke interference tubes for measuring the length of electric waves. One of the forms consists of a tube with two branches, like a branched circuit, while the other has the shape of a T. In both cases the length of the wave transmitted by the tube does not depend upon the length of the tube, but upon its diameter. The wave-length is about 1·6 times the diameter. The waves travel along the surface of the metallic tubes, and emerge into the air with a barely diminished intensity. The first form of interference tube acts as a polariser, which only transmits vibrations which are parallel to the plane of the branches. If the stem of the T-tube is filled with insulating liquids, the wave-length in the interior of the liquid may be determined, and a comparison of this with the wave-length in air gives the dielectric constant of the liquid. The dielectric constant may be determined by two other methods, one of which involves the reflection of the waves by a mirror.

[A. BECKER, *Ann. der Physik.*, No. 5, 1902.]

An Optical Illusion in Vacuum Tubes.—A somewhat obvious but hitherto unnoticed phenomenon is the apparent luminosity of the outer glass wall of vacuum tubes when traversed by cathode rays. The only observer, says E. Goldstein, who has described this phenomenon, without, however, gauging the true nature of it, appears to have been E. Wiedemann, who said, in 1880, that the approach of a finger to the wall of a tube made the outer wall luminescent. Goldstein points out that the outer wall is, apparently, luminous whenever the wall of the tube is thin in comparison with its diameter. The optical illusion produced by a thin wall is the same as that which makes the water in a tumbler, or the mercury in a thermometer bulb, apparently penetrate the thickness of the glass, whereas the thread of mercury in the stem appears only slightly enlarged. A film of glass of red luminescence stuck on the inner wall of a tube, and struck by cathode rays, makes the outer wall apparently red instead of green. When the gas, and not the inner wall, is luminous, the rays from it do not undergo the refraction necessary to produce the optical illusion. This fact furnishes an important criterion to distinguish between canal rays, which only affect the gas, and cathode rays, which affect the wall.

[E. GOLDSTEIN, *Ann. der Physik*, No. 5, 1902.]

Calibration of Thermo-Couples.—D. Berthelot gives some valuable hints with regard to the use of thermo-couples in pyrometry. The cheapest and most satisfactory combination appears to be that of platinum with a 10 per cent. alloy of platinum and iridium. The author believes that the anomalies sometimes encountered in the behaviour of this and other couples are altogether due to a chemical change which they undergo in a reducing atmosphere such as exists in some parts of a Bunsen burner. In any case, these irregularities are never seen in an atmosphere of air, nitrogen, or carbonic acid. Within the temperatures of 400 and 1,100deg., the curve representing the relation between log (E.M.F.) and log T is practically a straight line. The fixed points used by the author are the melting point of zinc, 419deg., and the melting point of gold, 1,064deg. The latter is best applied by inserting a piece of gold between the elements at the hot junction, and taking the reading at the instant when the gold melts and thus breaks the contact. The melting point of sulphur, 445deg., is not to be recommended unless the minute precautions prescribed by Heycock and Neville can be fully observed.

[D. BERTHELOT, *Comptes Rendus*, April 28, 1902.]

Scale of Periodicity.—A proposal of great interest to physicists and electricians concerned with the measurement of periodic motions of any kind is made by A. Guillemin. It deals with the choice of a standard interval. In acoustics,

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the standard intervals used are the octave, 2 : 1, and the comma, defined by the physicists as the ratio 81 : 80, and by the musicians as the ratio $3^{12} : 2^{19}$. The author proposes the ratio 10 : 1 as the standard interval, and calls it the "savart." The logarithm of this ratio is unity, which means a great simplification of numerical calculations. Savarts would be measured by a logarithmic scale, and thus the "millisavart" would be the ratio whose log is 0·001. This ratio would be 485 : 434, and the natural definition of standard international pitch would be 434·3 vibrations per second. One "tone" would be approximately 25σ, the symbol σ being used for the millisavart, and Σ for the savart. The millisavart may be variously defined as the ratio of two notes giving one beat per second, or as the ratio between two periodicities differing by one vibration per second, or as the fraction 1·00230, whose log = 0·001. All these definitions are concordant.

[A. GUILLEMIN, *Comptes Rendus*, April 28, 1902.]

Radiation Scale of Temperatures.—M. Fery has devised a practical method of employing Stefan's law for the measurement of temperatures. The apparatus employed consists of a kind of telescope with a fluorspar objective, which concentrates the radiation upon a thermo-couple. The author has ascertained that the absorption of radiant heat by the fluorspar increases in proportion to the amount of incident heat at temperatures above 900deg. Hence, the only noxious effect of the fluorspar is to reduce the sensitiveness by about 10 per cent. The lens is focussed for parallel rays, and an inner diaphragm is so arranged that a certain cone of rays only is received upon the thermo-couple, thus rendering the range independent of the distance of the hot body. A comparison between the new thermometer and a Le Chatelier pyrometer shows an error well below 1 per cent. at temperatures from 914 up to 1,450deg., the highest temperature measured. The indications are very rapid, the mass to be heated being less than a hundredth of a milligramme. The zero is also very exact and constant. The author has measured the temperature of the positive arc carbon by this instrument, and found it to be 3,490deg.

[FERY, *Comptes Rendus*, April 28, 1902.]

Self-Electrification of the Human Body.—A. Heydweiller has made the interesting discovery that charges of opposite sign may exist on different parts of the body without giving rise to a neutralising electric current. That all muscular activity gives rise to electric currents has been known since the researches of E. du Bois-Reymond, whose scientific fame mainly rests upon their elucidation. The author charges the needle of a quadrant electrometer to several hundred volts. One of the pairs of quadrants is put to earth, while the other is joined up to an insulated metal plate. If now one hand is held in the neighbourhood of the plate, without touching it, and the operator mounts upon an insulated stand, the electrometer gives a considerable deflection, showing a negative charge of the hand, which only disappears slowly. The deflection indicates a charge of nearly 1,000 volts. This charge is not due to the friction of the clothes, as it is the same without. Bending the knee produces an opposite charge. The charges correspond in every case to the well-known muscular currents. But the novel observation is that these charges can exist for some time without neutralising each other. This is attributed by the author to the existence of badly conducting layers in the epidermis. The energy displayed in producing these charges is very small in comparison with the mechanical work. The author puts it at about 250 ergs.

[A. HEYDWEILLER, *Ann. der Physik.*, No. 5, 1902.]

Electricity on Sandy Hook.—The installation of electricity at Sandy Hook will, according to *American Machinery*, greatly facilitate the testing and handling of heavy ordnance, which will be elevated, lowered and loaded by means of electromotors. The barracks also will be lighted by incandescent lamps, and the fortifications will have a number of arc lamps to supply the necessary illumination, these lights replacing the gas lamps at present in use.

CORRESPONDENCE.

RAILWAY AND TRAMWAY MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With further reference to Prof. Carus-Wilson's remarks upon the torque per ampere of motors, the greatest variation in the torque per ampere at half load and at full load that is possible is in the ratio of 100 to 200. To have this value it is necessary that the saturation curve of the motor up to the point of rated full load be absolutely straight. To have sparkless running with such conditions, or under anything approaching such conditions, means winding the armature so that the iron section and, consequently, the weight of the motor, be practically doubled. The ordinary tramcar weighs, loaded, about 11 tons. About a fifth of this weight is the motors. Upon tramway motors it is of great importance to keep down the weight so as to decrease the dead load. A motor designed according to Prof. Carus-Wilson's ideas would increase the dead weight by one-fifth of the entire weight of the car. For roads operating under steam railroad conditions there is another point of advantage that is of greater importance than the weight, and it is an advantage which I did not mention in my previous letter. For roads giving a fast service with a great number of stops, the rate of acceleration must be high and it must be long continued. The rate of acceleration is limited by the adhesion of the drivers, and in the greater numbers of cases only by this. Motors which are not worked to saturation cannot keep to this rapid acceleration long, as they quickly reach the speed corresponding to the starting current. With motors worked to saturation the initial acceleration is continued to a speed which is well up toward the maximum speed of the train. For motors which are not worked to saturation, the speed attained by the time the acceleration falls off is only a fractional part of the final speed. It is true that with motors worked to saturation the starting current is greater than with motors designed differently, but the speed cannot be obtained by any other means. For this class of service there is also the fact which Prof. Carus-Wilson has evidently overlooked—*i.e.*, that motors in which the magnetic circuit is brought to saturation will run at a more nearly constant speed under all conditions of load.

The question of design of motors cannot be settled by any one consideration. Motors operating tramways in the centre of a crowded city run at a slow speed, and must be continually slowing and accelerating. For this reason a heavy torque is desired. On the other hand, the weight of the motor must be kept down, as the cars themselves are fairly light. The ordinary tramway motor is more or less of a compromise between these two considerations. This may be seen in the torque per ampere, which varies between half load and full load in the ratio usually of 100 to 160, or thereabouts.

It is usually found, however, even in this class of service, that when slow-speed motors and high-speed motors are installed on the same road the high-speed motors are in greater favour with the tramway authorities.

For electric railroads operating under steam railroad conditions a heavy weight is not such a great objection. The other two points are, however, of great importance—*i.e.*, ability to attain a high speed quickly, and keeping a constant speed under all conditions of load. These two points can be met only by the motor which is worked to saturation.—Yours, &c.,

J. N. DODD.

London, May 13.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Journal of the Institution of Electrical Engineers." April. Vol. XXXI., Part 4. Edited by W. G. Macmillan. (London: E. & F. N. Spon, Ltd.) 6s.

"L'Electricité à l'Exposition de 1900." Edited by E. Hospitalier and J. A. Montpellier. No. 11. (Paris: Vve. Ch. Dunod.)

"Science Abstracts." April. (London: The Feilden Publishing Co.) 2s.

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PARLIAMENTARY INTELLIGENCE.

(*Continued from page 145.*)

LONDON UNDERGROUND RAILWAYS.

Lord Ribblesdale's Committee.

Friday, May 9.

THE CITY AND CRYSTAL PALACE RAILWAY.

Mr. STEPHEN SELLON, engineer to the British Electric Traction Co., stated that he was authorised to state that his company were prepared to assist substantially in carrying through the undertaking, but were not prepared at this stage to define what would be the extent of their participation. He had told his company that it would be an excellent scheme for them to obtain control of. If the company were satisfied with his report he was quite prepared to say they would finance the scheme to the full extent, provided they had control of it. Sir Charles Rivers Wilson, the chairman, Mr. Garcke, the managing director, and Mr. Hilton, another director, had told him that would be the case at a meeting held that morning.

In answer to further questions, the Witness said that the promoters named in the bill represented £2,400, and that sum was increased to £6,866, for the expenses of promotion, advanced by other gentlemen. The rate of construction per mile was £410,000, as against £300,000 odd for the Central London Railway.

Mr. HUTCHINSON, for the promoters, said that very much bigger figures per mile had been mentioned in connection with some of the bills before the other Committee.

The CHAIRMAN: Has your company ever financed a scheme where the cost of construction per mile has been as high as this?—No, my lord. Up to this time our company has dealt with nothing but light railways and tramways.

In reply to Lord CLANWILLIAM, Mr. SELLON said that the directors had held a meeting on the previous day, and were all unanimous on the financial question.

In cross-examination by Mr. FREEMAN, for the London, Brighton and South Coast Railway, Witness admitted that the matter had only been brought to his knowledge a week ago the previous Wednesday. He could not pledge the company further than the authorised statement he had made at the commencement of that day's proceedings. The financial expenses were put down at £253,000, which was not very large for such an undertaking, but he admitted he had not had time to consider in detail the figures put forward by the promoters. He had made an estimate of his own with regard to cost, which differed from theirs, and the margin between the cost and the capital asked for was not excessive.

Mr. GALBRAITH was recalled to make a personal explanation with regard to the prospectus mentioned on Wednesday. He said he must have seen it, but he had been laid up with influenza at the time, and the evidence given by him at the previous sitting was given under a misapprehension.

Mr. SCHENK, chairman of the Crystal Palace Co., recalled, said if the act were passed he would be prepared to find one million towards the construction of the line. He admitted that he had no promise in writing to support the present scheme financially, but it was usual to accept verbal promises in such matters. He had suggested to the promoters on the previous day that they should transfer the undertaking to the British Electric Traction Co. for a sum to cover the bare expenses of promotion, not to exceed £10,000. That arrangement the promoters had accepted, and was favourably regarded by the company named.

The CHAIRMAN: If agreed to, this would make the British Electric Traction Co. the promoters of the scheme?—Yes.

Mr. R. WHITE, chairman and joint manager of R. White & Sons (Ltd.), mineral water manufacturers, of Camberwell, said that the capital of his company was £800,000. He was also a director of other companies, all of which had a substantial capital. He and his friends might possibly find from £20,000 to £25,000 towards the capitalisation of the proposed line. He had joined in the promotion because he believed it would be a benefit to the public and to his firm.

Mr. HUTCHINSON said he did not propose to call further financial evidence, but would put Sir Douglas Fox into the box to explain the promoters' figures and estimates.

After some discussion,

The CHAIRMAN asked if Sir Douglas would assume any financial responsibility.

Mr. LITTLER (for the petitioners) said he was sure he would not. He was prepared to call evidence to show that, quite apart from whether the promoters could find the money, the railway could not pay.

The committee room was then cleared, and their lordships deliberated in private, after which

The CHAIRMAN said the Committee were not prepared to proceed further with the bill.

The bill was accordingly thrown out.

GREAT NORTHERN AND CITY RAILWAY.

Mr. ERNEST MOON, for the promoters, explained that the line from Finsbury Park to Finsbury-pavement had been authorised, and was now approaching completion, and the object of the bill was to make a short extension from the latter terminus to Lothbury, close to the Bank of England. It also proposed to extend the time for the construction of works, to put a generating station near the Regent's Canal in Shoreditch, to erect a new station at Highbury, and also to enlarge the Finsbury-pavement station.

Sir CHARLES SCOTTER, chairman of the railway, and deputy chairman of the London and South-Western Railway, said that the principal object of the bill was to take the line 400yds. nearer into the City. Unquestionably that would be of great benefit to the public. The amount to be spent upon the extension was estimated at £329,000, and there would be additional share capital of £450,000 and borrowing powers of £150,000. He accepted the responsibility of finding that capital.

Sir HENRY OAKLEY, director of the Great Northern Railway and chairman of the Central London Railway, was next called. He said that 99 per cent. of all Great Northern trains stopped at Finsbury Park—about 600 per day. Passengers would be able to alight there, and by going down to the lower station would have the choice of three different destinations, the present scheme providing access to the City. It was a very valuable addition to the means of reaching central London.

Mr. Bartley, M.P. for North Islington, Mr. Wm. John Crump, J.P. for the county of Middlesex and mayor of the Borough of Islington, and the Hon. Claude Hay, M.P. for the Hoxton Division of Shoreditch, supported the scheme.

Sir DOUGLAS FOX was then called. In reply to Mr. ACWORTH, he said that his firm had from the beginning been the engineers to the undertaking, originally with Mr. Greathead, who afterwards died. The tunnels between Drayton Park and Finsbury-pavement were now completed, but some of the stations were not. The company sought powers to open out the tunnel to put in a station at Highbury. The stations now in course of erection were at Finsbury Park, Drayton Park, Essex-road, Old-street and Finsbury-pavement, the extension from Drayton Park to Finsbury Park being about to be carried out by the Great Northern Railway under an act of this year. When completed it would be handed over to the Great Northern and City under a lease for 999 years. At Finsbury Park an excellent system of exchange had been agreed upon with the Great Northern; at Old-street there was a joint station with the City and South London Railway, with a means of exchange both there and at Finsbury-pavement. The latter company could take passengers to London Bridge and on to Clapham. At Lothbury it was proposed to connect the subway with the surface by four staircases, and he was authorised by the directors to say that they would be quite willing to connect the subway with those already existing at the Bank station. The distance was about 150yds, and would cost £7,000 or £8,000. That would be of great advantage to the City, and he was unable to find out on what the opposition of the Corporation was based. The electrical equipment, which was of the multiple motor type, was already under construction. The carriages would be somewhat roomier than was possible on the smaller tubes, but there was not much difference.

The CHAIRMAN: What have you to say with regard to the proposed clause on vibration?—We are quite willing to pay compensation for damage done during construction, or during two years afterwards.

Speaking outside this bill, you think the suggested basis of the clause is a fair one?—I do.

Monday, May 12.

Lord Aberdare and Lord Clanwilliam both being absent through illness, Lord Newton consented to join the Committee to make up the number of four peers required by the standing orders.

Consideration of the Great Northern and City Railway Bill was then continued.

Sir DOUGLAS FOX was re-called, and Mr. RAM, K.C., on behalf of the Bank of England, examined him. Sir Douglas said that, as regarded tunnel work, the line would not approach nearer to the Bank of England than the southern end of Moorgate-street, but, as regarded subway work, it came up to the railing of the Bank of England. They proposed to put down five shafts between the corner of the Bank and the end of Moorgate-street for the purpose of getting the lifts down into the tube. He agreed that it was in the construction of shafts rather than in that of the tube where the danger arose to the buildings. He admitted that the foundations of the Bank were rather bad.

Mr. RAM, having elicited these statements, asked for a special clause for the Bank of England.

The CHAIRMAN: Considering what the Bank of England means to the City of London and to the trade of the world, I should think that the Bank should be regarded as a special building, and a special clause might be given. I think it is a thing you might easily settle outside.

Mr. MOON said he was very sorry to say they could not agree. They were prepared to postpone the report stage of the bill and to insert any clause which Lord Windsor's Committee came to the conclusion should be the general clause applicable to those schemes.

Mr. RAM said he asked for the clause known as the "Bank of England clause," which was inserted for the protection of the Bank in the Central London Railway Act.*

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* The following is the text of sec. 18 of the Central London Railway Act, 1892, known as the "Bank of England Clause":—

Sec. 91 of the act of 1891, is hereby repealed, and in lieu thereof the following provisions for the protection of the governor and company of the Bank of England (in this section called "the bank") shall, unless otherwise agreed between the company and the bank, be observed and have effect (that is to say):—

1. The expression "bank premises" when used in this section means and includes the bank house, offices, cellars and premises connected therewith, situate in the parishes of St. Christopher-le-Stocks, St. Margaret Lothbury and St. Bartholomew-by-the-Exchange, and partly delineated on the deposited plans, and belonging to, or reputed to belong to, and occupied by the bank.

2 Subject to the provisions in this section hereinafter contained, the company, their contractors, officers or servants shall not for any purpose whatever, enter upon, take, use or interfere with, either permanently or temporarily, any part of the bank premises.

3. The railway and shafts by this act authorised shall be constructed under Mansion House-street, Threadneedle-street and in the open space opposite the bank premises, the Mansion House and the Royal Exchange, strictly in accordance with sec. 7 of the Act of 1891, and at such depth as

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The CHAIRMAN: We will come to no decision. We quite understand the merits, and it shall have full consideration when the right time comes.

Mr. LITTLER then examined Sir Douglas Fox on behalf of the Corporation of London. Witness said that the extension of a quarter of a mile from Moorgate-street station to the Bank was regarded as important by the directors, as it would relieve the congestion caused by the great discharge of passengers which obtained in Moorgate-street at the present time.

Mr. LITTLER said the views of his clients were that, instead of being an advantage and relieving the congestion, it proved an obstruction. They also objected on the grounds that they were spending too much money,

Mr. A. C. MORTON, a member of the Corporation of London, supported Mr. Littler's statement.

After some consultation,

The CHAIRMAN declared the preamble proved, but they would have to insist upon the insertion of clauses bearing on the question of damage, which would be decided by Lord Windsor's Committee, and he would have to consult with Lord Windsor as to the clause for the protection of the Bank of England.

The North-West London Bill.

The Committee then went on with the North-West London Bill, which is a line from the Marble Arch to Cricklewood. Counsel said that this was sanctioned in 1899, and the works were not begun because of difficulty in raising capital. Times had since then improved, and all they wanted now was an extension of time for their works.

The only opposition was from the County Council, who had produced a sheaf of clauses, but, after some argument, it was agreed between counsel that this should not be considered as opposition to the preamble.

The preamble was then formally proved on the evidence of Mr. Scott Russell (a director). and the consideration of the clauses was postponed.

Tuesday, May 13.

The Committee commenced with the clauses which the London County Council desired to be inserted in the North-West London Railway Bill.

Mr. Talbot (for the County Council), Mr. Baggallay, K.C., and Mr. Shaw argued for an hour on the first clause, which was eventually given to the Council. This was a clause compelling the railway to forfeit any land they might acquire which came within the standard width of any of the Council's streets.

The second clause, which Mr. Talbot also secured, was one the object of which was to keep the Railway Company to the general laws of the Building Act, subject to the exemptions they had already got.

Then came the question of workmen's trains, and Mr. Talbot said the Council proposed that the fares should be 1d. instead of 1½d., and 2d. for the return instead of 2½d., and that the time for workmen's trains should be construed differently.

Mr. HARPER, chief of the statistical department of the London County Council, was called, and said that the Metropolitan and the Great Eastern Railways ran workmen's trains at 1d. fares for 8 and 10 miles respectively.

The Committee did not agree to this proposal.

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that there shall not be less than 14ft. in thickness of London clay throughout above the crown of the tunnels in which the railway shall be constructed.

4. No part of the railway or of the works connected therewith shall be constructed under the bank premises.

5. The company shall, for the protection of the bank premises, before commencing any works within 200ft. of the bank premises, underpin the curtain wall thereof from a point commencing at the northern end of the barrack yard in Princes-street, and extending round the south-western corner of the said curtain wall to the western side of the main entrance into the bank premises in Threadneedle-street. Such underpinning shall be carried down to the solid clay, and shall be of such width as to support the curtain wall for its whole width at the least. The said underpinning shall be constructed in such material, in such manner, and with such precautions as shall be reasonably prescribed by and generally under the supervision of an engineer, architect or surveyor to be from time to time appointed for that purpose by the bank, and shall be executed entirely from the outside of the wall, and so that no persons shall be able to find access into the bank through the works of the underpinning. The whole cost and risk of the underpinning, including the making good of all injury consequent thereon, and the reasonable charges and expenses of the supervising engineer, architect or surveyor, shall be paid and borne by the company.

6. The said engineer, architect or surveyor may from time to time inspect the works of every kind under Mansion House-street and Threadneedle-street or within 200ft. in any direction of the bank premises during the construction, and the company shall give the person so appointed all necessary facilities for such inspection, and if he shall be of opinion that the construction of the works or other operations of the company are attended with danger to the bank premises the company shall forthwith, at its own expense, adopt such additional measures and precautions as may be considered necessary for the purpose of preventing damage or injury to the bank premises, and in the event of any difference arising between the bank and the company with reference thereto, such difference shall be referred to an engineer to be agreed upon between the bank and the company, and failing agreement to be appointed by the Board of Trade on the application of either party, whose decision shall be final, and in the meantime the works or other operations objected to shall be stopped. The cost of such reference and of the award shall be borne as such engineer shall direct.

7. The company shall pay to the bank compensation for all damage or injury of every description which may from time to time arise to the bank premises by or from the construction or working of the railway or any of the works connected therewith, and the bank may claim and receive and recover such compensation from the company, notwithstanding that no part of the bank premises is actually taken.

Great Northern and Strand Bill.

Mr. BALFOUR BROWNE, K.C., introduced the Great Northern and Strand Railway Bill. He said that was merely an application for an extension of time for the construction of the railway, which was sanctioned in 1899 between Finsbury Park and the Strand. It was a very important railway which would really make a terminus of the Great Northern Railway in the very centre of London. There was practically no opposition to the bill on the part of the landowners, the usual compensation clause being inserted. The view at present was to modify their scheme to some extent. At the northern end it was proposed to make about 4 furlongs of new railway, which was to be moved further to the west than originally designed in order to admit the Great Northern and City Railway. At the other end there was an important modification of the scheme. When they came down close to the Strand, they proposed to form a junction with the Brompton and Piccadilly Circus line, which had been sanctioned up to Piccadilly. The result would be that there would be through traffic from Finsbury Park to the west. They also proposed that the Brompton and Piccadilly should take over their interests as far as Finsbury Park. There was a sheaf of clauses from the London County Council, but there was no opposition from anywhere else. Many of the clauses were fought out in 1899, and he asked that, unless there were strong grounds, their lordships should adhere to the bill of 1899.

Mr. ALEXANDER ROSS, engineer to the Great Northern Railway and the Great Northern and Strand, explained the scheme by the aid of a model, and showed the arrangements that had been come to with the Great Northern Railway.

The preamble was formally proved.

Then the Committee considered the County Council clauses, traversing much the same ground as they did earlier in the day.

At three o'clock, by arrangement, the clauses for the **Great Northern and City Railway** were considered.

Mr. RAM, K.C. (for the Bank of England) asked their lordships to give the Bank of England clause that was given by the Central London Railway Act of 1891, remarking that that was the clause giving compensation to the Bank of England.

The CHAIRMAN: The Committee are of opinion that that clause should go in, but with the distinct understanding that it shall go in as protecting the Bank of England for their special building. I want it to be distinctly understood that that should not be regarded as a precedent for buildings like the Carlton Hotel.

Wednesday, May 14.

The clauses of the **Great Northern and Strand** Bill were considered. The London County Council's points as to fares and time in connection with workmen's trains were not raised, as these had already been decided by the Committee in connection with the North-West London Railway (see above).

The Committee allowed the County Council a clause in reference to the employers purchasing workmen's tickets, and also a clause to the effect that the company should not increase their fares on Sundays and Bank Holidays.

Clauses for the **Great Northern and City Railway** were next discussed, after which the Committee entered upon the last bill on their list—the Baker Street and Waterloo Railway.

Baker Street and Waterloo Railway.

Mr. PAGE, K.C., said that this was a bill for the extension of time for the purchase of land and the construction of works, and also for certain small alterations with reference to the exercise of borrowing powers in regard to the Baker Street and Waterloo line. This line was incorporated in 1893, and the line then stretched merely from Baker-street to Waterloo, the capital being £1,250,000, and there were borrowing powers for £416,000. The powers to take lands under that bill had been fully exercised. The powers with regard to works expired under that bill in 1898, but they had since been extended. In 1896 Parliament granted power to extend the bill to the Great Central station, which has been opened at Marylebone. The capital for that was £75,000 and the borrowing powers £25,000. In 1899 a small deviation at Waterloo was sanctioned, and there was the small addition to the capital of £60,000 and £20,000 borrowing powers, and a subway was made at Charing Cross. In 1900 Parliament granted powers to the company to extend to Paddington Station so as to join the Great Western Company at Paddington. And there was to be a subway at the Elephant and Castle, and a further railway south. The capital under that act was £1,000,000, with borrowing powers of £333,000. With regard to the works, they asked for an extension of time, under the Acts of 1893, 1896 and 1899, to the 1st August, 1905. In 1893 it had been found impossible to get capital, and nothing was done until 1897, when a contract was made with the London and Globe Company to construct the line which was then sanctioned. They were to receive the whole capital, subject to the reduction of £50,000 for expenses. In 1900, when the extension to Paddington was granted and a second contract was entered into with the London and Globe Company to do that work as well. Work was at once begun, and at the present time all the land had been bought and more than half the tunnels had been completed. He believed one tunnel was absolutely finished from Waterloo as far as Oxford-street, and the other at the present time went well up Regent-street. In January, 1901, unfortunately, there came the collapse of the London and Globe, and to some extent the company were left on their beam ends. There had previously been a prospectus issued, and there had been a small public response, and with that and other money obtained from the liquidator the work was continued, the sub-contractors going on with their work as usual. Up to December, 1901, practically a million pounds was expended, of which £345,000 was spent for lands. In March of this year the contracts of the London and

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Globe Company, under which they were bound to provide money for the completion of the line, were transferred to the Metropolitan District Electric Traction Co., of which Mr. Yerkes was the chairman, and which would be taken over by the Underground Electric Railways Co. of London, which had a capital of £5,000,000, and it was quite certain that the work, on which nearly a million pounds had been expended, would be hurried on as fast as possible and would very shortly be completed; and they asked for the moderate extension of time necessary for the completion of the works. There was a small alteration with regard to the borrowing powers contained in the bill and that was in clause 7. That section of the Act of 1893 provided that no money should be borrowed till the section between Piccadilly-circus and Waterloo Station was completed, and that section was affected by sec. 11 of the subsequent act, which provided that the money might be borrowed with any one of the railways being completed. At the present time not one of the railways had been completed, although the capital under the Act of 1893 had very nearly been expended; and now they asked for the ordinary and unrestricted right of borrowing in accordance with the expenditure of their shareholders' capital—which could not affect anybody.

There was very little opposition, and the preamble was formally proved on the evidence of Mr. Galbraith, engineer to the railway, who said they had carried out about 60 per cent. of the tunnels, and were going on as fast as they could.

The Committee then proceeded with the bill on clauses, and heard formal evidence from Mr. R. W. Perks, M.P.

This completed the list of bills for this Committee, excepting for the adjustment of clauses.

Thursday, May 15.

Yesterday (Thursday) Lord Ribblesdale's Committee spent a quarter of an-hour in the final adjustment of the clauses in the Great Northern and Strand and the Great Northern and City Railway Bills. Of course, all the bills dealt with by the Committee will still be subject to the clause to be agreed upon, in relation to tubes in general, for the protection of property owners.

Lord Windsor's Committee.

Friday, May 9.

Before proceeding with the opposition evidence to the bills which have already been put before the Committee, the views of the Board of Trade, which were submitted on the first day of the sitting of this Committee, were amplified by Col. Yorke, chief inspector of railways to the Board.

Col. YORKE said the definite view of the Board of Trade now was that promoters should, after construction, be obliged to deposit with that department plans showing the exact position of the lines within the limits of deviation. Mr. Shiress Will, K.C., had asked that such plans might be at the disposal of the public at large, but this was hardly possible. At the same time it would be satifactory for the public to know that such plans were in the hands of the Board of Trade, and could be seen specially. Such a clause as this was in the Waterworks Acts of 1847. With regard to sharp curves, he took exception to the one on the Piccadilly-Charing Cross branch of the Brompton and Piccadilly Railway. Even with the enlargement of this to 4½ chains it would be obligatory upon him to put a restriction of speed upon the train at that point, and this would probably have an effect upon the train service over the whole of the lines. He still adhered to his opinion, already expressed, that a 5-chain curve was most advisable. It would be incumbent upon his department to require a speed of 12 miles an hour on a 3½-chain curve, and a little higher with a 4½-chain curve. On the Metropolitan Railway of Paris the curves were restricted to 5 chains. One exception, however, occurred at the Place de Bastille, where a curve of under 3 chains came; but the approach to the curve was on an ascending gradient, and the curve itself was also on an ascending gradient. The curve on the Piccadilly-Charing Cross line was on a down gradient of 1 in 44. On this particular line there were several reverse curves, and it was his opinion that a length of straight line should certainly be interposed between the two opposite curves. In speaking of the size of the tunnel in his previous evidence, he had only in his mind those lines being promoted this session, and did not desire to put any further obligations upon already authorised lines. He desired that the relative proportion of the rolling stock to the tunnel should allow of sufficient clearance. A maximum size for the tunnel might be fixed up to which a company might work, but beyond which it might not go. As to the shape of the tubes, it seemed to have been generally taken for granted that this ought to be circular, and no doubt there were advantages, probably from the point of view of cost; but other advantages would show themselves, he felt sure, if tunnels of the section now adopted on steam lines were adopted. He did not see any danger in the proposed junction at Charing Cross.

Mr. LITTLER, K.C., for the Brompton and Piccadilly Railway, said he was quite prepared to put himself in the hands of Col. Yorke. Perhaps a heavy penalty in the event of exceeding a specified speed round the curve would satisfy the Board of Trade.

Col. YORKE said it was a case of making it obligatory upon the drivers not to exceed the specified speed.

Mr. LITTLER, speaking on the size of the tunnels, said that with regard to the authorised Brompton-Piccadilly Railway they would very likely meet with some objection on the part of landowners along the route if the size of the tunnel were increased, but at the same time if the Committee thought this necessary, he would pledge himself to promote a bill next session asking for powers to make the enlargement.

The opposition to the **North-East London and City and North-East Suburban Railways** was then continued.

Mr. J. F. S. GOODAY, general manager to the Great Eastern Railway Co., said that supposing these lines abstracted half of the traffic of the Great Eastern this would only pay 2¾ per cent. on the debentures and leave nothing for the ordinary shareholders. In order to pay 4 per cent. on the debentures and 4 per cent. on the ordinary shares, the traffic would have to be five times as large as that carried by the Eastern Company along these routes. In fact, right through, he considered the estimates of Mr. Clifton Robinson were enormously exaggerated. The average number of passengers carried between Walthamstow and Liverpool-street was 21 per cent. of the total seating capacity. Mr. Robinson's estimates were apparently based on the tramways, which were not to be compared with the railways. He did not deny that there was overcrowding on his railway, but it was not anything like so great as was alleged; the maximum difficulty was between 7:30 and 8 a.m. The average speed on the Great Eastern Railway was greater than on the tube railways, averaging out at 20 miles for the suburban lines. Their locomotive engineer was also designing an engine which would increase the acceleration by 50 per cent., and also increase the carrying capacity. The tube railways suggested last year were not put forward as definite proposals, but merely as being under the consideration of the directors, who abandoned the lines for the reasons stated by Lord Claud Hamilton. On the question of the electrification of the lines, he said the proprietors of the Langen suspended electric railway system had been anxious to meet the company. Apart from this, however, the matter of working the Walthamstow and Enfield lines had also been under discussion.

Cross-examined, he said he considered the Great Eastern Railway Co. were more likely to construct new lines than the promoters of the electric railways. If the North-East London and City and North-East Suburban lines were rejected, he would not guarantee that the Eastern Company would construct tubes to relieve the traffic along these routes. They were increasing the size of their carriages, &c., and did not consider a tube was immediately necessary. Further, he did not agree that all railway extension to already crowded districts should be by means of tubes. It was obvious, of course, that the fares on the new lines would be much cheaper, but passengers had the disadvantage of having to travel in tubes.

Mr. HOLDEN, locomotive superintendent to the Great Eastern Railway Co, referred to the new locomotive which he has designed. This would increase the acceleration from 1ft. per sec. per sec. to 1·5ft. per sec. per sec., equivalent to a speed of 30 miles per hour. It would enable a quicker service than the tubes with a heavier load.

Viscount KNUTSFORD: Has this engine been tried?

WITNESS said it had only been designed, and was being constructed.

Cross-examined by Mr. VESEY KNOX, he questioned whether 3·2ft. per sec. per sec. acceleration could be obtained with an electric motor, and if 4ft. per sec. per sec. had been obtained by the experimental train on the Liverpool Overhead Railway it could only be by an enormous amount of current. He did not believe there was any advantage in the matter of adhesion of an electric locomotive over steam traction. His new engine had 10 driving wheels.

Mr. W. GRINLING, traffic manager to the Great Northern Railway Co., repeated his evidence given in favour of the Brompton and Piccadilly Railway Bill. The North Metropolitan Tramways Co., which competed with the Great Northern Railway from the City to Wood Green, had now obtained powers to use electric traction on these lines, which would greatly increase the capacity of the trams, and the London County Council had powers to extend the tramways beyond Wood Green to Palmers Green, crossing the line of the proposed tube railway. Thus the district would be well served without the electric railway when the service of the Great Northern Railway to the same neighbourhood was considered. Judged by the numbers of passengers carried on the Great Northern Railway, he did not think there was any possibility that the promoters of the North-East London line would ever get the traffic sufficient to pay a dividend on capital expenditure.

Mr. F. J. DUNN, general manager of the North London Railway, said that the North-East London Railway passed under his lines three times between Broad-street and Dalston, and any damage to the railway due to subsidence from the electric line running under the North London Railway as well was likely to be very serious. In addition, he considered the route was extremely well served by existing means of communication via Dalston.

Monday, May 12.

Mr. DUNN, continuing his evidence, said he could not imagine anything in connection with electric traction which would make the working expenses a smaller percentage of the receipts than would be the case with steam traction. On the Central London Railway Co. working expenses were 54 per cent. of the receipts, and this was a new line which had not yet felt the steady brunt of maintenance. Further, he considered the proposed fares on the North-East London and City and North-East Suburban Railways were much too low to admit of any profit.

Cross-examined by Mr. VESEY KNOX for the North-East London Railway: He wanted protection against interruption to his system of electric signalling. The block system used upon the North London Railway was being affected at various points by stray currents which could not be traced. At Hammersmith, perhaps, it might be attributable to the London United Tramways. He would be perfectly satisfied, however, if (as counsel stated would be the case) the North-East London promoters intended to use an insulated return. Strictly speaking, too, he did not make a very strong point of the fact that the proposed tube railway passed under the North London line, and further admitted that the chief competition would be between Broad-street and Dalston. Summing up the general question, however, he considered the sanction of this electric railway would do his line serious injury and benefit itself very little.

Mr. E. H. PEMBER, K.C., who is representing both the Metropolitan District and the Great Eastern Railway Companies, then addressed the Committee for these concerns against the **North-East London, City and North-East Suburban** and **Piccadilly and City Railways**, a course which he said was necessary owing to the combination of these lines. Further it was to be understood that these comments were also applicable to the Central London Scheme. The problem really was: Were the existing lines of the Metropolitan District Co., *plus* the author-

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ised deep-level line, the authorised line of the Brompton and Piccadilly Railway, and the proposed extensions of this to Charing Cross, Parson's Green, and also to Holborn, together with the lines of the Great Eastern Railway and other existing lines serving the north and north-east of London, capable of doing all or nearly all that the proposed new lines would do? He contended that the existing lines over the Hammersmith–City route served exactly the same purpose as any of the new proposals and at a much less capital expenditure, especially taking into account the authorised Brompton–Piccadilly Circus line. Including the authorised Brompton and Piccadilly Railway, the capital necessary for doing this was £2,404,400, as against seven millions, or, leaving out the already authorised lines, the only new capital necessary to be authorised was a little over £800,000. The existing lines and their proposed extensions did even more than the system he was opposing, as they also served Earl's Court and South Kensington. Turning to the North-east London lines, he argued on the same basis—viz., enormous competition, the adequacy of present requirements, and the colossal expenditure necessary for the new lines. If these lines were really necessary they could just as well be made as continuations of the Metropolitan District lines. The cost, given in amended estimates of the two north-east London railways, was practically £9,000,000 sterling, and to make the undertakings a financial success with the very low fares proposed was, he said, impossible. Mr. Clifton Robinson's figures for estimated traffic were grossly exaggerated in comparison with the present traffic carried by existing railways serving the same portion of London. Dealing with the lines of the combination as a whole, it was preposterous to say that they were likely to carry 252,000,000 when the whole of the existing lines of London only carried a very little more. He contended that the construction of the whole through route would be an utter waste of capital, besides a decided hardship to vested interests. Further, however, there was to be considered the question of how the money was to be raised. Whether it was to be American or English he did not care, but what Messrs. Morgan did was merely to promise to put the shares before the British public for a consideration of £1,500,000, which was the difference between the estimated cost of the lines and the proposed capital. Once this was done Messrs. Morgan were finished with the matter, and in the event of the estimates being exceeded the shareholders would be left to find the difference in order to complete the construction of the line.

Lord ROBERT CECIL, K.C., then proceeded to address the Committee on behalf of Mr. Walker, a landowner at Palmer's Green, who objected to the portion of the North-East London Railway from Palmer's Green to Southgate, on the ground that it was absolutely unnecessary, and greatly detrimental to local interests (see *The Electrician*, May 2, p. 53).

Lord WINDSOR, in order to shorten proceedings, announced that on the promoter's evidence alone, they found that the preamble of the portion of the bill referred to by Lord Robert Cecil was not proved.

Mr. FRERE then wished to put his case for the Tallow Chandler's Company opposing the route taken by the portion of the City and North-East Suburban Railway near their building at the top of Cannon-street—viz., from the Monument to Mansion House. He called

Sir A. BINNIE, who described the property which is situated within 20ft. of the proposed route. It was a very ancient building, and any injury to it could not be met by compensation. Already the building had had to be underpinned by the Metropolitan and District Companies whose City lines ran very close to it in the gravel, and he apprehended great danger to the building if a tube railway were constructed underneath this railway.

After consultation the Committee agreed that that portion of the City and North-Eastern Suburban Railway from Whitechapel to Mansion House would not be allowed. This was the length of the line running under the District Railway Company.

Tuesday, May 13.

The CHAIRMAN announced that the Committee did not intend to call for any opposition evidence to the **Charing Cross, Hammersmith and District Bill**, as they found the preamble not proved.

Mr. PAGE, K.C., for the **City and North-East Suburban Railway**, referring to yesterday's decision with regard to the Whitechapel–Mansion House section of this line, said that it had been decided to proceed with the remainder of the bill, believing that the Committee did not intend that the line should never come further west than Whitechapel. He took it that the Committee, in carrying out the recommendation of the Joint Committee last year were opposed to the method of coming from Whitechapel, and, therefore, he proposed, if the remainder of the preamble were proved, to come forward next session with an extension into the City.

Mr. BALFOUR BROWNE, K.C., on behalf of the Morgan combination, said that the Committee's decision yesterday refusing the Whitechapel–Mansion House portion of the City and North-East Suburban Railway had had the effect of no longer constituting this railway a partner in the combination, the original understanding having been that Messrs. Morgan would find two-thirds of the necessary capital for that line as a continuation of the western lines. If, however, the extension into the City was sanctioned next year the same inducements would be held out as had been this session

Mr. PAGE said that this put the City and North-East Suburban Railway in exactly the same position as when the bill was deposited, as at that time the amalgamation had not taken place.

Viscount KNUTSFORD pointed out that the financial position of the line before the amalgamation had not been inquired into owing to the support promised by Messrs. Morgan.

The Committee then retired, and after consultation,

The CHAIRMAN said the Committee did not wish to call for further opposition evidence to the northern portion of the lines, but were quite ready to hear the learned counsel for the bill if he wished to address the Committee before a final decision was come to.

Mr. PAGE, after a little discussion, obtained sanction to make his speech on Wednesday.

The case against the **North-East London Railway** was then proceeded with.

Mr. LITTLER, K.C., for the Metropolitan Railway, while not calling witnesses, opposed the railway for the same reason that the District Company did the City and North-East Suburban—viz., that for 25 chains in the City it ran under the City lines of his company, and also competed with it. He asked the Committee to reject that piece of line in the same manner that they did the Whitechapel–Mansion House section of the other railway. For the Great Northern and the North London Railways, he contended that any further communication was absolutely unnecessary when the present services were considered in conjunction with the number of electric tramways which were authorised along the same routes.

Mr. VESEY KNOX pointed out that the actual distance which his line ran under the City lines was only 10 chains and not 25 chains.

Mr. CLODE, speaking for the South-Eastern and London, Chatham and Dover Railway, opposed the North-East London Railway on the ground that it passed underneath the forecourt of the Ludgate Hill station. Further, he opposed any interchange with the same railway as it was not considered a sufficient interchange of traffic would accrue to justify it. On the other hand, they considered the Central London extension offered much greater advantages in this respect, and a provisional agreement had been entered into with that company by which the South-Eastern and London, Chatham and Dover Railway was to be paid £40,000 towards the rebuilding of Ludgate Hill Station.

Mr. VINCENT HILL, general manager of the South-Eastern and London, Chatham and Dover Railway, gave corroborative evidence.

Wednesday, May 14.

Mr. BALFOUR BROWNE, on behalf of the **City and North-East Suburban Railway**, said that it was now felt that a truncated scheme, such as it now was, owing to the decision of the Committee with regard to the Whitechapel–Mansion House section, should be proceeded with, and he asked for leave to withdraw the remainder of the bill. The present promoters pledged themselves to come forward next session with a similar scheme, which would exactly follow the recommendation of the Joint Committee last year—viz., from the City, up Leadenhall-street, and thence in a north-easterly direction.

Counsel then addressed the Committee for the **North-East London Railway**. This was a line, he said, which did perfectly carry out last year's recommendation—viz., a route connecting the tramways in the north-west, through the City, with the tramways in the west. The Middlesex County Council supported the scheme, and a system of through fares with their tramways had been arranged. In fact, all the schemes, except the Central London Railway, were practically through routes. With regard to the opposition to the lines, it consisted solely of railway opposition, which said that there was not sufficient traffic for new lines, but the whole object of these new electric lines was to create new traffic, and there was abundant evidence that this was done. At Croydon, for instance, a short length of tramway which had been electrified, during the first three months carried 3,000,000 more passengers than ever had been carried on the horse tramways. The Great Eastern Railway Co. would not pledge themselves to do anything, and the North London Railway Co. admitted they could not run more trains during the busy hours of the day, and yet the overcrowding was not disputed. Summing up, he maintained that the public ought to have and wanted the railway; the London County Council had asked for it in order to serve the new colony at Tottenham; the local authorities, without exception, were in favour of it; and as far back as 1894 the Walthamstow and Epping Forest tube railway, which served part of the route proposed by the North-East London, was passed, but, unfortunately, in the public interest, not financed. There was nothing, therefore, but the railway opposition to stand in his way.

The Committee then retired to consider the best course of procedure, and after half-an-hour

The CHAIRMAN announced that, having carefully considered the position, it had been decided to go on with the remainder of the opposition to what had been called the Morgan group, then the opposition to the Brompton and Piccadilly Railway, and finally, that to the Central London Railway. After all this had been disposed of, the views of the London County Council on all the schemes would be taken, as well as the views of the Corporation of the City of London. Then the counsel for the schemes would be called upon, beginning with the Central London, followed by the Brompton and Piccadilly, and then the Piccadilly and City Railway. All landowners' opposition would be postponed for the present, and any evidence already given by one scheme against another would not, of course, be repeated.

No further preamble opposition being forthcoming against the Piccadilly and City Railway,

Sir DOUGLAS FOX was called on behalf of the Piccadilly–City and London United Electric Railways against the **Brompton and Piccadilly Circus Railway**, and criticised the Charing Cross–Piccadilly branch. This section was incompatible with his line, and, further, was laid out in the most extraordinary manner he had ever heard of. It was a series of 4 and 5 chain reverse curves all the way, which would make the line unworkable. The proposed junction at Piccadilly-circus would involve having four tubes almost one above the other, and this would greatly increase the cost of any other lines coming down that thoroughfare owing to the great depth necessary to get below them. Further, the junction at Charing Cross was as bad as it could be.

Opposing the **Central London Railway** on behalf of the Piccadilly and City and London United Electric Railways, Sir DOUGLAS FOX said that the question of exchange stations with such a closed circuit was extremely important. The North-West London Railway, which had just obtained an extension of time, had realised the fact that at Marble Arch, going city-wards, the trains of the Central London Company would be full. On engineering grounds there were also objectionable points. The rolling

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stock must be fixed by the diameter of the existing tunnels and the length of the existing platforms. The existing tube was 11ft. 8¼in., and the platforms 315ft., and the only advantage in having the larger tube on the new lines would be that of the deeper rail. No other of the requirements of the Board of Trade could be met. Night trains were impossible on the existing line, there being no means for the platelayers to get out of the way of the trains. Further, the step on the carriage in order to accommodate the motors was most objectionable. He also attached great importance to the question of ventilation, but in an 11ft. 5in. tunnel there was not sufficient area to ventilate effectively. Exception had been taken to his evidence on acceleration, and he quite agreed that with the present size tube of the Central London Railway, and the size of the motors which could be put into the tubes, the high acceleration which he hoped to get could not be obtained. But he had satisfied himself that the acceleration given in his previous evidence could be obtained. With regard to the Liverpool Overhead Railway, it was true that the higher speed had been attained with a train of 43 tons weight—probably only one-third of the usual weight of the trains—but this did not affect the question. It was entirely the number of motors put upon the train; and what had been done with this light train could be repeated with a heavier train. As a matter of fact, the rolling stock of the Liverpool Overhead Railway, for which line he was the original engineer, was being re-constructed for the purpose of this higher speed. On the question of the opposition of the South-Eastern and Chathan Railway at Ludgate-hill, he stated that in order to avoid coming under the forecourt of this station, the Central London had to have two 5-chain reverse curves. As he preferred not to have any curves less than 7 chains radius, this just brought him under the Ludgate-hill station, but at the great depth at which the line would run, no danger need be apprehended. He certainly did not consider there would be any difficulty in maintaining a two-minute service on a shuttle system. Dealing with the criticism as to his estimates, he said he considered those made by Sir Benjamin Baker for the Central London were about 10 per cent. too low for the work. The difference between the estimates for this line and those for the Piccadilly and City was accounted for by many things. For the small-sized tunnel Sir Benjamin Baker's figure was £246,000, but, according to his own evidence, the larger tube would add £30,000 per mile, the increased size of the platform £10,000, the larger-size station tunnels £10,000, and with the contingencies added to this, the cost of the Central London, upon the same basis as the Piccadilly-City line, would amount to £303,000, as against his figure of £312,800. This showed that there was very little difference between the two estimates. Even this figure was low compared with Sir Benjamin Baker's estimate of something like £600,000 per mile for the City and West End Railway. Outside these estimates the cost of the land for the Piccadilly-City line would be much greater than that for the Central London Railway, especially in the Hyde Park district, where the Central London proposed underground stations, and he intended to buy the land.

Mr. A. MACMORRAN, K.C., addressed the Committee against the Central London Railway on behalf of the Hammersmith Borough Council. The objection was that the company did not propose to do anything by way of widening the Broadway in order to accommodate the new traffic which it would bring there. If the Central London would agree to do the same as the London United offered to do, the Borough Council had no special objection to the former scheme. At the same time the Council considered the through fares with the trams and trains was an important advantage.

Mr. E. C. RAWLINGS, chairman of the Law and Parliamentary committee of the Hammersmith Borough Council, confirmed this statement.

Mr. H. N. THOMAS, on behalf of the Metropolitan Railway Co., stated that the objection of his company to all these new schemes from Hammersmith was the creation of a new east and west competition with his company, and in view of the electrification of the lines, which would be completed in about 15 to 18 months' time, he suggested to the Committee that no new lines competing with the Metropolitan and Metropolitan District Companies should be sanctioned until the effect upon London traffic of the introduction of electric traction upon the existing railways.

Mr. A. C. ELLIS, general manager of the Metropolitan Railway Co., described the system of his company and its various connections.

The Committee adjourned till Thursday, May 15.

THE REPAYMENT OF LOCAL LOANS.

The Select Committee of the House of Commons dealing with the question of local loans met on Tuesday and Friday, the 6th and 9th inst., and also Tuesday last, Mr. Grant Lawson presiding on each occasion.

Sir THOMAS PILE, ex-mayor of Dublin, gave evidence, in which he said that he thought that in all reproductive works the repayment should not begin until the completion of the works.

Mr. LONG, vice-chairman of the Cork County Council, was of the opinion that the period for the repayment of loans for reproductive works was too limited, and restricted local authorities from carrying out work which would be for the public advantage.

Sir E. CHANDOS LEIGH, K.C., counsel to the Speaker, said that in the case of horse tramways 30 years were allowed for repayment, and with electric tramways they had allowed 40 years.

Mr. J. W. LOWTHER, M.P., chairman of Committees of the House of Commons, said that he thought local authorities preferred committees of the House to the Local Government Board when applying for provisional orders, as they considered they obtained better terms regarding repayment. It was, however, the duty of the Local Government Board, if dissatisfied with the terms granted by a Parliamentary committee, to move amendments when the bill was considered in the House, and obtain the decision of the House as final in the matter.

Mr. GRAY, counsel to the Earl of Morley, said that if a definite period could be fixed by this Committee for loans for specific purposes, the chairmen of both Houses could easily carry that into effect. Parliament should lay down a maximum period for all purposes; but where it became necessary to average the periods, as in loans for composite purposes, the term should be fixed by the department and not by Parliament.

Mr. W. J. JEEVES, town clerk of Leeds, said that one half the municipal debt was in remunerative undertakings, which not only paid but yielded some £35,000 surplus profits, which were handed to the relief of the rates.

Mr. KERSHAW, of the Local Government Board, on being recalled, referred to the allegation that the term allowed by the department was too short, and mentioned that since he was last before the Committee, 29 cases had come under his notice, of works which had failed to last for the period allowed for repayment.

This concluded the inquiry, and the Committee will consider their report.

LONDON COUNTY COUNCIL TRAMWAYS AND IMPROVEMENTS BILL.

On Friday, Mr. A. T. MOORE, a member of the Camberwell Borough Council, said the principal plank in his platform at his election was the proposal of the London County Council to construct a tramway between Camberwell and Dulwich, and he was returned at the top of the poll. One reason why the Dulwich College estate remained undeveloped was the lack of good communication. At a mass meeting of the Dulwich ratepayers a resolution was passed (there being only 40 dissentients, who were mainly employés of omnibus companies) in favour of the proposed line.

Other local evidence was given in support of the bill, including that of Mr. SHUTER, deputy town clerk of Fulham, who admitted in cross-examination, however, that Wandsworth objected to the tramway crossing Putney Bridge.

Mr. ERSKINE POLLOCK, K.C., said that, if the Committee desired it, the Council would be prepared to throw a piece of land leading down to the river at the lower end of Putney Bridge into the roadway, which would give a width to the roadway of 70ft.

This concluded the case for the promoters.

Evidence was then taken in opposition to the Hammersmith and Putney scheme.

Mr. DODD, surveyor to the Wandsworth Borough Council, in reference to the proposal to lay a line across Putney Bridge, said that on Sunday, April 27, the traffic over the bridge was 6,249 vehicles between 8 a.m. and 8 p.m., 3,979 being bicycles. The number of vehicles was larger on weekdays.

Mr. PARKER, a member of the Wandsworth Council, said the opinion of the Council was that it would be dangerous to have a double line of tramways over Putney Bridge unless the bridge were widened.

Lord R. CECIL, K.C., on behalf of frontagers on the Victoria Embankment, next addressed the Committee. He said some chairmen of Committees had restricted counsel for frontagers to the point how far they, as frontagers, were directly affected, and others had allowed the general case for the tramway to be dealt with. If the frontagers in this case were restricted to such subjects as how far the cars would be unsightly, and so forth, it would hardly give them an effective voice.

The CHAIRMAN said the Court of Referees had decided that owners and occupiers were not entitled to be heard except under Standing Order No. 135, which would restrict them to the question whether they would be injuriously affected in the use or enjoyment of their premises or in the conduct of their business or trade.

Lord R. CECIL, after further discussion, said that if the Committee thought he was confined to the question of amenity, his clients were of opinion it would not be worth while to take up the time of the Committee.

Counsel then withdrew.

Mr. READER HARRIS, K.C., for the District Railway Co., next addressed the Committee. He said that, to make the proposed Embankment tramway pay, 5,000,000 passengers would have to be carried, but that number, he pointed out, was more than twice as many as other tramways in London carried. The District Railway, so far from deserving this threatened competition, had contributed £200,000 to the cost of the Embankment, had given an efficient service of trains, and were loyally carrying out their obligations. These obligations had been carried out at a cost which only the shareholders could appreciate, and now that they were about to electrify their system, and happier times seemed to be in sight—the money to improve their system having been forthcoming—they were threatened with this unfair and undeserved competition. Instead of going along the Embankment and injuring that magnificent boulevard, the County Council could carry their cars through a tube.

Mr. J. M. WHITTAM, accountant to the Metropolitan District Railway Co., said that to make the line pay they would have to carry more passengers per mile than they did at present, twice as many as were carried by the North Metropolitan Company, and four times as many as were carried by the London United Company. The ordinary shareholders in the District Railway had not received dividend since 1882, and the other shareholders last year only received 9s. 5d. per cent.

Major ISAACS, deputy-chairman of the Metropolitan District Railway Co., said that the prospects of the company now were good, and it would be unfair to allow them to be injured by the abstraction of the small traffic they enjoyed from the Embankment. The company were making a loss of £1,500 a week, or £75,000 a year, and this must last for another 18 months. He was an original shareholder, and in 40 years had only received one dividend.

On Monday Sir J. WOLFE BARRY, consulting engineer to the Metropolitan District Railway Co., said the proposed tramway for a distance of 1¼ miles (from Blackfriars to Westminster) would run parallel, or in close proximity, to the Metropolitan District Railway. For 740yds., or one-third of the distance, the tramway would run over the railway, and for the remainder of the distance the tramway would be 100ft. away from the railway. It was the intention of the railway company to run trains every

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minute and a half at accelerated speed, and at fares as low as those of a tramway, so that the tramway was not likely to pay. A speed of 18 miles an hour, including stoppages, might be reached, but the American electricians, who had made a most exhaustive study of this subject, were of opinion that 16 miles an hour would be the most convenient speed. It is extremely hard that the London County Council should seek this power just when the railway had a chance of emerging from its difficulties. The traffic taken away from the railway might not be considerable in extent, but every little bit of traffic was of importance to this railway, which was in anything but a flourishing position. The girders of the railway under the Embankment were laid down 30 years ago, and he viewed with alarm the considerable extra strain which would fall upon them by the placing of an electric tramway with heavy cars over them. The cost of reconstructing the tunnel to stand the new condition of things would raise the expense on the proposed tramway by about 50 per cent. To give the London County Council direct communication between their north and south tramway systems it would be better and cheaper to construct a tunnel from Waterloo to the new subway, the cost of which he roughly estimated would amount to £103,000. This would be very little more than the cost of the proposed tramway—£40,000, the expense on strengthening the Metropolitan Railway tunnel, and the cost of making connections over Blackfriars Bridge and Westminster Bridge.

Mr. WHITTAM recalled, handed in a return showing that between St. James's Park Station and the Mansion House the Railway Company carried in one year 2,669,772 passengers, at a gross receipt of £18,917. The total number of passengers between Westminster and Blackfriars was 724,992.

Mr. BLENNERHASSETT, K.C., then opened the case for the City of Westminster Corporation, his submission being that the tramway would spoil the Embankment and impede the quick traffic along it, the result of which would be to divert it into the Strand, which was already congested.

Mr. John Hunt, town clerk of Westminster, gave evidence against the bill, as also did Sir F. Dixon-Hartland, M.P., Chairman of the Thames Conservancy Commissioners and Chairman of the Finance Committee of the Middlesex County Council, and Mr. W. Emden, L.C.C.

Mr. LITTLER, K.C., addressed the Committee for the City of London, and evidence in support of his opening was heard.

On Tuesday Mr. ERSKINE POLLOCK, addressed the Committee in reply to the case of the petitioners against the Victoria Embankment part of the bill. He said that it had been pointed out that for 30 years attempts had been made, but without success, to run a tramway along the Thames Embankment. To his mind this argument was chiefly important as showing that for 30 years some one had thought that a tramway along the Embankment was needed. If it was thought in the early days that horse tramways would pay, there was much more reason for thinking that the electric tramway now proposed would be a success. In reply to the argument that there would not be sufficient traffic along the Embankment to justify the expenditure of the ratepayers' money on the tramway, he submitted that an electric tramway attracted traffic, and that it would be found that the tramway would be an immense relief to the Strand. The London County Council had in nothing been more successful than in their tramway enterprises. The profit made by them under their lease of the northern tramways alone was £39,000 a year. As an evidence of the value of competition he drew attention to the fact that for 30 years the District Railway Railway Co. had neglected to adopt improvements and give benefits to the public, and that they had been driven into setting their house in order by the opening of the Central London Railway. They found their business leaving them. With regard to the proposal for a tube railway to join the northern and southern tramway systems, he submitted that that was an afterthought on the part of Sir John Wolfe Barry. He had only formulated his scheme and made his estimate of expense last week after his (Mr. Pollock's) opening, and obviously the County Council could not deal with them.

In giving the decision of the Committee,

The CHAIRMAN said: The Committee have considered this question very carefully, and have unanimously come to the conclusion to authorise the tramway so far as the point at which it would form a junction with the tramway authorised a fortnight ago—that is to say, from Westminster to Waterloo Bridge. They propose to ask the opponents, or if they will not do it, the promoters, to bring up a clause to protect the structure of the District Railway Co. in the way that has been proposed.

The opposition to the proposed tramways from Camberwell Green to East Dulwich and Lordship-lane and from Hammersmith to Putney Bridge was then proceeded with.

On Wednesday, local evidence was taken against these lines, and counsel was heard on behalf of the Borough of Lambeth against the Camberwell line, and on behalf of the Borough of Deptford against the Woolwich and Eltham tramway.

Mr. CLODE, in addressing the Committee for the South-Eastern and Chatham and Dover Railway, said that since the bill was deposited it had become known, from proceedings before the Light Railway Commissioners, and confirmed through the cross examination of witnesses in this bill, that the proposal was not for a small, innocent line of 2¼ miles, but was part of a comprehensive scheme for carrying a line up to the doors of the Crystal Palace. This form of procedure was, he submitted, not a fair or dignified course of action on the part of an important body, and the effect of the Dulwich tramway would be to abstract traffic to and from the Crystal Palace from the lines of the petitioners.

The Committee decided to pass the preamble of the bill for the line from Hammersmith to Putney and the line from Camberwell to Dulwich, subject to a clause carrying out an arrangement at Lower Richmond-road (for widening). They strike out the clause empowering the Lambeth and Deptford Councils to contribute to the cost of widenings. The line from Woolwich to Eltham had become unopposed.

On Thursday (yesterday) the Committee considered the clauses of the bill, and a clause was inserted for the protection of the Metropolitan District Railway in connection with the Embankment tramway. It provided that that line should be laid down so as to interfere as little as possible with the tunnel of the railway, and that the plans should be submitted to the railway companies' engineer for approval and the works carried out to his satisfaction. In the event of injury to the railway tunnel by the construction or maintenance of the tramway, the railway company to repair such damage at the cost of the Council, and in the event of a strengthening of the railway tunnel being rendered necessary the matter to be referred to arbitration.

The CHAIRMAN said he hoped the tramways would be worked on the conduit system.

Mr. CRIPPS (Parliamentary agent to the London County Council) said the London County Council Act of 1900 provided for the construction of tramways on the conduit system unless an arrangement was entered into with the local authorities for the use of any other system.

The CHAIRMAN thought it would be safer, in regard to the Victoria Embankment tramway, if a clause were inserted in the bill prohibiting the use of overhead wires.

A provision to this effect was inserted, applying also to the Putney Bridge tramway.

The CHAIRMAN inquired whether there was any objection to that provision applying to all the lines, as he considered it would be right to prohibit the use of overhead wires.

Mr. ERSKINE POLLOCK said that under the provisions of the Electrical Powers Act of the London County Council, the system to be used was the conduit system unless the local authorities concerned approved of the overhead system. He quite saw, however, that in the case of the Victoria Embankment tramway a special arrangement was necessary, because the County Council were the road authority there.

A MEMBER OF THE COMMITTEE: We do not desire to bind the Council down to the conduit system, but we do not desire to have overhead wires.

It was ultimately decided to include the Denmark-hill tramway in the conduit system proviso; and the preamble of the bill having been found proved, the bill, as amended, was ordered for report.

OTHER ELECTRICAL BILLS.

In the House of Commons on Thursday last week the Norwich Corporation (Electricity, &c.) Bill, the Halifax Corporation Bill and the Scarborough Tramway Bill were read a third time.

On Friday last in the House of Commons the Cleethorpes Improvement Bill and the Preston Corporation Bill were read a third time.

The Kent Electric Power and the South Wales Electric Power Bills were read a second time in the House of Lords on Monday, and in the same House on that day the following bills were read a third time:—Northumberland Electric Tramways, Newcastle-upon-Tyne Electric Supply, Newcastle-upon-Tyne Corporation Tramways and the Cornwall Electric Power.

In the House of Lords on Tuesday the Southport and Lytham Tramroad, Birkenhead Corporation, Cavehill and Whitewell Tramways and Salford Corporation Bills were read a second time.

The Garston and District Tramways and Electric Supply (Transfer) Bill was read a third time in the House of Commons on Wednesday.

The North Staffordshire Tramways Bill on Tuesday passed the House of Lords Committee stage without opposition. The House of Commons has already passed this bill.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) and St. Marylebone Borough Council.

ARBITRATION.

At the Surveyor's Institution, Great George-street, Westminster, on Monday, May 12, arbitration proceedings between the above-named parties were continued. The preliminaries were settled on April 19, and the regular proceedings were now opened before Mr. C. A. Russell, K.C. (umpire), and Mr. Robert Vigers and Mr. W. C. Ryde (arbitrators). The inquiry was to assess the sum to be awarded to the Metropolitan Company for the acquisition, as a going concern, by the Borough Council of St. Marylebone of that portion of the company's important undertaking and business situate within that borough. It will be remembered that Parliamentary powers were obtained by the Borough Council in the 1901 session for the purchase referred to, and, negotiations between the parties having failed to bring about a satisfactory settlement, arbitration was resorted to under the provisions of the Lands Clauses Act. The total amount claimed by the company under various heads represents no less than £2,771,708, and the inquiry is, on this and other grounds, of great public and professional interest and importance. This is the first inquiry of the kind ever held in connection with electricity supply, and involves a larger sum than has ever before been claimed in arbitration.

The parties are legally represented as follows:—For the company: Mr. Balfour Browne, K.C., Mr. Cripps, K.C., Mr. Ernest Moon, K.C., Mr. Sargent and Mr. A. T. Lawrence (instructed by Messrs. Barlow and Barlow). For the St. Marylebone Borough Council: Sir E. Clarke, K.C., Mr. Fletcher Moulton, K.C., Lord Robert Cecil, K.C., and Mr. A. B. Cane (instructed by Messrs. Greenwell & Co.).

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In opening the proceedings on Monday, Mr. BALFOUR BROWNE reviewed the circumstances which led up to the formation, on July 20, 1888, of the Metropolitan Electric Supply Co. (Ltd.), working under powers conferred by various Acts of Parliament and provisional orders. The parish of St. Marylebone was (he said) included in the company's West London order, confirmed by an Act of Parliament in 1889. Current is supplied to this area by the company's generating stations at Rathbone-place and Manchester-sqare. These generating stations also receive current from the company's main station at Willesden, as did also certain sub-stations situate in the Marylebone area. The supply of current to the Marylebone area commenced on Sept. 27, 1889, current being distributed at a pressure of 1,000 volts, reduced by house transformers to about 100 volts. There were some exceptions, but this was the general practice. Later, in 1897, supply was altered to continuous current by means of a system of low-pressure networks suitable for either alternating or continuous current. In 1900 a large scheme was adopted for supplying continuous current in place of high-pressure alternating current in the greater portion of the Marylebone area. The Manchester-square station has a capacity of 2,100kw. of continuous-current generators, and is provided with 12 water-tube boilers. The Rathbone-place station is equipped with plant of a capacity of 825kw. of continuous-current generators, and has five water-tube boilers. The sub-station at South-street, Manchester-square, has 3,600kw. of static transformers for dealing with current supplied from Willesden, and has a 100kw. motor generator. The sub-station at North-street, Manchester-square, has 3,210kw. of motor generators for converting high-pressure alternating current from Willesden into continuous current. The Rathbone-place station has also 1,500kw. of static transformers for dealing with Willesden current, and 420kw. of motor generators for converting Willesden high-pressure alternating current into continuous current. Marylebone-passage station has 690kw. of static transformers for reducing the voltage of alternating current from 1,000 to 200 volts. All the generating stations and sub-stations are leasehold property expiring variously in 1913, 1930, 1944, 1961 and 1968. Other properties that the company has acquired in Marylebone, in consequence of complaints of vibration and noise, adjoining the stations and sub-stations expire variously in 1913, 1941 and 1972. Early in the company's history it was found that much benefit would result both to the company and its customers if all the areas could be worked together as one system, and trunk mains were accordingly laid between all the four generating stations (North-street, Rathbone-place, Manchester-square, and Amberley-road), and current has for a number of years past been distributed as required from any one station to supplement the resources of the others. Board of Trade sanction to this method of working was obtained in June, 1896. In addition to the stations and sub-stations previously mentioned, a narrow strip of Marylebone is supplied with current from the Norfolk-crescent-mews sub-station. Arrangements have been made for the severance of the Marylebone portion of the distributing mains from the Paddington portion when the Marylebone Borough Council take over the company's Marylebone undertaking. The expense of this physical severance, and also the injury, that will be done to the remaining portions of the company's undertaking by losing this alternative source of supply will have to be considered in this inquiry. In the same way the Rathbone-place station has for some years supplied part of the company's mid-London area, and arrangements are being made for the complete severance of this area from Marylebone before the Borough Council enter into possession, thus setting free the whole of the plant in the Rathbone-place station for the supply of Marylebone alone. The tables, which are the foundations of the claim of my clients in this matter, will be handed in by the first witness to be examined, Mr. Conacher, the manager of the Metropolitan Company.

The UMPIRE: What is the date from which the purchase is to take place?

Mr. BALFOUR BROWNE: I will deal with this now. The Electric Lighting Order Confirmation Act, No. 1, sec. 2, provides that the Metropolitan Company shall sell, and the Marylebone Borough Council shall purchase, the St. Marylebone undertaking and business of the company as hereinafter defined, except the offices at Stratford-place, which the company are to occupy and make no claim, the terms being "for such purchase money and compensation being a sum in gross and on such terms and conditions as may be agreed upon between the company and the Borough Council, or, failing such agreement, as shall be determined by arbitration in manner provided by the Lands Clauses Act." I agree with Sir Edward Clarke that the whole scope of the section of the Electric Lighting Order Confirmation Act No. 1 is to make this a purchase under the Lands Clauses Act. The Electric Lighting Order Confirmation Act No. 1, under which the purchase is to be effected, provides that the notice to treat for such purchase shall be given by the Borough Council to the company within six months after the passing of the act, unless this period is extended with the consent of the company under seal. I take it that the date of transfer means when the Council pay the money. We are quite prepared to transfer the whole Marylebone undertaking and business to them when you, Sir, have awarded the sum that is to be paid and when such sum has been paid. There is, of course, no "completion" until the Council have the works and the company have the money. The company's claim is, therefore, first, compensation for the actual loss which they sustain by having their Marylebone undertaking and business taken from them compulsorily; and what they lose is not merely the very large income they are making to-day, but the chance of increasing that income in the future—which is not only "chance," as we shall be able to show you, but a certainty. Therefore, the award must include compensation for the loss of our future profit on our undertaking and business. At the same time, the future profits must be limited to the period of 30 years, because under sec. 2 of the Electric Lighting Act, 1888, we had only 42 years to run, at the end of which period we were bound to sell to the local authority. Therefore, the first claim is its value to-day or future profits for a period of 30 years, and also, under the Lands Clauses Act, compensation for the loss which the company will sustain by having the important Marylebone portion of their business severed from the rest of their undertaking. But further than that, Sir, we have to look at the Act of 1888 and a second item of claim comes under sec. 2 of that Act. I have limited the claim for profits to 30 years, but at the end of 30 years we still have the right to sell under this section, and we are parting with that right now. The section provides that "on receipt in writing from the local authority of notice to purchase the undertakers shall thereupon sell their undertaking upon terms of payment of the then value of all lands, buildings, works, materials and plant of such undertakers suitable to and used by them for the purposes of their undertaking, such value to be, in case of difference, determined by arbitration: Provided that the value of such lands, buildings, works, materials and plant shall be deemed to be their fair market value at the time of the purchase, due regard being had to the nature and then condition of such buildings, works, materials and plant, and to the state of repair thereof, and to the circumstance that they are in such a position as to be ready for immediate working, and to the suitability of the same to the purposes of the undertaking, and, where a part only of the undertaking is purchased, to any loss occasioned by severance; but without any addition in respect of compulsory purchase or of goodwill, or of any profit which may or might have been or be made from the undertaking, or of any similar considerations." We regard the clause relating to the state of repair of the buildings, works, materials and plant as not unimportant from our point of view. Therefore, Sir, at the end of 30 years we were to be paid the then value, and not merely the value, but something was to be given to us because they were all ready to work. If we merely handed over the money value of these works to the Council at the end of the 31 years, that would have been one thing, but it would have taken them two or three years to erect their buildings, and we are going to hand over the whole of the buildings and plant ready for working, and this must be considered to our credit, because the direction in the section is, "and to the circumstances that they are in such a position as to be ready for immediate working." This is a matter that we wish to bring specifically before you. You will see that although "the then value of lands, buildings, materials and plant" are the same words as in sec. 43 of the Tramways Act, this reference to the circumstance that they are ready for immediate working is in addition to the Tramways Act, and is a new element introduced for the benefit of the electric lighting company. The said head will be the value of the lands, buildings, works, materials and plant at the end of 30 years, discounted, of course, to present value, because we are going to be paid shortly, if not to-day, and that has to be arrived at on totally different principles from the first head of our claim, which is the present value and future profits of our undertaking, plus an allowance for severance. On this head, therefore, of our claim you, Sir, will have to consider, first, the extent and growth of the company's business in the past, and from these will have to come to some conclusion as to its probable growth in the future. I do not take it that this means the actual value of the company to-day, which could easily be measured. We are making in this district of Marylebone £x income to-day. It would be quite easy to turn that into a capital sum, on the supposition that we get it—that it is absolutely secured, and that we go on making it for the next 30 years. That is quite easy. But we find our income is going up by leaps and bounds, and these figures will be spoken to by the first witness you will examine. Then comes the difficulty as to how much we shall probably be making during the next 30 years, and details as to this have been got out with some minuteness but, at the same time, with very great caution, so as not to assume that the profits will go on at the same ratio, but in a diminishing ratio, and in this connection certain considerations will be put before you. First, I want to say that we are absolutley safe, for we have practically a monopoly of this district. The Vestry of Marylebone in 1898 attempted to get power to compete with us, and that was fought out in Parliament at very great length, and the bill was rejected. I do not know a case in England to-day where a local authority has been allowed to compete with a company. There are companies competing with companies, as we can show in a district in London, but no case where the local authority has been allowed to compete. Only the other day, before the Board of Trade, the Borough of Camberwell, having purchased the plant of the London Electric Supply Corp. in the northern portion of its district, asked leave to compete with the County of London and Brush Provincial Co. in the lower half. There was and had been arranged a purchase clause in the company's order, and the purchase clause was that they might purchase at any time on giving £133 for £100 of the company's capital. They did not like those terms, and said: We want to compete. But the Board of Trade said they would not allow them to have their order at all till they had purchased the company. Therefore, so far as competition with a local authority is concerned I think we are absolutely safe. What took place only the other day makes us safer still. The London County Council promoted a bill by which they sought to get two powers which might have affected this company. One was that, if at the end of 42 years the local authority did not purchase, the London County Council might, and we insisted speaking for the electric companies in London that this was not fair. We have got the chance of one purchaser, but not of two; it makes it more certain that we shall be purchased. With one local authority they might say we do not want to purchase, and we would then have another lease of ten years. That demand of the Council was rejected. The other power that might have affected us materially, not in Marylebone, but in some other districts, was the County Council asked for leave to purchase by agreement any company, and what we feared, and what other companies feared, was that they might either set up a company or buy some company that was doing very little and compete. That proposal was rejected; in fact, the whole of the London County Council bills for electricity this session were rejected. I am, therefore, perfectly certain that, so far as local

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authorities are concerned, we are safe from competition. With regard to competition from companies, we are in this district practically immune, because various attempts have been made. In 1898 the County of London and Brush Provincial Company, which does not like to be competed with in Camberwell, wanted to compete here, and applied for an order, as did also the Marylebone Electric Supply Co. (Ltd.), but neither of those orders was granted by the Board of Trade, on the opposition of my clients. In 1899 the Marylebone Electric Supply Co. again gave notice of intention to apply for an order, but they abandoned any proceedings. In 1900 the Marylebone Electric Supply Co. again applied for and obtained from the Board of Trade an order for competitive powers in Marylebone, a bill was introduced into the House, and was thrown out on second reading; and in 1901 the Marylebone Electric Supply Co. applied and obtained a provisional order from the Board of Trade, and that was withdrawn by the promoters on the assurance by the Borough Council that they would insert certain clauses in the order which they were then promoting, which was the order subsequently confirmed, and which you have before you now. Therefore, I think there is no competition possible, all these failures being registered in the past. It would be a very bold company, I think, that would try to put its foot in Marylebone. There was an agreement between us and the Vestry in 1889, under which certain friction took place between us, and we had to apply for an injunction against the Vestry. An arrangement, however, was come to, and I only mention it because it gets rid of all difficulties that might possibly be raised. This agreement has these two clauses which are important. In consideration of the company withdrawing their opposition to the present bill the Council agree to withdraw their opposition to the company's bill, and clause 3 was that, on the completion of the agreement between the Council and the company and the confirmation of the order by Parliament, all questions the subject of the present litigation were to be treated as if both parties were perfectly satisfied. So that that gives us a clean sheet for the past; there is no going back on questions that were in dispute; and there is only one thing that I will mention out of that clause. The Borough Council is to purchase from the company in bulk all electrical energy they may require beyond the amount which they can from time to time generate themselves either within or without the St. Marylebone area, the company to supply on such conditions as to notice and otherwise, and at such reasonable prices as may be agreed upon, these points, in case of difference, to be settled by an arbitrator to be appointed by the Board of Trade. Now, sir, of course, as yet there is no arrangement as to bulk supply, and until we know what they are going to take—they might take one unit and no more—we cannot form a basis of what we are going to get from them. Therefore, all our calculations assume that we lose Marylebone, and that in losing Marylebone we lose the possibility of utilising plant which we set up for the purpose of supplying Marylebone.

The tables we put in before you* show the absolute continuous growth in our hands of the business in Marylebone, and also that our immense income in that area is derived from a comparatively small portion of the inhabited houses. Moreover, a large portion of the houses connected in 1901 were only partially supplied. We find that very many of the people have put in a small amount of electric installation, apparently for experimental purposes, and when a person is in only for a year or two at the end of a lease, they are content to go on with that small amount of installation, but when it changes hands, and the landlord has to try and get another tenant, we know he instals electricity throughout. Our growth has been continuous, and we are deriving it from a small portion of the number of houses in Marylebone, and when we have got customers, they are not fully taking the electric light. All this points to a very large growth in the future. In Marylebone there is a very large number of small dwellings that were formerly villas, and are now being taken down and replaced by very much larger blocks of houses; secondly, the connection of additional houses will be greatly facilitated by the changes going on in the population and the character of both population and houses. You will hear from various witnesses that there is a change going on, that while possibly the number of residents in certain districts of Marylebone is going down, the rateable value is going up; a better class of house is being built. Besides, flats are being very extensively built in this district, and flats give a very dense population of fairly well-to-do people, who will probably take electricity for light. Then, sir, we have a great future before us as to motive power, heating, and other purposes, only very slightly developed indeed at the present time. The annual increase in the number of consumers shows no signs of diminution; the amount of current sold per consumer is steadily increasing; the amount consumed per lamp is steadily increasing; the use of electricity for motive power, heating and other purposes than lighting is only in its infancy; and a great number of changes are taking place in Marylebone, which will necessarily lead to a much greater use of electricity; and the development of nearly one-half of the habitable area of Marylebone as a source of demand for electricity is hardly yet begun. Then in a recent case (Freake *v.* Kinnaird) Mr. Justice Joyce held that the provision of an electric lighting installation, exclusive of fittings such as would ordinarily be supplied by a tenant, was an "addition" within the meaning of sec. 13, sub-sec. (II.) of the Settled Land Act, 1890, and might properly be paid for out of capital money, and that shows considerable development in the direction of electrical installation. Again, a large number of house agents, who will be called before you, will tell you that they cannot let houses now unless they are wired for the electric light.

Then as to working expenses and the maintenance which must be set against our future profits. Coal has been very high in price, as you know, and we have passed through bad times, but certain economies are being introduced, which, with a diminution in the price of coal will greatly tend to increase our profits. We have erected water softening plant at several of our stations, the extension of the continuous-current system will mean a very great saving, and house transformers can be done away with (and these cause a tremendous waste of electricity).

As to additional capital required, that also has been carefully calculated because we do not think that we can go on supplying this district with its enormous increase until 1931 without additional capital.

Then as to the severance. First, there is the physical severance, that will be dealt with by our engineers at considerable length. We have to sever the Mid-London portion of Rathbone-place network, and the Marylebone portion of Norfolk-crescent-mews network, and the St. John's Wood district from Amberley-road circuits, and connecting it with Manchester-square, and re-connecting 1,000-volt trunk mains between Amberley-road and Norfolk-crescent-mews, now traversing part of Marylebone. There is also a serious matter for your further consideration, and that is the increased cost of working which will be entailed by reason of this severance.

In conclusion, I would say that I have assumed against myself that the local authority would purchase at the end of 30 years, because it is quite possible at the end of 30 years they might not be purchasers, and then I

* A set of 24 tabulated statements were put in in the course of the proceedings, as under:—

Table 1.—Machinery and plant at the stations of the company in Marylebone at Dec. 31, 1902, and dates of erection.

Table 2.—Length and description of mains, other than extra high-tension mains for Willesden current, at Dec. 31, 1901, with estimate of additions to be made in 1902.

Table 3.—Annual gross revenue from sale of current, and revenue from rental of meters and other apparatus to Dec. 31, 1901, &c.

Table 4.—Number of houses being wholly or partly supplied on Dec. 31, 1901, and number of consumers therein, together with estimated number of consumers at end of each year and proportion thereof to total number of possible consumers at Dec. 31, 1901.

Table 5.—Number of units supplied to consumers connected to Dec. 31, 1899, whose accounts for year 1901 amounted to not less than £100, and the increase in that year over the first complete year of supply.

Table 6.—List of the larger of the new and re-constructed houses now in course of erection or ready for occupation, which are being, or will be, wired, showing the actual or estimated number of lamps to be installed therein, and the number of lamps connected in the old houses at the time of their demolition, or before re-construction.

Table 7.—Estimated number of units sold in each year from 1902 to 1931, both inclusive, and estimated gross revenue to be derived therefrom.

Table 8.—Annual ratio of increase in units sold from 1894 to 1901, both inclusive, and the corresponding ratio of increase at which the additions estimated to be made to number sold for lighting in the years 1902 to 1931, inclusive, work out.

Table 9.—Total annual revenue of the company from all sources except rents of property, working expenses, number of units sold, and the rate of working expenses in proportion to the total revenue and per unit sold to Dec. 31, 1901.

Table 10.—Average price of coal during the 12 years ending Dec. 31, 1901, and the proportion of working expenses for 1901, attributable to the difference between the prices paid and the average prices during the 1½ years.

Table 11.—Estimated annual saving at town stations on completion of water-softening appliances, based upon the working expenses in 1901.

Table 12.—Estimated annual saving at Willesden on completion of the condensers, water-softening appliances and water heaters for utilisation of exhaust steam from auxiliary engines, based upon working expenses in 1901.

Table 13.—Loss of current from use of house transformers on alternating high-tension system.

Table 14.—Deficiency of generating plant in the borough at Dec. 31, 1901, and the capital sum to be deducted in respect thereof from present value of net profits.

Table 15.—Relation between capital expenditure and amount of current sold to Dec. 31, 1931, and an estimate of total capital required for the business in Marylebone during subsequent years.

Table 16.—Estimated net profit of Marylebone portion of company's undertaking and business in each year from 1902 to 1931 inclusive, after allowing for additional capital required for increased business, and the present value thereof, based partly on the 3½ per cent. and partly on the 5 per cent. table.

Table 17.—Description and present value of property belonging to the company in Marylebone not at present used in the business of the company and sub-let.

Table 18.—Instalments due to company after Dec. 31, 1902, under hire purchase agreements.

Table 19.—Estimated value in 1931 of buildings, works, materials and plant provided by company to Dec. 31, 1901, together with additions now being made thereto for the purpose of completing the continuous current scheme in district supplied from Manchester-square station, and of enlarging Marylebone-passage sub-station.

Table 19a.—Amount to be added to the value in 1931 of the land, buildings, works, materials and plant "in consideration of the circumstance that they are in such a position as to be ready for immediate working."

Table 20.—Cost of works required to enable the Marylebone portion to be severed from the remaining portions of the undertaking.

Table 21.—Capital sum required to compensate company for permanent losses arising from severance of Marylebone portion of undertaking from mid-London and Paddington portions.

Table 22.—Loss which will be sustained by company in maintaining and working Willesden station after severance has taken place. (This is detailed in a set of four statements.)

Table 23.—Temporary loss from increased cost of administration of undertaking and business after severance. (This is detailed in three statements.)

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would have profit for the other 10 years. Barring the one question, which is very important, as to the valuation to us of having the plant ready for working, the case seems to me a very simple one indeed, and such as you deal with every day. The value is the value to us of these works in Marylebone. The value to us is not what we have made out of them—we have that, and I daresay have spent it—but the value we can make out of it in the future. We are also to be compensated for any loss or damage by reason of cutting it in two, and you will hear, and may even yourself infer, that these things being worked as one system in three great areas will entail considerable loss. As you know, we have had fires in some of our stations. The Sardinia-street station was burnt down, and we had the others to fall back upon; but when this purchase is settled, we shall have no such possibility within our own works, and this insurance goes. Therefore, the present value and future profit and severance is the first head of claim. Secondly, what is the value of the works that we will have on our hands at the end of 1931, that value enhanced by the consideration that it is ready as a going concern to turn the wheel and supply electric energy?

At the conclusion of Mr. Balfour Browne's opening, after a short adjournment, Mr. John Conacher, general manager of the Metropolitan Electric Supply Co., was examined by Mr. Cripps, K.C. The examination of Mr. Conacher lasted the remainder of Monday, the whole of Tuesday, and part of Wednesday, and was followed by the examination (on Wednesday) of Mr. George Head, surveyor; Mr. E. W. Rushworth, surveyor; Mr. S. Clarke, surveyor; Mr. C. W. Miller, surveyor; Mr. L. H. Hordern, manager of the Westminster Electric Supply Corporation, and Mr. F. J. Walker, general manager of the St. James' and Pall Mall Electric Light Co. This latter evidence particularly turned upon the question of the large and steady increase in the number of lamps connected in the London electric lighting areas. Mr. Conacher was re-examined yesterday (Thursday).

Hitchins and Booth v. Ehrenfeldt.

In the Westminster (London) County Court, on Tuesday, before Judge Woodfall, plaintiffs sought to recover £10. 10s., nominal charge for a report prepared on a certain projected tramway.

Mr. H. BOOTH said he was a member of the plaintiff firm, carrying on business at Westminster as consulting electrical engineers. On Dec. 6, 1901, the firm was approached by Mr. Ehrenfeldt with regard to the preparation of a report on a proposed tramway, 5 miles in length, on the system patented by a Mr. Cook. Witness agreed that his firm should prepare the report for a nominal fee in consideration of Mr. Ehrenfeldt's arranging for them to be appointed consulting engineers if the prospective contract for laying down the tramways were obtained. The so-called "report" was really an estimate for the electrical equipment of these tramways, and was prepared so that it satisfied the local authorities. Throughout, witness dealt with Mr. Ehrenfeldt. Witness had to call in Messrs. Buchanan to consult in connection with certain points, and the 10 guineas was merely a nominal charge, considering the amount of work which had to be done. Had he been making a charge in the ordinary way, it would have been 25 guineas. He was introduced to defendant by a Mr. Hale, who was tendering for the metal work of the proposed contract. Had Mr. Cook's system been adopted, his firm would have been entitled to a large commission – probably 2½ or 3 per cent.

Mr. CHARLES HITCHINS gave confirmatory evidence.

Mr. M. EHRENFELDT said he was an auditor, carrying on business in the City of London. He was secretary of Cook's Patent Tramway Co, (Ltd.), and always dealt with plaintiffs in that capacity. He certainly never made himself personally responsible. He was secretary of several companies. The Cook Company was incorporated in March, 1901, with a capital of £5,000, none of which was paid up. The company had no assets, but witness did not tell plaintiffs this. Plaintiffs did their work on the usual understanding—a big fee if the contract was accepted and a merely nominal fee—a guinea or so—if it were not. His Honour found for defendant on the grounds (1) That the word "secretary" should have set the plaintiffs on enquiry, and (2) that the fee claimed in the action was not a nominal one. Judgment accordingly.

Weiss v. St. Helens Cable Co. (Ltd)

On Friday last, in the Court of Appeal, Lords Justices Romer and Mathew heard an appeal from the defendant company from an order of Mr. Justice Jelf, affirming an order of the Master in an action tried before Mr. Pollock, official referee at Liverpool. Plaintiff claimed £1,797 for work and labour done in connection with certain machinery, and defendants counterclaimed in respect of defective work and delay. Mr. Pollock gave judgment for plaintiff for the amount claimed, and for defendants on the counterclaim for £564, with costs in each case respectively. These costs were taxed, but Mr. Justice Jelf, on appeal, held that defendants were not entitled to their costs in the counterclaim as to defects in the machinery, holding that this claim should have been raised in the ordinary way of defence to the action. The matter went back to the Master, who then disallowed all costs incurred in proving defects in the machinery. Hence the present appeal.

Their lordships now held that the costs had been taxed on the wrong principle, and referred the matter back to the Master, with the reminder that the parties had on each side partly succeeded and partly failed, the costs of the present appeal to be dealt with at the same time.

Marsh v. Charing Cross and City Electric Co. (Ltd).

This case came before Judge Woodfall and a jury in the Westminster (London) County Court on Monday, and was brought to recover damages for personal injuries under the Employers Liability Act. Plaintiff was in the company's employ, and on Oct. 9 last was at work in a manhole at Ludgate-hill, City, when an explosion occurred and seriously injured him. There were three cables running into the box—a positive, a negative and a neutral. The accident kept him from any employment until January, when he returned to the company. Before the accident he was a jointer and wirer, but his injuries prevented him acting as a jointer, and his wages had dropped from an average of 45s. to 38s. a week. The accident was, plaintiff alleged, caused through defects in the plant. The cables and connectors were filled in with bitumen, and on the top of that was a layer of resin oil, which appeared to have had the effect of softening the bitumen, so that it did not serve the purpose for which it was intended—keeping the cables in position. The result was that when a screw was being fixed there was a connection which caused a short circuit. Since the accident means had been adopted to prevent such a thing happening again.

PLAINTIFF said he could not dispute that there were over 400 boxes similar to the one at Ludgate-hill and that his was the only accident that had happened. A box in Paternoster-row burst on the Sunday following his accident, and a few days later, one in Poultry. Witness was positive that when he started work no connection between the two cables existed. If it had, he could not have got a "link" on. He did not use a pick-shaft to force one of the cables into a certain position.

LEWIN, plaintiff's fellow-workman, who was also burnt, said his claim had been settled by the company's paying £50 and 10 guineas costs.

His HONOUR decided, without putting the case before the jury, in favour of the defendants, on the ground that no negligence had been established.

The plaintiff was, therefore, non-suited.

De Dion Bouton & Co. v. Brown Brothers (Ltd.)

In the Chancery Division yesterday plaintiffs applied to Mr. Justice Joyce for an injunction to restrain defendants from passing off batteries for motor cars as "De Dion" batteries, articles which were not the plaintiffs. Counsel for defendant said the matter complained of had occurred through the oversight of one employée who had acted contrary to the instructions given him. Mr. Hughes, K.C., for plaintiffs, said in these cases the matter was always due to an oversight. He desired the motion to be adjourned, and his lordship directed it to stand over until next sitting.

Compensation Claim.

In the King's Bench Division, on Wednesday, Mr. Justice Wright heard a special case by the arbitrator (Mr. R. Vigers) in the arbitration between the City and South London Railway Co. and the rector and churchwardens of the parishes of St. Mary Woolnoth and St. Mary Woolchurch Haw, in the City of London. The question was as to the basis on which the rector and churchwardens were to be compensated for that part of the site of the church of St. Mary Woolnoth which the company had taken for extending its line from London Bridge to the Angel, Islington. The arbitrator arrived at three alternate findings. He awarded £90,628 if all the lands taken belonged to the site of St. Mary Woolnoth, and could never be used for any other purpose; or £136,421 if the lands taken might have become at some future time available for building purposes; or £143,548 if the site of the church and the other land could be made immediately available for the erection of buildings other than a church. The company contended that compensation should be awarded on the basis that all the lands formed the site of the church, and could never be put to any other use.

His LORDSHIP held that claimants were entitled to an award on the basis that the land might at a future date be available as a building site.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Newport Corporation invite applications for the appointment of borough electrical engineer and tramways manager. Applications to the town clerk (Mr. Albert A. Newman) by May 31. See advertisement.

An assistant distributing engineer is required by a London borough council. Applications by 21st inst. See advertisement.

One or two pupils can be taken at a Lancashire electricity generating station. See advertisement.

A science master is required for the Tunbridge Wells Technical Institute. Applications by June 3.

St. Anne's-on-the-Sea District Council require a resident electrical engineer. Applications by 20th inst.

Mr. H. M. Sillar, of St. Pancras, has been appointed distributing assistant to the electricity department of the Belfast Corporation.

Mr. F. Purser Fletcher, of the Brompton and Kensington Electricity Supply Co., has been appointed shift engineer at Canterbury.

Mr. C. J. Field has been appointed inspector of fire-alarms at Bradford.

Mr. Foote has been appointed manager of the Gateshead Tramways Co.

Mr. Charles A. Spofford has been appointed to represent Messrs. Speyer in the management of Mr. Yerkes's London underground railway scheme.

Batoum (Russia).—The municipal authorities of the town of Poti in this district own electricity supply works, and the demand for current has justified the expenditure of a further £8,000 in

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extensions of the mains and the addition of further generating machinery. The public and harbour lighting is to be considerably extended.

At Baku, in the same district, famous for its huge oil industry, a German firm some time ago erected large electric generating stations, chiefly for power transmission, at a cost of over £1,000,000. This vast sum appears to have been lost, as the works are standing practically idle, only a very small portion of the plant being at work.

Bermondsey (London).—The Board of Trade has struck out the St. Olave's district from the Council's provisional order, and has inserted a purchase clause with regard to the Rotherhithe part of the undertaking of the London Electric Supply Corporation. The Council has accepted the amended order.

Birkenhead.—On Wednesday the chairman of the Tramways committee (Dr. H. Laird Pearson) announced that the net profit for the year on the working portions of the tramways had been £5,000.

Bradford.—The city electrical engineer (Mr. R. A. Chattock), in a recently-presented report, recommends that, owing to the growing demand for electric current for both lighting and traction, the engine-house at the new Valley-road generating station (of which only a portion is being erected under existing contracts) should be completed if possible by the summer of 1903, to allow for the installation of further generating plant. The committee have endorsed Mr. Chattock's recommendation, and have decided to advertise for tenders.

The Wakefield-road electric tramway route was opened for traffic on Wednesday.

Bridlington.—Mr. F. H. Medhurst is advising the Council on electric lighting matters.

Brighton.—It is probable that an electrical exhibition will be held at the Brighton Aquarium in the course of the next few weeks.

Broughty Ferry.—The Council has just let contracts for electricity generating plant, and has decided to adopt electric lighting in all the public buildings.

Burton-on-Trent.—The electric lighting mains are to be extended along the proposed tramway routes at an estimated cost of £4,630.

Cardiff.—The Council have re-considered their decision not to run trams on Sundays, and on Monday decided to give a Sunday service.

Cleckheaton (Yorks.).—Substantial progress has been made with the combined electric generating station and refuse destructor works which the District Council have in hand from plans and specifications by Messrs. Baker and Appleby, consulting engineers, and Mr. Lund, the Council's surveyor. The works are situated near the existing gas works, in close proximity to the Sye Beck, from which water supply is taken. The chimney shaft, 129ft. high and 8ft. diameter, is completed, and the buildings are roofed in. The water tank is erected and ready for use, and the economiser, accumulators and overhead traveller are in course of erection. Two of the steam dynamo sets (Belliss-Morcom Johnson-Lundell) are ready for testing, and the third set will be ready about the end of May. The switchboard will be despatched from Messrs. Dorman and Smith's works the first week in June; the boilers, condensers, pumps and steam piping are also well in hand, and by the end of June the whole of the machinery and accessories will be at the generating station. Outside the station, the feeders and distributing cables are being laid, and, as the Council hope to supply energy to the tramways as well as for lighting and power, the prospects are extremely encouraging, a comparatively large revenue being secured from the commencement. It is expected that the works will be opened in September.

Colchester.—There was a net profit of £473. 18s. 4d. on the electricity undertaking for the year to March 31. The chairman of the Electric Lighting committee (Mr. Barritt) said they had sold 180,166 units at a net profit of £150. 4s. 10d. The return from the military authorities had fallen somewhat below, and from private consumers had considerably exceeded the estimate. The net profit for trading account was £236. 13s. 4d., making the total net profit £473. 18s. 4d. This profit has been applied in writing off suspense account (£150. 2s. 3d.), and £100 for depreciation of battery, the balance being placed to reserve.

Corsica.—The birthplace of Napoleon does not take kindly to modern methods. The postal authorities have recently established a telephone service at Ajaccio and Bastia. At the former place, however, the service is not taxed to the utmost, only three subscribers having been secured in a population of 22,000 persons. Rather more support has been accorded the service by the 25,500 inhabitants of Bastia. These are the only two places in Corsica where the population runs into anything approaching five figures.

Cordoba (Spain).—Two companies originally contested for electric lighting business in Cordoba. One of these supplied steam-generated electric current, the other current generated by steam and water power. The latter company has proved the more successful, and has bought up its earlier-established rival.

Costa Rica.—The San José Electric Light and Traction Co., which owns the electric tramway service of the district, has recently extended its line to San Pedro, 2 miles east of the city. The receipts from both electric lighting and tramways for 1901 show a large increase over the previous year.

Dartford.—The Electric Lighting committee have agreed to supply electric current for Coronation illuminations at 2d. per unit., and demand indicators of consumers making displays will be disconnected during Coronation week. Temporary illuminations will be charged at 1d. per 8 c.p. per day.

East Suffolk.—The County Council have sanctioned the erection by the Coast Development Co. of poles and cables along the road from Southwold to Halesworth for supplying electric current for lighting.

Electricity in Mining.—At the Abangares Goldfields of Costa Rica, the Abangares Gold Mining Co. is largely increasing its plant, and is substituting electric for steam driving. Water-power plant has been erected of 300 H.P. capacity.

Electric Traction in France.—The Lombard-Gerin system of electric omnibuses, taking current from overhead conductors, appears to be making some headway in France. A service on this system has been started between Marseilles and the suburb of Allauch, another is being established at Montauban, while negotiations for a line between Nice and La Turbie are reported to be progressing.

Electric Tramways in the Leeds District.—A syndicate has been formed for obtaining powers to construct an electric tramway from Leeds through Horsforth, Rawdon and Yeadon, Shipley, Bingley and on to Keighley. In addition to constructing a tramway, the syndicate will supply electricity for lighting and power in these districts.

"Engineering Magazine."—The engineering society of the University of Birmingham has established the "Engineering Magazine," and the first number is just issued. The magazine will be issued twice in each term, the next number being due in October.

Exhibition.—The annual exhibition of work executed in the Board schools of London will be held at the Examination Hall, Victoria Embankment, London, on June 18 and three following days. The exhibition will include specimens of drawings, colour-work, modelling, metal-work, woodwork, wood carving, &c.; also scientific apparatus constructed by teachers and pupils. Admission is free.

Fire.—A fire took place on Tuesday night at the Toxteth Dock station of the Liverpool Overhead Railway. The 10 p.m. train from Dingle to Seaforth, when nearing Toxteth Dock station, caught fire. In the rear portion of the second carriage the fuse became overheated and ignited the carriage. The driver pulled up at the platform and the passengers got out. No one was hurt, but down-line traffic was interrupted.

French Cable Operations in China.—The submarine telegraph cable connecting Amoy with Hué and Tonquin, avoiding Hong Kong and touching at Kwangchowwan, which was in April, 1901, after lengthy operations, landed at Amoy, experienced a breakdown in January, 1902, and communication has not yet been restored. A report from the British consul at Amoy (Mr. Mansfield) states that there has been very little traffic over the line since its establishment.

Grimsby.—Sanction to borrow a further £17,000 (£4,100 for amount over-spent, and £12,900 for extensions of plant and mains) has been obtained. This makes the total capital expenditure sanctioned £72,000.

Harrogate.—Sanction to a loan of £46,000 for electric lighting extensions is being sought.

Hastings.—As announced in our last issue, the accounts of the electricity department for the year ended Dec. 31 were recently discussed by the Council. The capital expenditure was reported to be £123,405. 14s. Of this £104,439 had been raised by loan, so that £18,966. 14s. had been overspent. The total income was £14,961. 16s. 10d., and of this £10,472. 10s. 7d. was received from private lighting and £3,696. 11s. 10d. from public lighting. Generation expenses were £6,568. 3s. 1d., distribution £205. 15s. 11d., repairs and renewals of public lamps, attendance, &c., £670. 1s. 7d., rent, rates and taxes £395. 18s. 9d., management expenses £1,380. 0s. 9d., law costs £34. 9s. 8d, total £9,204. 9s. 9d Gross profit was £5,601. 2s. 3d., and, after providing interest and sinking fund, the deficit on the year was £1,949., against £1,741 in 1900. 867,622 units of current were generated, 508,612 were supplied to private consumers and 195,192 to public lamps. There were 104 public lamps, and the maximum supply demanded was 584kw. In a circular by the borough electrical engineer (Mr. L. Andrews) the average price paid for the year for coal is given as approximately 1s. a ton higher than in the preceding year. Though the output had increased by about 180,000 units, the actual cost of coal used had been nearly £100 less than in 1900. There was, however, a considerable increase in repairs to buildings, machinery, transformers, mains, &c. Of the 703,814 units sold, 253,150 were supplied at the flat rate of 6d. a unit, and the remainder at the reduced rate to long-hour consumers of 10s. per lamp and 1½d. per unit. The machinery installed was capable of supplying at least 5,000 additional 8 c.p. lamps, representing a further £4,000 per

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annum. The demand is increasing in a satisfactory manner, the present output being between 20 and 25 per cent. greater than at the same period last year.

Heston and Isleworth.—The Electric Light committee has instructed Mr. J. Enright to prepare an electric lighting scheme.

Huddersfield.—Three additional sections of the electric tramway system were opened on Wednesday. The Fartown and Sheepridge routes are approaching completion, and the remaining sections are anticipated to be ready for traffic by July 1.

Hyde.—The draft agreement for constructing and working electric tramways between Hyde and Stockport has been approved by the Council.

Kirkintilloch.—Mr John Young, general manager of the Glasgow Corporation tramways, is visiting Kirkintilloch in connection with the proposal to extend the Glasgow tramways system to that place.

Leigh.—A report on the proposal to construct electric tramways in the district has been prepared by the borough electrical engineer (Mr. J. Foster) and the borough surveyor (Mr. T. Hunter), in which the cost of a system of double-track tramways is put at £80,430, but if a single track, with passing places, were adopted, £70,256.

Light Railways.—The Halesowen and the Wakefield and District Light Railways (Extension) orders have been submitted to the Board of Trade for confirmation. Objections by 31st inst.

The Board of Trade have passed the order for the construction of the Cromarty and Dingwall light railway.

An inquiry was held on Friday last by the Light Railway Commissioners into the application of Messrs. T. Lilley, S. J. Stiff and others for the construction of the Clacton and St. Osyth light railway. Counsel for promoters (Mr. Neilson) gave particulars of the scheme, and the consulting engineer (Mr. John Russell, M.Inst.C.E.) supplied technical details. The cost was estimated at £36,887. The line is to be 4½ miles long, and electric traction on the overhead system will be adopted. Opposition was raised by ratepayers, who objected to the overhead system, and by property owners, who considered the line would deteriorate house property. Ultimately the Commissioners decided to issue an order.

A scheme is projected for the construction of a light electric railway to connect the Liverpool Overhead Railway with the electric tramway system of Southport Corporation, the distance being about 10 miles.

Little Wooltown.—An inquiry was held last week into the application of the Council to borrow £6,000 for electric lighting and other improvements. It was stated that the present oil lamp system would be abolished and electric current obtained from the Garston Electric Supply Co. The loan for electric lighting was £1,800.

London County Council.—At Tuesday's meeting it was agreed to extend the repayment of a loan from the Council by the Battersea Borough Council of £2,285 for electric lighting, granted in April, from 20 to 50 years. It was decided to grant a loan of £37,430 to Shoreditch for electric lighting, street lighting and meters on condition that the loan be taken up at once.

With regard to the recent purchase by the Council of a site at Pimlico for £80,000, for the erection of an electricity generating station, the Highways committee reported that they are advised that the Council has at present no power to utilise the site, and therefore recommend that emergency powers be sought in the present session of Parliament to acquire such right.

Fire Alarms.—Sanction was given for the provision at several fire stations of the Council of electric fire alarms. In connection with the Perry Vale fire station, the Fire Brigade committee reported that, owing to the withholding of consent by the Lewisham Borough Council, telephonic communication between the Perry Vale station (opened in March) and the superintendent's station at New Cross could not be provided, the Postmaster-General declining to give the undertaking demanded by the Borough Council "not to use the telephone pipes for the purpose of carrying the National Telephone Co.'s wires, or for any other purpose, without the previous consent of the Borough Council." The Postmaster-General agrees to give notice in writing to the Council in case at any time any wires are used, or require to be used, by the company, and that if the Borough Council then wishes to withdraw its consent the Postmaster-General will accept this withdrawal, and take immediate steps to obtain a determination of the difference between himself and the Council in the manner prescribed by the Telegraph Act, 1878.

London County Council Tramways.—The North Metropolitan Tramways Co., lessees of the County Council tramways in the north and north-east of London, have received from the Council the plans for the electrification of the whole of the tramways leased by the company.

Lowestoft.—The equivalent of 11,500 8 c.p. lamps are connected to the mains. Electric current will be supplied to places of worship at 6d. per unit. Sanction to a further loan of £7,143 for a new 500kw. set of condensing plant has been obtained.

Manchester.—Sir F. Bramwell has issued his award in the arbitration as to the value of the undertaking of the Manchester Carriage and Tramways Co. The arbitration proceedings occupied several days, and Sir F. Bramwell has made alternative awards. He finds in favour of the claim of the company that the purchasing authorities should buy the depots, rolling stock, and horses for working the whole of the system, and on this basis he awards the company £496,068. Should it be found that legally only such stock and plant should be purchased as is necessary for the working of that portion of the system actually owned by the company—which is the contention of the Corporation—he awards £229,353.

The equipment of the Heaton Park electric tramway route is complete, and the line will be opened for traffic in a day or two. The first engine at the Stuart-street generating station is ready for running, and next week a second will be ready.

The price for gas for motive power has been reduced from 2s. 9d. to 2s. within the city, and from 3s. to 2s. 3d. without, in order to meet the threatened competition of Mond gas.

Manchester Suburban Tramways.—A scheme is being promoted for the construction of tramways to connect Barton Bridge with Glossop. At Barton it is proposed to connect with the Trafford Park tramways, and thence the line will proceed to Davyhulme and Urmston, across the Mersey to Sale. The tramways will also connect Northenden, Cheadle and Gatley, Bramhall, Poynton, Hazel Grove, Marple, Ludworth, Chisworth, Charlesworth, Mottram, Broadbottom and Glossop. The project is meeting with support from all the local authorities.

Mentone.—A French company has recently started the erection of steam-driven electricity works here with the object of supplying hotels with electric current for lighting. The supply is expected to be ready next season. A large new hotel is being built, and the general demand for current is likely to prove remunerative.

Morley.—The accounts of the electricity department for the year to March 25 show total receipts £1,748. 2s. 5d. Of this, £1,175 was received for private and £346 for public lighting. Generation expenses were £1,067. 2s. 6d., and management expenses £340. 19s. 10d., and with rent, rates and taxes and miscellaneous items the total cost was £1,624, 18s. 5d., leaving £123. 14s. gross profit. After payment of interest (£1,181. 7s. 1d.) and sinking fund (£730. 19s. 2d.), and taking into account the debit balance of £2,002. 3s. 5½d. in 1901, there was a deficit to date of £3,890. 15s. 8½d. The total capital expenditure is £24,308. 5s. 3½d. Units generated in the year were 133,677, units sold £99,205, and units used in works 10,551.

Municipal Insurance.—A conference of local authorities in the West Riding of Yorkshire will shortly be held to consider the question of federating the West Riding towns in an insurance scheme.

Municipal Trading.—At the annual meeting of the Ironmongers' Federated Association, held at Birmingham last week, a resolution was passed requesting the Government "To re-appoint the Committee of both Houses of Parliament on municipal trading so that it may complete its labours, and that the injury that is being inflicted on private enterprise may be duly considered and reported upon.' The motion was carried unanimously.

Newburgh.—A report on electric lighting prepared by Mr. Hawtrey is before the council. The report favours the erection of gas-driven plant.

Newton Abbot.—Preliminary arrangements for the erection of electricity works have been made by Edmundson's Electricity Corporation, and the resident engineer (Mr. F. C. Pay) has taken up his duties. Current will be available by Christmas.

Nottingham.—The Woodborough-road and Mapperley sections of the municipal electric tramways were opened for traffic on Tuesday.

Obituary.—There passed away at Whickham, Durham, in his 70th year, Mr. Wm. Lcott, who was with Messrs. Dixon and Corbitt and R. S. Newall & Co. for 50 years. He was associated closely with the manufacture and laying of the earliest telegraph cables, notably with the Sebastopol cable of 1854.

Obstruction of Tramways.—At Middleton Borough Bench recently the police summoned three carters for obstructing the highway by refusing to let a tramcar pass. On the afternoon of April 26, defendants were driving lurries along the tram-track, and a tramcar having overtaken them they did not move out of the way for 300yds.

The MAGISTRATES' CLERK observed that the men were obliged to keep on the proper side, and the tramcar had no greater right to the road than the carters.

Superintendent MCQUEEN, who prosecuted, said he had a strong feeling that the carters were not committing an offence, but he brought the case to guide him in the future.

Mr. THOMPSON, for the defence, said that nobody had any right of precedence on the public highway. Had the carters gone on to the wrong side, it was probable they would have collided with cyclists on the other side of the tram.

The MAYOR thought the trams had a right to the streets.

The CLERK advised differently, and, after private consultation, the Bench decided to dismiss the summonses, but declined to allow costs.

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Paisley.—Negotiations between the Council and Mr. W. M. Murphy, promoter of the local tramways, are still proceeding. The Council recently informed Mr. Murphy that before embarking on any expenditure for supplying the tramways with electricity they should be assured of a minimum annual demand for 500,000 units of current, and that if the generating machinery was ready before the tramways, interest and sinking fund should, in the interval, be paid on their expenditure. Mr. Murphy, however, declined to accept these conditions, and stated that if the Corporation desired to be relieved of the liability to supply current to the tramways he was willing to entertain such a proposition. He only counted on the line from Hawkhead to Johnstone being opened at first, and that the electricity required for that line would be about 200,000 units per annum. After considering Mr. Murphy's letter and a report by the electric lighting convener (Mr. Fisher) and the burgh electrical engineer (Mr. Parkinson) the Council have decided to lay down, in the first instance, plant capable of supplying the tramways with 250,000 units per annum, at an estimated cost of £8,500.

Portsmouth—A profit of £4,300 is announced on last year's working of the electricity undertaking, compared with a loss of £800 in the previous year. The gross receipts were over £31,000.

Rotherham.—There was a small profit (£2. 16s.) on the first 10 months' working of the electricity works, in place of an anticipated loss. The Electric Lighting and Tramways committee's recommendation to reduce the charge for current to 4½d. per unit (a reduction of ½d.) was adopted.

Sheffield.—The Electric Light committee have decided to reduce from June 26 the charge for current for power to the following rates:—

For all energy used in motors, driving hoists, cranes, passenger lifts, and similar machinery, 2d. per unit; for other motors, 1½d.: to consumers running their motors continuously through the whole of the working hours of each day, 1¼d.; and to consumers whose motors run continuously day and night, 1d.

Electric current for Coronation illuminations will be supplied at 1d. per 8 c.p. lamp, or its equivalent, per night up to midnight.

South Africa.—Bloemfontein Town Council have received sanction to a further loan of £25,000 for electric lighting extensions.

The Pearl Electric Power Syndicate has, according to the *British and South African Export Gazette*, been recently formed to obtain Parliamentary sanction to appropriate and utilise a number of streams on the Paarl mountains for the generation of electric energy and supplying the municipality with current for lighting, power and traction.

Application has been made for power to construct an electric tramway from the southern boundary of Durban to New Brighton.

Southwark (London).—An offer from the County of London and Brush Provincial Electric Lighting Co. to supply electric current in bulk for all night public lighting at a flat rate of 2*l.* per unit has been referred to a committee.

Spennymoor.—The Northern Counties Electricity Supply Co. are erecting electricity works here, and will shortly be able to supply current for private lighting. The Council have asked the company to tender for street lighting for next season.

Swansea.—The Electric Lighting committee have offered to supply current for power to the Anglo-French Electrical Co. at 1½d. per unit for a maximum of 150,000 units per annum, or 1¼d. per unit if 200,000 units be taken.

Telegraphs in British North Borneo.—It is announced that the extension of the telegraph line to Kudat has been completed, putting that station and London in direct telegraphic communication.

Telephone in Belgium.—At the moment when telephonic communication between London and Brussels is on the eve of inauguration, some particulars regarding telephones in Belgium, which have recently been compiled by Mr. G. W. Roosevelt, will be read with interest. On account of dissatisfaction with the system of annual telephone subscriptions, the State Department of Railways, Posts and Telegraphs, under whose control the telephone service is administered, has decided to adopt the message system. It was in 1895 that the Belgium Government obtained complete possession of the telephone service of the country, when the interests of the Cie Belge du Téléphone Bell, the Cie Liégeoise du Téléphone Bell and other smaller companies were acquired. As soon as the preliminaries of this transfer were settled, Belgium was divided into 17 telephone "zones," each with a central exchange. Of these 17 "zones," two (Brussels and Charleroi) are equipped on the twin-wire system, and those of Antwerp and Liège are being converted to metallic circuit. The remainder of the exchanges are as yet on single-wire circuits. Under the system adopted in Belgium, the subscriber is entitled to communication with any other subscriber in the same "zone," irrespective of distance, also to communicate over long-distance lines at the regular rate, if he deposits at the beginning of each month the amount of his estimated monthly expenses. He is also entitled to telephonic delivery of telegrams. This latter privilege is almost universally used. Mistakes are rare, and each subscriber is provided with a "key" to words most alike in sound on the telephone. The "flat-rate" system of subscription varies considerably, in proportion to the size and importance of the locality. The Brussels-Antwerp rate is 250fr. (£10), Charleroi, 200fr. (£8), and the smaller exchange rate 170fr. (£6. 16s.), or for a three years' contract, 150fr. (£6). This latter rate is for a radius of 1 kilometre, the rates for longer lines being proportional. Following are some particulars of the Brussels service for 1900:—

Total number of subscribers	13,620
Total length of wire ... miles	23,365
Total number of messages	47,224
Telegrams received and sent by telephone	1,443,474
Total receipts	£24,412
Total expenditure	£18,490
Net profits	£5,922

The rate for "interurban" service is 1fr. per message of five minutes irrespective of distance. This time may be doubled for 1.50fr. after ten minutes, 1fr. for each additional five minutes.

International trunk lines now connect Belgium with France, Germany, Holland, Luxemburg and the United Kingdom. There are four direct lines between Brussels and Paris. These international lines are all of the metallic-circuit type. The rates for international service are for five minutes, and according to distance and whether a day or night service:—

	Day.	Night.
Up to 50 kilometres (31 miles)	29c.	17c.
50 to 150 kilometres (93·2 miles)	38c.	23c.
150 to 250 kilometres (155 miles)	46c.	29c.
250 to 350 kilometres (217 miles)	58c.	34c.
Extra 100 or fraction (62 miles)	10c.	6c.

Belgium is very deficient in public telephone facilities, there being only about 100 public telephone call offices, often in a large town only one. The rate for local messages from these call rooms is 5 cents. (½d.) for five minutes conversation.

Tiverton.—At the Council meeting on Monday, Mr. Partridge moved that no further steps be taken in connection with the electric lighting scheme for the present. Ald. Amory favoured putting down a small gas-driven plant. Mr. Watkins said 10 years ago electric lighting was first discussed. Since then the Corporation had been obstructionists, for, with a monopoly of gas, they had held a provisional electric lighting order, preventing anybody else from supplying electric current. He was averse to spending public money on an experimental scheme when a canvass showed that only 28 persons out of 1,800 were willing to adopt electric lighting. He moved that the question be referred to the Lighting committee for consideration, and, after discussion, this proposal was carried.

Train Lighting.—The trains of the Isle of Man Railway Co. are now lighted electrically.

Trunk Telephone Extension.—Weymouth and Bridport have been connected to the trunk telephone service of the country.

Wireless Telegraphy.—Mr. Marconi delivered an interesting lecture at Dundee last week. Passing reference having been made to the suggestions for a system of wireless telegraphy made so long ago as 1795 by a Spaniard, Mr. Marconi referred to the work of Mr. James Bowman Lindsay, and to the foresight displayed by that electrician in connection with wireless telegraph stations. With regard to his own system, Mr Marconi said at the present time 40 coast stations were equipped in Great Britain and Europe, and 66 vessels of His Majesty's navy and 12 in the Italian navy were carrying Marconi wireless installations. The objection to his system, that anyone at the receiver could pick up messages intended to be private, was true until two years ago, when, by the introduction of the tuning system, each pair of stations could be worked in a way that prevented a third party tapping or picking up a message. He believed wireless telegraphy would be of still greater importance to the world, if it were found practicable and applicable over great distances like those which divided Great Britain from her colonies and America.

Yarmouth—The electric tramways will be opened for traffic about the middle of June. The Tramways committee have decided to run the cars on Sundays.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Poplar (London) Electricity committee invite tenders for the supply of about 130 cast-iron arc lamp columns. Specifications, &c., from the borough electrical engineer (Mr. Alfred Blackman), electricity works, Glaucus-street, Bromley-by-Bow, E., after 19th inst. An advertisement contains further particulars. Tenders to town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, by 10 a.m. May 28.

Poplar (London) Electricity committee also invite tenders for special armoured cables suitable for laying in water. Specifications of the borough electrical engineer after 19th inst., and tenders to town clerk (Mr. Leonard Potts) by 10 a.m. May 28. See advertisement.

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The Guardians of the *Poplar* (London) Union invite tenders for electric wiring and fittings at the Union offices. Tenders to clerk (Mr. G. Herbert Lough), 45, Upper North-street, Poplar, E., by 6 p.m. May 28.

Coventry Electric Light committee invite tenders for the supply and erection of steam and water pipes and accessories. Specifications, &c., of the electrical engineer (Mr. Joseph A. Jeckell), and tenders to the town clerk (Mr. Lewis Beard), 10, Hay-lane, Coventry, by 10 a.m. 26th inst. See advertisement.

Burton-on-Trent Corporation invite tenders for supply and erection of three 100kw. high-speed tramway generators and switchboard and three Lancashire boilers, steam pipes, jet condensing plant, economiser and accessories. Further particulars are set out in an advertisement. Plans and specifications may be inspected at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, or at the offices of the manager and engineer (Mr. F. L. Ramsden), gas and electric light works, Burton-on-Trent. Tenders must be forwarded to the town clerk, Town Hall, Burton-on-Trent, by noon of May 30.

Beckenham Electric Lighting committee invite tenders for the supply of incandescent lamps. Specifications from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, and tenders, addressed chairman, Urban District Council offices, Beckenham, by noon June 6. See advertisement.

Dudley Electric Lighting committee invite tenders for the supply of incandescent lamps and oil. An advertisement contains additional particulars. Specifications from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster. Tenders, addressed chairman, Electric Lighting and Tramways committee, Town Hall, Dudley, by noon June 6.

Dudley Electric Lighting committee also invite tenders for motors. Tenders to chairman by noon May 20.

The Guardians of *Hunslet* Union invite tenders for two electric ward lifts for their new infirmary at Rothwell Haigh, near Leeds. Specifications from the consulting engineers (Messrs. Shepherd and Watney), Greek-street Chambers, Leeds, and tenders to the clerk (Mr. Fred. W. Mee), Union offices, Hunslet, Leeds, by 10 a.m. June 3. See advertisement.

Halesowen Rural District Council invite communications from companies willing to take over their electric lighting and light railway powers, and to carry out the works authorised thereby. Communications to the clerk (Mr. E. H. Grove) by May 21.

Bray Urban District Council will, on May 19, at 10:30 a.m., receive and consider tenders for meters, transformers, batteries, voltmeters, balances, demand indicators, &c. Tenders to clerk (Mr. P. Macdonnell).

Govan Town Council invite tenders for stores for 12 months from June 1, including fuse-boxes, meters, demand indicators, manhole boxes and connections and joint boxes for armoured cables. Tenders to town clerk by May 27.

Manchester Tramways committee require cast-iron boxes, collars and finials for tramway poles and rail bonds. Tenders by 1 p.m. 24th inst.

West Ham Corporation invite tenders for the construction of about 8 miles of tramway permanent way, copper bonding, &c. Tenders by June 10.

Oldham Corporation Electricity committee invite tenders for cables, troughing, bitumen and insulators. Tenders to superintendent, gas and water offices, Oldham, by May 20.

Worthing Corporation invite tenders for a 250kw. steam dynamo and a dryback marine-type boiler with fittings. Tenders to town clerk by noon May 26.

Tenders are invited for wiring and fittings at the Parc Gwyllt and Angelton Asylums, near *Bridgend*, Glam. Tenders to Mr. W. E. Allen (clerk to the Committee of Visitors) by May 31.

The *War Office* invite tenders for a self-propelled lorry for military purposes. Specifications, from Director of Army Contracts (Mr. A. Major), War Office, London, S.W., to whom tenders by noon July 31.

Brighton Town Council invite tenders for points, crossings, tie-bars, bolts, &c., also about 300 tons of steel girder tram rails. Tenders by noon June 9.

Ilkeston Tramways and Electricity committee invite tenders for erection of car shed, transforming station, &c. Tenders by noon 26th inst.

Swindon Corporation invite tenders fora storage battery of 252 cells, and accessories. Tenders to town clerk by May 19.

Hull Corporation invite tenders for about 20,000 cast-iron holding-down plates. Tenders by noon 30th inst.

Bury (Lanca.) Electricity committee invite tenders for jet condenser and pumps. Tenders by May 20.

Bedford Electricity committee invite tenders for economisers. Tenders to chairman by May 19.

Glasgow Corporation invite tenders for an economiser with induced draught fan and condensing plant. Tenders by June 7.

Stockport Gas and Electricity committee invite tenders for a water-tube boiler. Tenders to chairman by May 21.

In our columns for March 21 (p. 877) particulars are given of tenders invited for the supply of plant necessary for the electric lighting on board three Spanish gunboats. Owing to the eight tenders sent in being informal in many respects, fresh tenders are called for, which will be opened on May 28, at 11 a.m. The *Madrid Gazette* of May 11 contains further particulars, and can be seen at *The Electrician* offices by appointment.

Kolozsvár (Hungary) municipality invite orders until Sept. 1 for the erection of electricity works. Particulars from M. Béla Fekete Nagy, Kolozsvár.

TENDERS RECEIVED AND ACCEPTED.

Bexley District Council recently received nine tenders for the supply of tramway rails and fish-plates, four of these specified rails of English manufacture, four Belgian and one German. All tenders for Belgian rails were lower than for English or German, and the lowest English was £7. 10s. per ton. Three of the Belgian offers were £6. 7s. 6d. per ton. The consulting engineers reported that there was no reason why the Council should not accept Belgian rails, especially as Belgian makers would accept more stringent conditions than most of the English makers. It was, therefore, recommended that the tender of Messrs. A. Penney & Co. to supply 800 tons of rails, to be manufactured by the Marcinelle Company, Charleroi, at £6. 7s. 6d. per ton, be accepted. The same firm's offer for 1,500 pairs of fish-plates, at £247. 5s., was also recommended for acceptance, as was the tender of Messrs. Walter Scott & Co. for 1,450 anchor plates (with royalty), at £652. 10s., and that of Messrs. Dick, Kerr & Co. for 4,800 tie-bars, 9,000 bolts and 1,800 rivets, at £775, bringing the total amount of the tenders recommended for acceptance to £6,764. 15s. These tenders were accepted by the council after some discussion.

Rathmines (Dublin) District Council have accepted the following tenders for the extension of the electricity supply works and mains. Mr. Robert Hammond is consulting engineer.

Dick, Kerr & Co. (one 300kw. steam dynamo, with Willans engine, pipework and accessories)	£3,547 10 8
Kelvin and James White (extension of switchboard)	174 0 0
British Insulated Wire Co. (supply mains)	Schedule rates.

Edinburgh Town Council have accepted the tender of Messrs. Crompton & Co. for the supply of carbons and continuous-current arcs for one year from May 15 at the following prices :—18mm. and 12mm., £4. 11s. 2d. per 1,000 pairs ; 22mm. and 15mm., £5. 13s. 7d. per 1,000 pairs ; and the tender of Messrs. Mackenzie Bros. for 12 months' supply of pavement box frames and covers at £7 per ton.

The London County Council have accepted the following tenders for electrical plant at their Horton Asylum :—

Thos. Parker (Ltd.), electric motor	£171 0 0
Tangyes Tool and Electric Co., machine tools	131 15 0

The Fire Brigade committee of the London County Council have received the following tenders for wiring and fittings for an electric lighting installation at Scotland Yard police station :—

C. O. Clark (*accepted*)	£134 15 0	Anti-Vibrator, Ltd.	£170 0 0
G. Benkert	320 0 0	Jackson Bros.	163 8 0
Lawrence & Co.	220 9 6	A. Goldsmith & Co.	165 0 0
E. Deane	203 1 0	C. Mickleburgh	157 10 0
Harrod's Ltd.	176 15 0	Nunn, Watts & Co.	145 0 0
W. Mossop & Co.	171 0 0		

The Koffyfontein Mines (Ltd.), South Africa, have placed an order with Messrs. Dick, Kerr & Co. for complete electrical plant for haulage and lighting at their mines.

Cardiff Corporation have accepted the tender of Messrs. Dick, Kerr & Co. for 20 double-deck double-bogie and 20 double-deck single-truck cars for their electric tramways department.

Dundee Town Council have accepted the tender of Callender's Company for the supply and laying of cable extensions to the Bridgend, Balhousie and Glasgow-road districts.

Broughty Ferry Town Council have accepted the tender of Messrs. Belliss and Morcom for a 60kw. steam dynamo and a 30kw. steam dynamo, together with spare parts, for £1,280, and that of Messrs. Cooper and Greig for condensers and pumps at £456.

Messrs. Belliss and Morcom, Ledsam-street works, Birmingham, have received an order for two 220 H.P. engines for the electrical power installation at Holwell Iron Works, Leicestershire; also for two 200 H.P. engines for the Elland (Yorks.) Electricity Works.

The East Sussex County Council have accepted the tender of Messrs. J. E. Spagnoletti & Co. for the supply of electric lighting and power plant for their new asylum at £11,773. 11s. 2d., and also for construction of a short length of electric tramway at £1,940.

Elland District Council have accepted the following tenders for their electricity supply scheme :—Bellis and Morcom, steam-engines ; Greenwood and Batley, dynamos ; Ashmore, Benson, Pease & Co., storage battery ; H. H. Wright, switchboard ; J. Hitchen & Son, crane ; Anchor Cable Co., cables ; Thornton and Crebbin, condensers.

Hamilton Town Council have accepted the offer of Edmundson's Electricity Corporation to erect electricity works complete at £32,302.

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BUSINESS NOTICES.

Cryselco Limited, Kempston Works, Bedford, have recently supplemented their means of output, and are now laying down a 100 H P. Dowson gas generating plant with Crossley gas engines.

We learn that Mr. H. M. Salmony has disposed of most of his shares and interest in Julius Sax & Co. (Ltd.), and has resigned his position as managing director. Mr. Salmony intends to occupy himself with the purchase and sale of patents and in acting in an advisory position in connection with the buying, selling and valuing of electrical plant and undertakings. Mr. Salmony's address is 95, Mortimer-street, Cavendish-square, London, W.

Messrs. A. E Ward and David Fulton, electrical engineers, &c., 4, Browne-street, Bootle, have dissolved partnership. Debts by Mr. Ward.

Messrs. Gambrell Bros. are removing, on 19th inst., to Durham House, 23, North Side, Clapham, London, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of George Willie Clarke, electrical engineer, Harold Wood, and Grays, Essex, and Queen Victoria-street, London, was concluded on Wednesday.

The discharge of J. G. Maxwell Hilton, electrician, Trafalgar Works, Bow Common-lane, London, E., was yesterday suspended by Mr. Registrar Brougham for two years. In 1895 debtor and another took over the electrical portion of the Nalder and Harrison Construction Syndicate, and two years later sold it to a company, which in May, 1899, went into voluntary liquidation. Failure attributed to that of the company and want of business experience. Liabilities £1,858. 10s. 4d.; nothing was realised in respect of the estate.

At a meeting of the shareholders of Moon, Loughlin & Co. (Ltd.), on May 12, a resolution was passed that by reason of its liabilities the company cannot continue its business. It was decided to wind up the company voluntarily under the liquidatorship of Mr. Ernest Hull, C.A., 5, John Dalton-street, Manchester.

Plant, &c., for Sale.—Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Business for Sale.—The receiver and manager of the British Electrical Manufacturing Co. (Ltd.), Fulham Electric Works, Putney Bridge Station, S.W., advertises the undertaking for sale as a going concern, with the manufacturing plant and an extensive stock of switches, &c. Further particulars of Mr. James E. Ward, C.A., 122, Cannon-street, London, E.C., and 58, New-street, Birmingham.

For Sale.—The electrical patents and business recently carried on by the Doe Electric Light and Power Syndicate are for sale. Some particulars are set out in an advertisement.

Factory Sites.—Messrs. Humbert and Flint, Watford, Herts., and 11, Serle-street, Lincoln's Inn, London, W.C., announce in another column some convenient factory sites in the Watford district for disposal.

Mr. J. H. Osborne, 15, Charterhouse-street, London, E.C., has for disposal convenient freehold sites for factories, under 11 miles from City, and adjoining railway and navigable river.

Water-Softening Plant.—Messrs. Mather and Platt have received an order from the Metropolitan Electric Supply Co. to instal a second plant for softening and purifying water by the Archbutt-Deeley process for an output of 10,000 gallons per hour, thus doubling the capacity of the plant.

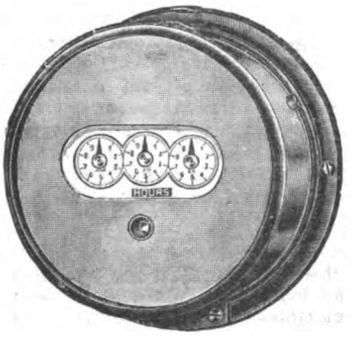
Heating and Ventilation.—Those interested in the subject of the heating and ventilation of large public buildings will welcome a report on the heating and ventilation of the Houses of Parliament, which has been prepared by Mr. James Keith, A.M.Inst.C.E., 57, Holborn-viaduct, London, E.C.

"Ediswan" Fittings.—A handy catalogue, showing a selection from the large list of new Ediswan artistic electric light fittings now ready for the market, is issued by the Edison and Swan Company. Most of the goods in the list are made in the following finishes:—Polished brass, antique brass, steel bronze, black bronze, Florentine bronze, coinage bronze, antique copper, lustrous copper, antique iron and oxidised silver.

Coronation Illuminations.—The part that electricity will play in the Coronation festivities is indicated in such orders as that recently received by the British Thomson-Houston Co., who are to supply 225,000 B.T.H. Edison incandescent lamps to one firm for the purpose.

Electric Power Plant.—Messrs. Pease and Partners (Ltd.), who are making considerable improvements at their Bankfoot Works, Crook, are laying down electric power plant and introducing coal-cutting machines for longwall work; an electric ram of 70 tons in weight is being fitted at the ovens. A 400-ampere Tyne dynamo (driven by a 320 I H P. Robey steam engine) supplies current for power and lighting. The whole of the works will be lighted by the new plant, the French ovens having five arc lamps of 1,000 c.p. each.

Current-Duration Counter.—Messrs. O. Berend & Co., Basinghall-avenue, London, E.C., are placing on the market a current-duration counter for gauging the amount of energy used in any electric light or power installation where the number of lamps alight at the same moment, or the power taken by any motor, is approximately constant. It is pointed out that in many installations, where only a small amount of energy is annually consumed, the cost of installing a watt-meter and periodically testing it bears a considerable ratio to the cost of the energy itself, and the substitution of a current-duration counter will prove economical. The instrument is a 300-hour anti-magnetic clock provided with an electrically-operated starting and arresting device. It is made in two forms, one for small and the other for large currents. In the former the instrument is connected in series and in the latter in parallel with the mains. The clock requires winding about once a month, the dial representing the number of hours during which the current has been taken from the circuit to which the instrument is connected.



Current-Duration Counter.

Alternating-Current Generator Contracts.—Among the contracts recently obtained by the British Schuckert Electric Co. (Ltd.) for alternating-current plant are two 600kw. two-phase generators for Coventry Corporation; one three-phase generator and two three-phase motors for the Oakbank Oil Co.; and two three-phase generators and three three-phase motors for the Lancashire and Yorkshire Railway Co.

Charging Stations.—The Thames Valley Launch Co., Weybridge, who have branch works and charging stations for electric launches and cars at Maidenhead, Hurley, Henley, Pangbourne and Shillingford Bridge, announce that they will shortly open two new stations at Windsor and Reading.

Catalogues.—Messrs. Ferranti Limited, Hollinwood, Lancs., are about to issue a pamphlet illustrating and describing the well-known continuous-current meters manufactured and supplied by the company. The details which make up the complete current-measuring apparatus are shown, and generally, the pamphlet is more than usually interesting.

A new price list (No. 4) of single and multiphase alternating-current generators, manufactured and supplied by the Electrical Co., is now available, illustrating a variety of these machines. Full technical and working details accompany the illustrations.

A list of multipolar "Standard" and "Universal" generators and motors, direct-connected and belted types (catalogue 26), is now ready, and can be obtained from Messrs. R. W. Blackwell & Co., 59, City-road, London, E.C. Illustrations of a large number of these machines are given for a variety of trade uses, especially in connection with the printing trades.

A trade list of "Packard" incandescent lamps, for which a special offer is made for the Coronation period, is issued by Messrs. R. W. Blackwell & Co.

Imports of Electrical Goods.—The value of the electrical goods imported into this country during April was £65,363, against £86,629 in April, 1901, and £58,714 in April, 1900. The total value for the four months ended April 30 was £230,341, compared with £408,318 and £255,733 in the corresponding periods of 1901 and 1900 respectively.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 7 to May 13, with the ports of destination:—

Africa—Alexandria, £51; Cape Town, £357; Delagoa Bay, £4,058 (telegraph cable); Durban, £1,115; East London, £645; Port Elizabeth, £58. *Australasia*—Auckland, £7,351; Christchurch, £42; Fremantle, £251 (telegraph cable); Melbourne, £1,450; Perth, £420; Sydney, £1,169; Wellington, £1,422 (telegraph material). *Ceylon*—Colombo, £150 (including £101 telegraph material). *China*—Shanghai, £333 (including £30 telegraph apparatus). *France*—Boulogne, £800 (telegraph instruments). *Gibraltar*, £74. *Holland*—Amsterdam, £170. *India*—Bombay, £98; Calcutta, £3,978 (including £3,327 telegraph material); Madras, £205. *Japan*—Yokohama, £560. *Spain*—Bilbao, £90. Total, £24,847, against £19,873 in the corresponding week last year (May 8 to 14).

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COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Co. (Ltd.)

The fiftieth ordinary general meeting of this Company was held on Wednesday, Mr. W. B. KINGSFORD presiding.

The MANAGER AND SECRETARY (Mr. R. T. Brown) read the notice convening the meeting and the Auditors' report.

The CHAIRMAN, after referring to the absence of Mr. W. S. Andrews owing to illness, said: The appalling catastrophe which has shattered the lovely island of Martinique casts over us to-day its black and baleful shadow. In the dreadful tragedy which, in a moment, in the twinkling of an eye, has destroyed a fair and thriving city with its 30,000 people, and pitilessly laid waste a flourishing and ancient colony, filling France in all her borders with utter sadness and consternation, our good friends and neighbours across the Channel may be well assured that they have the profound and heartfelt sympathy of the whole English people. But, gentlemen, our hearts are also filled with the sincerest sympathy for our own fellow-countrymen and fellow-subjects in the stricken island of St Vincent. We feel most truly for and with them in the grievous loss and suffering which they have already undergone, and in the awful perils by which they still are threatened. Although in their case, happily, the calamity in its extent and in its various conditions falls infinitely short of the huge and hideous disaster which has laid in ruins the neighbouring island of Martinique, yet, most assuredly, even as it is, it is sad and terrible enough. In addition to the immense destruction of crops and buildings, and all sorts of other property over a large district of St. Vincent, I regret to say that this morning it is stated that the deaths have already reached a total of not less than 2,000, and it is much to be feared that even that sad death roll is as yet very far from being complete. In the dangers, disasters and distress by which they are surrounded, our brethren beyond the sea may be very certain that their friends and fellow-countrymen at home bear them in their thoughts continually, and every day, yes, and every hour, look eagerly and anxiously, with mingled hopes and fears, for tidings of what befalls. We ourselves, too, as you know, find a place—and, alas! a conspicuous place—in the melancholy story of sorrow and disaster. On the fatal morning of the 8th inst., while she was in the roadstead of St. Pierre, engaged in repairing one of our broken cables, our good ship the "Grappler," with her captain and all hands, was utterly destroyed. Stationed, as she was, close by the foot of the mountain, it appears that she was the first of the many ill-fated vessels which perished when the fiery deluge fell upon the doomed city and overwhelmed the shipping in the harbour. At the moment of the great explosion, the crew of a schooner standing out to sea, and making for Dominica, actually saw our vessel suddenly wrapped in a sheet of flame and consumed. She had on board, including the captain, 11 Englishmen and 45 West Indians—56 souls all told, her full complement. Captain Boreham entered our service in 1891, and save for one interval of some duration had been with us ever since. He acted in turn as second officer and as chief officer, and about two years ago was promoted to the rank of captain. He was a good and efficient officer. Mr. Marshall, the chief engineer, had been with us about 12 years. He was known for always manifesting a keen personal interest in his professional work, which he performed right well. Mr. Murphy, our chief electrician, joined us in April last. This was, in fact, his first expedition. We received with him the highest certificates of character and fitness, and we felt ourselves very fortunate in securing the services of a man so thoroughly trustworthy and able. Gentlemen, there is no need for me to take you further through the sad catalogue of names. It may suffice to say, briefly and generally, that our ship's company was throughout a good one. On shore, in the destruction of the city, we have lost in Mr. Millar, our clerk-in-charge, a much-valued official. More than 20 years ago he came to us, when he was quite a boy, as a learner, and by hard work, diligence and efficiency he steadily worked his way up to be our clerk-in-charge—an important post, the duties of which he always admirably performed. In these most sad and distressing circumstances, I am very sure it would be your wish that on behalf of the Board and the shareholders of this Company, there should be conveyed to the relatives and friends of our poor fellows who thus have perished in this most shocking, tragic and terrible disaster, an expression of very deep sympathy with them in their sorrow and bereavement. Proceeding now to comment on the report, I do not think that I need detain you long. As you will have seen, the receipts for the half-year amount to £25,243, compared with £24,300 for the corresponding period of the previous year, thus showing an increase of £943. The traffics for the half-year amount to £1,140 more. This, and some smaller items, make up the total increase of £1,581. As a set-off to that the subsidies are £638 less, owing almost entirely to deductions for interruption in our cables, thus making a net increase of £943 for the half-year under review. The expenses amount to £19,836, compared with £20,962 for the corresponding period. That is a decrease of £1,126, due to the smaller cost of repairs. The final results, therefore, come out as follows:—Receipts £25,243, expenses £19,836, showing a profit of £5,407. Then there is a balance from the last account of £6,512, and interest on investments amounting to £2,529. There is thus an available balance of £14,448, out of which the Directors recommend the payment of a dividend on account of first preference arrears of 6s. per share, which will exhaust the sum of £10,369, leaving to be carried forward £4,079. You may have seen by the papers, since the date of the last meeting, that the Brussels Sugar Conference has agreed, subject to ratification by the chief European Powers, to abolish, as from Sept. 1, 1903, all bounties upon the production and export of sugar. That decision has been received with very great satisfaction by the West Indian sugar trade, but unluckily the present position remains very far from being satisfactory, the present price of sugar being, as I understand, from £2 to £3 or thereabouts below the mere cost of production. Representations have, therefore, been made to His Majesty's Government for pecuniary help to enable our colonies to tide over the critical interval between now and the time when the convention will come into operation. Our appeal to the House of Lords in the Cuba Company's action is expected to come on for hearing in the course of a few weeks. At our last meeting the Chairman expressed the hope that the Submarine Cables committee would make some representation to the Imperial Government in favour of our Company. The Committee has issued its report, and it is gratifying to us to find that they ascribe the position of the Company to what is absolutely and entirely its true cause—the paucity of traffic in the region served by our cables, which is, of course, a matter altogether beyond our control. I regret to have to tell you that the Committee did not make any such recommendation as we had hoped, but it appears to us that in the present circumstances, which, of necessity, have greatly changed, our position, some such help as we have long hoped for and endeavoured to obtain may even yet be given. I now move the adoption of the report and accounts, and the dividend therein set forth.

Mr. HENRY HOLMES: I beg to second that, and I should like to say a few words to express my feeling as to the disaster to which the Chairman has so sympathetically referred. I am sure you will feel with us, on this side of the table, that a misfortune has overtaken us. It is not only the loss of our ship and the interruption of our cables, but we have to lament the great loss of life which we have sustained. I trust that the next time we meet we shall have something better to place before you than the melancholy tale that we have to-day.

A SHAREHOLDER: Is there much of our cable destroyed in consequence of this terrible disaster.

Mr. BROWN: Four of our cables are interrupted, but we hope they are not destroyed. We are cut off from all stations south of St. Lucia by reason of the interruption to the four cables just mentioned, but the lines of cable south to Barbados, Grenada, Trinidad and Demerara are in perfect working order. During this interruption of communication, messages are sent by chartered schooners, and by steamships from the best available points, and there is only a short delay of from 24 to 48 hours.

Mr. THORPE: We on this side of the table must associate ourselves thoroughly with the expressions of sympathy with the friends of our officers and men which have fallen from our Chairman and Mr. Holmes. I should like to carry that a little further. It is true we are a poor Company, but I think we can afford something to these widows and orphans who are left behind by men who have served us well. As a first preferenceshareholder, I should be willing that any money coming to me may be partially or entirely appropriated for that object. I feel strongly that something should be done. I should like to ask whether the Board have received any private information as to the position of the islands of St. Lucia and Dominica.

The CHAIRMAN: In the absence of any information as to volcanic disturbance in St. Lucia we presume that none has occurred, but in one of the newspapers there is a statement that in Dominica a volcano is steaming. I do not think it goes beyond that.

A SHAREHOLDER: May I ask whether it will be necessary to encroach on the reserve funds in order to replace the broken cables, and whether the insurance money will be sufficient to provide another ship of the same class as the one we have lost?

The CHAIRMAN: I am afraid that it is quite impossible for us at this stage to say anything that will be definite or useful as to the amount likely to be required for repairing the broken cables and for providing another ship.

The resolution was then carried unanimously.

The retiring director, Mr. W. S. Andrews, and the auditors, Messrs. Deloitte, Dever, Griffiths and Co., were re-elected.

Mr. BIRKS: We are met under the shadow of a great sorrow, and in the presence of a calamity which has at once become historical. I think this is a very fitting occasion for adopting a tone of congratulation with regard to the report and accounts. If it had not been for this terrible disaster our tone might very well have been of a congratulatory character. We have a rather better position disclosed to us on this occasion, and I think it is due to our Board, and to our servants in remote places, to tender to them our thanks for what they have done for us. We carry forward £4,000 odd, and I suggest that £2,000 of that be applied for the relief of the widows and families of our servants who have perished.

Mr. CHURCH: I think the matter should be left entirely to the Board.

Mr. THORPE: I will move, then, that the Board be authorised to expend such sums as they think desirable for the relief of the widows and families of those of our men who have lost their lives.

Mr. ARONSON: I will second that.

Mr. THORPE: Have we lost any of the staff at St. Vincent?

The CHAIRMAN: The staff at St. Vincent are all right, I am glad to say.

The resolution was then carried unanimously.

A hearty vote of thanks to the chairman and directors and a message of sympathy with Mr. Andrews in his illness were then unanimously approved, and the proceedings terminated.

Western Telegraph Co. (Ltd.).

The fifty-seventh ordinary general meeting was held on Wednesday, under the presidency of Sir J. WOLFE BARRY, K.C.B.

The SECRETARY (Mr. E. Steer Hodson) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: I have to explain my presence in the chair to-day as being due to the continued indisposition of our chairman, Mr. Andrews, but I am happy to say that the accounts of him are extremely encouraging, and that he hopes very soon to be among us again in his usual health and strength. I must apologise to the meeting for any shortcomings of my own in taking the chair at this meeting, and we

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know, of course, that Mr. Andrews, from his long connection with the Company, is much more posted up in its affairs than I am; but I shall do my best to answer any questions that may come from the shareholders. The report for the past half-year is not altogether so satisfactory as we could have wished, because you will see that the message receipts for the six months ended Dec. 31 last amounted to £209,000, as compared with £252,000 in the corresponding period of the previous year, showing a decrease of £43,000. I must, however, remind the meeting that Mr. Andrews stated last year that the receipts of the December half of 1900 were the largest that the Company had ever secured, and were owing, to a large extent, to the interruptions and inefficient working of competing lines, and the consequent selection, in preference, of our route by the mercantile public for their telegrams. The Company has also, in the period now under review, been working at a lower tariff than that in force in 1900; but the more important consideration affecting the business of our Company — and of all companies such as ours, whose existence depends upon the general business of the world—is the noticeable fact that general business in South America has been, and continues to be, on a very much smaller scale than it was in the corresponding period of the previous year. Brazilian exchange remained steady during the half-year, whereas in the six months to December, 1900, violent fluctuations occurred, which induced a considerable number of telegrams to be sent between the principal cities in Brazil, the fact being, as I say, that cable companies are mainly useful for conducting the commerce of the world. If the commerce of a country served by a telegraph cable is to some extent suffering from depression, we feel the depression in the same way that business generally feels it. We also feel the rise in the prosperity of a country in a corresponding way. The fact is, that our business rises and falls with the commercial business of the country. It is also right to say that, although we make a rather adverse comparison with the corresponding period of 1900, yet we make a satisfactory comparison with every December half-year excepting 1900. There is, therefore, nothing whatever to discourage the shareholders, I think, in the accounts now submitted. London expenditure, compared with that of the preceding half-year, shows a decrease of £1,470, principally due to non-recurrent items which occurred in the June half-year. The expenditure at the stations was less by £2,560, including a decrease of £1,740 in the maintenance of land lines, &c., £680 in repairs to buildings, and £565 in stationery and printing. The other accounts of the stations show various increases and decreases of smaller amounts, which need not be referred to. Under abstract C, this being the cost of repairs of cables and expenses of ships, there is an increase of £8,949. This is due to the fact that our repairing ship was in commission for the whole six months in the December half-year, as against four months in the June half-year. Chartered steamers for repairs cost us £2,613 more, and more cable was used to the value of £3,511. The net result is an increase in the working expenses of £2,101. It is right to remember that the original cable, laid along the coast of Brazil, has for the last year or two kept our cable ship so constantly engaged in repairs that the Directors decided to renew, and in some parts to divert, the course of the cable at several positions where frequent interruptions occurred. The cost of the new cable required appears in the accounts now submitted. The operations have just been carried out by a chartered cable steamer, the expense of which will be shown in the current half-year's accounts. The renewals have greatly improved the condition of these sections, and duplex working has been successfully applied to one of the cables, which before was impracticable. A large amount of the old cable has been recovered, and a considerable quantity is being brought home to be re-served and rendered serviceable for future use. The result of the half-year's working is that the usual first and second interim dividends have been paid, £40,000 carried to the general reserve fund, £2,000 to the maintenance ship's reserve fund, and the balance of £5,531 carried forward. I do not think that that is altogether an unsatisfactory state of things, although I felt bound to deal with the question of the fall in the net amount of the revenue for the half-year. You will also remember that for the year 1901 7 per cent. was paid to the shareholders, being the same as has been paid for many years past, and we were able also to place £79,000 to reserves. Altogether, therefore, I think that the condition of the Western Telegraph Co. affords no reason for anxiety. In January last the Board created a further amount of £400,000 debenture stock, which ranks pari passu with that already issued. Of this, £103,000 has been allotted at a small premium, and the balance will be issued as required. The capital account is over-spent by £236,000, and this explains the fact of the reserve funds being under-invested. As the debenture capital is issued the money will be invested as before in the usual way. I do not know that it is necessary at this meeting to refer at all to the subject of wireless telegraphy. I was addressing the shareholders of another company a very short time ago, and I also dealt with the subject at some considerable length last January, and the fact is, that really no new circumstances have arisen which it is at all necessary for us to consider. I have no reason whatever to alter the opinion I have formed—and all that I have heard since corroborates the idea I then expressed—that, although wireless telegraphy may be a useful handmaid for cable companies, I do not look upon it at all as a serious competitor. There is one other point of interest to telegraph companies for me to mention—the valuable report of the Inter-Departmental Committee on cable communications. That Committee was appointed by the Government to investigate the whole subject of cable communications, and it has issued a Blue Book which is extremely interesting, and will well repay reading by any shareholder who takes an interest in the subject. Broadly speaking, the result of this inquiry has been most abundantly to show the great public services rendered to the British Empire by the cable companies, and it has also shown that their charges are not excessive. As a matter of fact, there is no suggestion of any required alteration at the hands of the Government, either as to their management or the rates excepting in one very trifling matter on the West Coast of Africa, to which really, it is not necessary to allude, it being so trifling. I now move the adoption of the report and accounts.

Mr. D. H. GOODSALL seconded the resolution, and

The CHAIRMAN having replied to various questions, the resolution was carried unanimously.

Major COTTON then proposed a hearty vote of thanks to the Chairman, Directors and staff, which was seconded by Mr. JOHN NEWTON and carried unanimously.

The CHAIRMAN, in acknowledging the compliment on behalf of his colleagues, the staff, and himself, observed that there was nothing more encouraging than to have a vote of thanks accorded to them by the body of the shareholders. As regarded the staff, they were devoted to the interests of the Company, and he cordially endorsed the vote to them.

The proceedings then terminated.

Telegraph Manufacturing Co. (Ltd.).

An extraordinary general meeting was held at Liverpool on Friday last.

The CHAIRMAN (Mr. James Taylor) said this was the most important meeting that they had been called upon to attend in connection with the company, because of the proposed amalgamation with the British Insulated Wire Co. (Ltd.)

At this point the SOLICITOR (Mr. Gardner) read the draft agreement of amalgamation.

The CHAIRMAN, proceeding, said the agreement did not state the advantages which, in the opinion of the directors, would accrue to the shareholders from the amalgamation. It had been evident for a considerable time to them that competition had been increasing, and that if profits were to be maintained they must have an increased turnover, especially with the heavy cables used for town lighting, traction work and power. They would say from that, that if they entered into that manufacture there would be still be greater competition than there had been, and prices were bound to be still more cut down, and, probably, the working expenses increased; therefore, after a lot of consideration, they came to the conclusion that it would be better to enter into partnership with a firm doing that heavy class of work, rather than to enter into competition; and he might state that it had stopped the firm in question from going into competition in the goods they were working in. Especially had they that in view, because their biggest competitor, and also the biggest competitor of the Insulated Wire Company, in the south were joining hands also. By joining with the British Insulated Wire Co., instead of their interests in the future clashing, and both laying out further capital in heavy plant and buildings, their interests became mutual. The British Insulated Company last year did not have as good a year as one could have wished; but from the figures he had had given him, for the last four months, they were certainly doing a largely-increased trade, and, he believed, a profitable one. In addition to that, they had laid out a lot of capital in wire-rolling and wire-drawing plant, which was expensive. They were not only cable makers, but own one of these wire plants themselves, and that, he thought, had been only fairly got to work since last Christmas. That put them in the very bottom price for copper, which, when a firm was using thousands of tons, placed them in a very favourable position. At Helsby, for the special cables they made, getting the copper wire they used that way would make a distinct increase in the Helsby profits. Another important thing was the saving which the combination ought to make in expenses. For the future he could see very well that great advantage would accrue to both firms, and more especially would that happen with regard to the foreign trade. There they were in South Africa, where trade was reviving, simply knocking at each other's heads, and losing profits, whereas had they been one they should have benefited considerably. The same thing applied in Australia and some foreign countries. Assuming the joint profits only allowed, as they did at present, of 10 per cent. on ordinary shares, the ordinary shareholders of the Telegraph Mfg. Co. would stand in as good a position as they did before, because 10 per cent. on six shares was equal to 12 per cent. on five, and preference shares received 1 per cent. better, and that amalgamation would prevent the severe competition which would undoubtedly have had to come on in the immediate future. From that point of view, he put it as a clear joint gain. He and his brother were a long way the largest shareholders in the company, and if they had not thought that that was to the benefit, not of themselves only, but their other shareholders also, he did not think they would have entertained it for one moment. In the past they had given the whole of their time to the company, and they had no intention of deserting the ship; but they intended giving the whole of their time still to their (the shareholders) interests and to it. He was reminded of one point in regard to their manufacturing, which he omitted to mention, and that was the telephone industry. Last year he told them they were putting up another new factory for the making of switchboards and instrument work. That factory, in Edge-lane, Liverpool, was half-way up. There had been some delay in acquiring the land. Towns in Great Britain were going in more and more for that work—Glasgow, Tunbridge Wells, and Portsmouth they had secured, and the British Insulated Wire Co. secured the cable work, which was a very heavy item. Brighton had also gone in for a municipal telephone system, and they had both quoted, but had not yet heard the result. The amalgamation enabled them to take that telephone work throughout, and, if necessary, to run the exchanges for the town councils for a time. He then moved that the provisional agreement, dated April 28, 1902, for the sale of the undertaking of that company to the British Insulated Wire Co. (Ltd.) be ratified and confirmed, and that the directors be authorised to affix the company's seal thereto, and to carry the same into effect, with such modifications in the details thereof as they might think fit to assent to.

Mr. J. S. HARMOOD BANNER seconded the resolution, and said that

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they had to consider how best to meet the threatened competition from the amalgamation of their two southern competitors. To do so alone they would have to largely extend their works. Then they had the opportunity of amalgamating with the British Insulated Wire Co. offered to them, which they had considered very carefully. It became perfectly plain that they would either have to spend a large amount of capital, and then they would be competing with the British Insulated Wire Co., and they also would have to expend a much larger capital to compete with them (the Telegraph Mfg. Co.), or else they would have to go together. Mr. Taylor satisfied himself as to the condition of the British Insulated Wire Co.'s works, and their manufacturing possibilities, and they satisfied themselves, subject to conditions (which had been complied with) as regards the financial position of that company. The first terms were not as good as they had now to submit. Of course, the first thing they desired to do was to give an equal income, and, after negotiation, they got that by the addition of that one share, giving them six shares for five, which insured them—provided the amalgamated company keep up their dividends, which there was every probability of their doing—of a continuance of the 12 per cent. on their shares—a very good return for the original shareholders, at any rate, and a very good return at present prices to any shareholders who hold shares in the company. He might say they were rather disappointed in the declining value of the British Insulated Wire Co.'s shares; but still, notwithstanding that, they were convinced that they should be doing the wisest thing in amalgamating, because it ensured their income and got rid of competition, and because he could not but think that, in view of the satisfactory position the British Insulated Wire Co. now occupied, and the addition to their facilities, their shares were at present below value, and ought to improve.

The CHAIRMAN invited questions and discussion, and there being no response, put the resolution, and it was carried unanimously. Continuing, he said that it had been arranged that as soon as the new shares were issued by the British Insulated Wire Co. to the liquidator of their company they could be almost immediately exchanged. It had also been arranged that fractions of shares should be sold by the liquidator when he received them, and the proceeds divided among the people entitled. That would do away with the bugbear of fractional shares. They would be sold free of charge. He would also remind them that their cables were known as the "Helsby" cables more than as the Telegraph Mfg. Co.'s cables, and that name was to be embodied for the future with that of the British Insulated Wire Co. They would decide that name as soon as possible and advise. That was the whole of the business.

Capt. ROBERTSON had great pleasure in proposing a vote of thanks to the chairman and directors. The statements presented to the meeting were, in his opinion, most satisfactory.

Mr. J. SMETHURST seconded, and said the shareholders of the Helsby Company would be highly satisfied with the statement laid before them. He hoped the company they were going into might prove as prosperous as their late company had been.

The motion was carried unanimously.

The CHAIRMAN, in returning thanks, said there was a lot of hard work before them, but he had no doubt they would become one of the strongest cable making and laying firms in the country.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)—The Chairman (Mr. H. R. Beeton) at the meeting, last week, said the accounts for the period from the formation of the Company (Nov. 20, 1900) to Dec. 31 showed a net available balance of £42,815. 5s. 4d., out of which they had paid debenture interest and an interim preference dividend, and now proposed the payment of a balance preference dividend of 2s. 6d., making the full 5 per cent., leaving £7,523. 13s. 3d. to credit of next account. The company was formed to acquire the shares of the Brisbane Tramways Co. (Ltd.). The record of the Brisbane Tramways Co. has been one of continuous progress since 1896, when the tramway system was first taken over for conversion to electric traction. In 1896 the gross receipts were £26,600, in 1901 £111,105, an increase of £84,505. They had the first electric tramway installation in Australia, and their manager reported that the omnibus proprietors were contemplating the disposal of their business. The company had undertaken to construct additional lines, to extend the equipment of their power station, and to carry out other works for the development of the property. At the time the company took over the tramways they had about 20 miles of street and about 33 miles of single line. Since that time they had opened about 5 additional miles of street and 9 miles of single lines, and there remained to be opened, so far as they could estimate, a further 7 miles of street and another 8 miles or more of single line. Their manager (Mr. Badger) and their colonial director (Sir M. McEacharn) estimated that when all the extensions were open for traffic the total should amount to about £160,000. The receipts for the first four months of the present year amounted to about £40,143, against £35,547 for the corresponding period of last year. During the past year they had worked the lines at a percentage of 58 per cent., and they had reason to anticipate that an even more satisfactory result would be reached in the future.

DEUTSCHE SEE-TELEGRAPHEN-GESELLSCHAFT.—The annual meeting of this company was recently held at Cologne, under the presidency of the Marquis of Tweeddale. The directors' report for 1901 states that in consequence of the prolonged interruptions to the Emden-Vigo cable, the result of the year's working has not been so satisfactory. The first interruption lasted from Jan. 28 to March 13, and the second from Nov. 1 to 9. Considerable expense was incurred in making the repairs, owing to unfavourable weather, and the traffic was also adversely affected, compared with 1900. After transferring £4,200. 6s. 2d. to renewal fund, and deducting the usual amount for depreciation, the net profit for 1901 was £6,085. 13s. 11d., plus £1,305. 4s. 3d. brought forward, making a total of £7,390. 18s. 2d. £304. 5s. 8d. is put to general reserve, a dividend of 3 per cent. absorbs £5,250. 14s. 10d., leaving a balance forward of £700. 9s. 2d.

ENGLISH ELECTRO-METALLURGICAL CO. (LTD.)—At the meeting on Friday, the chairman (the Marquis d'Hautpoul) referred to the complications which had arisen in the execution of the purchase contract by differing interpretations put upon it by the Elmore Trust and themselves. The matters in issue involved more than £12,000 of claims by the vendors, which the directors repudiated. The company had been upon a commercial basis since January, gradually increasing their output and extending their connections. The manufacture proceeded without the smallest hitch, and for that they owed acknowledgments to their colleagues, who had brought to Leeds the best of their experience at Dives, and had produced works which already demonstrated clearly considerable advantages over the original from which they had been copied. At present their output was on the basis of 25 tons gross per week, but they were really installed for 60 tons. Mr Elliott's appointment had been most fortunate, and as works manager Mr. Parkes had previously had intimate charge of electrolytic work. Messrs. Demmler and Bethmont, who had also joined the staff, had had great experience of the Elmore-Secretan processes in the French works. Under the advice of their managers they had decided to add a small plant for making brass tubes. The plant would be capable of turning out about 80 tons a month, and would greatly facilitate them in taking orders from firms who required supplies both of copper and brass goods.

NEW GENERAL TRACTION CO. (LTD.)—At the meeting on Monday the chairman (Baron E. B. D'Erlanger) said that the accounts presented showed some noteworthy changes. The share capital remained unaltered at £370,000, but there appeared £181,300 debentures for the first time. The balance of profit for the year ended March 31 was £40,000, making, with the unappropriated balance, £81,000. The £561,798 in securities in different companies compared with £482,073 in the last balance-sheet. The item of Parliamentary deposits stood at under £3,000, against £20,367 at March 31, 1901, which implied that a great deal of the work under construction had been completed. The goodwill at cost (£120,000) had been wiped out by the transfer of £70,000 from the available balance and the appropriation of the two reserve funds. He thought the policy of passing the dividend was in the interests of the shareholders. The auditors and the directors had valued the shares held in subsidiary companies at par, and they could not value them at any other figure. After giving particulars of the tramways in Douglas, Coventry, Norwich and Philadelphia, he said that, allowing for the completion of certain work, the company's securities in those undertakings aggregated £620,000, and they had other assets worth about £10,000, while the total capital expenditure was £606,000. In five years they had accumulated that large amount of securities, and had paid about £70,000 in dividends.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRIC GARAGE AND STORAGE CO. (LTD.)—Reg. April 18, capital £100 in £1 shares, to carry on the business of an electric carriage and storage company, to construct and deal in carriages, motor vehicles, electrical appliances, &c., and to produce and supply electricity. Reg. office, 65, New Broad-street, London, E.C.

NEW BRITISH ARC LAMP CO. (LTD.)—Reg. May 5, capital £10,000 in £1 shares, to adopt an agreement with the Davy Electrical Construction Co. (Ltd.), to carry on the business of electricians, electrical and mechanical engineers, producers and suppliers of electricity, manufacturers of and dealers in plant, apparatus, lamps, cables, wires, accumulators, &c.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)—In the return to April 7 the capital is given as £50,000 in 10,000 shares of £5 each, 3,561 of which have been taken up, and £5 per share has been called and paid up. Mortgages and charges, £20,000.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)—In the return to March 12 the capital is £1,400,000 in 80,000 ordinary, 80,000 preference, 80,000 City ordinary and 40,000 City preference shares of £5 each, of which 70,000 preference, 70,000 ordinary and 40,000 City ordinary have been taken up. £5 per share has been called up on 70,000 preference and 70,000 ordinary shares, and £700,000 has been received. £200,000 is considered as paid on 40,000 City ordinary shares. Mortgages and charges, £450,000.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The return to March 19 gives the capital as £400,500 in 74,000 ordinary shares of £5 each, 6,000 preference shares of £5 each, and 500 founders' shares of £1 each, of which 44,436 ordinary, 6,000 preference and 500 founders' have been taken up. £5 per share has been called up and paid on 37,770 ordinary and 6,000 preference shares. £33,830 is considered as paid on 6,666 ordinary and 500 founders' shares. Mortgages and charges, £150,000 debenture stock and £8,800 buildings.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The return to March 26 gives the capital as £1,200,000 in 40,000 preference and 80,000 ordinary shares of £10 each, of which 40,000 preference and 70,595 ordinary shares have been taken up. £10 per share has been called up, and £1,105,950 has been received. Mortgages and charges, £700,000.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The return to March 24 states that the capital is £95,000 in 13,000 ordinary and 6,000 preference shares of £5 each, of which 12,931 ordinary and 6,000 preference have been taken up. £5 per share has been called up and paid. No mortgages or charges.

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FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—The return to April 9 gives the capital as £50,000 in 10,000 shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, £50,000.

FRANK SUTER & CO. (LTD.)—In the return to April 9 the capital is £20,000 in 6,500 preference and 13,500 ordinary shares of £1 each, of which 2,050 preference and 13,404 ordinary have been taken up. £1 per share has been called up on 2,050 preference and 3,404 ordinary shares, and £5,454 has been received; 10,000 ordinary shares are considered as fully paid. Mortgages and charges, £7,000.

WARRINGTON AND DISTRICT ELECTRIC LIGHT AND POWER CO. (LTD.)—The return to March 26 gives the capital as £2,000 in £1 shares, 1,919 of which have been taken up. £1 per share has been called up on 1,869 shares, and £1,818 has been received; 50 shares considered as fully paid. No mortgages or charges. Capital increased to £5,000 April 26, 1902.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 23⅞d. per oz. (May 15). Consols (2¾ per cent.) ⅝5—95⅛ for money, 95⅛—95¼ for account; 2½ per cent. 95¼—95⅜ (May 15). Consols Pay Day June 2; Stocks and Shares Continuation Days, May 27 and June 10; Ticket Days, May 28 and June 11; Pay Days, May 29 and June 12; Mining Share Carry-over Days, May 23 and June 9.

BROWETT, LINDLEY & CO. (LTD.)—This company has made an issue of £30,000 5 per cent. debentures.

COMPAGNIE FRANCAISE DES TRAMWAYS ELECTRIQUES ET OMNIBUS DE BORDEAUX.—A dividend of 5fr. for the year to Dec. 31 has been declared. Ninety-three shares have been drawn for redemption, a list of which can be seen at the Comptoir National d'Escompte de Paris, 52, Threadneedle-street, London, E.C.

DUNDERLAND IRON ORE CO. (LTD.)—Some particulars have been published relating to the formation of the above company, whose object is to employ on a large scale Mr. T. A. Edison's recently perfected process of treating low-grade ores electrolytically. The company will own an exclusive licence for the use of a process which is regarded as of the very highest value in connection with the treatment of the immense iron ore deposits in Norway and Sweden, which have not hitherto been of value commercially. The company starts under the most favourable conditions as to the directorate, the members of the board being gentlemen of the highest position in the metal and engineering industries. The capital of the new company is to be £2,000,000, in equal moieties of £5 ordinary and cumulative 6 per cent. preference shares. Of these the public have been this week invited to subscribe for 200,000 preference at par. Water power to the extent of 40,000 H.P. is said to be available close to the mines, and land sufficient to provide for the construction of the necessary railways, tramways, wharves, buildings, &c. Labour in quantity is cheap, and the climatic conditions will enable operations to be conducted all the year round. The enterprise will be the most extensive of its kind ever established. From reports in the daily press it would appear that the subscription for capital recently invited has proved successful.

GENERAL ELECTRIC CO. (U.S.A.)—The proposal to increase the capital stock from $25,000,000 to $45,000,000 has been approved. In the report of the directors the following remarks are made:—

We have so perfected the methods of collecting current, controlling motors and transmitting electric current that we see no serious engineering obstacle to the displacement of steam locomotives on many existing steam railroads where the conditions of traffic show the electric system to be economical. That electricity is thoroughly reliable and entirely able to handle heavy passenger traffic with success has been amply demonstrated by many installations in regular operation for several years. Steam railroad managers are showing more interest in electric traction, and the company's engineers have carefully studied the problems presented by large terminals and heavy traffic conditions. There has been a notable increase in the mileage and importance of electric railways, due to the consolidation of adjoining systems and the development of high-speed inter-urban lines. The successful operation during the year of transformers at 80,000 volts renders practicable the use of hitherto unavailable water powers and the transmission of power therefrom over distances of 200 miles or more, in competition with coal. This is the highest pressure for which transformers have been commercially built. The highest was previously 60,000 volts. Electrical energy is now commonly transmitted over distances from 50 to 100 miles with commercial economy. The company has recently closed an order for several electric generators, each of a capacity of 10,000 H.P., for a new power-house at Niagara Falls, which are 50 per cent. larger than any machines heretofore built. Another order of five 5,000 H.P. generators for Niagara Falls has been received, making a total of 11 machines of this size ordered for that plant. The order for the electrical equipment of trains for the Manhattan Elevated Railway calls for the construction of 1,800 125 H.P. motors.

ISLE OF MAN TRAMWAYS.—Mr. E. Shenck, who purchased the undertaking of the Isle of Man Tramways and Electric Power Co. (with the exception of the Douglas section) for £252,000, has been granted an extension of time to May 31 for the completion of the purchase.

MUNICIPAL ISSUE.—Cardiff Corporation this week made an issue of £742,000 3 per cent. redeemable stock, at £96, for the purchase of tramways, the construction and equipment of electric tramways, electric lighting, &c.

PACIFIC COMMERCIAL CABLE CO.—This company has increased its capital from $3,000,000 to $12,000,000 to provide for the completion of the proposed San Francisco-Manila cable.

PARIS METROPOLITAN RAILWAY CO.—For the past year the total receipts were £342,002, and working expenditure was £161,263. The gross profits amounted to £180,735, out of which £111,125 was paid to the Municipal Council, leaving a net profit of £69,510. A dividend of 15f. per share has been declared.

PRIMITIVA GAS AND ELECTRIC LIGHTING CO. OF BEUNOS AYRES (LTD.).—At the meeting, on Tuesday, the chairman (Mr. H. E. Jones) said that £300,000 of their capital was represented by a very efficient and profitable electric light undertaking. The earnings of this electric light undertaking, separately, would justify a larger dividend than they had declared upon the whole undertaking, but it was all new plant. It had been largely constructed within the last two years. The sale of gas did not show any increase, but electricity showed an increase of 8 per cent. Mr. Joseph Kincaid (Messrs. Kincaid, Waller and Manville) has joined the Board.

SNOWDON MOUNTAIN RAILROAD.—At the meeting last week the chairman stated that the line was in an efficient condition and that the traffic during the past season had been dealt with in a satisfactory manner.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—Letters of allotment for the recent issue of 45,000 shares have been posted.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed May 22 a special settling-day in 30,000 £5 fully-paid 5 per cent. cumulative preference shares of the *Isle of Thanet Electric Tramways and Lighting Co. (Ltd.)* and May 27 a special settling-day in the further issue of 40,000 £1 fully-paid shares of the *Cape Electric Tramways (Ltd.)*, and has also ordered the securities to be quoted. The committee has also been asked to allow $397,000 additional 30-year consolidated mortgage 5 per cent. gold coupon bonds, 1926, of the *Milwaukee Electric Railway and Light Co.* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	May 3	683	+ 30	48	33,977	+ 2,136
Ayr Corporation	„ 10	155	...	33	4,676	...
*Birmingham Tramways.	„ 10	4,723	+ 321	18	83,238	+ 28,217
*Blackburn Corporation..	„ 9	705	+ 4	19	12,076	+ 1,415
Blackpool Corporation...	„ 8	493	+ 136	6	2,665	+ 48
Blackpool and Fleetwood	„ 10	332	- 3	19	4,578	+ 293
Bolton Corporation	„ 11	1,511	+ 86	6	8,772	- 162
Bradford Corporation ...	..	...	...	...	...	...
Brighton Corporation ...	„ 11	689	...	24	13,832	...
Brisbane Tramways.....	Mar. 26	2,318	+ 344	13	30,113	+ 3,163
*Bristol Trams & Carriage	May 9	4,103	- 202	18	73,939	+ 4,181
Burnley Corporation ...	„ 10	667	+ 212	‡6	3,933	+ 1,181
*Buenos Ayres & Belgrano	Apl. 13	2,790	- 179	15	40,550	- 1,130
Calcutta Tramways Co...	May 10	R22,806	+R3,213	19	R421,127	+R38,769
Carlisle Tramways Co....	„ 10	149	- 10	†19	2,511	+ 34
Central London Railway	„ 10	7,088	+ 574	19	126,884	+ 9,346
City & South London Ry.	„ 11	3,050	+1,028	19	56,507	+18,649
Cork Elec. Tramways Co.	„ 8	615	+ 101	§18	7,328	+ 293
Devonport & Dist. Trams	„ 2	383	...	17½	6,720	...
Dover Corporation	„ 10	182	- 15	6	1,106	- 163
Dublin & Lucan Railway	„ 11	104	+ 6	19	1,752	+ 145
Dublin Southern Dist....	„ 9	808	+ 28	¶18	13,638	+ 3,636
Dublin United	„ 9	3,669	+ 146	¶18	63,256	
Dudley—Stourbridge ...	„ 2	681	+ 65	17½	11,417	+ 2,068
*Dundee Corporation ...	„ 7	683	- 18	...	...	...
East Ham Council	„ 10	401	...	46	16,607	...
Gateshead & Dist. Trams	„ 2	682	...	17½	11,164	...
Glasgow Corporation ...	„ 10	11,712	+ 721	...	...	...
Greenock & Port Glasgow	„ 2	517	+ 307	17½	7,035	+ 3,951
Hartlepool Tramways ..	„ 2	233	+ 33	17½	3,431	+ 270
Hull Corporation	„ 10	1,608	+ 11	6	9,814	+ 72
Isle of Thanet Co.	„ 3	409	+ 85	...	...	...
Kidderminster & Dist....	„ 2	106	+ 9	17½	1,726	+ 150
*Liverpool Corporation...	„ 3	9,521	+ 557	18	161,023	+14,781
Liverpool Overhead Rly.	„ 11	1,419	- 197	‡19	26,657	- 2,510
Manchester Corporation	„ 10	2,588	...	§48	99,501	...
Merthyr.....	„ 2	201	- 57	17½	3,332	- 423
Middleton	„ 2	281	...	5½	1,587	...
Newcastle-on-Tyne Corp	„ 10	2,558	...	...	...	...
Oldham, Ashton & Hyde.	„ 2	514	+ 33	17½	8,229	+ 33
Perth (W.A.) Elec. Trams	„ 9	1,057	+ 252	‡45	44,009	+14,332
Poole & Dist.....	„ 2	245	- 1	17½	3,619	+ 37
Portsmouth Corporation	„ 10	1,281	+ 758	...	...	...
Potteries	„ 2	1,476	+ 110	17½	24,056	+ 1,006
Salford Corporation ...	„ 12	2,353	...	6	13,408	...
*Sheffield Corporation ..	„ 11	3,734	+ 231	19	70,061	+13,645
Southampton Corporat'n	„ 8	837	+ 114	18	14,569	+ 2,835
Southport Tramways	„ 2	228	+ 101	17½	2,860	+ 805
*S. Staffordshire Trams...	„ 2	769	+ 41	17½	12,753	+ 636
Swansea Trams.....	„ 2	424	+ 23	17½	7,918	+ 672
Taunton Trams.....	„ 2	56	...	17½	961	...
Tynemouth & Dist.	„ 2	218	+ 59	17½	3,480	+ 203
Wigan Corporation	„ 9	184	+ 104	6	991	+ 537
Wolverhampton District	„ 2	159	+ 109	17½	2,342	+ 1,510

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 7.	Price Wednesday, May 14.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 14.	
						£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.						
100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ ¾	¾ ¾		...	..	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100 104	100 104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11 12	11 12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103 106	103 106	6 5 2	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9 9¾	9 9¾	4 4 8	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	March and September	...	...
20,000	5	3 6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000) xd	8½ 9½	8 9	3 6 8	...	8¾	8½
10,000	5	3/1.6	Do (Nos. 20,001-30,000) xd	8 9	8 9		...	...	...
£250,000	Stock	...	Central Electric Supply Co. 4% Guar. Deb. Stock	106 108	106 108	3 14 9	...	...	...
50,000	5	6.0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9 10	9 10	5 0 0	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...	..	8¾	8½
70,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	,, ,,	5.⅝	1½
£250,000	Stock	4/0	Do. 4% Deb. Stock Red.	105 107	105 107	3 15 6	...	...	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½ 5¾	5 5¾	3 12 9	March	...	...
£150,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	110 113	110 113	4 0 2	June and December	1.½	1 2
70,579	10	10/0	City of London Electric Lighting Ord.	8 9	8 9	5 5 7	February and August	8½	8¾
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12¾	...
£400,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	123 128	123 123	3 18 10	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103 106	103 106	4 6 0	...	105½	...
20,000	10	8/0	County of London and Brush Prov. Ordinary	8 9	8 9	4 8 11	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	107 110	107 110	4 8 0	...	108¾	...
16,000	5	4.6	Folkestone Electricity Supply Co. Ordinary	6¾ 6½	6¾ 6½	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½ 6¾	6½ 6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104 107	104 107	3 14 11	...	...	...
£111,000	5	...	London Electric Supply Ordinary	1½ 1¾	1½ 1¾	..	...	...	...
42,440	5	3/0	Do. 6 per Cent. Preference	4 4½	4 4½	6 13 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95 100	95 100	4 0 4	Mar., June, Sept., Dec.	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15½ 16¼	16 17	3 16 6	April and October	17	16
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 115	111 115	3 18 2	June and December	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 100	97 100	3 10 8	...	98¾	...
10,552	10	6/0	Notting Hill Electric Ordinary	14 15	14 15	4 0 0	March	14½	...
12,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 8 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	93 101	93 101	3 19 8	...	...	...
300,000	1	...	Rand Electric	⅛ ⅛	⅛ ⅛	...	...	...	...
£125,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	65 70	66 72	...	January and July	70	69¾
£100,100	100	4½	Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	102 104	103 105	4 6 9	April and October	...	...
40,000	5	9 6	St. James's and Pall Mall Electric Ordinary	14½ 15½	15 15½	4 13 7	February and August	14¾	...
20,000	5	8/6	Do. 7 per Cent. Preference	8¾ 9¾	8¾ 9¾	3 13 8	,, ,,	9¾	9
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98 101	98 101	3 9 6	...	...	...
12,000	5	..	Smithfield Markets Electric Supply Ordinary	1¾ 2¾	1¾ 2½	..	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	...	...
68,000	5	...	South London Electric Supply Ordinary	2¾ 3½	2¾ 3½	...	...	3⅛	...
110,000	5	5 6	Westminster Electric Supply Ordinary	1 1¾	11 12	4 7 6	March and September	1.⅜	...
28,141	5	...	Do. 5 per Cent. Cumulative Preference	3½ 4	3½ 4	...	...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	3¾ 4½	4 4½	4 14 2	April and October	4⅛	4
£220,000	Stock	6%	Do. Permanent 6% Deb. Stock	115 130	125 130	4 18 9	...	...	...
20,000	10	...	Barcelona Tramways Ordinary	7¾ 8¾	7¾ 8¾	...	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	8 9	8 9	5 11 1	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95 100	95 100	4 10 4	...	95½	95
15,000	10	9/0	Blackpool and Fleetwood Tramways	13 14	13½ 14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3 3½	3 3½	...	...	3⅛	...
75,000	5	2/6	Do. 5% Cum. Pref. xd	4½ 5	4½ 5	5 0 0	...	4¾	4⅛
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	104 107	104 107	4 4 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	...	...
25,000	10	6%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	109 111	107 110	3 12 9	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	6¾ 7	6¾ 7¼	2 15 2	...	7	...
20,000	10	5/0	Do. 5% Preference	9⅝ 9¾	9⅝ 10	5 0 0	May and November	9¾	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102⅞ 104⅛	102⅞ 104⅞	4 6 9	...	...	...
100,000	10	6/0	British Electric Traction Ordinary	13½ 14¼	13⅝ 14⅛	6 4 2	...	14	13¾
100,000	10	6/0	Do. 6% Cum. Pref.	12¾ 13¼	12¾ 13¼	4 14 1	February and August	13¾	13⅛
£800,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	121 127	121 127	3 18 9	...	126	12.⅛
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1¾ 1¾	1¾ 1¾	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4¾ 5¼	4¾ 5¼	5 14 3	...	...	...
27,500	5	10/0	Do. "B"	4¾ 5¼	4¾ 5¼	5 14 3	...	...	...
£230,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	105 106	4 14 4	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 0	...	...	...
34,440	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	14½ 15½	13⅝ 14½	2 1 5	...	14¾	13¾
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107 109	107 109	4 3 7	...	108⅛	108
440,000	1	1/2½	Cape Electric Tramways Shares	2½ 2¾	2⅝ 2¾	3 6 2	...	2½	...
£1,810,014	Stock	4%	Central London Ordinary Stock	103 106	103 106	3 15 11	June and December	105⅛	1 4½
£494,093	Stock	4%	Do. 4% Preferred Stock	103 106	103 106	3 15 11	...	1.5⅜	...
£494,993	Stock	4%	Do. Deferred Stock	100 103	100 103	3 17 11	...	...	...
£686,201	100	4%	Do. 4% Deb.	116 118	116 118	3 8 0	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5¼	5 5¼	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...	...
£1,330,000	Stock	2½%	City and South London Railway Con. Ordinary	70 72	72 74	2 14 1	February and August	73¼	70
37,500	10	1/0⅝	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	... ...	... ...	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 15 5	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	124 127	124 127	3 18 10	...	126¼	126¼
£150,000	Stock	...	Do. (1901)	120 124	120 124	...	...	...	...
£446,463	Stock	8%	Do. 4 per Cent. Perpetual Debenture xd	113 117	114 116	3 9 7	May and November	115	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11¼ 12¾	11¼ 12¾	4 0 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½ 15¾	14½ 15¾	3 17 5	...	...	...
£100,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	86 89	86 89	3 10 8	...	...	...
31,000	5	6.0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4 4½	4 4½	6 13 4	...	...	...
£75,000	Stock	40/8	Do. 5 per Cent. Debenture Stock (red.)	101 104	101 104	4 15 2	...	...	...
78,600	10	8/0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	...	...	...
20,000	10	8%	†Imperial Tramways Ordinary	16¼ 17½	16¼ 17½	3 13 6	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½ 14½	13½ 14½	4 4 0	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110 112	110 112	4 0 6	January and July	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4⅜ 5	4⅜ 5	3 0 0	February and August	...	...
10,000	10	8%	Do. 5 per Cent. Preference	10⅜ 11	10⅜ 11	4 11 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98 99	98 99	4 0 10	January and July	...	...
51,501	10	..	London United Trams 5% Cum. Pref. (£10 paid)	...	10½ 11½	...	...	...	...
10,999	10	...	Do. (£5 paid)	...	5½ 6	...	...	...	...
£655,341	Stock	...	Do. 4% 1st Mortgage Debenture Stock	...	104 106	...	...	105	104½
£169,659	Stock	...	Do. Prov. Certs. (£50 paid)	...	53 55	...	...	...	...
96,103,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 6% 30yr Cn. Mrt. Bonds	111 115	111 115	4 0 11	...	...	...
£80,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908)	103 105	104 106	4 14 9	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1932)	102 104	103 105	4 5 10	...	...	...
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 3 4	...	...	...
80,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½ 4½	3½ 4½	6 13 4	May	...	...
£161,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96 100	96 100	5 0 0	...	...	...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stck.	99 102	100 103	4 12 9	...	101½	100½
5,334	10	8/0	Potteries Electric Traction Ordinary	9½ 10½	9½ 10½	3 16 2	...	...	...
10,000	10	8.0	Do. 8 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	...	...
£320,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock xd	106 109	105 108	4 3 0	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...	...	...	...
51,132	1	...	Do. 6% Preference (10/0 paid)	...	...	...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...	...	...	...	...	...
£500,000	Stock	...	Do. 4½% Debenture Stock (50% paid)	...	...	...	January and July	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	91 94	91 94	3 4 0	June and December	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 7.		Price Wednesday, May 14.		Rate per Cent. Yielded,	Dividend Due.	Business Done During Week Ending May 14.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅜	4⅜	3⅜	4⅜	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...		...	...
£7·8,840	Stock	12/6	Anglo-American	44	47	44	47	5 19 5	Feb., May, Aug., Nov.	44	...
£3,105,580	Stock	25/0	Do. Preferred	89	91	88	90	6 9 2	" "	90	88⅝
£3,105,580	Stock	2/0	Do. Deferred	7	7⅛	7	7⅛	1 6 8	" "	7 1/16	7 1/16
$13,333,300	$100	$12	Commercial Cable Capital Stock	150	160	150	160	5 0 0	Jan., Apr., July, Oct.	...	...
1,341,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	93	96	93	96	4 3 4	" "	£4	93⅝
16,000	10	4/0	Cuba Submarine Ordinary xd	4	5	4	5	8 0 0	February and August	4⅛	...
6,000	10	10/0	Do. Preference 10 per Cent. xd	13	14	12½	13½	7 8 2	" "	1⅜	...
13,000	5	2/0	Direct Spanish Ordinary	2⅛	3⅛	2⅛	3⅛	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8⅛	9⅛	8⅛	9⅛	5 5 3	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	98%	102%	98%	102%	4 8 3	January and July	...	...
60,710	20	3/0	Direct United States Cable	9⅛	10⅛	9⅛	10⅛	6 3 10	Jan., Apr., July, Oct.	10⅛	...
£101,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200) (red.)	120	130	1 7	127	5 10 3	Jan., Apr., July, Oct.	122½	117½
£1,930,807	Stock	17/6	Do. 3% per Cent. Preference Stock	83	86	84	87	4 0 8	" "	86⅛	84⅛
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.) xd	107	111	106	110	3 12 9	May and November	1 1	106⅛
300,000	10	6/6	Eastern Extension xd & bonus	12⅝	13⅛	12	13	5 7 8	Jan., Apr., July, Oct.	13	12½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	112	107	112	3 11 10	February and August	111	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 17 4	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	99%	102%	99%	101%	3 18 5	May and November	...	...
150,000	10	20/0	Great Northern of Copenhagen	26	28	26	28	5 7 2	January and July	27½	...
£75,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthin Nos.	99	103	99	103	4 8 3	June and December	100	...
17,000	25	37/6	Indo-European [1 to 1,200) (red. xd	37	41	37	41	6 1 11	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 7	June and December	...	...
15,609	...	...	*West African Telegraph Shares	1⅛	2⅛	1⅛	2⅛	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99	101	99	102	4 19 0	March and September	...	...
30,008	2½	...	West Coast of America	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅛	⅜	⅛	⅜	...	May and November	⅝	1 9/16
34,563	10	£/0	Do. 6 per Cent. 1st Preference	5½	6	5½	6	10 0 0	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3¼	4½	3¼	4½	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	101	104	101	104	4 16 8	January and July	...	...
207,930	10	3/0	Western Telegraph (late Br zil'n Submarine)	11⅛	12⅛	11½	12½	5 16 4	Mar., June, Oct., Dec.	12	11 1/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1905)	102	106	102	106	4 15 3	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 18 5	...	99½	...
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3⅜	4	3⅜	4	6 5 0	August	3⅜	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	⅝	½	⅝	5 0 0	November	...	...
86,492	1	1/6	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£983,333	Stock	£%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	98	96
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	3⅛	3⅜	3⅛	3⅜	6 4 6	...	...	...
£1,906,667	Stock	4½%	Do. Deferred Stock	56	60	55	59	7 12 4	...	53	55
1a,000	£0	0/0	Do. 6 per Cent. Cumulative 1st Preference	12	14	12	14	4 5 9	February and August	12½	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	12	14	4 5 9	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	4⅞	5⅛	4 17 7	" "	5	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	94	97	94	97	3 12 5	June and December	95½	94
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	103	107	103	107	3 15 8	...	104½	103½
171,504	1	0/8	Oriental xd	1 1/16	1 1/16	1 1/16	1 1/16	5 12 11	April and October	1 1/16	...
58,000	5	2/6	United River Plate	4⅜	5⅛	4⅜	5⅛	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	5 0 0	June and December	...	...
£179,247	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 8	June and December	...	...
			ELECTRIC MANUFACTURING &c.								
£70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛	¼	⅛	¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛	¼	⅛	¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜	⅜	⅜	⅜	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	8	9	8	9	8 6 8	July and February	...	...
70,000	5	3/0	Do. 6 per Cent. Preference	5½	5¾	5½	5¾	5 4 0	January and July	...	...
£250,000	Stock	50/3	Do. 4½% 1st Mort. Deb. Red.	102	105	102	105	4 5 11	...	...	...
150,000	5	3/0	British Westinghouse 6% Preference	5⅛	5⅜	5⅝	5⅞	5 2 2	...	6	5⅞
105,731	2	...	Brush Electrical Engineering	¾	1⅛	¾	1⅛		March	...	...
150,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	1⅛	2	1⅛	2	4 13 0	March and September	1 1/16	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	101	104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	95	100	95	100	4 10 0	January and July	...	...
80,000	5	5/0	Callender's Cable Construction Ord.	17	18	17	18	4 3 4	" "	17½	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	" "	6	5 15/16
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111	115	111	115	3 18 4	November and May	...	...
150,000	1	0/4½	Castner-Kellner Alkali Co. (fully paid)	¾	1	¾	1	3 0 0	...	1	...
£250,000	Stock	6½%	Do. 4½% First Mort. Deb. (red.)	87	92	90	95	4 16 0	...	93½	93
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	8 0 0	March	...	...
85,000	3	1/9½	Crompton and Co. (Nos. 1 to 54,000)	3	3½	3	3½	6 8 6	January and July	3⅜	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103%	108%	103%	108%	4 12 8	" "	107	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅛	⅜	⅛	⅜	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	2	3	2	3	...	...	...	...
£344,022	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	75	80	75	80	5 1 3	June and December	...	...
26,500	5	2/6	Edmundson's Electricity Corporation Ord.	6½	6¾	6½	6¾	5 3 3	Half-yearly	6½	6 7/8
120,000	5	3/0	Do. 6% Cumulative Preference	6	6⅛	6	6⅛	4 12 4	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	107	110	4 2 7	...	109	...
112,100	2	1/2½	Electric Construction Co.	1½	1¾	1½	1¾	6 17 2	January and July	1 5/16	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅛	3	2⅛	3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97	101	97	101	3 19 3	January and July	101	...
122,185	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾	1⅛	¾	1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	9⅞	10⅛	9⅞	10⅛	4 17	...	10	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98	101	98	101	3 19 3	...	...	...
35,000	5	10/0	Henley's Telegraph Works Ordinary	17	18	17	18	4 3 4	February and August	17 1/16	...
35,000	5	3/3	Do. 6% per Cent. Preference	5⅛	6	5⅛	6	3 15 0	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	115	111	115	3 18 3	" "	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21½	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
27,350	12	36/0	Telegraph Construction and Maintnce.	34	37	24	37	6 9 8	March and July	38½	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	106	3 15 5	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary xd	10½	11⅛	10	11	5 9 1	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	6	5⅛	6	4 3 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary		...	8⅛	9⅛	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.		...	6⅛	6⅞	...	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures		...	105	107	...	May and November	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	5⅜	5⅛	5⅜	5 9 1	...	...	...
180,327	10	2/6	Globe Telegraph and Trust	8	9	8	9	5 16 8	Jan., Apr., July, Oct.	8 1/16	8⅛
140,042	10	3/0	Do. 6 per Cent. Preference	12½	13⅛	12½	13⅛	4 8 11	" "	13	12⅝
11,239	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	11½	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

An important announcement was made by Lord Windsor at the last sitting of his Committee on London underground railways before the Whitsun recess. It appears that the Committee, in considering the Bills before it competing for powers along the Hammersmith—Charing Cross—City route, is proceeding by a process of elimination, and among the last schemes to be weeded out is the proposed extension of the Central London Railway into a flat ellipse. Mr. Balfour Browne, the counsel opposing this measure on behalf the Morgan combination, put many objections to the measure before the Committee, and some, at any rate, have proved vital. He suggested that it was a scheme that would never be realised, and that it was merely promoted to block the way for any other scheme along the route which might compete with the existing Central London line, arguing that the two routes were so close together as to be competing. Anticipating that this attack might not prove effective, Mr. Browne quoted an indiscreet statement in the company's original prospectus to the effect that the company's policy was not one of expansion; and he followed this up by reminding the Committee that the Company's Chairman had admitted in cross-examination that no definite scheme for the acquisition of the extra capital required for the new line had been put before the shareholders.

Another interim decision of the Committee is that the connecting link between the Brompton—Piccadilly Circus Railway and Charing Cross, which was desired by the Yerkes group of Bills to effect through communication to the City, is to be abandoned. The result of these two decisions is that we are now dependent for a through route along Kensington Gore, Knightsbridge and Piccadilly to the City on the passing of the main part of the Morgan—London United Tramways combined scheme.

Prof. Birkeland's electromagnetic cannon has attracted considerable notice, not unmingled with curiosity, in scientific circles and among the general public. It is now stated that a German firm of ordnance manufacturers has offered to buy the rights to the invention. In the electromagnetic method of imparting speed to projectiles there is one great advantage over the chemical, or explosive, method. For, whereas with explosives it is practically impossible to increase the muzzle velocity without a corresponding increase in the sudden stresses set up at the moment of explosion, with electromagnetic force the muzzle velocity can be augmented without any increase in the stresses on the gun merely by making the gun longer. Moreover, in the chemical or other explosive gun, the initial force is the maximum force, and the impelling force diminishes rapidly as the projectile moves towards the muzzle. But, in the electromagnetic gun the impelling force can be maintained at its maximum value almost up to the muzzle, and thus the whole length of the cannon can be utilised to greater advantage. An electromagnetic cannon, in fact, is a high-speed electric tube railway, constructed so that there is rapid acceleration during the whole length of the tube. If higher speed is wanted, it is only necessary to turn on more current or to have a longer tube. We do not doubt that, by building an extremely long cannon, it would be practicable to impart even interstellar speeds to projectiles by this method.

Complaint has already been made in these columns of the inferior quality of the Papers presented at the London meetings of the Institution of Electrical Engineers, and the justness of this is borne out by the list of premiums awarded by the Council. From this list, which is included in our abstract of the Council's report published in another column of this issue, it will be seen that only one Paper read at Great George-street this session has been honoured with a premium—viz., Mr. S. G. Brown's excellent Paper on a relay for long submarine cables. This Paper has received the Fahie premium, one which is usually bestowed upon the best Paper on telegraphic or telephonic subjects.

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Herr Lasche's Paper at Glasgow, describing his investigation of the problem of high-speed electric railways and his experiments towards the solution of it, was well deserving of the Institution premium which it obtained; and no one will grudge the successful readers of Papers at local sections their success, especially as the quality of the Papers submitted at these branch meetings of the Institution has vastly improved. Yet once again we wish to urge members of the Institution and of its Council to renewed efforts. So far as membership is concerned, the Institution is in a healthy condition, but the results shown in Papers and committee reports are most disappointing. Papers as excellent as those forthcoming a few years ago are not submitted to the Institution, and the majority of the various special committees have moved far too slowly, with the result that their labours have been for the greater part futile. For instance, what has become of the Committee on Standardisation? The only report received from it so far has been a recommendation as to frequency made three years ago.

Whether or no it is right that local authorities should spend the money of their ratepayers in making experiments is a broad question which has been discussed in these columns on other occasions. Although it may not be correct in financial principle, the experiment made by the Corporation of Wolverhampton in putting down a surface-contact system of tramways is one we welcome. The Lorain Steel Co.'s system, which we describe in considerable detail this week, is one of the few which is likely to offer a practical solution of the problem, and will now have a fair trial on a working basis. It may be noted that the cost of the system is about £1,800 per mile of single track, this figure including the cost of the contact studs, feeder pillars and distributing cable, and excluding feeders and rails. This is not immeasurably greater than the equivalent cost of the best practice in trolley-poles and wire, but it must be remembered that the latter is almost the same for double as for single track, while the costs of the surface contacts and their wiring for double track is very nearly twice the equivalent for a single line of rails.

Return of Lord Kelvin.—Lord and Lady Kelvin were among the passengers who arrived at Liverpool from New York on Saturday by the "Lucania."

Hailstorm at Farnham.—A violent hailstorm, accompanied by vivid flashes of lightning and thunder, occurred at Farnham on the 18th inst. Hailstones as large as marbles are said to have fallen during the afternoon.

Lime-washing of Factories and Workshops.—The Secretary of State has issued an order granting exceptions to the lime-washing of factories in the case of electricity works. Exceptions will only be granted when a space of 2,500 cubic ft. is afforded for each person in the factory, though the order does not remove the obligation of keeping the particular building in a cleanly state.

New York Rapid Transit Railway.—Work on this underground railway has been making good progress during the year, and it is expected that traffic will commence before the end of 1903. It is proposed to make the stations of different colours and mural designs, so that a constant traveller will recognise his station immediately without searching for a sign. One station has already been completed, while others are in an advanced state.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Bolama	April 19, 1902
Puerto Plata—Martinique	May 6, 1902
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902

National Electric Light Association.—The above American association held its annual Convention this week, at Cincinnatti, when a number of interesting Papers were read and the works of the Bullock Manufacturing Co. were inspected. Among the Papers discussed were "Boilers Fired with Oil," "Best Efficiencies for Incandescent Lamps," "Advantages of Gas Engines," "Steam Turbines," and "The Protection of Long-distance Transmission Lines."

Incorporated Municipal Electrical Association.—At the Seventh Annual Convention of this Association (announced in our issue of 2nd inst., p. 44), the Westminster Palace Hotel, S.W., will be the head-quarters of the Council of the Convention. Those requiring accommodation at head-quarters or elsewhere must make their own arrangements, and are advised to reserve rooms at once. The majority of members having favoured a smoking concert in lieu of the usual annual dinner, arrangements are being made accordingly. Those members who wish to introduce visitors to the Convention must make early application to the secretary for visitors' tickets.

Train Telephones.—A recent issue of the *Western Electrician*, Chicago, contains particulars of the electrical equipment of 10 new trains to run between Chicago and San Francisco. In addition to the train lighting, which is carried out by means of incandescent lamps supplied with current from a steam-driven generator, a portable telephone is brought into use at the most important stopping places, and the instrument is temporarily connected with the local exchange system. Regular toll rates are charged, and a servant of the telephone company has the care of the instrument and collects the tolls. Other electrical conveniences on the train are curling-iron heaters and ventilating fans.

Glasgow Section of the Institution of Electrical Engineers.—The annual business meeting of the above was held last week, when Prof. Magnus Maclean presided. In the report of the work of the section, it was stated that the Papers had been of a high standard, and the president's address, Mr. Murray Morrison's Paper on "Aluminium" and Mr. Ward's Paper on "Mains" had been printed by the publishing committee of the parent institution. The membership increase was 81, the total number being now 189. Office bearers as follows were appointed:—Past chairmen, Lord Kelvin and Dr. Magnus Maclean; chairman, Mr. Henry Mavor; vice-chairman, Mr. W. A. Chamen; and hon. secretary and treasurer, Mr. E. G. Tidd.

Tramways and Light Railways Exhibition.—In our issue of the 2nd inst. we announced this forthcoming exhibition, and we now give further particulars from the *Tramway and Railway World*. Before the public announcement of the exhibition, some 75 firms who had exhibited in 1900 were allotted sections, and the full list, which was published in that journal, comprises about 160 of the leading firms interested in tramway enterprise. The British Westinghouse Company have secured by far the largest portion of the building, and their exhibit will extend the entire length of the large hall, other large exhibitors being, British Thomson-Houston Company, Brush Company, Dick, Kerr & Co. and British Electric Car Co.

Electrically-driven Mail Vans.—On Tuesday morning last the Post Office authorities commenced a series of trials with a mail van driven by electricity and constructed by Mr. Carl Oppermann. The van, which was on view at the recent Automobile Exhibition at the Agricultural Hall, Islington, is operated by A.B.C. accumulators, which will carry it about 40 miles on one charge. It is proposed to carry mails, chiefly in the City and West-end services, the journey on Tuesday morning being from Mount Pleasant to Waterloo. This is not

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the first occasion on which the Post Office authorities have tested electric mail vans, trials having been carried out in the early part of 1898 with vehicles of the defunct London Electric Cab Co.

Electricity in Steel and Iron Mills.—The advance in the use of electric power for operating steel and iron mills is dealt with in a recent issue of the *Electrical World*. A typical plant is instanced, which seven years ago employed a 20 H.P. dynamo to operate a 7-ton crane, the same works being now equipped with a plant of 2,000kw. capacity. This supplies power to some 5,000 H.P. of motors ranging from ½ H.P. to 150 H.P., and almost the entire machinery is driven by motor, with the exception of the main rolls. The author draws attention to his experience, in estimating the size of motors for this class of work, which recommends the addition of 25 per cent. in the motor capacity, a circumstance which sacrifices the efficiency somewhat, but decreases the danger of burn-outs during times of overload. Although direct currents are mostly used in such works, the modern plants now being erected employ alternating currents of low periodicity, and on account of their greater simplicity in the way of apparatus they are likely to hold the field.

A New Honorary Member of the Institution of Electrical Engineers.—At the meeting on May 15th it was announced that the Council had unanimously elected Prof. Antonio Pacinotti, of Pisa, Italy, an honorary member. Prof. Pacinotti, as is well known, was the first inventor of the closed-ring armature dynamo, and made a great step forward towards the generation of non-fluctuating continuous currents. He also employed a toothed armature core, a device which was forgotten for a long time, but is now almost generally employed in modern continuous-current dynamo practice. Signor Pacinotti's researches have been of a varied character, comprising studies of thermo-electric currents between metals and liquids and observations on photo-chemical currents. He was also one of the first, if not the first, constructor of a disc armature. Prof. Pacinotti is 61 years of age, having been born at Pisa in 1841. During the last few years he has lived in retirement, and has not associated himself prominently with electrical engineering matters.

High-tension Transmission Lines.—The Bay Counties and Standard Electric Companies of California, who are at present conjointly transmitting energy to San Francisco and neighbouring towns, have an extensive pole-line system, the construction of which has entailed considerable care. The *Journal of Electricity*, California, recently gave some interesting details of the sources from which the poles were selected. The Bay Counties lines are fixed to cedar poles, chosen from the best timbered sections of the Columbia River, these being specially noted for strength and lasting properties in the ground. The average life of this cedar is 30 years, and live trees only are used, cut and trimmed during the autumn and winter months. The poles vary from 25ft. to 60ft. high, the depth in the ground being 5ft. and 8ft. in each case. The Standard Company's lines are slung on sawed redwood poles, taken from the hearts of young trees, not more than four poles being cut from any single tree. Both companies have notices fixed to all their poles warning persons off the line and offering rewards for the conviction of anyone breaking insulators.

Electrical Equipment of a Shipyard.—The shipyards of the Fore River Ship and Engine Co., Mass., recently erected on the American Atlantic coast, are, according to the *Electrical Review* of New York, equipped throughout with electric power. The frontage extends 1¾ miles, and on an area of 11 acres some 14 large buildings and a number of smaller ones have been erected. The whole of the work is arranged to concentrate on a huge structure known as the ship house, a steel building high enough to permit the travel of cranes over any part of a battleship or other vessel lying on the stocks below. Continuous current at 240 volts is generated in the power house by two 300kw. direct-coupled sets, the load comprising some 175 motors, 165 arc lamps and about 2,000 incandescents. Motors are used for the operation of all tools, either by belt or directly, the tools including plate shears, planing machine, boring mills and large lathes, besides a large number of small portable tools employed in the building up of the ship's skeleton. Some large cranes are also in use, there being one of 150ft. span, having a run of 700ft., in the shipyard where plates, angles, &c., are stored.

Iron and Steel Institute.—The annual meetings of this Institute were held on the 7th and 8th inst. at the Institution of Civil Engineers, Westminster, when a number of interesting Papers were read, the majority of these dealing with the mining of ore, the construction of blast furnaces and the production of steel. A Paper by J. Douglas, past-president of the American Institute of Mining Engineers, described a generator for the manufacture of a fixed gas from wood, for use in gas engines or in the manufacture of steel. The plant has been installed at the works of the Montezuma Copper Co., Nacozari, Mexico, where Crossley gas engines, developing 70 B.H.P., are used to drive 50kw. dynamos. The producer is of the down-draught form, of the Loomis pattern, the chief feature of this system being the generation and separate collection of water and producer gas. The efficiency of the mixed gases, whether made from wood or coal, is practically the same in the engines. The precise amount of gas generated per ton of coal or wood has not been measured, but the consumption of coal per horse-power-hour, measured electrically, is 1·5lb., and of wood 3lb., there being 20 per cent. of ash with the coal.

Birmingham Local Section.—On Wednesday, 14th inst., the members of the above section visited the Corporation electricity works at Water-street at the invitation of Mr. J. C. Vaudrey, city electrical engineer. The station, though not so large as that at Dale End, has a capacity of 2,000kw. After inspecting the plant, adjournment was made to the Grand Hotel, where the members were the guests of Mr. J. C. Vaudrey.——The report of the committee announces an increase in the membership during the session, there being 152 members on the roll. Offers are invited for Papers from the local members, and a bye-law has been passed which makes it necessary that a nomination of officers during future sessions should be made by one member and supported by two members or associate members. The following officers have been elected for the coming session :—

Past Chairman : Oliver Lodge, D.Sc., F.R.S. Chairman : Henry Lea, M.I.C.E. Vice-Chairman : F. C. Vaudrey, M.I.C.E. Committee : F. Brown, A. Coleman, A. Dickinson, R. H. Housman, W. O. Rooper, W. E. Sumpner, D.Sc., A. M. Taylor, R. Threlfall, F.R.S.

Dr. D. K. Morris has consented to act as hon. sec. for the session.

Electrically-driven Cotton Mills.—Some interesting particulars regarding the operation of cotton mills by electricity were given recently in *Cassier's Magazine*. The mills described have been erected in the American Southern States, and there are some good comparisons drawn between the old and new methods of operation. The rope drive is quickly giving place to the electromotor, and in the construction of all new mills the provision of a generating station for the operation of the machinery is considered as a necessity. Failure of the engine with rope driving resulted in the entire stoppage of the plant, but with electricity a number of generators could be run on sections of the machinery, a system which enabled an interchange of power to take place should emergency demand it. The improved conditions of labour under which the operatives could work were conducive to greater steps in this direction, while the more satisfactory state of the atmosphere was also beneficial. The fact that a constant demand for power is made on the generating sets, keeps them running under the best conditions for all-round efficiency, and the operation of mills having now passed the experimental stage, considerable progress becomes possible.

Electrically-equipped Model Basin.—In the U.S. Navy Yard, Washington, there is a model basin for experimenting with different shaped and sized models, with a view to finding the resistance to be overcome for speeds corresponding to those of a vessel, and from the results the performance of a proposed design can be approximated. The basin, which is 40ft. wide by 470ft. long, is spanned by a towing carriage, somewhat similar to an engine-room crane, driven by four electromotors. These are coupled in pairs, through gearing, by a rigid shaft across the carriage, and they are controlled on the Ward-Leonard system, the armature E.M.F. being

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varied, and the field kept constantly excited from a separate source. The carriage can be reversed and arrangements are made for controlling the speed or bringing the whole moving portion to rest speedily. Speeds up to 18 knots an hour can be obtained, and at this speed the motors are used as generators for braking purposes. Two cranes driven by small motors are fitted to the carriage for the purpose of handling the various models. For the measuring apparatus electricity is used to a considerable extent, and there are also a number of electrically-driven tools employed in the building for the construction of the models. The generating station contains three 125kw. generators, directly connected to McIntosh and Seymour engines, and also two smaller sets of 15kw. and 40kw. capacity for furnishing the exciter current. The entire equipment was recently described in the *Electrical World*, New York.

Prof. Blondel's Fluxograph.—At a recent meeting of the French Physical Society, Prof. Blondel described a new apparatus for registering the curves of magnetic flux in any circuit. A search coil is wound round the magnetic circuit, and connected to the primary circuit of a transformer containing no iron, the secondary of which is connected to the fluxograph. The latter is a galvanometer without directing torque or damping effect. Denoting the flux by ϕ, the inertia of the moving part of the meter by K, the equation of the movement can be written $A\frac{d^2\phi}{dt^2} = K\frac{d^2\theta}{dt^2}$, A being a constant. The cycle of variation of the needle deflection, therefore, reproduces the cycle of variation of the flux. For developing the curve of variation of this angle as a function of the time, Prof. Blondel uses a mirror revolving with uniform speed, as is already used with his oscillograph. An iron box enveloping the meter coil prevents influence from outside magnetic field of force. The coil is fixed, and acts on a moving magnet resting on pivots and enclosed in a vacuum tube. Prof. Blondel states that many applications may be added to the one above pointed out. For registering directly the magnetising cycle of an iron sample, he replaces the rotating mirror by an oscillating plane mirror mounted on a galvanometer with horizontal axis.

Cable-laying Plough.—M. A. Bajac, of Liancourt, Oise, has brought out a new form of plough for laying cables, chiefly for telegraph work, over soft ground. It is a large and heavy instrument on two wheels, with a beam sliding in vertical guides, and operated by worm gearing to give the necessary depth to the share. This latter is formed of two steel plates with a cutting edge, and in front are two coulters to loosen the soil ahead of the main share. A cable drum is mounted on the rear end of the plough, the cable passing round rollers to the cutting which has been made by the plough, the drum revolving and paying out the cable as the plough proceeds. A traction engine with winding gear does the necessary hauling, in a similar manner to steam ploughing, a distance of 200yds. being cut and laid. A speed of about 1¼ miles an hour is possible over soft soil, though the plough is capable of doing work in hard ground, but at a lower rate. *Engineering*, in a recent issue, from whence we gather these particulars, says that the apparatus is to be employed by the French Government for the laying of a trans-African cable, which will put France in direct communication with Madagascar. The orignal cost of this particular project was estimated at £840,000, but it is expected that use of the plough will reduce these figures to about £360,000, the distance being 1,490 miles from Gabés, in Tunis, to Lake Tchad. The ground to be covered is of a sandy nature, so that trenching would be almost impossible, and the plough affords an easy way out of the difficulty, though, should it be a hard matter to procure water in the desert, the plough will be hauled by an oil engine, and failing this some dozen camels will be employed.

Three-phase Mining Plant.—At a recent meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers, Mr. J. H. Whittaker read a Paper on "The Advantages of Three-phase Plant for Mining Purposes." In his opening remarks he said that, on the whole, electricity for mining use had been taken up somewhat slowly—a circumstance which he attributed to the average mining engineer being ignorant of electrical science, and also that there existed a nervous feeling with regard to sparks firing gases in an unexpected manner. The pit bottom and underground engine rooms had been electrically lighted for some years, though the workings of the mine were somewhat neglected in this respect, chiefly on account of the difficulties encountered in carrying the cables into the mine. The various types of continuous-current motors were then dealt with, the general opinion of engineers being in favour of an open type machine, though enclosed motors were acceptable if constructed to admit of easy inspection. Three-phase plant represented the ideal for mining purposes; the motor, having no brushes, could be overloaded with less risk and without sparking or burning. For pumping they were especially useful, as, once started, they ran steadily under all conditions; and in coal cutting, also, there was less likelihood of the fuses blowing if the cutter jammed. The motors could be left running for long periods without attention, and their life was more than double that of continuous-current machines, the efficiency also being good. Having entered into the question of lighting from three-phase circuits, the author concluded by saying that, beyond the regulation of the motor speed, he thought there were no serious defects.

Wireless Telegraphy.—In our issue of the 2nd inst., p. 43, we noted the experiments of Prof. Fessenden with his wireless telegraph apparatus. A recent issue of the *Electrical World* gives some further particulars of these experiments, and it appears that messages were transmitted some 50 miles, between stations on each side of Pamplico Sound, a stretch of water near Cape Hatteras. At the time of operating the water was almost fresh, and Prof. Fessenden has found that nearly 96 times the amount of energy is required to send messages over this brackish water as would be necessary when transmitting over salt water. At the sending stations, a mast 140ft. high is used to support the air-wires, these consisting of five copper wires stretched about 12in. apart. Induction coils common to other wireless telegraph systems are employed for transmitting messages, but the receiving instruments differ from all other methods, and are at present kept secret in detail, though it is known that a telephonic receiver is introduced, but the coherer does not form part of the apparatus. In correspondence with the *New York Herald*, the professor criticised the Marconi system, saying that the use of the coherer formed a serious barrier to its progress, and that while Mr. Marconi had been developing long distance working, other inventors had been producing better forms of receiver and making wireless telegraphy capable of competition with land lines and cables.

Lieut.-Col. G. Baunerhjelm, of the Swedish Army, is said to have recently made improvements in wireless telegraph apparatus, with special reference to its use for military and naval purposes. One of Baunerhjelm's improvements is stated to be an electric reflector, which is now being tested by Swedish experts. This device is based on the fact that electric waves are reflected by metallic surfaces.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 23rd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "On the Ebullition of Rotating Water," a Lecture Experiment, by T. C. Porter. (2) "The Conservation of Entropy," by J. A. Erskine. (3) "Rational Units of Electromagnetism," by Signor G. Giorgi.

THURSDAY, May 29th.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Ordinary Meeting at the Royal College of Science, Stephens Green. Paper to be read: "The Lighting and Driving of Textile Mills by Electricity," by Marshall Osborne. Immediately after this Paper has been dealt with the Annual General Meeting will be held.

FRIDAY, May 30th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by G. Marconi. Subject: "The Progress of Electric Space Telegraphy."

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Effect of Inductance upon Spark Discharges.—B. Eginitis has studied the heat effects on the poles of a spark-gap as affected by a variation of the inductance of the circuit. He uses Tesla coils without a core, and poles of thin wire. At first the brightness of the aureole varies inversely as the heating effect for all metals examined. At high inductances both the temperature and brightness increase with increasing inductance—at least, in iron and nickel. The author made a closer study of the effects by determining the temperatures of the poles with the aid of a thermo-electric couple. The metals examined included iron, nickel, aluminium, copper and silver. The heating effect is of a very complex nature. It first increases rapidly with increasing inductance, and then breaks into a succession of maxima and minima. A rough generalisation arrived at is that the metals whose heating is very great are also those whose spectra are enriched by an increase of inductance, as in the case of the highly magnetic metals. The presence of metallic vapour is not a primary factor in the heating effect, as is shown by the fact that at small inductances the brightness of the spectrum decreases with increasing inductances, whereas the heating increases very rapidly.

[B. Eginitis, *Comptes Rendus*, May 5, 1902.]

Resistance of a Magnetic Field.—H. Pellat adduces some further evidence in favour of his contention that there is a kind of friction across the tubes of magnetic force which makes the electric corpuscles tend to run along them rather than across them (see *The Electrician*, p. 1005, 1902). A cylindrical tube 1 metre long and 17mm. in diameter, and showing a good stratified discharge, is placed between the cylindrical pole-pieces of an electromagnet so that its middle, say, is embedded in a strong magnetic field at right angles to the axis of the tube. As long as the field has not more than some 425 units, the anode stream is deviated in the well-known manner, forming a thread along the wall of the tube, and getting thinner and brighter with an increasing field. But if the field is increased to about 7,000 units, the anode light fills the whole tube nearly uniformly, without stratifications, and the resistance of the tube increases some 24 times. If now a second and thinner tube is fused into the first, so as to form a branch circuit which does not pass through the strong magnetic field, the whole discharge passes through this branch tube, just as if its resistance were enormously less than that of the main tube. When the lines of force run along the tube instead of across it, the anode stream traces out the lines of force.

[H. Pellat, *Comptes Rendus*, May 5, 1902.]

Ions in the Atmosphere.—H. Ebert describes some simple and instructive experiments to demonstrate the ionic charge of the atmosphere. A plate of tinned iron, 2 sq. metres in area, was supported 4 metres above the earth's surface on insulating pillars, planted on the top of a slope 70 metres high overlooking the river Isar. On a fine-weather day the plate was first connected to earth, and, of course, acquired a negative charge. It was then disconnected, and left to itself for some time, so as to acquire the potential of the surrounding air. Finally, it was earthed through a galvanometer, and showed a current proceeding from the plate to the earth. The exposure necessary for acquiring the potential was greatly shortened by covering the plate with sods of grass, the time then required being usually about five minutes. The charges acquired varied within wide limits with the weather, being largest in fine and smallest in foggy weather. This shows that the connection of negative ions from the atmosphere to the earth varies in accordance with their mobility in the atmosphere. A rough estimate of the quantity of electricity thus conveyed on a fine day gives about 300,000 electrostatic units per square kilometre per minute. This gives a mean current density of $1{\cdot}7 + 10^{-16}$ amperes per square centimetre, which corresponds well to the value of $0{\cdot}42 + 10^{-16}$ amperes per square centimetre found by Rutherford and Allen in the laboratory.

[H. Ebert, *Physikal Zeitschr.*, May 1, 1902.]

Influence of Inductance upon Spectra.—In the direct spectrum analysis of minerals, the spectra are usually complicated by the presence of prominent air lines and lines belonging to certain metalloids. A. de Gramont has studied the influence of an inductance in the circuit with a view towards the suppression of these lines. He finds that the introduction of feeble inductances produces a great simplification of the spectra. The air lines are greatly reduced by inserting an inductance of only 2×10^{-5} henrys, and are entirely eliminated by three or four times that amount of inductance. A slightly larger amount suffices to get rid of the rays due to sulphur. If the latter are to be preserved, the best way is to eliminate the air lines with an inductance of 7×10^{-5} henrys, and to increase those of sulphur by introducing three or four jars. In a mixture of selenium and sulphur the selenium may be obtained alone by eliminating the sulphur and keeping the inductance below 23×10^{-5} henrys, the value at which the most persistent of the green selenium rays disappears. Tellurium persists until the green ray 5,650 disappears at $1{,}014 + 20^{-5}$ henrys. Phosphorus is a substance whose spectrum disappears comparatively early; it is slightly more persistent than sulphur.

[A. de Gramont, *Comptes Rendus*, May 5, 1902.]

Temperature Variation of Resistance.—A remarkable attempt to correlate expansion coefficients, specific heats, and resistances has been made by W. Williams. He calculates the specific resistance from the formula

$$\sigma = \frac{Km\sqrt{\theta}}{cT},$$

where m is the maximum chemical valency, V the atomic volume, T the absolute melting point, c Pictet's constant $\sqrt{\alpha}T$, K a constant varying for each group in the periodic series, and θ the absolute temperature. This relation roughly holds good for Ag, Cu, Mg, Na, Zn, Cd, Ca, K, Pt, Pa, Th, Pb, Hg, As, Sb, and Bi. It fails for Au, In, Sn, and Al, as well as the magnetic metals. Another relation connects the specific resistances in the solid and liquid states, σ_s and σ_l, at the fusing point, with the corresponding "average atomic displacements" λ_s and λ_l. This relation is

$$\frac{\sigma_l}{\sigma_s} = \frac{\lambda_l}{\lambda_s},$$

λ being defined as the relative displacement of the centres of two neighbouring atoms between absolute zero and the fusing point. This is roughly true for lead, cadmium, tin and zinc, the only metals for which it can at present be tested.

[W. Williams, *Phil. Mag.*, May, 1902.]

Alternating v. Continuous-Current Lift Motors.—At a recent meeting of the American Institute of Electrical Engineers a Paper was read by Mr. G. F. Sever, in which the power consumption of alternating and continuous-current motors, when employed for lift work, was compared. Some 3,000 direct-current motors are used for working elevators in New York, as compared with 300 alternating-current, but this great difference is chiefly due to the larger application of continuous currents in the supply mains of that city. Tests had been made in many portions of the city, but they all worked out very much in favour of the continuous-current motor, which showed considerable decrease in energy consumed both for starting and running. The majority of the alternating motors, which were two-phase 60 cycles, had no method of control, one was controlled by varying its voltage from two transformers and one motor had resistances in the rotor circuit, giving four steps to full speed. The starting power-factor varied from 0·79 to 0·97, while the running power-factor ranged from 0·14 to 0·68, a circumstance which illustrated that the motor was too large for its ordinary work, but a reserve was necessary to cope with any overload. The Paper concluded with the remark that, if the controlling apparatus was more simple with the alternating system, and the absence of a commutator regarded as an advantage, the extra expense of operating an alternating-current motor might be offset by the decrease in repairs and attendance.

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THE WOLVERHAMPTON SURFACE-CONTACT TRAMWAYS.

Considerable interest attaches to the new municipal electric tramways at Wolverhampton owing to the fact that they are the first in this country on which the surface-contact system has been employed on more than an experimental scale. The particular system chosen was that invented by Mr. W. M. Brown and made by the Lorain Steel Co., of Lorain (Ohio), and is one of the numerous systems devised to close the circuit between the car and the line by the attraction of an electromagnet. As in all surface-contact systems, a series of surface contacts or studs are placed between the tramrails at a distance apart slightly shorter than the length of the car, and a device is employed in connection with each of these so that the stud is "live" when it is covered by the car and "dead" as soon as the car has passed it. Fig. 1, which shows one of these studs in section, will explain how this is accomplished in this case. The underground distributing cables, which are the equivalent of the trolley wire and are fed from section pillars in the ordinary manner, are led to a brass terminal fixed in the cup G, which is made of insulating material, and projecting upward is a brass lug C forming part of the terminal. This forms what may be called the permanent part, the cables being led from the wooden conduit of the Callender solid system and through the cast-iron pipe as shown, the whole up to the level of the middle of the cup being filled "solid" with bitumen. The remainder of the contact block may be considered as being in three parts: the granite block E, the actual surface plate A, and the contact cup K. The latter is made of a special hard insulating material, and the cover is held down so as to be water and oil-tight by the screw-ring B. Two brass terminals LL are moulded into the cup, and each is connected to one of the circular carbon plates OO, at which contact is made and broken. The lower carbon block is connected to the lower terminal by a copper strip, N, folded upon itself, and fixed between them is a rectangular soft iron plate, P, which normally rests on a circular ledge moulded in the cup K. The lower terminal carries two brass clips, MM, which make contact with the tongue C, and through this with the line. As is seen in the figure, there is a space between the cup K and the granite block E, and this is filled with a heavy oil, so as to ensure that no water can percolate into the contact box. Bolted down as a cover to E is the iron surface plate A, let into which is a piece of hard low-permeability steel, Q, to which the upper terminal L is attached. Fig. 2 is a photographic view of the various parts of the contact block, and Fig. 3 shows the block fitted together.

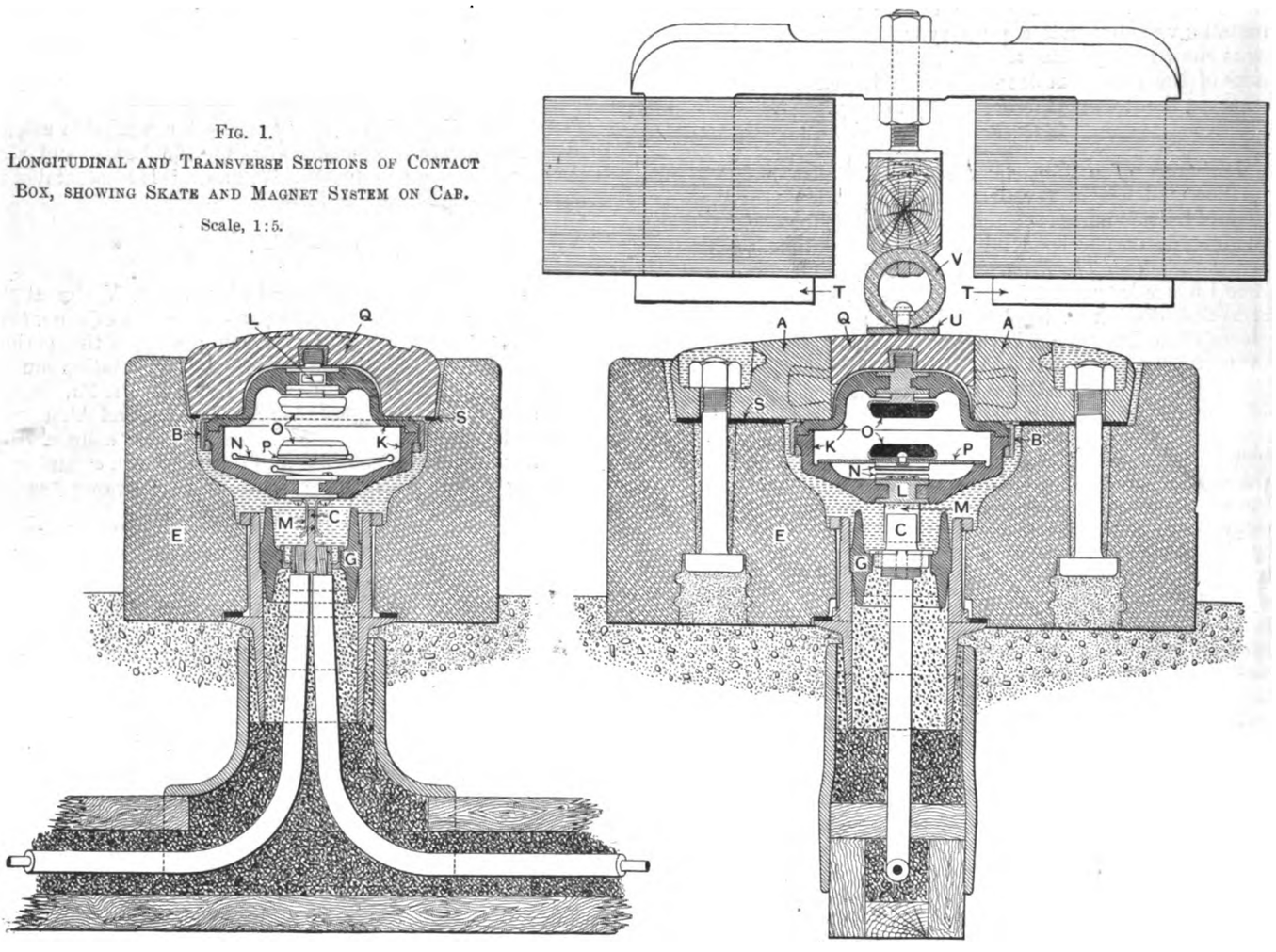

FIG. 1.
LONGITUDINAL AND TRANSVERSE SECTIONS OF CONTACT BOX, SHOWING SKATE AND MAGNET SYSTEM ON CAR.
Scale, 1:5.

At the bottom of the truck is fitted the skate U, shown in cross-section in Fig. 1, and in plan, elevation and sectional elevation in Figs. 5, 6 and 7. The truck also carries a row of electromagnets, TT, which is longer than the skate, both towards the front and back of the car. These magnets are kept permanently energised by current from the line, and at starting by a small battery of accumulators. As soon as they cover the contact box the lines of force concentrate themselves through the iron part of the surface plate, and the iron plate P within the contact box acts as armature and completes the magnetic circuit. The central part of the surface plate being of low-permeability steel does not short-circuit the magnetic circuit. The armature is therefore lifted, and contact is made between the skate and the underground line through the carbon contacts OO and the surface plate. As soon as the car has passed, the lower contact drops again by gravity. It should be noticed that this takes place after the

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skate has passed the surface contact plate, so that the spark at break, if there is any, would occur in the street beneath the car, and not in the box. In ordinary circumstances, however, this spark need only be slight, as by the time the skate leaves the hinder contact it has already passed over the one in front. The skate itself is of phosphor bronze, riveted to a rubber tube, V, which is carried on a wooden beam.

As seen in Figs. 5 and 10, the surface contact sproject very little above the top of the roadway; in fact, in muddy weather they are hardly visible. Fig. 9 is a view of two of the cars running at Wolverhampton, one a single-deck and the other a double-deck car. The 12 cars now running have four different types of equipment, three having been

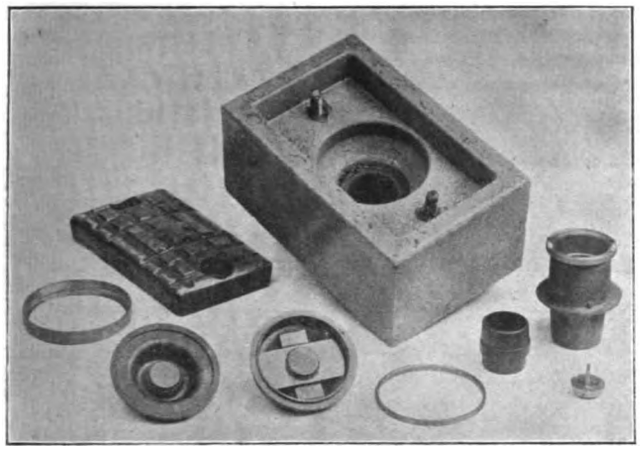

FIG. 2.—PARTS OF CONTACT BLOCK.

supplied by each of the following firms:—The British Thomson-Houston Co., the Westinghouse Co., Dick, Kerr & Co., and the Lorain Steel Co. All cars are built on single trucks, part being of the Brill manufacture and part by the Lorain Steel Co. The latter are supplying 12 more trucks, six to have Preston car-bodies and equipments and six to have Lorain motors and Milne bodies. Different types of fender have been tried, those in Fig. 9 being "Providence life-guards." The series parallel controllers and hand and electric brakes are of the usual patterns. As already mentioned, a small battery serves to energise the picking-up electromagnets at starting. There are eight cells to this battery

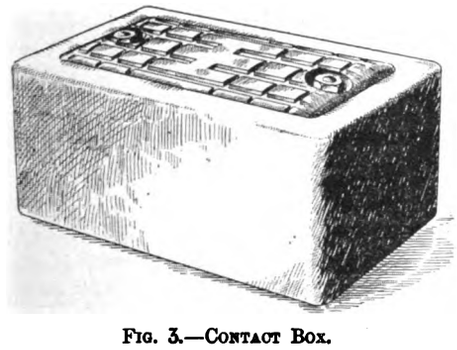

FIG. 3.—CONTACT BOX.

and a current of 60 amperes is taken for about a second. Normally, the current—1·09 amperes at 500 volts—to energise these magnets is supplied from the line, and the magnets have, therefore, two windings. The series winding, to which the battery is connected when required, is in series with the motors, so that a drop in the voltage at starting, &c., is compensated for; and the 500-volt winding is, of course, shunted across the line. A foot switch is provided to connect the battery to the magnet. The battery is contained in a small box, and can be used in the ordinary way for a week or more without a re-charge being necessary.

Mr. C. E. C. Shawfield, the Wolverhampton borough electrical engineer, has made some interesting tests both as regards leakage and mechanical strength and capacity for heavy currents. By artificial means a leak of 5 amperes was made on a stud and contact was broken 97,000 times, calculated to be equivalent to two years' normal service. No signs of burning were visible on the carbon contacts, however. It was found that with the track freshly salted with rock salt at a place where the occurrence of points brought the surface contact to within 4in. of the cross rail, a leak of 10 amperes could be produced, and that this did not occasion any sticking of the contacts or any visible burring. One or two cases of shock have been reported, but all have been traceable to contact boxes, which have been damaged before or during laying, and with increased precautions it is anticipated that no further events of this kind will occur. In the early stages of the service, frequent tests are made with a voltmeter to detect any studs which might develop a leakage due to defects in laying. A certain amount of trouble is occasioned by the youth of the district placing iron turnings across the track, so that, when the car

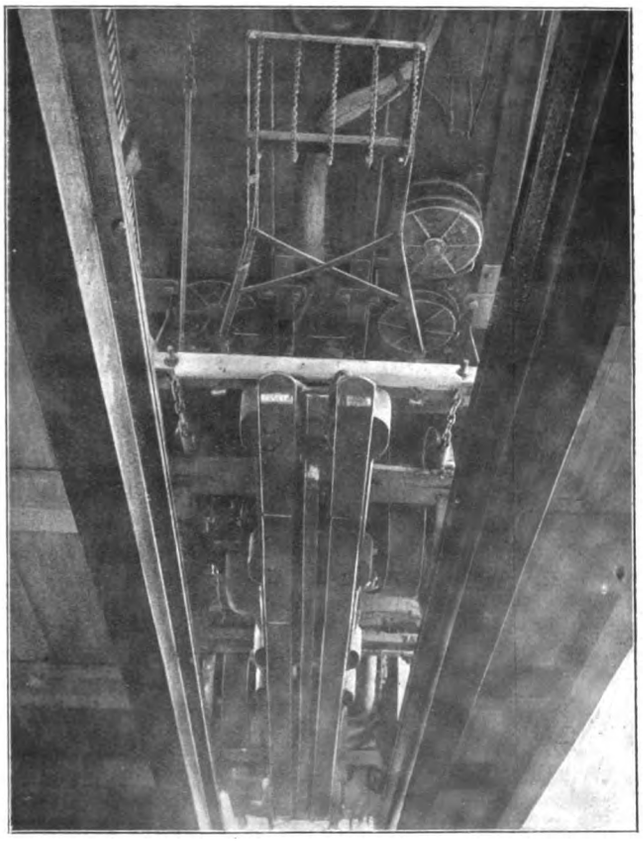

FIG. 4.—VIEW OF UNDER-SIDE OF CAR TAKEN FROM BELOW.

passes, a short circuit occurs between the stud and the rail. We witnessed one of these during our stay at Wolverhampton recently, and the flash and noise occasioned causes distinct trouble with horse traffic. We believe, however, that a simple means of sweeping away these scraps of iron automatically is being worked out.

The heavy current test consisted in coupling two cars together and screwing down the brakes so that 135 amperes were taken (corresponding to 81 B.H.P.). The cars were run up and down the line, but no bad effect on the boxes was noticeable. A steam roller was passed up and down the line, small pieces of iron, road metal, &c., being placed on the boxes to concentrate the pressure on one point, but no mechanical damage was apparent. Another test was to raise two of the boxes slightly, so that the roller thumped down on the following one, but no harm was done beyond the depression of the gasket under the top plate of the box by $\frac{1}{8}$in.

The track is well laid throughout, and the cars run very smoothly round curves and over points and crossings. The latter have been supplied by Messrs. Askham Bros. and

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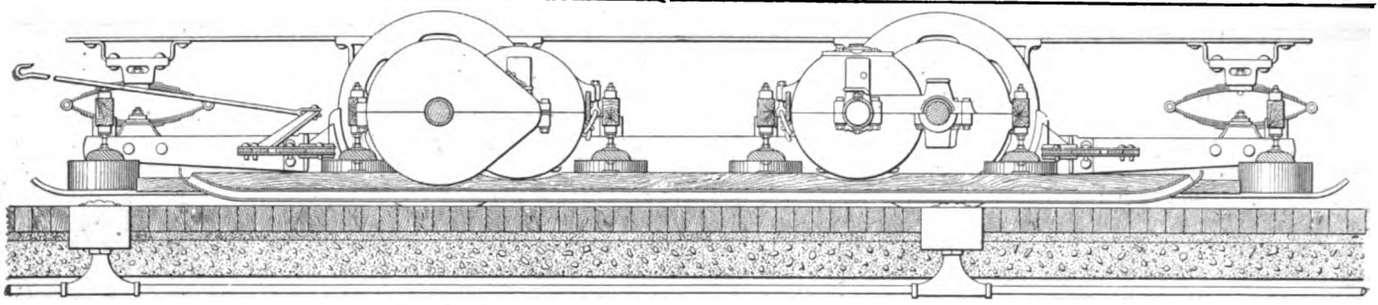

FIG. 5.—LONGITUDINAL SECTION OF TRACK AND MOTOR TRUCK.
Scale, 1:32.

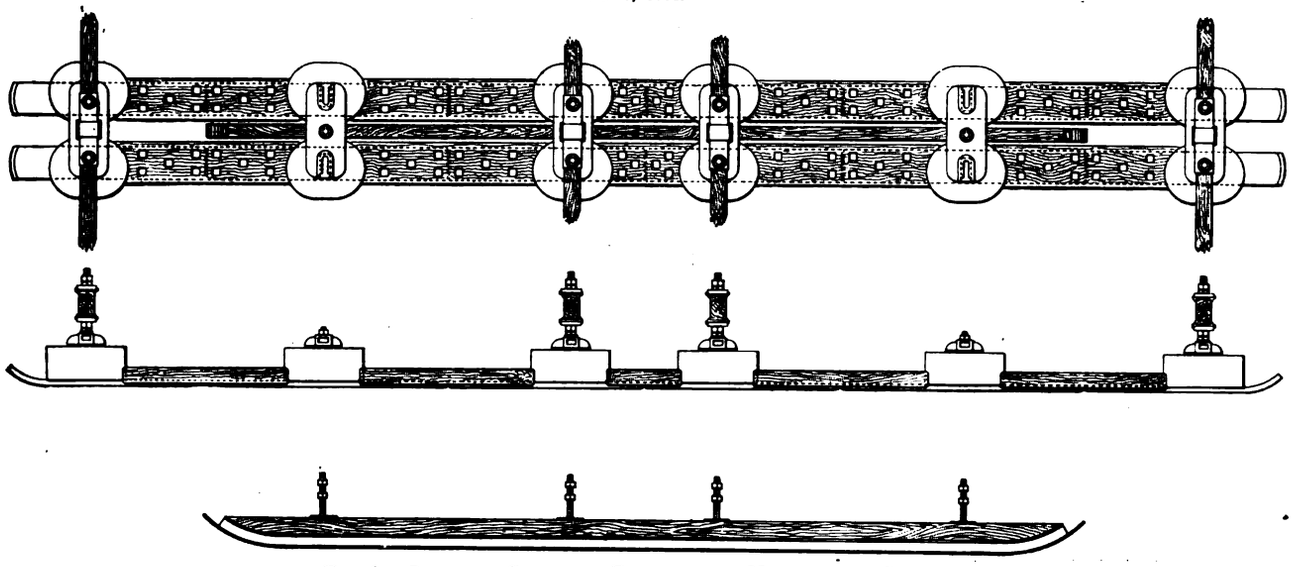

FIG. 6.—PLAN AND SECTIONAL ELEVATION OF MAGNETS AND SKATE.
Scale, 1:30.

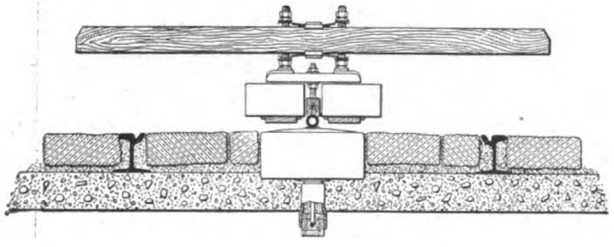

FIG. 6A.—CROSS SECTION OF TRACK AND MAGNET SYSTEM.
Scale, 1:30.

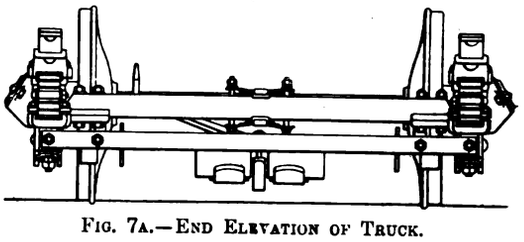

FIG. 7A.—END ELEVATION OF TRUCK.

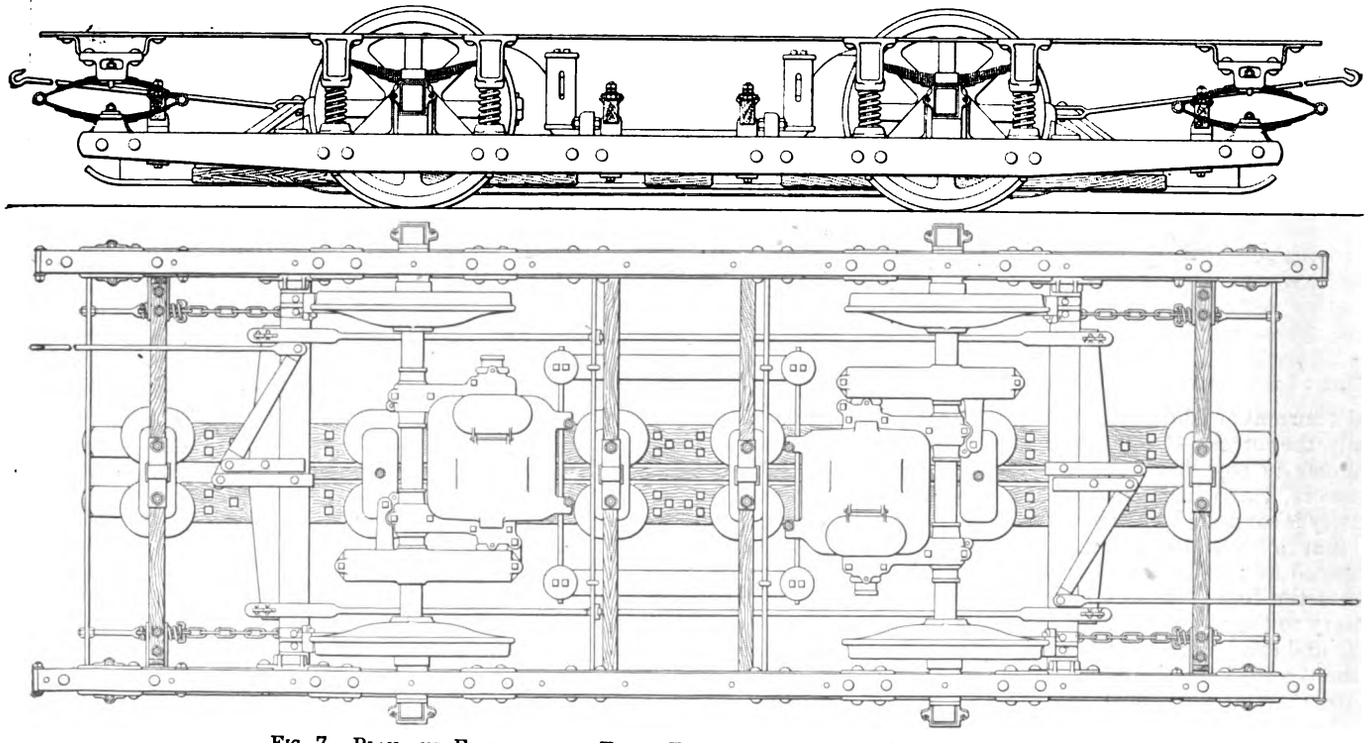

FIG. 7.—PLAN AND ELEVATIONS OF TRUCK EQUIPPED WITH SKATE, MAGNETS AND MOTORS.
Scale 1:32.

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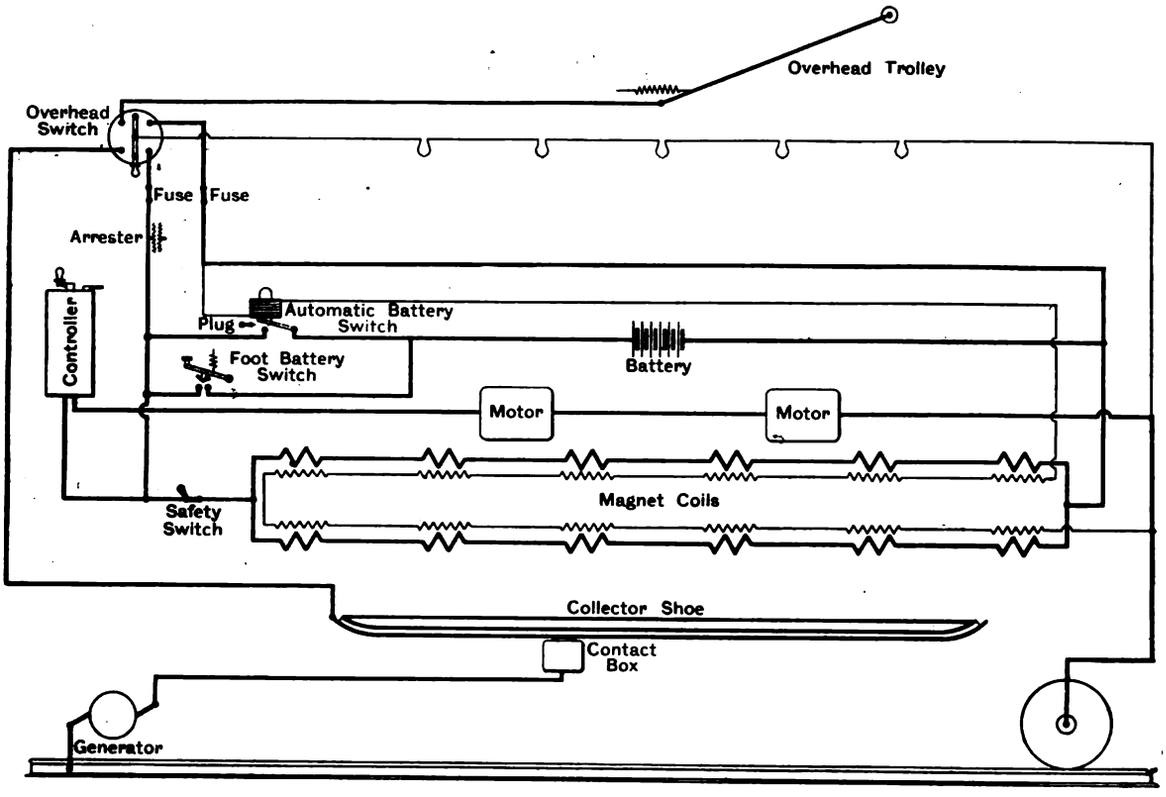

FIG. 8.—DIAGRAM OF CAR WIRING.

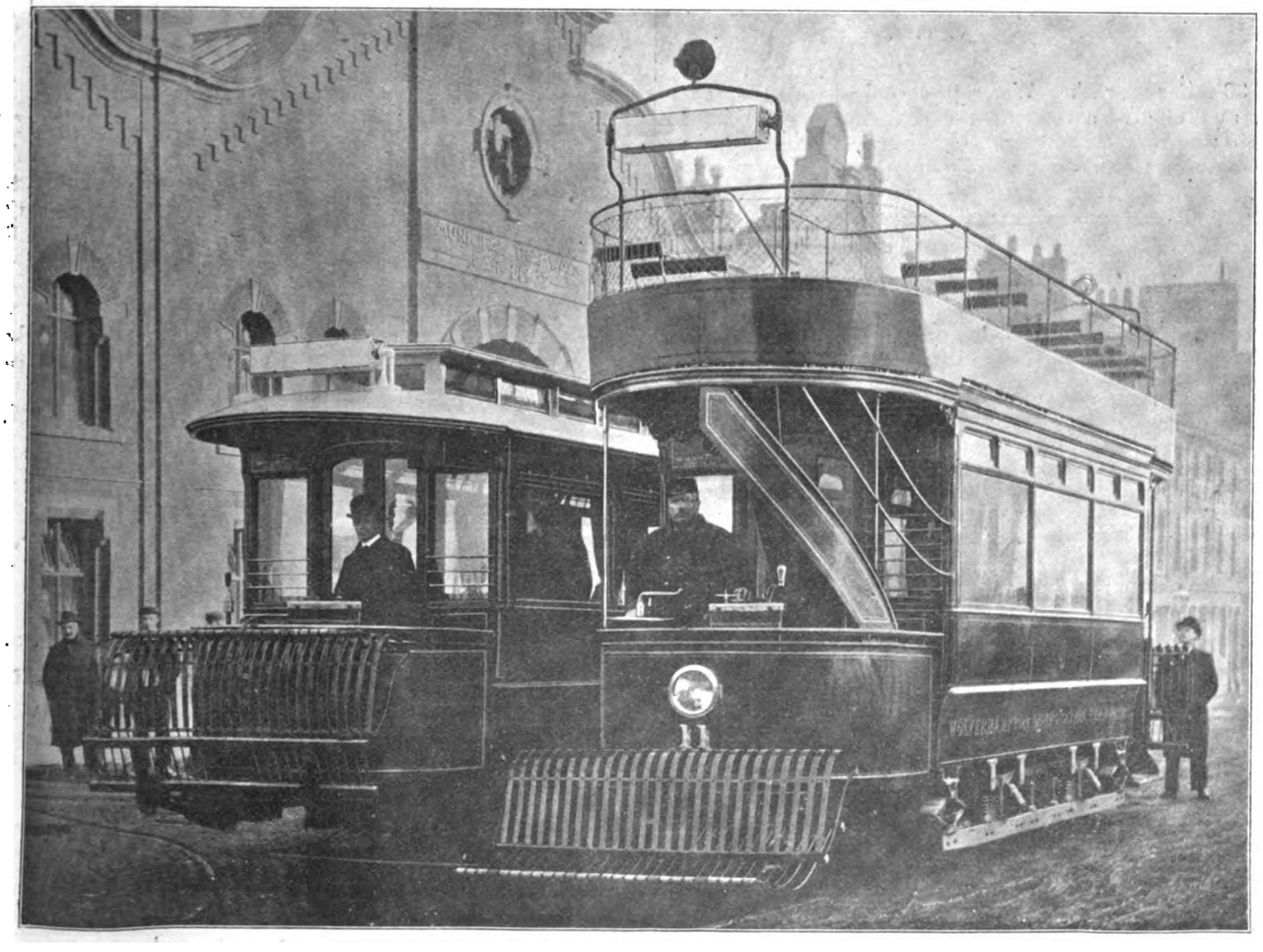

FIG 9.—SINGLE AND DOUBLE-DECK CARS OUTSIDE CAR DEPOT.

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Wilson and the Lorain Steel Co. Special patterns of crossings had to be made for every junction, and these crossings are fitted with special hard renewable pieces. Messrs. Askham Bros. and Wilson's drain rails on Dawson's patent are also employed.

Cars are already running on 5 or 6 miles of track (mostly double), and another 6 miles is being added. If powers are obtained for the outlying districts, the whole system will include 30 miles of track. We propose to deal with the feeder system, and to give a map of the route in another article in which the recently re-modelled electricity works of the Wolverhampton Corporation will be described.

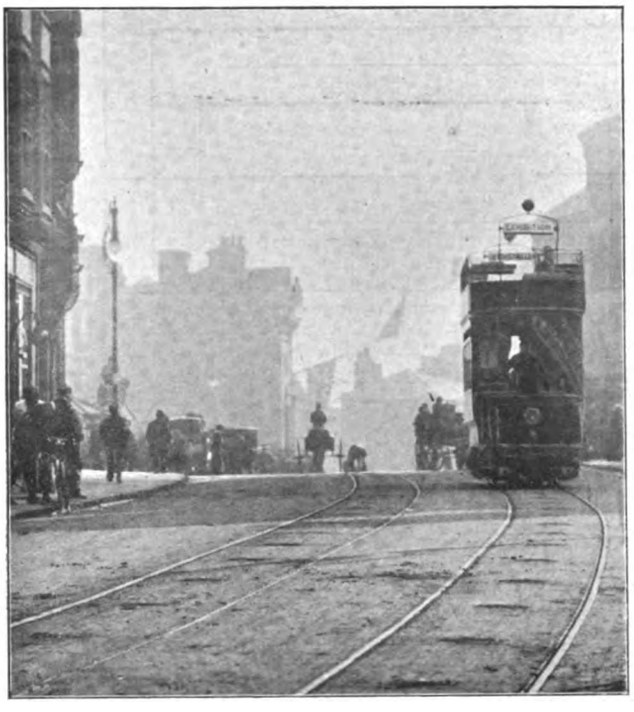

FIG. 10.—VIEW OF LINE.

THE WOLVERHAMPTON EXHIBITION.—III.

Messrs. Joseph Evans & Sons have provided a battery of feed pumps for supplying the feed water to the main range of boilers. These pumps are fixed in an extension of the boiler house; they draw their water from a storage tank supplied from the Corporation mains. The steam pressure carried on the main boilers is 180lb. per square inch, and the discharge water passes through a relief valve loaded to 200lb. per square inch pressure when not required in the boilers. Two of the three pumps are horizontal, and fitted with Messrs. Evans' "Cornish" system of compound steam cylinders, and double-acting outside-packed ram pump ends. The two cylinders of each pump are 9in. and 16in. diameter, the rams being 7½in., and all have a stroke of 24in. Each of these two pumps, at moderate speed, will deliver 8,000 gallons of feed water per hour, and either of them is capable of taking the maximum load duty that the boilers will be called upon to perform. They can be run as slow as 2 piston feet per minute.

In addition to these two pumps Messrs. Evans & Sons have provided a vertical compound feed pump of a new pattern. This has 6in. diameter high pressure and 10in. diameter low-pressure steam cylinders, and two 6in. diameter single-acting rams, all 12in. stroke. It is capable of delivering about 3,500 gallons of water per hour to the boilers, and is calculated to deal with their ordinary day load. This pump, which is illustrated in Fig. 4, may be considered as a development of the fly wheel principle of pump, with vertical outside-packed single-acting rams. The crank motion and flywheel are dispensed with, but the same general arrangement of steam cylinders and rams is maintained; the two sides, however, are coupled together by means of a steel beam vibrating on a central shaft. Each pump ram has a crosshead and slide arrangement, enabling the radial motion of the beam to accommodate itself, the actual travel of the slipper block, however, being very small; for a 12in. stroke of ram it is about 1in. only. The high-pressure steam cylinder is placed over one ram, and the low-pressure cylinder over the other; and the steam valve motion is driven by means of a small crank on the end of the beam shaft, connected up by means of a rod to a small L lever, mounted on a suitable bracket. This latter lever, in its travel, moves over a small auxiliary valve working in the high-pressure steam chest, and so admits steam to either end (as the case may be) of a piston working in a small supplementary cylinder. This piston is attached by means of a suitable spindle to both the high-pressure and low-pressure slide valves, so that when it is driven over by the steam, it reverses the slide valves of both steam cylinders simultaneously. The auxiliary valve mentioned is also a small slide valve of very simple construction, and is so arranged that it uncovers its ports at the extreme end of its travel only; consequently, the liability to vary in the stress, common to most direct-acting pumps, is eliminated, and the working speed of this pump can be reduced to a very small one.

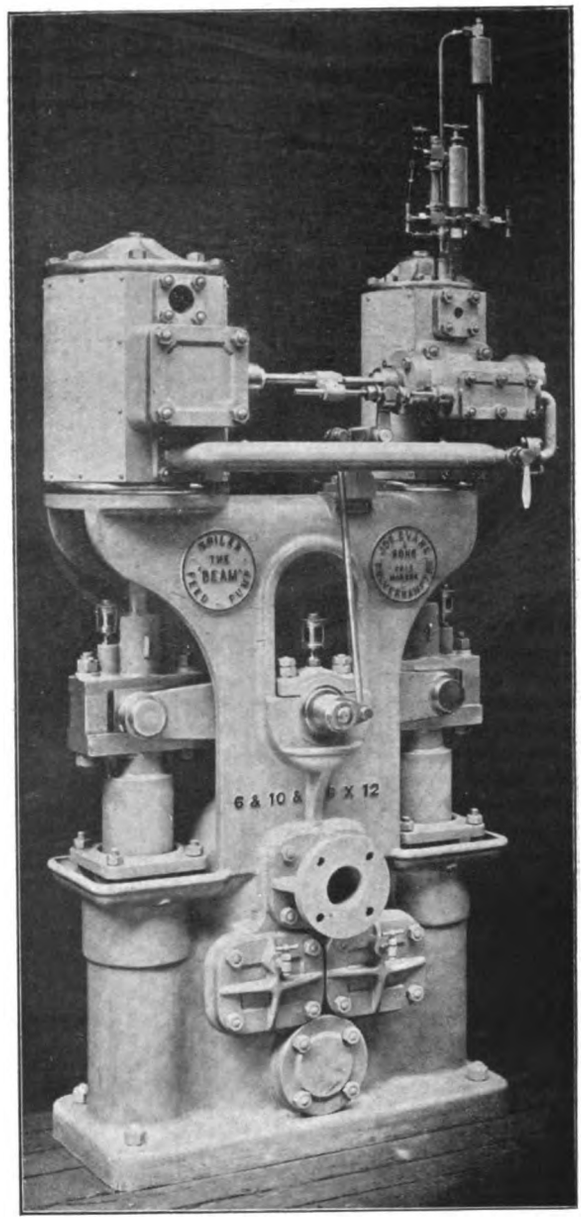

FIG. 4.—MESSRS. J. EVANS AND SONS' NEW VERTICAL FEED PUMP.

Messrs. Mavor and Coulson exhibit their "Hurd" electric bar coal cutter, shown in Fig. 5. This consists essentially of five parts, viz.:—(1) Cutter bar, (2) gear head, (3) motor, (4) switch box, (5) hauling gear. The cutter bar is forged of mild steel, and is tapered towards its point. Taper holes for the cutter shanks are drilled on and also between the threads, and the cutters may be inserted in either series of holes according to the width of the holing required. The spiral thread formed on the bar acts as a worm conveyor, bringing the cuttings out from the holing, giving freedom to the cutting picks,

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and leaving space for the coal to drop. On the inner end of the bar renewable thrust rings are fitted, and through these a reciprocating motion is imparted to the bar. The gear head (Fig. 7) of the large machine is of cast iron, and of the small size of cast steel. The

The reciprocating motion is obtained from a worm upon the boss of the bar-driving pinion (see Fig. 8) gearing into two small wheels, each of which drives a toggle by means of an eccentric pin. The toggles impart a to-and-fro movement of about 2in. to the thrust

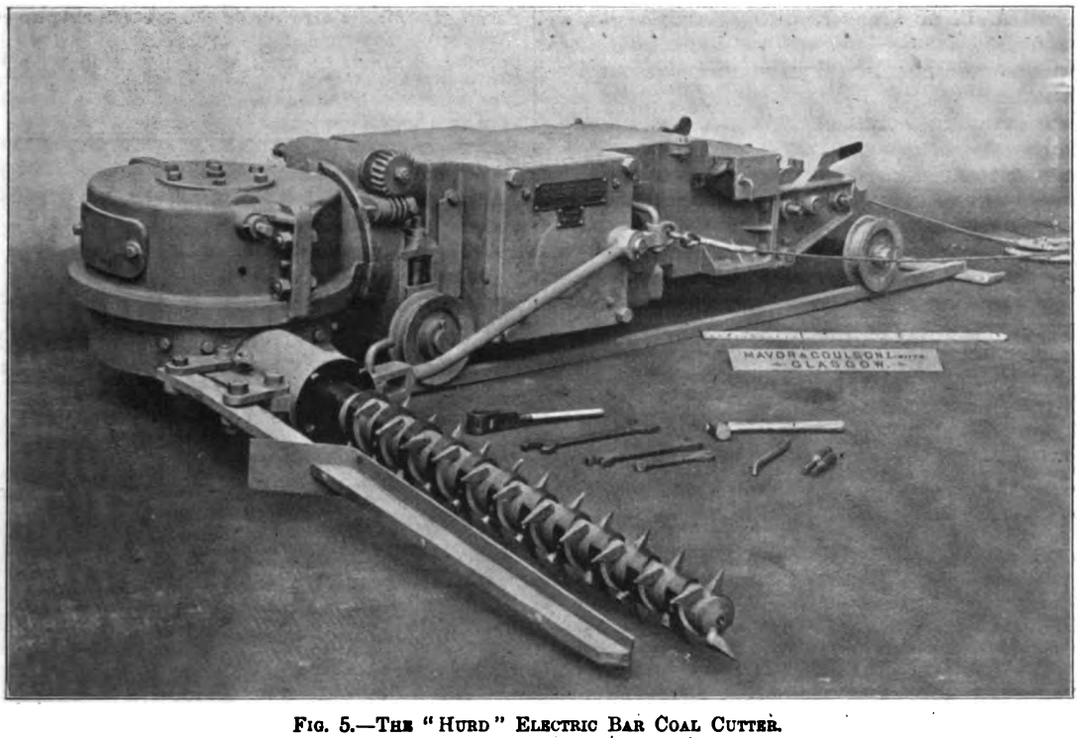

FIG. 5.—THE "HURD" ELECTRIC BAR COAL CUTTER.

motor shaft projects into the gear case, and its pinion drives the double bevel wheel, which in turn drives (with a reduction of 2 to 1 in speed) the pinion on the cutter bar. Ready

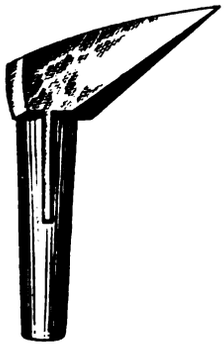

FIG. 6.—CUTTER PICK. (Half-size).

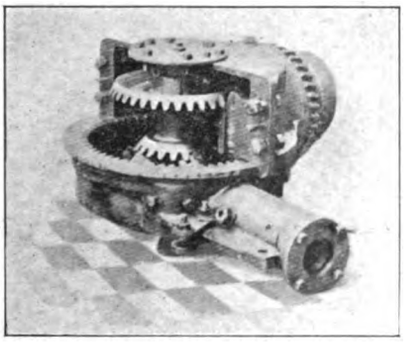

FIG. 7.—GEAR HEAD.

access to the gear is obtained by removing the gear case cover. The rack in the lower part of the gear case, in conjunction with a pinion not shown in the illustration, provides for turning the lower

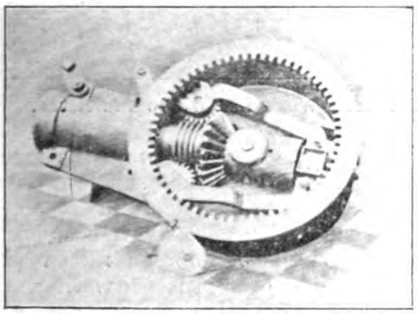

FIG 8.—RECIPROCATING GEAR.

part of the gear head with the cutter bar round the vertical axis for cutting in, and a worm gearing, with the worm wheel shown upon the spigot of the gear case, provides for turning the whole gear case round its horizontal axis to tilt the bar.

block, and with it the cutter bar. A feather in the bar enables it to pass to and fro within its driving pinion. The combined rotary and reciprocating movement of the bar gives a chipping and shearing action on the coal, greatly reducing the strain, and effectually preventing the bar from clogging. The whole gear case being completely enclosed, copious lubrication is ensured by partly filling the lower portion with oil or grease. At the outer end of the bar bearing a stuffing box is provided to keep the oil in and the dust out.

The motor, is, of course, enclosed, so that it is absolutely gas tight. Its shell is of high permeability cast steel, and has incorporated with it the socket into which the spigot of the gear head is fitted, and also the hand gear by which the bar is raised and lowered. The pole pieces with their exciting coils are detachable from the sides of the shell as shown in Fig. 9. The armature is of the slotted core drum

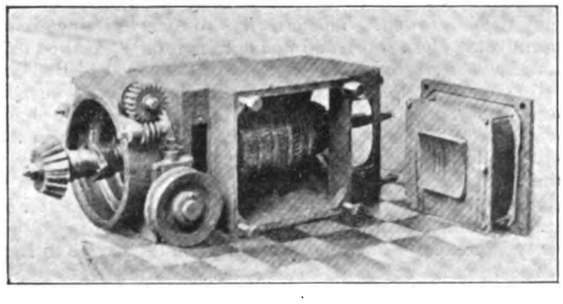

FIG. 9.—MOTOR OF COAL CUTTER.

type, the core being built up on a cast-iron hub, which also carries the commutator independently of the shaft. A screw with external handle is provided to admit an adjustment of the brushes without opening the hand hole. The starting switch and resistance for this machine are likewise enclosed in a gas tight cast-iron box with an insulated external handle.

The haulage gear is automatic and is driven by a renewable worm on the end of the armature shaft operating a crank and ratchet. The rate of travelling may be instantly adjusted to adapt it to the hardness of the holing by varying the travel of the ratchet. On the medium and large size machines a self-coiling arrangement is fitted to lay the steel-wire rope evenly on the drum.

The Edison and Swan United Electric Light Co.'s stand has on it a show case containing examples of every kind of lamp manufactured by them. In addition, there is also a smaller case, containing a historical collection of lamps from the very earliest attempt at incandescent

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electric lamps down to the present "Ediswan" lamp. Among these lamps are the first experimental lamps, as made by Mr. Edison and Mr. Swan independently in America and England, also the lamps produced at the celebrated law suit when the Edison and Swan patents were upheld.

The company also show a large number of small motors from $\frac{1}{20}$ H.P. upwards. A 12 H.P. motor, directly coupled to an "Ediswan" dynamo, takes current from the exhibition mains at 500 volts, and supplies current at 200 volts for use on the stand. The company makes a speciality of sewing machine motors, designed so that they may be attached to any existing machine without belting. A simple method of speed control is used worked by a treadle.

The most popular part of the Edison Company's exhibit is probably the electric light fittings, some of which are of most artistic design.

We may also mention that this company is supplying the majority of the lamps used for the exhibition lighting, both for interior illumination and also for decorative purposes, the order received by them from the exhibition authorities amounting to 12,500 lamps, all of 16 c.p.

The Hiram Maxim Lamp Co. have supplied the lamps for the illumination of the concert hall and central bandstand, and they have a small exhibit representing an artistically-lighted velvet and plush drawing-room containing statuary. This firm also show the "Spiralette" globe, which is a glass spiral made to cover the ordinary globe of an incandescent lamp.

The cable-manufacturing firms do not exhibit, with the exception of Messrs. Isidor Frankenburg, who have built up a cone 16ft. high with drums of cable of various sizes, insulated with vulcanised india-rubber. Messrs. Frankenburg also show two cases, one containing samples of various classes of cable, and the other interesting samples of rubber in various stages of manufacture, as prepared by the firm at their works, and samples of cables showing the different stages of construction. There are also on the stand a number of coils and drums of wires and cables of different classes.

The arc light cables used in the interior of the exhibition are insulated with vulcanised rubber, taped and braided and supplied by this firm; and all the other main feeders, distributors, junction-boxes, &c., in the exhibition and grounds have been lent by the British Insulated Wire Co. The latter firm has no actual exhibit, however.

"MARCONI, WILLIAM."*

William Marconi, inventor, electrical engineer and wireless wizard—born Bologna, 1875; invented "The Marconi System of Doing Everything Without Anything"—was brought up in a nurseless nursery, and learned to play gameless games with toyless toys. Early hardships in living on such foodless foods as beefless steaks, sauceless sausages, and cowless milk taught him the ingenious principle which he has later put into effect with such marvellous results.

Was educated at Leghorn under Prof. Rosa, and became an expert in the making of Leghorn hats without brims, and in the raising of a special breed of Leghorn roosters, the peculiarity of which is that they never crowed. The crowless rooster has since become a leading industry of Leghorn and as a fighter is only excelled in invincible toughness by himself as a broiler. Returned to Bologna and took up experimentation in "Lessology." Inside of a year he had discovered a method of making a pigless sausage that has since become a most attractive edible, although the exact secret of the recipe has never been divulged.

In the next year his energies were devoted to the Marconi system of language, and the several little text books—"Frenchless French," "Spainless Spanish," and "Germless German," or "How to be Silent in Twenty Tongues"—have been of inestimable service to linguistic students.

To amuse a small boy in a semi-scientific manner, one winter's day he ran about the child's nursery shuffling his feet along the carpet for a few minutes, and then suggested touching noses with the youngster. The electricity generated by his activity created a spark, which, before the noses touched, formed a link between them. The discovery flashed upon him instantly. "If," the young man reasoned, "we can project a spark of electricity $\frac{1}{8}$in. between two unconnected nasal poles, what is to prevent our sending it 3,600 miles through the air without a wire?"

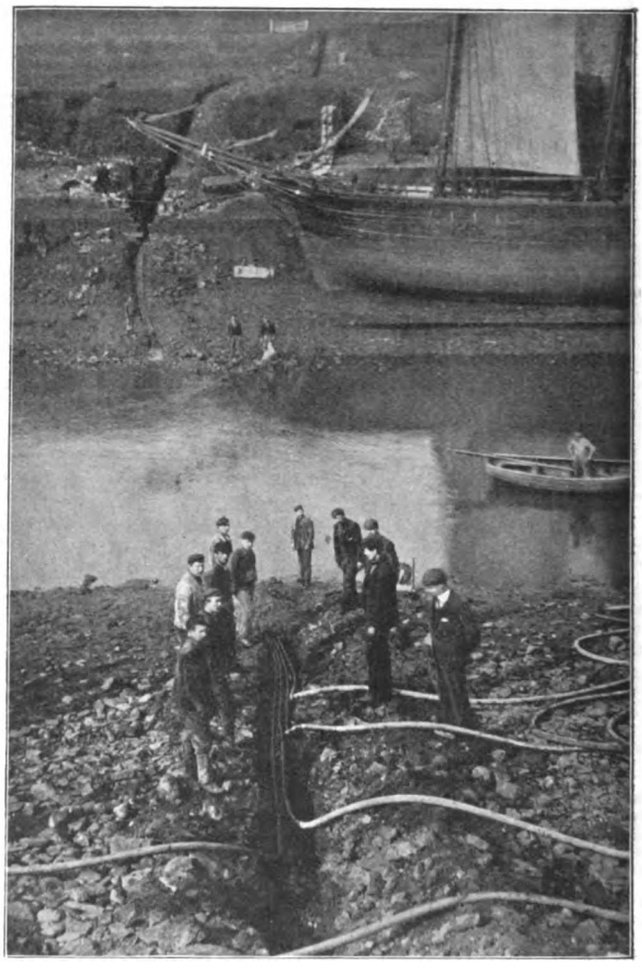
It was as simple as Newton's discovery of the law of gravitation. Experiments followed. Inside of six weeks the young inventor was able to elicit a response on the wireless method from a galvanised dog standing 8ft. away from the keyboard. Later the distance was extended further and further, until 1902, when the letter "S," ticked off in the British Isles, hissed through the ether and s oughed sibilantly upon the top of a trolley pole in Newfoundland.

Upon this Marconi's claim to immortality now stands, but it is expected that he will not rest tranquilly upon laurels alre ady won, an expectation which gains reasonableness from the rumour that he is perfecting a method by which suspension bridges may be built without cables, as well as a wireless wire mattress by the use of which a tired person may lie down upon nothing at all and sleep the sleep of the just. The Marconi pie, made wholly of electric currents, is said to be most nourishing, and the pocket telephone, by means of which a man in New York can ring up a friend in San Francisco at any time of the day, provided the two instruments are in tune, is likely to work a revolution in telephony. Address: William Marconi, The Atmosphere, Morse Code.

* From the *New York Herald*.

CABLE LAYING ACROSS THE TAWE (S. WALES).

It is not often that central station engineers are called upon to lay high-tension cables in the bed of a river. Usually there is sufficient responsibility and difficulty in laying cables under the pavements of a town. Mr. C. A. L. Prusmann, however, has recently laid some such cables across the river Tawe at Swansea, particulars of which he has supplied us with and which we give below. To supply an outlying portion



Trench Work Leading to the River.

of the town it became necessary to cross the river, and four concentric cables, each of 0·048 sq. in. section, have been laid, transmitting single and two-phase currents of 50 periods at a pressure of 3,000 volts. The cables have been specially made, and the dielectric consists of impregnated paper, this latter being lead-sheathed, and over it is a covering of vulcanised bitumen. Outside this is a heavy yarn and armouring of double layers of galvanised steel wires, the whole being finally yarned and compounded.

The sheathing of bitumen on the lead has been introduced to protect the lead against any action of the water. The cables have been laid in a shallow channel in the bed of the river, a hawser and pulley being used for the purpose.

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RAILWAY BLOCKS AND TELEGRAPHS—RECENT PRACTICE.*

BY A. T. KINSEY.

I feel that I am at some disadvantage in introducing this subject to the Institution, as I am neither to talk of thousands of volts nor yet of kilowatts, and I have no imposing mathematical array. I have thought it best to deal with matters of which I have first-hand knowledge, and also some experience, and matters which, I think, have not previously been brought before the Dublin Local Section. The Irish railways have, however, an enviable freedom from accidents, which have almost entirely disappeared since the introduction of block working on all lines. The cost of the block signalling is a very considerable factor in the working expense of a railway, and the railways of none of the countries in the world spend so large a proportion of their earnings in this manner as those of the United Kingdom. When I responded to your committee's invitation for a Paper, it was my original intention to outline the gradual changes in the electrical equipment of the Irish railways, due mainly to the passing of the Regulation of Railways Act of 1888. But I have since felt that it would be best to confine myself almost entirely to the extension of block signal working where double lines of rails exist, and to the introduction of the train staff block instrument where—as in the majority of Irish lines—there is only a single line of rails.

Prior to the gradual operation of the act mentioned, there was usually a telegraph circuit of the omnibus type calling at all the more important stations, and the more it served the better, as transmission was thus avoided. The commercial telegraph circuit usually connects two places, and the less busy circuit may possibly take in several places, at the most four or five. This is the ordinary telegraph circuit, and, whatever type of instrument may be employed, five offices is usually considered a limit. But the conditions and demands of Irish railway telegraphy are quite different. I know of a double-current sounder circuit on one of the "great" railways of Ireland, which has no less than 13 stations spread over 80 miles of line upon it; the relays are all differentially wound, of Siemens' make, with their coils joined in multiple for economy in primary cells; and, strange as it may seem to an ordinary telegraphist, this circuit works year in year out almost without a complaint, and excellent signals are obtained at all stations. I only mention it to show how far we have upon the railways wandered from the beaten track, and satisfied what not long ago would have been considered impossible conditions.

The block signal method of controlling the traffic on a line of railway puts a *space*-distance between each train. It therefore follows that one train cannot overtake or meet another, as one train only is permitted to enter a block section at a time. The space and distance is determined by the amount of traffic to be dealt with on the section. It may be a space-distance of miles on one section, and of a fraction of a mile only on another. The usual conditions of traffic are known beforehand, and the signal cabins disposed accordingly; and as their maintenance is such a considerable item of the working expenses, the fewer of them to be maintained, the better for the dividend, provided that the traffic be smartly handled. It must not be assumed that the cost of block working on double lines of rails is all loss, to be tolerated only on account of its absolute safety. It has rather, I think, tended also to some economy, as a driver, knowing that he has a "clear road" until he reaches the next section, can make the most of it.

The earlier types of block signalling instruments were designed to represent the actual semaphores on the line—miniature signals, in fact—and the reversing switch was a facsimile of the lever in the signalman's lever frame, which pulled the semaphore "on" and "off," with a loud bell in addition to make these movements heard as well as seen. Time has tended to modify these parts and to reduce them. The reversing switch has disappeared, and the plunger has united with the semaphores in the one case. There are plenty of the block instruments designed by Mr. (now Sir William) Preece still in use in Ireland, and they continue to do excellent work. They consist of three separate parts—a plunger (or key), for signalling; a reversing switch, for putting either pole of the battery to line; and a block containing a semaphore arm raised and lowered by the current, a second semaphore showing by means of a disc whether the signal arm was "off" or "on" at the distant station, and the indispensable bell.

This apparatus has, however, been gradually displaced in Ireland by "Harper's" block, which, I understand, is cheaper in first cost and its after-maintenance, the minimum voltage employed for Harper's instrument being 5 volts, as against a minimum for Preece's of 20 volts—a considerable difference. As Harper's instrument now holds the field almost to itself, perhaps I should describe it more closely. The apparatus is identical in each signal cabin. It consists of two electromagnets, one in the sending circuit and one in the receiving circuit. Attached to the open ends of the cores of these electromagnets are four steel extension pieces, operating induced needles of Spagnoletti's design, brazed in the centre so as to prevent the formation of a closed magnetic circuit. The pivots of these needles extend through the face of the instrument and carry the miniature semaphore arms, which move up and down according to the direction of the current through an angle of 45deg., remaining either in the horizontal or drooping position until a reversal is sent. There are two internal sets of key-springs for sending the reversals to line operated by a single plunger, the position of which over one or other set of the key-springs is determined by a rotating disc. This disc at the same time gives the signalman a visual coloured indication of the signal he is sending—viz., "All clear" (on a white ground); "Train on line" (on a red ground); and "Train off, but section blocked" (on a green ground). The warning colours of the disc guide him mechanically, and if the disc is in its true position a wrong signal cannot be sent. Every signal is marked on the bell at the distant cabin. This bell is operated by a relay, and not by the line current direct. Experience has proved that these instruments are exceedingly reliable and satisfactory, as there is no adjustment beyond that of the relay and bell ever necessary.

The length of the block section is determined, as I have previously stated, by the number of trains passing, and as this quantity may be very variable over the 24 hours, it becomes necessary to vary the length of the sections themselves so as to accommodate it. It is usual to vary the length by means of switches to suit three conditions—*i.e.*, day, night and Sunday. These may be represented diagrammatically as in Fig. 1. These changes are made by means of the switches at times specified. There are, of course, rules laid down for the guidance of the signalmen, each of whom cannot switch out and close his cabin until the section of line which he controls is clear of traffic. This arrangement, which admits of indefinite expansion as the traffic expands, or contraction if it lessens, has worked very well upon the whole. The switches in use have been of differing forms, but my own experience has gone to show that there is nothing to beat the bar tumbler type of switch with rubbing contacts, the bars being arranged to work vertically so as to admit of easy inspection and burnishing of the contacts from time to time.

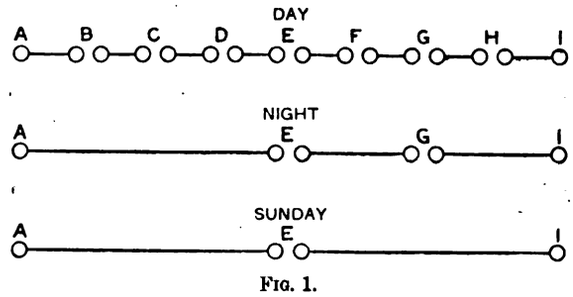

FIG. 1.

The merit of Harper's instrument in such a section as that displayed in Fig. 1 is that although the amount of current passing through the coils may vary within considerable limits, it is quite unnecessary to use compensating resistances in any of the circuits. The electromagnets respond equally well to the heaviest as to the lightest current without any adjustment of the arms or bell relay. In the diagram given, the distance between A and B is only 1 mile, whilst the distance between A and E is about 12 miles, and the current varies accordingly, but the arm in A's sending circuit rises and falls equally well without adjustment. A daily working test such as this is a severe one, but the working has continued satisfactory for years. There is, moreover, no difficulty in a contingency in working a Preece's block at one end of a circuit and a Harper's block at the other end, but this will readily be understood after what I have said as to "Harper's" adaptation to a much heavier current than the normal one. There are working circuits with Preece's blocks and day and night arrangements comparable to those in Fig. 1, but it is necessary to use compensating resistances in the shorter line circuits, and shunts in the circuit controlling the disc. If, however, these points are carefully considered when the circuit is established, almost as smooth working is obtained as with Harper's blocks, and considering the trouble of their initial adjustment it is surprising what constancy is obtainable afterwards with Preece's instruments. This leads me to say that railway working demands as its first and last condition an absolute freedom from interruption, or the nearest thing to it. And the arrangement figured satisfies these working conditions, and gives a very small annual percentage of faults per instrument.

Some special modification is, of course, necessary for junction working, and this is provided for in Harper's instruments mechanically by placing the two block instruments of the converging lines of railway inside one case, and so arranging the discs that the "All clear" signal can only be sent to one side at once, and not then unless the other disc is showing green—viz., "Train off but section blocked." In addition to the block and the telegraph circuit it is desirable to give each signal cabin some means of speaking to the adjacent cabin on each

* Paper read at the Dublin Local Section of the Institution of Electrical Engineers.

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side. Of course, this could be done by means of a separate circuit, but the question of the cost of erecting miles of wire, and its maintenance afterwards, has to be looked at. Except, however, on very busy sections a second circuit is not necessary, as there is usually but one signalman in a cabin at a time to work whatever number of instruments may be in it. It is, therefore, sufficient to enable him to use the same line for speaking or for block working at will; the exacting conditions before mentioned demanding that, whatever may happen to the speaking circuit, it shall in no case disturb the block circuit. A simple switch putting the line either to the block instrument, or to the telephone, would appear to satisfy the conditions, but experience has found it to be a faulty arrangement, both instruments having at times been inadvertently left cut off from the line. To obviate this contingency, condenser working was resorted to for the telephone circuit, and by this method the block circuits are left intact and attention can be gained upon the block or bell in all positions of the switches. I append (Fig. 2) a diagram of a cabin having two blocks and a telephone to be used on either circuit, but a similar arrangement is employed at junctions having more than two blocks. By using separate line leads from the open conductor on the outside insulator to the two-way switch an independent condenser circuit is obtained, having nothing in common with the block circuit but the open conductor, and this is a further safeguard against risk of total failure of communication. The block signal is used for calling to telephone. The speaking is not free from noises due to inductive disturbance. It would

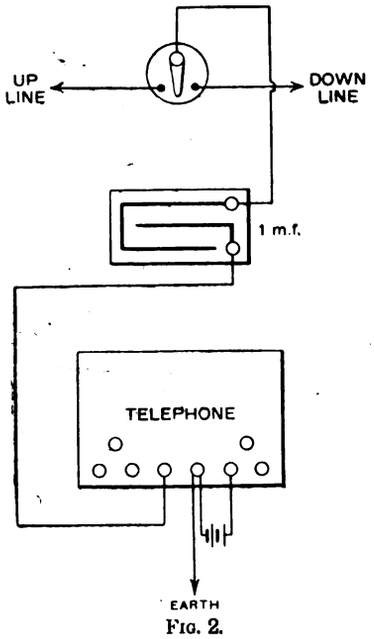

Fig. 2.

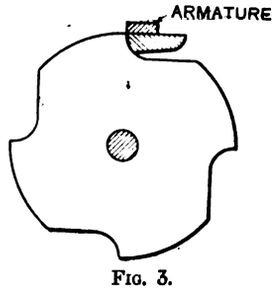

Fig. 3.

hardly be expected that dead silence could be obtained with a single untwisted conductor run in along with (in some cases as many as 20) telegraph circuits, but it gives telephonic speech which appears to satisfy railway requirements fairly well, and I hear of no proposal to spend money to improve it. Telephone transmitters of the Deckert granular type are used, and a condenser capacity of 1 microfarad, but I have not been able to observe any difference in speaking when half a microfarad has been used instead. This method of providing a speaking circuit is also used on train staff block sections, and it has stood the test of experience there also. It is extremely reliable, and a fault to either circuit under decent maintenance is unheard of. These circuits have lightning arresters of the comb, or saw-tooth, type, and their advantage is that they do not stop the circuit, after an ordinary discharge. Their blackened condition shows, however, how silently and well they perform their office.

I now come to the blocking of single lines of railway by means of Webb and Thompson's train staff instrument. On single lines the conditions are more complex, as provision must be made for trains to proceed in either direction on the one set of metals, and it is not an uncommon thing for the traffic first to be all in one direction, and then to reverse and to be all in the opposite direction, as for instance, engines and wagons going empty to a fair and afterwards returning as loaded trains. The older method of working was for there to be one "staff" of wood or metal for each section, and no driver could proceed unless he carried it on the engine as his authority. This was all well and good so long as the trains were alternately up and down, as the staff from A would be carried to B and left there, the next train taking it up again at B and leaving it A. But it is obvious that in the case of the fair, it would have to be modified. One method was to send a driver on with a ticket issued by the station holding the staff, tickets to be continued until the last train had arrived, which went forward carrying the staff. This mode of working—dispensing as it did with the space-distance—had the obvious defect that one train might possibly overtake another with disastrous results, especially at night. It had also the disadvantage that the staff might be at the wrong end for the train. These difficulties were designed to be overcome by Tyer's tablet instruments, which are still in use, and by Webb and Thompson's train staff instruments. The latter having been almost exclusively adopted in Ireland, I propose to describe it only. This instrument, patented in 1889, was designed for use with a metallic circuit of two lines, but the cost of the additional conductor led to the experimental use of the earth as the return, and it has been proved that it may safely be used instead of the second line, which has thus been dispensed with.

Webb and Thompson's train staff instrument consists essentially of a magazine to contain any given number of metal staffs. Entrance to this magazine is obtained through an opening in the head of the instrument and at a right angle to it. When a staff is inserted it cannot pass directly to the magazine, as there are five circular iron discs (free to rotate together on a central spindle) between them, a quadrant of each of the five filling the rectangle. The effort to push the staff downwards into the magazine causes all the discs to revolve, and when a quarter revolution has been made their mechanism again locks them. Any number of staffs can thus be inserted into either of the connected instruments, but they cannot be withdrawn. And I will explain why. The central member of the five discs is shaped (Fig. 3) with four deep indentations, and in some one of these lies the principal lock, which carries a soft-iron armature, and its electromagnet rests normally upon it. As will be seen by the figure, this centre disc and armature is practically a mechanical ratchet arrangement, permitting of the turning movement in one direction only. Hence in normal conditions any number of "staffs" can be placed in the magazine, but once there they are securely locked.

(To be concluded.)

REPORT OF THE COUNCIL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an abstract of the report of the Council of the Institution of Electrical Engineers for the session which has just closed. It was presented at the annual general meeting last night:—

Local Sections.—No new local sections have been created during the year under report, but an increasing amount of valuable work is being done in those previously established. The Council places on record its hearty thanks for the great assistance rendered by the Glasgow Local Section in the arrangements in connection with the International Engineering Congress.

Elections and Transfers.—Notwithstanding the increased stringency of the Articles of Association relating to qualifications for membership, the increase in membership during the past twelvemonth has been most remarkable; there have been elected during this period 25 members, 126 associate members, 183 associates, 203 students, making a total of 538. Candidates were also approved for ballot last night, and several transfers from one class of members to the next grade have been made. At the beginning of the current year the Manchester Society of Junior Electrical Engineers was merged in the Institution as a students' section of the Manchester Local Section.

Deaths and Resignations.—The Council has to record with extreme regret the loss to the Institution by death of one local honorary secretary, Dr. C. Lemon; 12 members, W. D. Bailey, A. S. Bolton, G. L. Bristow, E. W. Buller, W. T. Goolden, Matthew Gray, J. Howe, J. Slater Lewis, H. R. Low, C. W. Lundy, J. Neale, H. D. Norman; two associate members, G. A. Clark, J. M. G. Wilson; one foreign member, Jules Wünschendorf; five associates, R. Bayly, F. M. Hartley, J. Kemsley, Commander Clifton Sclater, F. H. Wilson; and one student, E. Amos.

Two members, one associate member, six foreign members, 15 associates and nine students have resigned since the date of the last report.

Papers.—The Council, owing to the illness of the authors, or to causes over which they could exercise no control, has had to defer several Papers which had been definitely promised for reading during the session now ending. Several of these Papers promised to be of special interest, but it is hoped that they will yet find a place in the proceedings of the Institution.

Publications of the Institution.—The general index of Vols. XXI.–XXX. referred to in last year's report, was issued in August, 1901, simultaneously with the last number of the *Journal* to which it referred. The Council has decided that as the current year's volume is the first of a new 10-year period, the system of indexing the *Journal* might with advantage be revised. The index will, therefore, in future be somewhat extended, fuller references being given to subjects of importance incidentally introduced in Papers and discussions.

In collaboration with the Physical Society, the publication and issue to the members of the Institution of *Science Abstracts* has been continued, and the Council believes that the usefulness of the publication is more than fully maintained. It was with great regret that the Council learnt that Mr. R. W. Cooper was no longer able to devote the time necessary to the editing of the abstracts, and that he, therefore, felt himself compelled to resign the editorship in December, 1901. They heartily recognise the great indebtedness of the publication to his able management during the three years he held the office. They are glad to report that he has accepted nomination as one of the representatives of this Institution on the Executive Committee of Science Abstracts, the other representative appointed being Mr. H. E. Harrison. The Committee of Science Abstracts has appointed Mr. G. W. de Tunzelmann, a member of this Institution, editor in Mr. Cooper's place,

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The publication of the following Papers in the *Journal* as original communications has been approved;—

"Note on Duplexing of Cables"	W. KINGLAND, Member.
"The Capacities of Polyphase Cables"	A. RUSSELL, Member.
"The Rise of Temperature in the Field Coils of Dynamos"	E. BROWN, Student.
"The Application of Electric Power to Machine Tools" (Abstract of Students' Paper)	C. B. NIXON, Student.
"The Limitations of Graphical Methods in Electrical Theory"	A. RUSSELL, Member.
"Note on an Observed Effect of Lightning Discharge on Birds in Mid-air"	L. JOSEPH, Assoc.-Mem.
"A General Formula for Regular Armature Windings"	D. ROBERTSON, Associate.
"A Method of Studying Armature Windings by means of Winding Diagrams"	D. ROBERTSON, Associate.
"Sparking in Switches"	ALEXANDER RUSSELL, Member, and CLIFFORD PATERSON.

Annual Premiums.—The Council has awarded the following premiums for Papers and communications:—

The Institution Premium, value £25, to Mr. O. Lasche, for his Glasgow Congress Paper on "The High-Speed Railway Car of the Allgemeine Elektricitäts Gesellschaft."

The "Paris Electrical Exhibition Premium," value £10, to Mr. H. W. Clothier, for his Paper before the Manchester Section on "The Construction of High-Tension Central Station Switch Gears, with a Comparison of British and Foreign Methods."

The "Fahie Premium," value £10, to Mr. S. G. Brown, for his Paper on "Automatic Relay Translation for Long Submarine Cables."

An Extra Premium, value £10, to Messrs. Frith and Lamb, for their Paper before the Manchester Local Section on "The Breaking of Shafts in Direct-coupled Units, due to Oscillations set up at Critical Speeds."

Two Extra Premiums, value £5, each respectively to Mr. H. M. Hobart for his Glasgow Congress Paper entitled "Modern Commutating Dynamo Machinery, with Special Reference to the Commutating Limits"; and to Mr. K. A. Scott-Moncrieff for his Paper before the Calcutta Local Section on "The Insulation of Conductors of Electricity in India."

A Premium, value £10, to Mr. David Robertson, for his original communication entitled "A Method of Studying Armature Windings by means of Winding Diagrams."

A Premium, value £5, to Mr. A. Russell for his original communications entitled "The Capacity of Polyphase Cables"; "The Limitations of Graphical Methods in Electrical Theory."

Three Students' premiums, value £10, £5 and £5, are also to be awarded.

Salomons Scholarship.—The Council has awarded the Salomons Scholarship, value £50, to Mr. Philip A. Laubach, of the Finsbury Technical College.

David Hughes Scholarship.—The David Hughes Scholarship, value £50, has this year been awarded by the Council to Mr. Edward Fisher, of the Finsbury Technical College.

Students' Class.—Following the precedent of 1900, the Council invited reports from students in connection with the Glasgow Exhibition of 1901. Certain classes of electrical exhibits were selected and every student was invited to name two or more of these classes of exhibits on which he would be prepared to submit a report. One of these subjects was allotted to each student who responded to the invitation. Thirty-one reports in all were received, and a premium of £5 has been awarded to each of the following students:—

Name.	Subject for report.
ATCHISON, A. F. T..	"Gas and Oil Engines Suitable for Electrical Generators"
DAVIES, T. A.	"Electric Generators and Transformers."
GRIFFIN, J.	"Materials used in Secondary and Primary Batteries."
LANGFORD, J. B. ...	"Electrical Measuring Instruments."
LAUBACH, P.	"Electric Generators and Transformers."
PERCY, H. L.	"The Special Fittings of Electric Cars, and for Electric Traction generally, including the Poles for Trolley Wires."
RAWORTH, A.	"Steam Engines Driving Generators."
REID, D.	"The Special Fittings of Electric Cars, and for Electric Traction generally, including the Poles for Trolley Wires."
ROBINSON F. E. ...	"Labour-saving Apparatus and Machine Tools worked with Electrical Energy."
SMAIL, J. C.	"The Electrical Driving of Lifts, Fans, and Pumps."

Sectional Committees.—The Council again calls attention to the appointment of the sectional committees representing the following interests respectively:—(1) Traction, Light, and Power Distribution; (2) Telegraphs and Telephones; (3) Manufacturing; (4) Electro-Chemistry and Electro-Metallurgy. The Council would point out that the constitution of these committees is regularly shown in the list of members, and will in future be printed in the opening pages of the *Journal*.

Annual Accounts and Financial Position.—The very rapid development in the work of the Institution that has taken place during the past few years has led to an increase in expenditure that is only partially compensated for by the growth of the revenue and the results achieved. Considering, however, that there were several special expenses that may be fairly considered abnormal, incurred during the financial year under consideration, the Council is gratified in being able to report a surplus of £758. 2s. on the year's work. It should further be observed that the surplus would have been greater this year had it not been that a sum of £84 was written off for depreciation on books, pictures and furniture. No allowance is made in the accounts for the value of books and pictures presented to the Institution, which might otherwise have been estimated at £40. The sum of £30. 12s. 3d. has been invested on account of life compositions, leaving £16. 7s. 9d. still uninvested on Dec. 31. The estimated realisable amount of subscriptions outstanding on Dec. 31 was £375, and of this over £210 has since been received.

Building Fund.—This fund still continues to progress steadily, having risen from £8,421 in December, 1900, to £9,398 in December, 1901. Further contributions from members, and a further addition from the general funds of the Institution during the early months of 1902, have brought the fund up to £10,000 at the date of this report. Of the increase since December, 1900, over £880 has been derived by contributions from the Institution. It is very desirable that this fund should meet with the liberal support of the members, and your Council strongly urges the propriety of all classes contributing annually towards it.

Wilde Benevolent Fund.—No demand has yet been made on this fund, the interest of which has, therefore, been accumulating.

Local Honorary Secretaries.—By the death of Dr. Lemon, the position which he, greatly to the interest of the Institution, had held for 18 years, as local honorary secretary and treasurer for New Zealand, fell vacant, and was filled by the appointment of Mr. J. K. Logan. The removal of Mr. Hartley Gisborne to the Far West lead to his resignation of the local honorary secretaryship for Canada, and to the appointment of Dr. R. B. Owens, professor of electrical engineering at the McGill University, Montreal, in his place. Mr. M. G. Simpson's return to England on furlough, and Mr. A. J. Arnot's departure from Melbourne, have caused vacancies in the Indian and Victorian secretariats respectively. The former position has been filled by the appointment of Mr. T. D. Berrington, of the Indian Government Telegraphs, whilst the latter has not yet been filled. The vacancy in the secretaryship for the Netherlands-Indies has led to the re-arrangement of the secretariat, in greater conformity with the present distribution of the membership in the district. Mr. W. Grigor Taylor, a superintendent of the Eastern Extension Telegraph Co., who has been appointed, is, therefore, officially designated local honorary secretary and treasurer for the Straits Settlements and Netherlands-Indies; his district, however, includes not only these territories, but also the Federated Malay States and Borneo.

Engineering Standards Committee.—The Council, having in view the importance of standardisation, and having learned that the co-operation of this Institution, as representing electrical engineering, would be acceptable, has cordially consented to assist in the work of the Engineering Standards committee, of which the constituent bodies had previously been the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Iron and Steel Institute.

Special Committees.—The committee which was appointed to revise the wiring rules of the Institution has met frequently during the past twelvemonth, and has so far completed its work that, subject to a few unimportant alterations, the draft of the proposed new rules has been approved by the Council. In the hope of making the rules as generally acceptable as may be, the committee was so constituted as to represent different interests. By invitation, the Incorporated Municipal Electrical Association sent a delegate, and the rules have been laid before the committee of the association. The fire insurance experts also gave most valuable assistance, especially in the direction of enabling the committee to learn the views of the fire offices on all points connected with electrical risks. It is hoped that the new rules may be ready for issue during the present summer, and that they may prove generally acceptable.

[Reference is also made to the committees engaged on the production of "Model General Conditions for Electrical Contracts," and on the consideration of the law of electric lighting, power, traction, &c., which have been published in our columns recently.]

The Factories and Workshops Act, 1901.—In the summer of 1901 the Institution joined in a movement aiming at the exclusion of electrical generating stations, or, failing that, at least of transformer stations from the operation of the act. It appeared from the correspondence that passed to be impossible for the Home Office to concede this point. There is every reason to hope, however, that the Home Secretary will be prepared to receive from the Council an expression of the views of the industry upon any regulation that may be found to operate adversely, and that is susceptible of modification without jeopardising the interests that the act was intended to safeguard. The Council is now dealing with this question. A conference representing the industry of electricity supply has been held, and has, by resolution, requested the Institution "to take steps to approach the Home Secretary in order to lay before him the views expressed at this conference as to the prejudicial effect of the incidence of certain provisions of the Factory and Workshops Act of 1901 on the industry of electricity supply, and to pray him to allow the Institution to confer with him when he is framing regulations under the act."

Museum.—As a result of an appeal to members issued during the past year, many objects of interest have been promised, and the intending donors have, at the request of the Council, consented to retain possession of their donations for the present, with a view to making them over to the Institution as soon as it is in a position to place them on view.

Presentation of Addresses.—Illuminated addresses have been presented, through the officially-invited delegates of this Institution, to the University of Glasgow on the occasion of its ninth jubilee in 1901, and to the Owens College, Manchester, on that of its jubilee in March, 1902.

Visit to Northern Italy.—The Council has in hand arrangements for a visit to objects of electrical interest in Northern Italy immediately before Easter in 1903.

International Techno-Lexicon.—At the request of the Verein Deutscher Ingenieure, the Council has promised such assistance as may be in its power in the editorial work of producing the comprehensive tri-lingual technical dictionary that is being prepared by that society.

The Library.—The secretary reports that the accessions to the library during the 12 months numbered 65, nearly all of which were kindly presented by the authors or publishers, and mentions the impossibility of adding to the library many books that it is desirable to include owing to the limited space at present available.

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ELECTRIC TRACTION LEGISLATION.

The debate which took place in the House of Commons on Thursday last week in relation to the obnoxious Standing Order No. 22 was disappointing in character, and still more disappointing in its results. This Standing Order imposes a fundamental condition with regard to the promotion of tramway enterprise which is of such a nature as to impede seriously the development of electric traction. Before a Bill seeking powers to build or extend a tramway can be brought before Parliament, the formal consent must be obtained of every local authority through whose territory it is proposed that the line shall pass. If it cannot be proved to the satisfaction of the Examiners of Private Bills that these consents have been obtained, and that the Standing Orders have been complied with, the Bill is not allowed to proceed to the consideration of Parliament. These Orders are rigidly enforced, and it will be remembered, as a recent example, that, owing to the non-compliance of the London–Brighton Electric Railway Bill with certain other of the Standing Orders relating to correct maps and plans of the proposed route, this Bill was thrown out before it could obtain a hearing in Parliament. Obviously, the intention of regulations of this nature is to protect the valuable time of our busy legislators from being wasted by compelling them to listen to arguments in favour of ill-considered or immature schemes, but the local authorities have taken advantage of this condition of affairs and have recognised that it gives them the "whip hand" in negotiating with tramway promoters. The word "blackmail" was used in the course of the debate, and it was not too strong to apply to the extortions practised by some local authorities. Instead of giving a simple yea or nay to the request for consent, they almost invariably impose conditions—that is to say, they set a price to their consent. Mr. Clifton Robinson is fond of speaking of a local authority naming as the price of its consent a new façade to the town hall, and whether this be an actual or merely a hypothetical case, there is no doubt that the conditions imposed have occasionally almost as distant a relation as this to the tramway undertaking promoted. Peculiarly enough this right of absolute and unreasonable veto is confined to tramway bills. In the case of lines built under the Light Railways Act, a local inquiry is held by the Light Railway Commissioners, and the application for a light railway ord er may be granted in spite of the opposition of the local authority if this be deemed unreasonable. As was pointed out in the course of the debate, the Standing Order also gives a small local authority power to block a large measure for a line passing through several districts, and trouble on this score is continually being experienced by tramway promoters.

It is surprising, however, that the resolution to amend the Standing Order should have been brought up in

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the form in which it was submitted to the House of Commons last week. Proposed as it was by the ex-President of the Local Government Board, and supported by the Chairman of Committees, the resolution should have been put forward, if at all, as coming officially from the Government, and not merely as a suggestion by a private member, and made in a thin house immediately before the Whitsun recess. Mr. CHAPLIN certainly stated his case well, and showed considerable tact in attempting to conciliate the radical and progressive county councillors' votes by emphasising, and, in fact, basing his argument upon the fact that the housing question was dependent on tramways for its proper solution. He did not succeed, however, and it would have been better had he not attempted it. This alteration in the law is urgently needed, and, in fact, it is one of those which the Institution of Electrical Engineers proposes to advocate by the aid of a deputation to the Prime Minister. But it is only one among many alterations that are needed to place the electrical industry in a more favourable and progressive position, and these alterations must not be proposed half-heartedly and one at a time. Now, when this question of a local veto on tramway schemes comes up again, we shall be confronted with the abortive attempt to improve the existing state of affairs which has already been made in Parliament. The law of electric lighting, traction and power distribution must be entirely revised from top to bottom. One single measure to do this is what is required, but it must be a Government measure, and one by which the Government should stand or fall, for the upholding of our engineering industries is a question of national importance.

THE PROFITABLE SUPPLY OF ELECTRICITY, AND THE CITY OF LONDON ELECTRIC LIGHTING CO.'S TARIFF.

BY EDWARD V. CLARK, B SC, ASSOC.M.INST.C.E.

In *The Electrician* of January 10th,* in commenting on the question of charge for electric supply, the writer instanced the case of a customer of the City of London Electric Lighting Co., who found it advisable in part to unwire his premises, on account of that Company's form of tariff. As this is one of the very few companies that adopt a Hopkinson form of tariff *without* a demand indicator, an examination of their accounts (as given in *The Electrician* of April 25th) with a view to ascertain the general effect of this tariff upon the undertaking may perhaps be of interest.

The present charge—viz., 8d. per unit for the first six units per quarter per lamp connected during the six winter months, and for the first three units per quarter per lamp for the six summer months, and 2d. per unit thereafter, has been in force throughout 1901. This, for a customer using his lamps freely, is, of course, equivalent to a rental of 9s. per lamp per annum, plus a flat rate of 2d. per unit for all current; and means that the benefit of the low rate is not received till 4s. per quarter per lamp in winter and 2s. per quarter per lamp in summer has been paid, or 12s. per annum for an all-year customer. In 1900, on the other hand, the charge during the earlier part of the year was a flat rate of 4½d., and, later, a tariff of 8d. for the first four units per quarter per lamp in winter, and two units per quarter per lamp in summer and 2d. thereafter—*i.e.*, equivalent to a rental of 6s. per lamp per annum.

In each year current for power was supplied at a flat rate of 2½d. per unit, but the writer has no means of ascertaining how much was sold at this rate.

Eliminating current sold for public lighting, a comparison of the two years, as far as private consumption is concerned, is as follows:—

	1900.		1901.
Units sold to private customers	11,273,000	...	11,527,000
Maximum supply demanded ..... kw.	10,980	...	12,330
Connections to mains (at end of year) 8 c.p. lamps	511,000	...	549,200
Connections to mains (mean) do.	470,000	...	530,000
Diversity factor. $\frac{\text{Conn. to mains at end of year}}{\text{Max. supply demanded}}$	1·49	...	1·42
Units sold per mean lamp	24	...	21·8
Load factor $\frac{\text{Units sold} \times 100}{\text{Max. demand} \times 8{,}760}$	11·7%	...	10·7%
Revenue from private customers, excluding meter rents	£192,000	...	£216,000
Revenue per mean lamp connected	8·17s.	...	8·16s.
Revenue per kw. of max. demand	£17 10 0	...	£17 11 0
Revenue per unit sold	4·09d.	...	4·5d.

The first thing that strikes one's attention in this summary is that, although the average charge per unit has increased from 4·09d. to 4·5d., or by 10 per cent., yet the revenue per mean lamp connected has actually fallen a trifle, and the revenue per kilowatt of maximum demand on station has risen by little over ¼ per cent. As it is the charge per unit that the customer feels, while it is a high revenue per kilowatt of maximum demand that benefits the station, the above figures can hardly be regarded as other than most unsatisfactory.

Again, the units sold per lamp per annum have fallen from 24 to 21·8, the load factor from 11·7 to 10·7 per cent., and the "diversity factor" (*i.e.*, the ratio of connections to mains at end of year to maximum supply demanded) from 1·49 to 1·42—in each case a distinct retrogression.

The increase in current sold in the year amounts to but 2·3 per cent., as against 51 per cent. last year; but this may be explained in part by the fact that in 1900 a large amount of electricity was sold to other companies, and much less (though still some) in 1901. But the falling off in new connections, from 19 to 7½ per cent. (or from 82,000 lamps to 88,200), is decidedly unhealthy.

The most unsatisfactory feature, however, is the relation of connections to maximum demand, the latter having risen by 1,350kw., against an increase of but 1,225kw. in the former. This can only mean that, in addition to all new customers coming on at the peak, over 100kw. of day-load has been replaced by peak-load—a most unfortunate state of affairs.

To what extent this retrogression of the company is apparent only, and due to but little current being sold to other companies this year in comparison with last, it is hard to say; but it certainly seems that the tariff is proving detrimental to the welfare of the undertaking, and that the absence of the maximum demand indicator is doing a good deal of mischief. In the first place, there must be, it is evident, a very large number of unprofitable, short-hour consumers, since the revenue per lamp connected is but 8·16s. in spite of an average receipt of 4·5d. per unit; and for these the demand indicator is clearly an unnecessary luxury. This class of consumer, in no case using anything like 18 units per annum per lamp, and quite content to pay the full rate of 8d. per unit for the convenience of the light, will naturally instal just as many lamps as are desired, thereby keeping low the revenue per lamp and per kilowatt of maximum demand; and nothing in the present state of the law can prevent their connection. But with long-hour consumers needing lamps nearly all day during the winter months it can hardly be questioned that the demand indicator would be highly beneficial to company and customer alike. The case of the writer's friend who disconnected some 12 or 15 lamps out of a total of about 56 is seen, from the company's accounts, to have been by no means unique; and it must be remembered that lamps thus disconnected—those in vaults and dark corners, not used often, perhaps, and never for long at a time—must be highly profitable to the company, even if their total consumption amounts to but a few units each per quarter. Being used at any hour of the day, and for but short periods at a time, their diversity factor will be very high, and they will cause but little extra strain on the supply, even if used at time of peak; it is for this class of lamp par excellence that the indicator with time-lag caters so well, and it is this class of lamp that the present tariff is fast tending to eliminate—the lamp that

The Electrician Vol. XLVIII., p. 471, over the initials "E. V. C."

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can be spared with a little inconvenience, and that does not *look* to be worth 9s. per annum, though it may, nevertheless, use a fair amount of current before the year is up. If long-hour consumers—those burning nearly, if not quite, 18 units per lamp per annum—were given the option of a maximum demand indicator (at an additional meter rental to cover its costs), and its use was urged wherever it appeared likely to be beneficial, this falling off of intermittent lamps should be largely prevented; and the lower rate per unit that would result to the most profitable consumers would certainly tend to increase their use of current, and to prevent their recession to the rival company. There would be no necessity to instal these indicators in every case, and wherever found that the maximum demand was the same as the number of lamps connected, the indicator could at once be removed, and the sole expense would be the one year's rent and the cost of fitting.

Finally, though firmly of opinion that the present tariff is not the most desirable, the writer has no wish to convey the impression that the City of London Company's position (despite last year's working) is other than promising. The competition of the Charing Cross and City Company is far from an unmitigated evil, as with their flat tariff to all classes of customer, they may be safely relied on to attract the short hour, unprofitable consumers in shoals, and to relieve the City of London Company from their unwelcome attentions. But with the latter's tariff in its present form there is bound to be removed with the chaff a large amount of wheat which the demand indicator ought to be able to retain.

In any case, the progress of the competition between these two companies, with their respective tariffs, cannot fail to be of the very greatest interest.

SOME FACTORS IN COLONIAL RAILWAY CONSTRUCTION.

At a meeting of the Institution of Junior Engineers, held on May 2nd, the chairman (Mr. Percival Marshall) presiding, a Paper was read on the above subject by Mr. Lewis H. Rugg. The difference between a Colonial railway and a light railway was first dealt with, and it was shown that the latter was one on which the rails and general character and construction was light, as a whole, and the speed and carrying capacity of the trains low in comparison with the standard main lines of the country. The cost of Colonial railways varied between £6,000 and £10,000 per mile per a single track, with average maximum gradients of 1 in 45, 5-chain curves, and rails weighing 50lb. per yard. It was now recognised as false economy to reduce the weight of rails; but as the weight, and therefore cost, was frequently about one-third of the whole cost of the line, good design of rail was most essential. The sections should vary with the size, on account of the strength varying as the square and the stiffness as the cube, while sleepers should be placed nearer together than was the practice in England.

From a financial point of view steep grades and high summit leads were desirable, it being quite a mistake to suppose and to agree with the popular idea that easy grades and curves resulted in a successful railway. Sharp curves should never be adopted, except where necessary to avoid heavy earthworks, as they diminished the speed of trains and advantage could not be taken of the energy given to the train on the down grade to assist it in the next ascent. For this reason sharp curves were most undesirable at the bottom of long gradients. Nothing less than 2ft. 6in. should be adopted per gauge, as this was adequate for the sharpest curves. Except in mountainous districts where sharp curves were necessary, or where a very inexpensive line was proposed, there were no advantages in adopting a gauge less than the standard of the country. Rolling stock could be of the same weight, and the formation width could also be the same. The only disadvantage, and that a small one, was the extra length of sleeper. On the other hand, the limited space for the locomotive machinery was an undesirable feature of the narrower gauge. In constructing earthworks it was not necessary that banks and cuttings should balance, as material for banks, with cheap land and labour, was more economically obtained from side cutting. The monorail trucks made by the Monorail Portable Railway Co. were recommended where two rails were objectionable, as offering greater facilities to progress with ordinary native labour. Steel sleepers (about double the cost of creosoted sleepers) were frequently used, durability being greatly in their favour, but they did not give the ease and elasticity to running which were characteristic of the timber sleeper. With reference to bridges, half-through girders, if applicable, were to be preferred to through girders; they were cheaper and most rigid. Where timber was cheap the Howe truss should be adopted. There was no actual economy in making trestle bridges in place of banks, except through swampy ground or where great heights were encountered, and where first cost was an important factor.

ELECTRICITY WORKS ACCOUNTS.

Huddersfield Municipal Electric Supply Works.

Our first table this week includes analyses of the last two years of working of the Huddersfield undertaking. Compared with the 1899 results, those of 1900 marked an unfortunate retrograde movement in respect of many of the cost items. It is satisfactory to find that the lost ground has been virtually regained, for, after deducting the public lighting costs (attendance and renewals of public lamps), the total cost figures per unit sold for the three years stand at 1·56d., 2·29d. and 1·57d. respectively. These values (without, excepting the 1900 costs) are most creditable to the engineer, while the last figure given—that pertaining to last year's working—is at least 0·8d. under the average total cost of municipal concerns of similar output and load factor in 1900.

It should be an encouraging sign to find the output and load factor rising as they do. Last year's output exceeded that of 1900 by 27 per cent., while the load factor was 10·7 per cent., as against 8·96 per cent.

The average total revenue received from all sources was also slightly under the average, but it was found possible to pay out of the gross profit amounts totalling over 8 per cent. of the mean expended capital in respect of capital charges.

We repeat the following table giving particulars of the financial results in past years :—

Year ended Dec. 31.	No. of consumers.	No. of 8 c.p. lamps connected.	Output in units sold.	Gross surplus.	Surplus appropriation			Met by boro' fund.
					Int. on loans.	Sinking fund.	Deprec. and conting.	
1893*	112	9,613	43,224	- £209	£658	£1,680	...	£2,547
1894	214	15,342	156,169	+ 1,376	1,606	1,836	...	2,065
1895	280	20,889	237,753	2,474	1,769	2,079	...	1,373
1896	385	28,983	304,163	3,724	1,880	1,410	£434	...
1897	598	41,702	438,848	4,964	2,190	1,589	1,184	...
1898	806	54,154	593,377	6,936	2,602	1,898	2,437	...
1899	1,082	70,178	951,033	9,040	3,646	2,565	2,829	...
1900	1,331	85,653	928,996	7,830	3,737	3,983	110	...
1901	1,547	100,734	1,179,849	11,647	4,342	3,948	3,358	...

* 17 months.

Walsall Municipal Electric Supply Works.

Consistent with its now well established character this undertaking again shows diminished costs, and, moreover, costs which, considered in relation to the output and load factor, are highly creditable. In spite of increases in the rates and taxes, as well as in the rents, the total costs show a reduction of over 0·3d. per unit on the already low costs of 1900.

Most of the items of works costs, as well as the management charges, have contributed to the improvement. The repairs and maintenance costs at the station are still too high at 0·5d. per unit. This fact, however, only enhances the credit due in respect of the other contributing items of cost.

A salient feature of the financial results is that the deficit handed down from former years was last year wiped out. Sums amounting in total to 4·7 per cent. on the capital were paid in interest and depreciation, and there was a net balance of £106.

REMARKS.

HUDDERSFIELD.—*a* Does not include units sold by contract (about 32,000). *b* Sold for public lighting and by contracts. The amount sold for public lighting alone was probably about the same as in 1900. *c* Over-expended. *d* Includes salaries of engineer and clerks. *e* Insurance £21, compensation for accident £100. *f* Exclusive of public lighting and inclusive of £266 contract sales. *g* Engineer's salary £450 and clerks £152. *h* Includes £793 spent on motors.

WALSALL.—*a* Over expended. *b* Insurance. *c* Maximum demand system. The lighting and motor power charges are subject to discount of 10 per cent. for 10,000 units per annum or 12½ per cent. for 15,000 units per annum. *d* Maximum demand system (first 300 hours of maximum demand per quarter at 2½d. per unit). *e* Maximum demand system, 6d. for 230 hours half-yearly and 2d. after, with 10 per cent. discount for annual consumption of 10,000 units and 12½ per cent. for 15,000 units. *f* 2½d. for 200 hours quarterly and 1d. after (maximum demand system). *g* Includes £150 in 1900 and £158 in 1901 salary of engineer.

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	HUDDERSFIELD.		WALSALL.	
Undertaking Worked by	Huddersfield Corporation.		Walsall Corporation.	
Date of Commencement of Supply	July, 1893.		December, 1895.	
System of Supply	Alternate-current transformer sub-stations.		High-press. con.-current with trans. and storage [batteries.	
Chief Engineer	A. B. Mountain.		Alexander Wyllie.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	1,357,607	1,635,608	404,682	479,865
„ **SOLD (TOTAL)**	**928,996**	**1,179,849**	**275,643**	**340,232**
„ sold to consumers	843,687	1,062,358[a]	246,363	310,952
„ sold for public lighting, &c.	85,309	117,491[b]	29,280	29,280
„ sold for traction	—	—	—	—
„ used on works	86,000	94,322	17,606	18,510
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**13·0**	**16·5**	**17·3**	**18·2**
Actual maximum supply demanded	1,184	1,257	301 kilowatts	347 kilowatts
Load factor	8·96%	10·7%	10·5%	11·2%
Number of public lamps	33 arc, 51 (32 c.p.) glow	33 arc, 52 (32 c.p.) glow	19 arc	19 arc
Number of consumers	1,331	1,547	169	210
Connections to mains in 8-c.p. lamps at end of year	85,653	100,734	16,457	18,961
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	**2,290**	**2,290**	**600**	**600**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	**£144,215** / **£63·0**	**£144,215** / **£63·0**	**£45,498** / **£75·8**	**£54,198** / **£90·3**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	144,215 / 63·0	144,215 / 63·0	45,498 / 75·8	54,198 / 90·3
RECEIVED (TOTAL)	**136,015** / **59·4**	**136,015** / **59·4**	**25,450** / **42·4**	**45,498** / **75·8**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	136,015 / 59·4	136,015 / 59·4	25,450 / 42·4	45,498 / 75·8
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**8,200** / **3·58**	**8,200** / **3·58**	**20,049** / **33·4**	**8,700** / **14·5**
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	8,200 / 3·58	8,200 / 3·58	20,049 / 33·4	8,700 / 14·5
REPAID (TOTAL)	**18,320** / **8 00**	**22,083** / **9·64**	**902** / **1·50**	**902** / **1·50**
RESERVE OR SINKING FUND	— / —	— / —	**2,783** / **4·64**	**3,528** / **5·88**
DEPRECIATION FUND	**3,110** / **1·36**	**5,510** / **2·41**	— / —	— / —
EXPENDED (TOTAL)	**139,588** / **61·0**	**149,917** / **65·5**	**34,310** / **57·2**	**43,339** / **72·2**
Lands and buildings	18,768 / 8 20	18,768 / 8·20	3,833 / 6·39	5,899 / 9·83
Plant	65,149 / 28·4	73,489 / 32·1	20,961 / 34·9	25,260 / 42·1
Mains	55,155 / 24·1	57,144 / 24 9	9,485 / 15·8	12,150 / 20·2
Miscellaneous	517 / 0·226	517 / 0·226	30 / 0·05	30 / 0 05
BALANCE OF CAPITAL ACCOUNT	**−3,573**[c] / **−1·56**	**−13,902**[c] / **−6 07**	**−8,860**[a] / **−14·8**	**+2,159** / **3·60**
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	**£16,874** / **4·360d.**	**£19,591** / **3·985d.**	**£4,693** / **4·088d.**	**£5,592** / **3·945d.**
Revenue from supply	14,849 / 3·839d.	17,238[f] / 3·509d.	4,122 / 3·590d.	5,004 / 3·531d.
„ meters, &c.	1,031 / 0·266d.	1,306 / 0·265d.	83 / 0·072d.	100 / 0·071d.
„ public lighting	803 / 0·207d.	803 / 0·163d.	488 / 0·425d.	488 / 0·344d.
„ supply for traction	— / —	— / —	— / —	— / —
„ miscellaneous sources	191 / 0·049d.	244 / 0·050d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£9,045** / **2·336d.**	**£7,944** / **1 615d.**	**£3,100** / **2·700d.**	**£3,395** / **2·395d.**
TOTAL WORKS COSTS	**6,646** / **1·717d.**	**5,806** / **1·181d.**	**2,520** / **2·195d.**	**2,676** / **1·888d.**
Generation of electricity	*5,766* / *1·489d.*	*5,012* / *1·019d.*	*2,346* / *2·044d.*	*2,491* / *1·758d.*
Fuel (including cartage, &c.)	3,203 / 0 828d.	2,499 / 0 508d.	1,041 / 0·906d.	1,140 / 0·804d.
Oil, waste, water, stores	253 / 0·065d.	327 / 0 067d.	159 / 0·139d.	203 / 0·143d.
Wages at station	1,280 / 0·331d.	1,228 / 0·250d.	385 / 0·335d.	433 / 0·306d.
Repairs and maintenance at station	1,030 / 0 266d.	958 / 0·195d.	760 / 0·662d.	715 / 0·505d.
Distribution of electricity	*691* / *0·178d.*	*576* / *0·117d.*	*87* / *0·076d.*	*102* / *0·072d.*
Wages, &c.	332 / 0 086d.	282 / 0·057d.	78 / 0·068d.	87 / 0·061d.
Repairs, renewals of mains, &c.	359 / 0 093d.	294 / 0·060d.	9 / 0·008d.	15 / 0·011d.
Public lighting	*189* / *0·049d.*	*217* / *0·044d.*	*89* / *0·078d.*	*83* / *0·059d.*
Attendance	107 / 0 028d.	113 / 0 023d.	83 / 0 078d.	83 / 0·059d.
Renewals	81 / 0·021d.	104 / 0·021d.		
MANAGEMENT AND PROPERTY CHARGES	**2,399** / **0·620d.**	**2,138** / **0·435d.**	**580** / **0·505d.**	**719** / **0 507d.**
Net rents	*63* / *0·016d.*	*69* / *0·014d.*	*143* / *0·125d.*	*187* / *0·132d.*
Rates and taxes	*742* / *0·192d.*	*785* / *0·160d.*	*102* / *0 089d.*	*149* / *0 105d.*
Management	*1,594* / *0·412d.*	*1,284* / *0·261d.*	*334* / *0·291d.*	*383* / *0·270d.*
Salaries	1,024[d] / 0·265d.	892[d] / 0·181d.	240[g] / 0·209d.	259[g] / 0·183d.
Stationery, &c.	104 / 0 027d.	113 / 0 023d.	28 / 0·024d.	34 / 0·024d.
Establishment charges	315 / 0 081d.	214 / 0 044d.	42 / 0·037d.	67 / 0·047d.
Law charges &c.	151[e] / 0·039d.	66 / 0·013d.	24[b] / 0·021d.	23[b] / 0·016d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	**£7,830** / **6·36%**	**£11,647** / **8·05%**	**£1,593** / **5·00%**	**£2,197** / **5 66%**
Sum carried to Depreciation Fund	110 / 0·089%	3,358[h] / 2·32%	— / —	— / —
Sum carried to Reserve Fund	3,983 / 3·23%	3,948 / 2·73%	717 / 2·25%	745 / 1·92%
Net interest on loans (incl. Debenture charges)	3,737 / 3·04%	4,342 / 3·00%	757 / 2·38%	1,070 / 2·76%
Net profit for the year	— / —	— / —	— / —	381 / 0·982%
BALANCE FROM LAST ACCOUNT	— / —	— / —	−395 / −1·24%	−275 / −0·71%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	— / —	106 / 0·273%
Deficit	— / —	— / —	*275* / *0·86%*	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	53·6%	40·5%	66·1%	60·7%
Expenditure per mean kilowatt capacity	£3. 19s. 0d.	£3. 9s. 4d.	£6. 1s. 7d.	£5. 13s. 2d.
REVENUE PER MEAN KILOWATT CAPACITY	**£7. 7s. 5d.**	**£8. 11s. 2d.**	**£8. 12s. 2d.**	**£9. 6s. 5d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**4s. 3½d.**	**4s. 2½d.**	**6s. 1d.**	**6s. 4d.**
Price charged for lighting, per unit	4½d. less discount	4½d. less discount	6d. (1½ hrs.) to 2d.[e]	6d. to 2d.[e]
Price charged for power, per unit	2½d. (2 hrs.) to 1d.	2½d. (2 hrs.) to 1d.	2½d. to 1d.[d]	2½d. to 1d.[f]
Price charged for public lighting	£20 arc, £2. 5s. per 32 c.p. [glow	£20 arc, £2. 5s. per glow	£25. 14s. per arc per ann.	£25. 14s. per arc per ann.
Receipts per unit for private supply	3·84d.	—	4 01d.	3·53d.
„ „ public lighting	1 73d.	—	3·27d.	3·32d.
„ „ traction	—	—	—	—

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AUTOMATIC RELAY TRANSLATION FOR LONG SUBMARINE CABLES.*

BY S. G. BROWN.

(*Concluded from page 140.*)

Having finished the description of the cable relay translation apparatus, I wish now to describe briefly the "magnifying relay," a relay that was the forerunner of the "drum cable relay." I invented the "magnifying relay" in the year 1898. It is not, at present, employed on any of the cables, but I know no reason why it should not be of great use to the cable companies in the future. As shown in Fig. 7, the instrument consists of a permanent magnet, or direct-current electromagnet, A, and of an alternating electromagnet, B. In the field of the magnet A is suspended a "recorder" coil *a*, say of about 500 ohms resistance; in the field of the alternating-current magnet B is suspended another and similar "recorder" coil *b*. The suspended coils *a* and *b* are coupled together by silk fibres, as is shown in the drawing. The arrival current from the cable C flows through the coil *a* to the earth-plate E, causing the coil to move, and as the suspended coil *b* is joined to it by the fibres, *b* will follow the motion of *a*. G is an electric battery. W is a current reverser that turns the direct current from G into an alternating one. H is a condenser of suitable capacity, placed in the circuit so as to neutralise the self-induction and stop sparking at the current reverser W.

If W is revolved at a proper speed, the magnetic lines of force will be moving in and out of the iron of the magnet B, say at a periodicity of 100 ∿, threading through the suspended coil *b*, when it is at all moved out of its normal or neutral position, and inducing a voltage, proportional to the angle or more correctly, perhaps, to

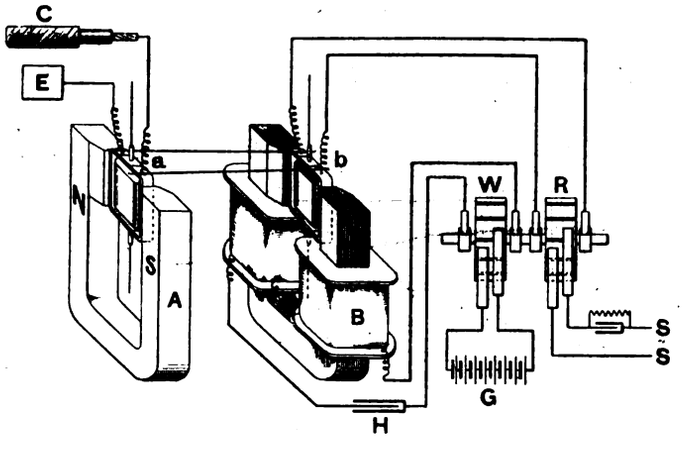

FIG. 7.

the sine of the angle of deflection. By these means energy may be generated in the coil *b*, which may be hundreds of times greater than that employed to move the coil, this greater energy increasing and diminishing in exact proportion to the rise and fall of the controlling current. I should compare this action, if I may be allowed the licence, to a driver directing the energies of a horse by a pair of reins. R is a rectifier revolving on the same shaft as the current reverser, so as to turn the alternating current induced in the suspended coil *b* into a direct or unidirectional current in order that it may operate a "siphon recorder," "direct-writing recorder," or any other suitable instrument, as the case may be, the instrument being placed in circuit with the lead SS. If the circuit of the coil *b*, that hangs in the alternating-current field, possesses only resistance, the induced current will produce no disturbance on the period of the coils, or on the sensitiveness of the suspension.

To explain this, in Fig. 8 I have drawn theoretical diagrams representing sine-wave curves. I is the curve of magnetic induction, A the curved of induced volts, which is, as is well known, at right angles to the curve of magnetic induction, and B is the current curve, which flowing in a circuit of plain resistance would be exactly in phase with the induced volts. This being so, the amperes, as a whole, will produce no reaction on the alternating field *aIe*, because, as is seen, the portion *abc* is exactly equal to, opposed and neutralised by, the portion *cde*. But it is otherwise if there is capacity, because then the amperes will be accelerated, this acceleration being due to two E.M.F.'s impressed on the circuit, one due to the moving magnetic lines, and the other to the voltage stored up in the condenser, the portion *abc* being less than that part of the curve *cde*, the difference acting on the magnetism so as to cause the coil *b* to move out of the field. If there is inductance, the contrary action will take place, in which case, the part *abc* being greater than the part *cde*, the coil will then endeavour to remain in the field opposing the action to move it out.

Capacity has the same effect as slackening the control of the suspensions, increasing the period of the coils and making the instrument more sensitive, while induction stiffens up the coil reducing the period. This being so, a ready means for adjustment is provided for by plugging in induction or capacity, the control over the coils may be instantly increased or lowered, and this is so, whatever may have been the initial mechanical control, within reason.

I have arranged the instrument, on some occasions, to work with only one suspended coil, combining the alternating and direct currents on one field magnet, the current from the cable passing through a choking coil before flowing round the suspended coil. The choking coil stops the induced alternating current from flowing into the cable, while the current from the cable is blocked, say by a condenser, from flowing past the rectifier and wasting its energy in the local circuit. Such a single-coil instrument acts as well as a double-coil one, but I do not know if it possesses any special advantage except on the score of mechanical simplicity.

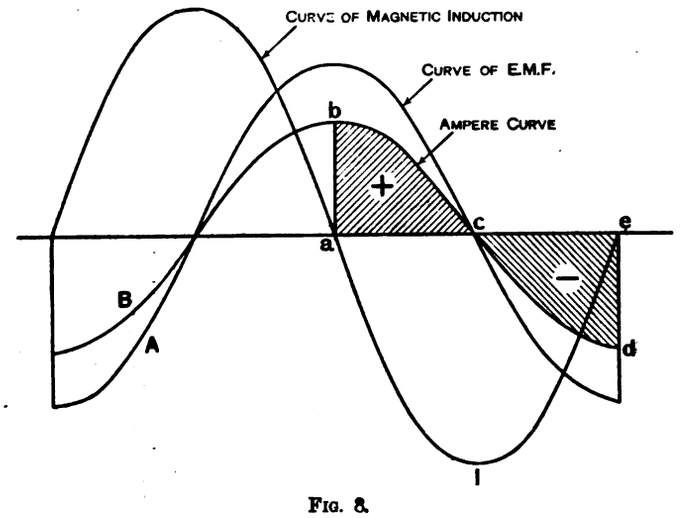

FIG. 8.

On trial with the magnifying relay over an artificial cable I have obtained some rather interesting results. For instance, the Slip A in Fig. 9 shows signals written by a siphon recorder, worked by a "magnifying relay." The "magnifying relay" acts as a receiver at the end of an artificial line of 7,000 ohms resistance and 310 microfarads capacity. An automatic "curb" transmitter was used as sender, the speed being 150 letters per minute, the sending battery having a potential of only 3 volts. Slip B shows the signals received under identical conditions, but with the "magnifying relay" cut out of circuit, the siphon recorder acting as receiver direct. Again, the Slip C shows signals written by a siphon recorder worked off a "magnifying relay," while Slip D shows the signals as received by the siphon recorder direct, the relay being cut out of circuit. The currents were transmitted by an automatic "curb" transmitter of 185 letters per minute, with sending battery of 50 volts, the K.R. of the line being 3·6.

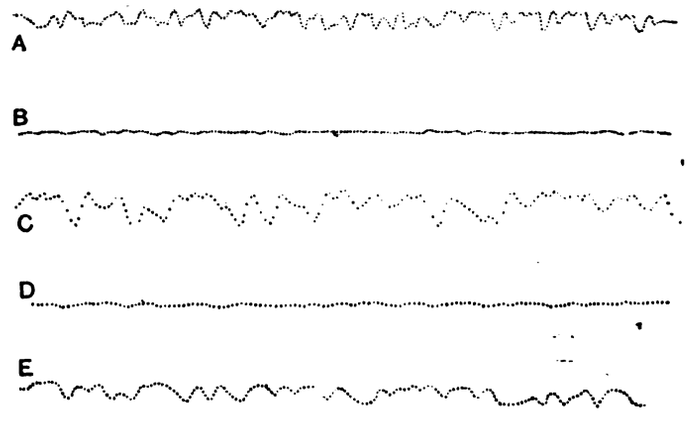

FIG. 9.

Slip E shows signals received at a fairly high speed, the siphon recorder being worked off the induced currents of the "magnifying

* Paper read before the Institution of Electrical Engineers, May 1st.

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relay," as in slips A and C, the artificial line had a retardation of 3·6 K.R., the automatic "curb" transmitter was sending with a battery of 42 volts, the speed of signalling was at the rate of 280 letters per minute. When signals at a moderate speed were being received on the particular magnifying relay used in these experiments, it was difficult to detect by the eye any motion whatever in either of the suspended coils when observed through a strong magnifying glass. Though small in amplitude, it is certain that the motion occurred from the fact that the currents induced thereby were sufficient to cause large and very visible movements in the signalling coil of the siphon recorder.

The "magnifying relay" seems to possess three main points of advantage for cable working :—

1. It may be used to work the siphon recorder with the signals of the same size and at the same speed as at present, but with greatly reduced sending battery power.
2. It may be used to work the siphon recorder with the signals of the same size, the same definition, and the same sending battery as at present, but at a greater speed.
3. I believe it may be used to work over a cable under the same conditions as regards speed and battery power as at present, but the signals may be written by a "direct writing recorder" in place of the present "siphon recorder."

tion to me. They gave the convenience and necessary encouragement, and have done all in their power to help me in every possible way, and I wish to acknowledge by deep indebtedness to them.

DISCUSSION.

Prof. AYRTON said the Paper took him back to the old days 20 years ago when this sort of transmission was the only kind of transmission of power which anyone had to do with. The problem of transforming the blurred signals received at the end of a long cable into the ordinary Morse signals, such as were used on land-line telegraphs, had occupied a number of people, but, so far as he was aware, this was the only practical and successful solution that had ever been reached. The idea of restoring the waves that had disappeared and blotted out was an extremely interesting and ingenious one. All who were familiar with submarine telegraphy would understand at once the problem of turning the slip A in Fig. 4 into slip B. In this slip A certain waves would be seen followed by straight lines. Of course, the expert cable signaller knew by experience that that straight line was not meant for a straight line ; it was meant for a series of ripples, and by experience he learnt to decipher them. In fact, he did exactly what a well-trained clerk did in connection with the bad handwriting of any particular individual whom he knew. He deciphered it by using his brain ; and what Mr. Brown had to do in tackling the problem was to invent a *machine* which had that discriminating brain. Of course,

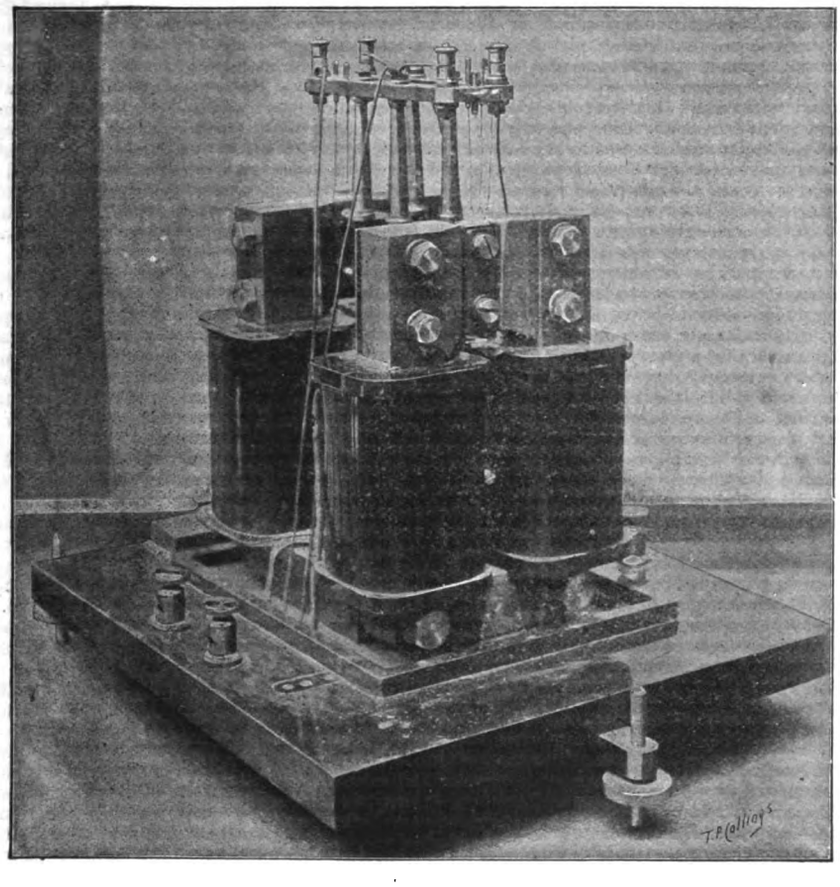

FIG. 7A.—MAGNIFYING RELAY.

Now I should like to suggest a use for this instrument or part of the instrument for electrical engineers other than telegraph men. Referring again to Fig. 8, and considering only that part marked B*b*: If the winding round the magnet is supplied with an alternating current, say of sine-wave form, we have seen that if induction or capacity is introduced in the circuit of *b*, the rectifier being dispensed with, the current flowing in the circuit will be put out of phase with the induced volts, and a mechanical reaction takes place between the coil *b* and the magnet B, the coil tending to move one way for induction, and in the opposite way for capacity, *b* being supposed suspended in such a manner as to cut some of the moving magnetic lines, its motion being studied by means of a mirror reflecting a spot of light on to a scale. A complex circuit could be tested and compared with a standard, the deflection showing the resultant capacity or induction ; or, perhaps, the capacity, say of such a thing as a coherer, could be found out by this means. I believe that such a reaction galvanometer could be worked up to measure capacity and induction in the same way as an ordinary galvanometer measures resistance.

Messrs. H. A. Taylor and A. L. Dearlove, both of the firm of Messrs. Clarke, Forde and Taylor, pointed out this line of investigation it was a little easier than it would be to invent a machine to decipher handwriting, because there was one advantage in connection with the telegraphic scrawl which did not exist in handwriting—viz., that a certain length of straight line meant a definite number of ripples. If it was longer, the telegraph signaller knew that it meant more ripples ; in fact, the length of the line was really a measure of the number of ripples. This fact Mr. Brown had been sufficiently acute enough to see. He apparently said to himself that if he made an apparatus which introduced ripples at a given rate he would be able to put in the right number of ripples that had been blurred out. It was a very interesting idea. Of course, the accomplishment of this necessitated the two instruments running at nearly uniform speed. This was why the interpolator had to run at a fairly constant speed synchronously with the machine at the other end. The drum cable relay, described in the Paper, was also a very ingenious contrivance. It got over friction by causing one of the two bodies to be in continuous motion relatively to the other. Of course, this was not a new idea, as the author himself had said : "What was really new was the utilisation of it." They had all known for a very long time that if one body had to move over another, and to eliminate friction, the oscillation or rotation of one of the bodies would enable the two to move much more quickly over each other. The last part of the Paper had a special interest for him, because Mr. Brown had solved a problem which Prof. Perry and himself were tackling some 10 or 12 years ago, which they solved in a different way

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but not in such a good way. The object had been to do what Mr. Brown had done—to magnify these slight telegraphic messages. There were all sorts of variations succeeding one another with considerable rapidity, and it was necessary to get an enlarged image of them. The way Prof. Perry and himself had gone about it was simply to take a small dynamo and run it at a uniform speed. They used the field magnet coil as the receiving coil of the telegraph line—*i.e.*, they magnetised the field simply by the current received along the telegraph line. The armature was rotated by any convenient arrangement at a considerable and uniform speed, and thus the E.M.F. of the armature, and, therefore, the current produced through the fixed resistance, was an exact copy of the wave which had come along the telegraph line. This was used to magnetise the field magnet, and the wave might easily be a very much enlarged one, because energy was being given to the arrangement by the work done to turn the dynamo. The difficulty of the arrangement, however, was this: They had unwisely aimed at getting an extremely perfect magnified image of the received current, and this necessitated having no iron, either in the field or armature of the dynamo, and thus they had been led to the unhappy conclusion that before it was possible to introduce energy by such a contrivance it was necessary to run the dynamo at a speed greater than the speed of self-excitation. They thought they had proved this mathematically, and that it would mean such a high speed as to make the thing impracticable, but in talking over the matter with Mr. Brown some two years ago he had been told that iron could be introduced without blurring the message too much. Thus, of course, the speed of self-excitation would be a speed possible to attain in practice, and the arrangement just described, adding the iron, he thought would be able to give just as good a record as Mr. Brown's, because Mr. Brown was met with a difficulty mentioned in the Paper—viz., "If the circuit of the coil *b* (Fig. 6) that hangs in the alternating-current field possesses only resistance, the induced current will produce no disturbance of the period of the coils or on the sensitiveness of the suspension." If the circuit possessed no resistance there could be no induced current at all. There was only induced current when the coil had self-induction. If it were wound non-inductively, so that it only had resistance, then there could be no mutual induction between the electromagnet B and the coil *b*, and therefore there could be no current produced in the coil. It was necessary, therefore, that the coil should be inductive. Then came the question, was it possible with self-induction and capacity so to balance the self-induction of the coil as to get a perfectly true representation of the current through the coil *a*? And he was not quite clear that this was so, because the current in this latter coil was varying in all sorts of ways at different rates, and they knew that capacity only balanced self-induction for a given frequency. He did not mean to suggest for a moment that it was impracticable. Far from it. This was an extremely ingenious idea, and got over one of the difficulties which Prof. Perry and himself had to contend with—viz., that it was possible to use iron, and therefore get a considerable magnification without the difficulty spoken of—the great speed of rotation. He would like to know from Mr. Brown whether this arrangement for all sorts of speeds of signalling did not give a better magnified image than the high-speed dynamo with a small amount of iron in it. He offered the warmest congratulations to Mr. Brown on a result which should be of the very highest importance to the submarine cable companies, who at the present time required all the assistance they could get in view of wireless telegraphy.

Mr. JOHN GAVEY thought the whole design of this instrument simply marvellously perfect. He remembered when he first had an opportunity of seeing it some two years ago at the offices of Messrs. Clark, Forde and Taylor he was simply thunderstruck with surprise. In the past, on many occasions when he had endeavoured to read the mystic Morse symbols from the slip of a siphon recorder, it had dawned upon him that his professional education must have been sadly neglected somewhere, because he had never been able to read two or three consecutive words, and if Mr. Brown would continue his illustration of the working of this instrument after the meeting he was sure the members would go away with a much more vivid impression of the beauty of the instrument. One point which forced itself upon him in connection with the invention was that it was very curious how, when one inventor started on a line of investigation, others, not working with the same object in view, perhaps, were also working in that direction. The ideas of telegraphy in the past had always consisted of the one fundamental principle that it was necessary to send a separate impulse for every particular movement which it was wanted to effect at the distant end. Owing to the capacity of a cable, however, all these were blurred into one uniform impulse, and Mr. Brown had set himself to split this up into the original ones again. In other directions the same thing had been done. In wireless telegraphy there was the make and break of the induction coil, and there were impulses lasting perhaps one-tenth or one-twentieth of a second, but owing to the capacity and induction of the vertical conductor these might be flooded into 200 or 400 millions per second, and the result was a mass of Hertzian waves. In telegraphy Mr. Donald Murray who had invented a very beautiful apparatus for high-speed telegraphy of the typing character (see *The Electrician*, Vol. XLVIII., p. 86), and which he (Mr. Gavey) hoped to bring before the Institution next session, had, curiously enough, started in the inverse direction to Mr. Brown. He sent a current of a definite duration, and the instrument at the far end split it up into a number of separate impulses.

Mr. W. JUDD, of the Eastern Extension Telegraph Co., said that his company had begun to adopt the instrument, and they hoped to extend its use eventually. It was very obvious that it was not a thing to be put down and left to itself. It was an instrument which had its difficulties, climatic and otherwise, and with so much delicate apparatus as that in a tropical climate it was clear that there was a certain amount of difficulty in keeping everything in absolute thorough working order. But it was an undoubted advance upon all previous experience, and he only hoped that the anticipations of all of them would not be disappointed.

Mr. H. W. SULLIVAN said he had had no personal experience of the instrument. With regard to a remark made by Mr. Brown, in which he seemed to rather exaggerate the trouble with what he called "butt" contracts of relays, he mentioned that in some experiments he had been making on a cable he used these contacts and did not have anything like the trouble Mr. Brown appeared to have had. In fact, he did not think any such trouble existed at all. He would like to ask Mr. Brown what was the longest length of cable upon which he had worked the relay without the interpolator.

Mr. H. D. WILKINSON thought previous speakers had rather missed the great achievement that Mr. Brown had effected. They had spoken of the achievement of producing ripples where they did not exist—*i.e.*, where these ripples were lost in the signals at the receiving end, Mr. Brown had put them in again, but this, in his own opinion, was not the greatest merit of this instrument. As a matter of fact, signals without the ripples were just as easy to read as with them, and, to tell a secret, they rather preferred them. What he considered so perfectly marvellous was the reduction of the friction in the contacts of the relay when approached by such minute forces as arrived at the distant end of a cable—such impulses as would only just turn a light mirror weighing a few grains—and what to do with such infinitesimal forces had been the problem before cable engineers up to the present time. The difficulties had been enormous, and the opinion of all cable experts was that the great achievement of this instrument was the harnessing of these minute forces by means of the rotating drum in which the friction was annihilated. This had been the bugbear of all who had previously attempted to overcome the difficulty. Further, when Mr. Brown had arrived at that stage he was confronted by a difficulty even greater than this—viz., the wandering zero, as had been described in the Paper. When using condensers in the transmitting and receiving ends of a cable, as was absolutely necessary in order to get speed out of the cable, this wandering away from zero was introduced. It was not the absence of ripples which was the trouble, it was the wandering zero, and everyone was aware that in a relay which was to act with accuracy and certainty it must come back to zero between every signal, otherwise there would be no possible means of reproducing the signals. Mr. Brown thereupon devised other means, and he hit upon the solution by using the local circuit—*i.e.*, the circuit produced by the relay—to counteract the wandering away from zero and send back a kick in the right direction. Personally, he was filled with astonishment that the thing had been brought to a successful issue, and cable electricians were deeply indebted to the author of the Paper.

Prof. AYRTON, taking up the previous speaker's remark that he liked the absence of ripples, said the question was not so much what the signaller liked as what the instrument liked which had to produce the perforated slip for use in sending a message along a land line. Supposing the ripples were not put in, and it was wanted to automatically produce a slip at the other end which could be used in a Wheatstone fast-speed instrument, how would it be possible to get such a perforated slip, and how was it possible to solve the problem which Mr. Brown had solved—viz, to receive the submarine cable message and to transmit it along a land line in the ordinary Morse way?

Mr. WILKINSON replied that the land line was a very small matter in cable work. The great problem had been to transmit the messages from one cable to another. The land lines were about 5 or 10 miles away; the cables were thousands of miles. Cable men did not look at the matter in the light that Prof. Ayrton had indicated. If Mr. Brown had given them the same instrument without the ripples he could have transmitted the very cable shown them precisely at the same speed as he had done without introducing these ripples.

Mr. W. M. MORDEY told a story about Mr. Brown. The latter was engaged in electrical engineering at Messrs. Crompton's about three or four years ago, and had then stated that he did not think there was much future for electrical engineering, but considered telegraphy offered a much better scope. He thereupon resigned his position at Crompton's and went in for telegraphy, and the result of the change was before the Institution that evening. Personally knowing something of Mr. Brown, he was quite sure all along that he would achieve something very useful, but had not imagined he would have advanced so rapidly as he had done. It was only about a year after leaving Crompton's that Mr. Brown had asked him to come and see this apparatus in an earlier form, and he was simply delighted with it. Mr. Wilkinson had put it very clearly. It was one of the most extraordinary inventions in connection with telegraphy that had been made for 30 years. Prof. Ayrton had explained to the meeting very clearly why he did not invent this apparatus. This success of Mr. Brown's showed conclusively that the two branches of the profession—*i.e.*, electrical engineering and telegraphy—ought not to be separated. All persons engaged in telegraphic work ought to make a close study of the problems which occurred in transformation and so on. One could not go into a workshop where apparatus of this kind was made without feeling that they would be better designed by people who could bring some knowledge of things dealing with larger machines to bear upon their manufacture. The drum relay was a wonderful thing. Probably everyone knew the principle that if one thing moved another body which was in contact with it would have less friction, but this invention was a long way from that. Anyone who knew the extremely feeble effect from the siphon recorder, and then saw the application of it to this instrument would be very much astonished. The second very beautiful thing about this invention was the magnifying relay. To imagine that a thing which had about a one-tenth fly power could make a dynamo deliver energy into the circuit and work the whole lot of apparatus which required a considerable proportion of a horse-power was a marvellous thing. It was one of the prettiest electrical inventions ever brought out by anybody, and he welcomed the invention as the result of a combination of a knowledge of engineering, properly so called, and telegraphy

Mr. S. G. BROWN, replying, referred to Prof. Ayrton's remarks that the automatic transmitter and re-transmitting instrument must run in approxi-

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mate synchronism. As the speed got higher and higher and nearer the speed of the siphon recorder, the difference of speed between the two instruments began to get less, and one could easily imagine that by forcing the instruments to an extreme limit there would be no difference of speed at all. The question of vibration, also mentioned by Prof. Ayrton, he said, had been worked out very carefully by Delaney, who had done a great deal in cable telegraphy by striving to make a practical cable relay. The real difficulty was with the contact, which struck so feebly as the point came down that practically no current at all was passed. In all cases, with the exception perhaps of silver, there was always a film of oxide forming on the metals, so that unless they actually hammered together they did not make clear metallic contact. In connection with the magnifying relay, he had worked out and tried two distinct types, but the one for alternating currents, which pumped energy into the suspended coil, seemed by far the best way of doing it. He had most carefully calculated the effect of a dynamo magnifying relay, and it had come to this—he found that in designing such an instrument the loss in the iron might be very considerable when worked with feeble forces. When operated by these exceedingly feeble forces the molecules of the iron acted very sluggishly—the curve of induction went up very slowly. At the beginning of the curve the rise of current for any given magnetising force was exceedingly small, and they always had to work at the extreme lower end of the curve. In dealing with the magnifying relay of the dynamo form they must take into consideration the effect on the iron, and to do this he had got over the difficulty by working a magnetic balance on the top. The dynamo magnifier had two field magnets, and they could be excited from the magnetising circuit; but in calculating out the instrument it was found that the main controlling point was the air-gap, and, as this was the great thing which controlled everything in a dynamo magnifier, it was naturally impossible to make the instrument, as Prof. Ayrton had intended, of air only. Prof. Ayrton had pointed out that in a magnifying relay the suspended coil could not possess resistance only. There must be a certain amount of self-induction. This latter had the capability of guiding the lines of force, and, therefore, it was impossible, but it was possible to neutralise the effect of self-induction by the introduction of a shunt. It was very marvellous, in watching the vibration of the magnifying relay, how easily it could be made to put in induction at an extraordinary high rate of speed, and it could be slackened down to anything, making the coil move out of the field by the introduction of capacity. As regards Mr. Donald Murray's invention, mentioned by Mr. Gavey, he did not think this so complicated as his own. It had been said that Mr. Murray sent along a contact and interpolated it at the far end; but the difficulty he himself had to contend with was to get a suitable relay to receive, then to be able to work the instrument on the cable, and then to be able to send the signal on by a suitable instrument. Mr. Judd, in his remarks, had mentioned the effect of tropical climates upon the instrument, and probably this was the oxidisation of the metals. Mr. Sullivan had mentioned about butt contacts. There were a great many difficulties in connection with the relay, but in a butt contact there must be a certain pressure to break down the oxidising film of the metals, but this could be done by bringing the pointer over the point of suspension. As regards the length of cable over which he had worked the instrument, he said it had been utilised over cables as long as the new Pacific, and the speed was about the same as the ordinary siphon recorder.

Mr. SULLIVAN: Do you use the interpolator always?

Mr. BROWN said it could be used, but in the Paper he had shown how it could be dispensed with. Slip B showed the signals as received when the interpolator was cut out of circuit. It was not necessary to have the interpolator; they could have a couple of condensers—shutter condensers—in the magnetic shunt.

The PRESIDENT, in proposing a vote of thanks to the author, said this admirable instrument was the outcome of a careful consideration of the subject and a study of the principles of electrical engineering. Mr. Mordey was quite correct in his remarks upon this point, and it was an example which might be followed by others in application to telegraph work. Apart from anything else, the Paper was noteworthy in that it was the only one on a telegraph matter this session.

THE INSTITUTION AND ITS PROPOSED MODEL CONTRACTS.

The following is an abstract of the conclusion of the discussion which took place at the Institution of Electrical Engineers on May 8th upon the form of model general conditions for use in connection with contracts for plant, mains and apparatus for electricity works, as drafted by a committee of the Institution. An abstract of the conditions was published in our issue of April 25th, p. 13, and the first discussion upon them in our issue for May 2nd, p. 63. Where only the numbers and titles of the clauses are given the full text will be found in *The Electrician* for April 25th :—

Mr. G. H. NISBETT, continuing his remarks made at the previous meeting, said he had now gone carefully through the conditions, and found that no less than 57 clauses safeguarded the interests of the purchaser and only 17 gave any rights at all to the contractor. The last paragraph of clause 10, "Contract and Bond," said that the expenses of stamping and completing the contract were to be borne equally by the contractor and the purchaser. This was unusual, as at present the purchaser usually paid the cost of the contract. If this was to be a new departure he would suggest that the contractor's share should be stated in the specification, so that he knew how much to add. With regard to clause 22, "Power to Vary or Omit Work," he suggested the addition of the following to the third paragraph: "And the purchaser should pay the cost of new patterns if they are necessary by reason of such alterations." In the "Negligence" clause he suggested a new paragraph embodying the penalties for non-fulfilment of the terms of the contracts by the purchaser, as there was nothing in the conditions as they stood to force the purchaser to carry out his side of the bargain. With regard to testing and inspection at the maker's works, clause 25, he took it that the rejection of the work there set forth was subject to arbitration. Clause 27, "Delivery of Materials," provided that if the purchasers withheld the forwarding of instructions so as to prevent the contractor giving delivery by the dates specified in the contract, the purchasers should bear the cost of the storage of the plant and materials, and make payments therefor as if delivery had been given, provided that the possession thereof and the property therein be duly secured to the purchasers. There ought, in his opinion, to be a penalty, failing this, of 5 per cent. interest to be paid to the contractor. Clause 29, "Materials brought on to the Site," provided that if any money was due from the contractor the purchaser should have the right to sell the materials used for the construction of the work. He did not think this quite fair. It was fair if the contractor was unable or unwilling to pay, but not unless. The mere fact that money was due ought not to give the purchaser powers to sell the contractor's plant unless the latter had refused to pay. Clause 30, "Engineer's Supervision," ought to stipulate the "reasonable" instead of "entire" satisfaction. Clause 33, first paragraph, "Liability for Accidents," should contain the proviso, "unless the purchaser was in beneficial use at the time of the accident." No provision was made in clause 36, "Terms of Payment and Certificates of Engineer," for the cases in which goods were made and delivered only. In sec. 1 of the same clause he would add "the date of taking over the works not to depend upon the completion of any other contract."

Mr. HAMMOND pointed out that as soon as a contractor was ready to have his material taken over he had power to give notice.

Mr. NISBETT said in the case of works already in existence this might be so. But with new works it was different.

Mr. HAMMOND thought the contractor was fully covered under clause 42 in such cases.

Mr. NISBETT said this was so, but it was not very clear as to when the works were to be taken over. Continuing on the same clause (36), he asked if the 10 per cent. had to be paid for any portion of the contract, because otherwise the purchaser might have the beneficial use of £99 out of £100, and keep the 10 per cent. back because the other £1 of work was not completed. With regard to the portion of the same clause dealing with defective work, the following wording had been used by the Cable Makers' Association, and he would suggest a similar provision: "In the event of there being any dispute as to the amount of any claim in connection with the work, the engineer may take such reasonable sum as may be necessary to cover the work in dispute, and failing this the purchaser should pay interest at the rate of 5 per cent. per annum." There was nothing in the clause to make the purchaser pay. In clause 45, "Inefficient Work," the options given to the purchaser were much too drastic. There was no proviso that the contractor should be given any opportunity of remedying any defects, and one month should be allowed for this. With regard to clause 46, "Maintenance," he contended that the period of beneficial use should be deducted from the maintenance. As to the second paragraph of the clause, the contractor should have the right of entry to the works, not only during the term of the contract, but also during any period of guarantee. Clause 47, "Requirements of Local Authorities," suggested the addition of the words, "provided copies of all local regulations have been previously furnished him by the engineer." There was also one thing in the form of agreement which was very widely worded. It said the contractor should duly complete and perform the works mentioned or implied therefrom. He thought that if the contractor did all that the specification asked him, whether it asked him to complete the works or not, he had fairly fulfilled his contract and should not be called upon to complete the works unless the specification asked for complete works.

Mr. STUART RUSSELL, referring to the first paragraph of clause 36, "Terms of Payment, &c.," said this was quite clear when applied to the next sections of the same clause regarding progress of payments, but later on with regard to the retention of payments, the wording of the clause seemed to have become altered. Further in sec. (*a*) of clause 36 it was stated "10 per cent. at the expiration of one month after the works shall have been taken over by the purchaser under clause 42, or alternately, at the option of the contractor, at the expiration of one month after the works shall have been put into beneficial use by the purchasers." This did not state whether the payments were to be made at the expiration of one month or merely to become due. They all knew there was a difference between the two. If the first 10 per cent. was to become due at the expiration of one month, and the purchaser had another 28 days within which to make payment, he got an extra month thrown in which was in contradiction to the first paragraph of the clause in which it said that payment should be made within 28 days from the date of the engineer's certificate. He was not so much concerned as to whether payment was to be made a month earlier or later so long as he knew the exact time the contractors could make provision. It was often found that these payments were put off from time to time because the engineer would not give his certificate of completion on account of something which did not suit him, and which the contractors thought the 10 per cent. covered. But this might easily be got over by carrying the idea of the first paragraph of clause 36 right through the three statements concerning payment. But at present three different periods—viz., 28 days, 30 days and one month—were mentioned throughout the conditions, and the committee did not seem to have quite made up its mind as to which was the most suitable. Clause 10, "Contract and Bond," was a sample, wherein all three terms were stated. Clause 13, "Contract Drawings," he did not think fair to the contractor. "The contractor shall submit, for the engineer's approval, a preliminary set of

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the list of drawings, set out under each section of the specification, by the dates therein indicated. Within 14 days after the date of the notification by the engineer to the contractor of his approval of the preliminary set of drawings, two additional sets, in ink on tracing cloth, or black and white prints mounted on cloth, of the drawings as approved, shall be supplied to him by the contractor, and be signed by him and by the contractor respectively, and thereafter deemed to be the 'Contract Drawings.' These drawings when so signed shall become the property of the purchasers and be deposited with the engineer, and shall not be departed from in any way whatsoever, except by the written order of the engineer, as hereinafter provided. During the execution of the works one of the sets of drawings shall be available for reference on the site. In the event of the contractor desiring to possess a signed set of drawings he may submit three sets, and in this case the engineer will sign the third set, and return the same to the contractor. The contractor shall also supply from time to time such additional drawings of any details as the engineer may deem necessary for the execution of the work, but the contractor shall not be called upon to furnish drawings of constructional details further than those which, in the opinion of the engineer, are required for the purposes of the contract. [NOTE.—*For use in connection with municipal contracts only.*] In the event of the sanction of the Local Government Board (London County Council), referred to in clause 11, not being obtained, the purchasers shall pay the contractor such reasonable sum for the drawings as the engineer may determine, the sum to be based upon the cost of the production of the same. The engineer shall have the right, at all reasonable times, to inspect, at the works of the contractor, drawings of any portion of the work. If the contractor shall not submit the drawings within the time specified, or subsequently within seven days, after the purchasers or the engineer shall, in writing, have required him so to do, and if the delay shall not have been occasioned by the purchasers or the engineer or any other contractor, the purchasers may notify in writing to the contractor that they will not be bound by the contract, and on such notification the contract shall be avoided, and the purchasers shall not be liable to or for any claim or demand from the contractor in respect of work then already done or material furnished, or in any respect of any other matter or thing whatever. Or, *alternatively*, the purchasers may, at their option, maintain the contract, and in such case the contractor shall pay or allow to them in account all expenses incurred by such default." The contractor was bound under penalty to submit for the engineer's approval a preliminary set of drawings, then a certain time after that approval he was bound to supply two copies of these drawings which were to be signed as contract drawings, within a fortnight from the notification of approval, no limit being set to the time which the engineer might take for approving the drawings. Delay on the part of the engineer might cause very serious loss to the contractor far greater than could be compensated for by the only thing which the contractor can get—viz., an extension of time for completion. An instance which came within his knowledge a year or two ago, at the time when the prices of metals were rising greatly, was in a contract concerning the supply and erection of pipe work. The drawings were a very long time being approved, and when this was finally done and the contractor was in a position to place his orders, he found he had to pay 30 per cent. more for his pipes than he would have had to could he have placed the orders a couple of months earlier. With regard to the penalty imposed for the delay in supplying drawings, he would like some further explanation. Was it to be understood that the contractor was liable to pay a penalty if his drawings were late, and then, supposing he was late in completing the contract (a very natural result if his drawings were late), was he to pay a further penalty? If so, how was this penalty to be valued? Was it to be a fine, irrespective of damage actually suffered by the purchaser, or was it to be actually valued by the amount of the damage? Clause 13 in question he thought would lead to a great deal of discussion and disagreement between the engineer and the contractor if it was ever enforced or tried to be enforced, and he did not think it fair that the contractor should be liable to two separate penalties really for the same offence. If there was no delay in completion then he did not think the purchaser had suffered any damage through the drawings being a bit late, and the contractor ought not to be fined at all. He would like to see the last paragraph deleted and the previous paragraph left to stand by itself.

Mr. C. C. HAWKINS thought clause 48, "Arbitration," would be clearer if the words "as to any matter of construction, fact, or otherwise" were omitted. It was most important to the contractor that he should retain his free and undisputed sway of the field for arbitration. Another most important clause, from the point of view of the contractor, was 33, "Liability for Accidents." Taking an imaginary case, if an arc was started at the back of the switchboard and set fire to the cables, and then extended to the whole of the station buildings, by the present wording of the clause the contractor for the switchboard might be called upon to replace the whole of the station. This was the usual form in which it now appeared in municipal conditions, but it was one of the worst municipal conditions. Obviously the intention was to safeguard the purchaser, but if A's house caught fire and set fire to B's house be believed he was right in saying that B had no remedy against A, and the proper remedy was to force each contractor to insure his own plant. It was impossible for the contractor to insure against the wording of this clause, because he would have to specify some money value, and it was a totally indefinite amount. If he had to put down the cost of the whole central station and insure upon that he would have to pay a very large premium, whereas his contract might be only for the switchboard. Then, again, take the case of damages for vibration set up by a steam engine: This opened up the whole question of consequential damages. A contractor was always ready to be responsible for accidents arising during the erection of his plant, such as the breaking of a steam pipe or injury to a labourer, but when the clause was so loosely worded as this one was it was impossible for him to know whether he would simply be liable for any claims brought against the purchaser, say, on account of vibration, which he would be unable to control in any way. This latter would depend entirely upon the subsoil, and he really would have no control over this. Such a clause as this should be very carefully worded on behalf of the contractor. As to clause 26, "Inspection and Testing at Maker's Works," he said as a rule steam-consumption tests were made at the works of the maker of the steam engine, and this had been found to give satisfaction; but if at any time the question arose—very likely on very good grounds—by which the engineer would feel called upon to investigate the steam consumption again, he was at liberty by the present wording of the clause to call upon the contractors to supply the coal, waste, oil, resistances or water bars necessary to take up the power of the motors, voltmeters, indicators, starting observers, &c., for a very expensive series of tests at the central station, all of which had already been carried out at the maker's works. Would it not be possible to define where the tests were to take place?

Mr. HAMMOND: But it does define this.

Mr. HAWKINS replied that the engineer might call for the tests to be made on the site.

Mr. HAMMOND: Then the contractor would include in his price sufficient to cover this.

Mr. HAWKINS: But not in the case of a dispute, and it is unfair to call upon the contractor to find all materials, &c., for fresh tests which he could not possibly foresee at the time of entering into the contract.

Mr. J. H. KINGSBURY suggested that clause 12, "Interview with Engineer," should contain a provision allowing the duly authorised representative of the engineer to take the latter's place if necessary. Paragraph 7 of clause 13, "Contract Drawings" (given in Mr. Russell's remarks), ought to have some saving clause added to it, such as "or any reasonable preventable cause" for the contractor who did not deliver his drawings in time. In reading through the conditions he was struck with the good work which the committee had carried out, and he was sorry to see that some captious criticisms had been indulged in on that work. To begin with it had been remarked that the clauses were in favour of the buyer. But he took it that the object to be met was that the conditions should be available for general use, and it therefore occurred to him that there was very little prospect of getting any conditions generally used if they were in favour of the seller. They had inherited the feeling that the buyer was the superior person and the seller the inferior person, and he hoped that in the preparation of these conditions too much attention would not be given to the right of the seller. As a seller himself he was glad to get something which had reasonable fairness in it, and should despair of getting any condition at all if they were entirely in favour—even if it were absolutely just—of the seller. He was glad that in drawing up these conditions, however, the committee had taken the advantage of the assistance of representative bodies of contractors and manufacturers, so that really they had had a hand in the making of the laws under which they were going to be ruled. Contractors had been accustomed to so much injustice from contract conditions drawn up by buyers and handed to the seller that he would either take it or leave it, that it would be a good thing to have a modicum of justice. Personally, he should only like to be able to draw up a set of conditions which he could hand to the buyer and say take it or leave it, but in the meantime was quite willing to conform to such a set as these under discussion.

Mr. J. N. SHOOLBRED said that although these clauses and conditions had been framed after the model of those published by the Royal Institute of British Architects and the National Builders' Association, the underlying principle in those issued by the Institution was diametrically opposed to those upon which they were framed. It was the generally accepted idea that the architect or the consulting engineer was the adviser and the exponent of the views of the purchaser, but in these conditions it was the contractor who was made the person to interpret the views and ideas of the purchaser. The drawings were to be supplied by the contractor, and the consulting engineer was to stand on one side until he received them. This was not a very exalted position to occupy, and yet the consulting engineer was supposed to be the adviser of the contractor. This principle seemed to him to run throughout these conditions; the consulting engineer was to be placed in a secondary position, which he knew would be objected to by many purchasers. Had any leading consulting engineer ever allowed himself to be put into this position? Clause 36, "Terms of Payment and Certificates of Engineer," he considered a little complicated.

Mr. W. B. ESSON fully agreed with Mr. Nisbett—viz., that this document, to be made effective for both sides, would want a considerable degree of modification. Mr. Hammond had been careful to state that the prototype of the conditions was a similar set issued by the Royal Institute of British Architects, and, therefore, these really applied to a different kind of contract to that for carrying out central station work. It was quite easy to see that if the contractor had to manufacture work on the site out of such raw materials as bricks, mortar and iron, an altogether new lot of contingencies had to be provided for by the buyer than when the contractor delivered manufactured articles on the spot. Coming to the clauses, he thought the words as to the use of the crane ought to be left out of the general conditions altogether, and ought to be put in the proper sub-section to which it applied. It was perfectly evident that the crane could not be used for laying the mains, and it ought to be included in the engine section. Clause 9 referred to by Mr. Nisbett as nullifying the arbitration clause, he did not think did this, because a contractor could fall back upon clause 9 and say he did not know what the specification meant. Clause 11 ought to come out altogether. Nobody knew better than the reporter to the committee (Mr. Hammond) that the contractor had no margin to cover this. Clause 20, "Patent Rights," he had mentioned to a friend of his, but would not like to repeat his answer. Mildly, he had called it preposterous. Supposing Mr. Mark Rücker had been successful in establishing his claim to the parallel system of distribution by transforming, which he had attempted to do a year ago, all the contractors would by now have been in bankruptcy. A contractor ought certainly to indemnify an inventor of the apparatus which he supplied, but as to the

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manner of using the apparatus after it left his hand, well—— With regard to clause 24, "Death, Bankruptcy, Assignment, and Sub-contracting"—"The conditions and penalties in favour of the purchasers contained in the last preceding condition may, subject as hereinafter provided, be enforced by the purchasers if the contractor die, go into liquidation, become bankrupt or insolvent, or have a receiving order made against him, or compound with his creditors, or propose any composition to his creditors for the settlement of his debts, or assign his contract without the consent of the purchasers, or if the contract becomes vested in any other person, or if he commit any act of bankruptcy, or carry on his business under an inspector or a receiver for the benefit of his creditors, or permit any execution to be levied on his property, or if he sub-contract for any portion of the work otherwise than as provided in clause 17. Provided that the consent of the purchasers to an assignment of the contract shall not be unreasonably withheld and also that in the case of the death, liquidation, insolvency, or other disability or act as aforesaid of the contractor, his executors or other representatives in law of his estate shall have the option (to be exercised in writing within such time as the purchasers shall prescribe) of offering to carry out the contract, and if such offer shall be accepted in writing by the purchasers the contract shall be carried out and be in all respects binding and enforceable accordingly"—he thought the circumstance of the purchaser, as well as the contractor, going bankrupt ought to be provided for, on the principle that what was sauce for the goose was sauce for the gander, and there ought also to be some addition to the clause which made it incumbent upon the consulting engineer to certify in respect of work which was unexecuted, so that the contractor could properly prove his claim in the bankruptcy. Clause 33, "Liability for Accidents," stated that the contractor should be liable for all sorts of things, but it did not state that the purchaser should be liable for any accidents arising from their neglect, or their agents' neglect; and he thought there ought to be such a clause distinctly stating this, and also that the purchaser should be liable for any damage caused by other contractors whom they employed. He knew of a case in which he had been assured that the walls of the station were falling down and would crush his machinery. Query: Were the contractors for the machinery responsible for the walls tumbling down? Clause 36, "Terms of Payment, &c.," was likely to become an important thing, but there was no provision made if the contractor was not paid in accordance with the contract. The contractor certainly had the right to stop the work at 14 days' notice, but he thought there ought to be an additional proviso that the purchaser should pay to the contractor interest on such overdue accounts at the rate of 5 per cent. per annum until the sum was paid. This was only fair because it was just a question whether a contractor would take the drastic measure of stopping the work in 14 days. It might be very much better for him to go on and take his 5 per cent. interest. At any rate he ought to have an alternative course open. The clause, also, he considered was quite inoperative as regards the final certificate, because it was no use stopping the work if it was all done if the final certificate was wanting. He would prefer his 5 per cent. Clause 39, "Dates of Completion."—"The works will be completed on the site and ready for beneficial use or for testing by the date named under each section, or by such other date (if any) as may be incorporated in the contract. Provided always that, if by reason of [* delay in obtaining the sanction of the Local Government Board (London County Council) to the necessary loan], extra work, alterations in, or deviations from the specification, directed in writing by the engineer, or by reason of the suspension of the works under the direction of the engineer, or of unusual inclemency of the weather, or by reason of civil commotion or general or local strikes, or lock-outs, or combinations of workmen, or in consequence of fire or of any unpreventable accident to or breakage of machinery in the manufacturers' premises or on the site, causing a delay in the supply of plant or materials to the contractor, or by reason of the non-completion of a section of the contract executed by another contractor, or by any act or default on the part of the purchaser, or of other cause beyond the reasonable control of the contractor, or by any delay on the part of the purchaser to give forwarding instructions to the contractor under clause 27, the contractor shall have been unduly delayed or impeded in the completion of the work, the engineer shall, on the receipt of a written request from the contractor, grant from time to time, and at any time or times, by writing under his hand, such extension of time, either prospectively or retrospectively, and assign such other day or days for the completion as to him may seem reasonable, without thereby prejudicing or in any manner affecting the validity of the contract, and any and every such extension of time shall be deemed to be in full compensation and satisfaction for, and in respect of, any and every actual and probable loss sustained or which may be sustainable by the contractor in the premises, and shall in like manner exonerate him from any claim or demand on the part of the purchasers for, and in respect of, the delay occasioned by the cause or causes in respect of which any and every such extension of time shall have been made, but not further or otherwise, nor for, or in respect of, any delay continued beyond the time mentioned in such writing or writings respectively, provided that unless such request be made within two weeks after the expiry of the calendar month in which the delay existed, no such extension of time shall be granted. The contractor shall not be called upon to commence any work which is of a nature requiring a building or structure for the reception or efficient installation thereof, and which building or structure is, by the contract, to be provided by the purchasers, unless and until such building or structure shall be in a condition sufficient for the reception or efficient installation of the plant, and the contract date of completion shall be extended pari passu with the delay in the providing of any such building or structure"—ought to allow the contractor to ask for an extension of time when the contractor is hindered from completing his contract through outside causes quite beyond his control. It often happened that the consulting engineer took months to make up his mind about things, with the result that a small contract had to wait until the major part of the work was decided, and in a case like that the contractor ought to be allowed an extension of time without asking for it. He also had had machinery all made and ready for delivery waiting until the station buildings were put up, and he had never found a consulting engineer to come forward and say he ought to pay for that because the machinery could have been delivered if the buildings had been ready. This ought to be provided for, again, on the principle that what was sauce for the goose was sauce for the gander. It ought to be clearly stated that in such cases payment should become due from the date the contractor was ready to deliver.

Mr. W. E. GRAY said that Mr. Raworth when he spoke seemed to think that if a contract was given to the Brush Company no conditions were necessary, but that if it were given to anyone else they were. He did not think business was done on Mr. Raworth's £20 fine and a let-off principle. These conditions were framed with the object of providing a common ground upon which a self-respecting engineer and contractor could meet and agree in such a way that the work would not be performed in a red-tape fashion, and he did not doubt but that the committee had been very glad to hear the criticisms. At the same time nothing had been said which really held water against a set of rules based on fairly generous and fair grounds.

Mr. N. GUNZ corrected Mr. Esson as regards clause 27, which provided for payments on the part of the purchaser in case he did not take delivery when the goods were ready. To this same clause he would like to add something to the second paragraph. There were other things to be considered besides the storage, such as fire insurance. If the plant had to be stored at the warehouse the purchaser ought to pay the fire insurance premium during the extra time of storage, and any other extra expenses incurred through the delay, such as extra freight, carriage or cartage, cost of keeping the machinery in good condition, &c. He would also suggest the addition of the word "fire" to the title of clause 33, "Liability for Accidents." With regard to clause 36, "Terms of Payments," he thought some of the expressions were very vague. For instance, what was the true definition of "due diligence"? and, further, the last paragraph seemed hardly fair. He did not see why the engineer should be allowed to go back on his certificates.

Mr. HAMMOND: But supposing he makes a clerical error of a thousand pounds?

Mr. GUNZ said there was a clause that certificates were given without prejudice. Continuing, he thought the damages in clause 40 for delay in completion were frightful. They amounted to 1 per cent. of the contract after one month, 3 per cent. after two months, 6 per cent. after the expiration of three months, 10 per cent. after four months, 14 per cent. after five months, and 18 per cent. after six months. After the second or third month the whole of the contractor's profit would be wiped away.

Mr. HAMMOND remarked that evidently the clause was not quite clear. The damages were not intended to be accumulative, and he would see this was put right.

Mr. GUNZ next quoted clause 43, "Right of Use," the concluding paragraph of which he did not think was quite clear. This read: "The purchasers may, pending any arbitration under the contract, use any portion of the works reasonably capable of being used, but in such case the contractor shall be entitled to be paid in respect of any work beneficially used, but not eventually paid for under the contract, a sum equal to £5 per cent. per annum (according to the period of user) upon the amount withheld or deducted in respect of such work," and to this he would suggest the addition of the following: "The purchasers may, pending any arbitration, use any portion of the works reasonably capable of being used, but in such case the contractor shall be entitled to be paid a sum equal to 5 per cent. per annum, according to the period of use, upon the amount of the sum withheld."

Mr. C. H. YEAMAN complained of the indefiniteness of the time of payment. Clause 12, "Interview with Engineer," stated that the contractor should, after executing the contract, do certain things. The general experience was that it was always better to settle what was going to be bought in the period between the acceptance of the contract by the authority constituting the purchaser and the actual signing of the contract, and let the drawings which were signed at the time of entering into the contract be the contract drawings instead of, as stated in clause 13—viz., "The contractor shall submit, for the engineer's approval, a preliminary set of drawings set out under each section of the specification," after the contract was signed. A form which had worked very well stated that the contractor should supply drawings with the tender which showed the general lines upon which the machinery was tendered for. Then, between the period of acceptance and the signing of the contract the drawings, were amended if necessary, and the final drawings were signed and formed part of the contract if necessary. The fact that the contractor was to pay half the expense of completing and stamping the contract seemed to him a rather paltry matter to put into clause 10 "Contract and Bond." Under ordinary circumstances it would pay the purchaser to pay the full amount and so save the cost of the time of a clerk in working out what was his half share. Clauses 3 and 14 both stated that drawings of the foundations necessary for any plant should be supplied by the contractor. This was a matter which would give rise to considerable difficulty. Take the case of a condensing plant, where certain cutting away of small foundations were necessary. What was wanted to be known was the total amount of money it was wanted to borrow, and such uncertain things as these ought to be left out or not according to the local conditions. In the case of a motor generator he should say the foundations ought to be put in by the contractor. Perhaps it would be better to have the clause drafted to the effect that the work in itself must be complete—*i.e.*, if a contractor preferred to tender for something not quite in accordance with what was specified then he should include everything to make the altered specification as complete as if the original specification had been adhered to. The

* Words in brackets refer only to contracts with local authorities.

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real importance of these conditions lay in their giving definiteness to the different stages in the execution of the work.

Mr. ROBERT HAMMOND, replying upon the criticisms, assured contractors present that the committee which drew up these conditions was by no means an anti-contractor committee, and if there were any gentlemen on that committee to which the very greatest attention was paid, it was the representatives of the Cable Makers' Association, so that when Mr. Nisbett stood up with his 57 objections and seven acquiescences he felt that the cable people were being active enough to take care that their interests were going to be safeguarded. He would lay before the committee the views of the members as expressed in the discussion, and endeavour to produce a set of conditions which would be acceptable not only to contractors but also to town clerks, &c. One little misapprehension appeared to have happened in connection with his statement at the commencement of the discussion, that these conditions had been drawn up after the model of the Royal Institute of British Architects. What he intended to convey was that this Institution had such a set of conditions which were found to work extremely well. Another point was the suprise which had been evident on the part of the consulting engineer, that one clause after another placed the purchaser in the hands of the contractor, but he thought it would be an extremely bad thing for the profession if every consulting engineer was to sit down and design his own dynamo or engine or transformer, and ask for tenders upon these drawings. It did seem to him to be one of the very best things to do to leave the question of the drawings honestly open. It had been provided that with the specification there should be a set of drawings. But they were outline drawings merely to give an idea of what was wanted. Then it had been provided that the tenderer should send in with his specification his drawings, but not detailed drawings at all, and if he desired to draw attention to any particular fad or otherwise he could do so. Finally, the contract having fully described by the specification what the engineer wanted, these were put into contract drawing form. With regard to Mr. Yeaman's suggestion that the contract should not be signed until everything had been settled, he might say that he personally would have a very happy life indeed if it were not for the trouble he had to get the contract drawings from the contractors, but they must give them a certain amount of latitude with regard to these drawings. He differed from Mr. Raworth, naturally, that these conditions were only fit for the waste-paper basket. Mr. Yeaman had also pleaded for the return to a clause which he always felt was a wrong one. This was a good old-fashioned one which said that if there was anything omitted from any of the drawings or specification or, in fact, anything at all, the contractor had to supply it. But he did feel, when this cropped up time after time, that it was a bit of a fraud. The best thing for the industry was that the engineer should be encouraged to state most fully what he wanted, and then the contractor knew what he had to supply and did not need a covering clause which said that having paid 20s. in the £ he might, by a loophole, be called upon for a few shillings more.

PHYSICAL SOCIETY.

At the ordinary meeting of the Physical Society, held on May 9, Prof. S. P. Thompson, president, in the chair, Dr. P. E. SHAW exhibited a

Simple Electric Micrometer.

Two years ago Dr. Shaw described an instrument with which he measured very small lengths by the application of electric contacts, and the micrometer shown was a simple form of the original apparatus. A screw, fitted with a milled head, turns in a fixed nut and its lower end presses upon the extremity of the long arm of a lever. A metal point is attached to the short arm and the distance through which it moves, on turning the milled head, can be deduced from a knowledge of the pitch of the screw and the ratio between the arms of the lever. In using the instrument this point is always brought up to a metal surface and the contact is accurately determined by the telephonic arrangement described in connection with the original micrometer. Dr. Shaw illustrated the use of the instrument for measuring small lengths by describing the following eight applications to ordinary laboratory measurements :—(1) The measurement of the thickness of plates, films or fibres. The object is placed between two metal plates. The point of the micrometer is adjusted to touch the top plate and the reading taken. The object is removed, the point is again brought into contact with the top plate and the difference between the readings in the two cases gives the thickness of the film. (2) The determination of Young's modulus by the elongation of a wire. Dr. Shaw described experiments on two wires, each 2½ metres long, hanging side by side, one of copper and the other of steel. The wires terminated in horizontal platforms to which the stretching weights were attached. The base of the instrument rested on one platform while depressions of the other, due to loading, were measured. In this way any error on account of the bending of the beam from which the wires were hung was eliminated. (3) The determination of Young's modulus by the bending of a beam. (4) The determination of simple rigidity by a static method. Observations were made upon a rod held horizontally by rigid wall brackets. One end of the rod was fixed and the other held in position by a pin pressed into a hole in the end of the rod. From this end an arm projected outwards. Weights were applied to the extremity of this arm and the twist measured by observing with the micrometer the movement of the end of the arm. (5) Application to the extensometer. (6) Measurement of thermal expansion. (7) Microscopic measurements. In measuring the diameter of a capillary tube the cross wire of the microscope is made to touch one side of the tube and the point of the micrometer is brought into contact with the metal stage. The stage is then moved by a screw until the crosswire comes to the other side of the tube. The micrometer point is moved into contact again and the difference in the readings gives the diameter of the tube. In this measurement the full magnifying power of the microscope is utilised, and the work of moving the stage is performed by a rough screw. (8) The direct measurement of the wave length of light. Newton's rings are formed by a convex lens and a piece of plate glass. The convex lens is fixed to the short arm of the lever, and the distance through which it must be moved to cause a certain number of bands to appear at the centre gives a means of calculating the wave length of the light employed.

Prof. EVERETT said the apparatus combined fineness and accuracy of measurement, and expressed his interest in the determination of distances with the microscope.

Mr. R. J. SOWTER asked if any special precautions had been taken to prevent deformation in the instrument. If not, then it was optimistic to assume that one or more multiplying levers could be used to measure lengths of the order of a millionth of a millimetre with any physical accuracy, assuming the multiplication of measurement to be according to the law of the lever, as Dr. Shaw apparently did.

Mr. W. WATSON said that in determining the wave length of light by Newton's rings, it was necessary to measure from the knife edge of the lever to the centre of the rings. The accuracy of the experiment was limited by the difficulty in judging the centre. The variation of the temperature of the air would distort the lever and produce errors. In reference to the experiments on Young's modulus, using two wires of different material, he said that no precautions had been taken to procure a steady temperature, and pointed out that variations in temperature would affect the two wires unequally. In the experiment on the torsion of a rod the twisting had been produced by an unbalanced force. The other arm of the necessary couple must, therefore, have been unsatisfactorily supplied by the friction of the pin which held the rod in position. In measuring the diameter of a capillary tube with extreme accuracy, it was necessary to have a normal section, which was somewhat difficult to obtain. Dr. Shaw apparently considered the instrument as suitable for laboratory work. If it was for students it was unnecessarily elaborate, and if for obtaining accurate measurements, there were objections and uncertainties which should be investigated. Mr. Watson said that a similar form of micrometer had been described by Mr. H. C. Russell, and used in the observatory at Sydney.

Mr. J. M. BARR said that as errors would be introduced by variations in temperature, it might be advisable to make the instrument of a nickel steel alloy with a small coefficient of expansion. He asked if the knife edges and screws used were good enough to give the same reading twice, and said he thought the limit of physical accuracy could be obtained by using a single disc on a screw calibrated throughout its length. He considered one ten-thousandth of an inch to be about the limit attainable by such methods.

Dr. SHAW, in reply, said the main justification of the apparatus was in the consistency of the results given by it; these were excellent, as the tables given in the Paper showed. The method had been shown to be much more accurate than those in general use. As to the contention that the apparatus, while too sensitive for laboratory practice, was not sufficiently so for research on length changes, he pointed out that the accuracy of all measuring instruments was always on the increase, so that laboratory methods which were considered good recently would not necessarily suffice in the immediate future. Why be content, even for teaching students, with measuring to the one-fiftieth of a millimetre by the microscope, when with the simple electric micrometer we get, with little trouble, to the thousandth of a millimetre? Dr. Shaw knew nothing of the prior publication in Australia mentioned by Mr. Watson; if there were such a method introduced years ago it was all the more astounding that Mr. Russell and his successors should have allowed such an excellent idea to lapse and remain immature and unknown. Some speakers had suggested that uncertain deformation of the levers might occur during an experiment and vitiate results; but a new strain implied a new stress, and unless a definite change occurred in the forces of the system we could not suppose a change in deformation. A like answer was given to the criticism that the levers might expand under heat during a measurement. Why, if sufficient time has elapsed to allow the system to attain temperature equillibrium, should anyone postulate expansions without indicating a new or irregular source of heat? Most of the above supposed evils of course existed, but they were of small account. As with every good apparatus ever produced if ordinary and suitable precautions be taken, these errors were reduced to a lower order of importance, and could be neglected. In conclusion, the method had been firmly established in University College, Nottingham, and that superseded other apparatus, It would no doubt spread and become general.

Papers on "The Conservation of Entropy," by Mr. J. A. Erskine, and "Rational Units of Electro-magnetism," by Sig. G. Giorgi, were postponed, and the Society adjourned until May 23.

ELEKTRICITATS AKTIENGESELLSCHAFT VORMALS SCHUCKERT & CO. The profit on the past year's working was equal to a 4 per cent. dividend, but the amount will be carried forward. A committee of investigation has been appointed with power to carry out the compact with the Allgemeine Electricitäts Gesellschaft of Berlin.

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THE MANUFACTURE OF VULCANITE BOXES FOR ACCUMULATORS.*

The thoroughly well-worked mass of material which, when possible, should have been kept some weeks after mixing, is warmed by passing through a pair of heated mixing rolls, and is then converted into a plate 1mm. in thickness by passing through a second pair of rolls likewise heated. From the material so prepared, sheets of the required thickness for the boxes are built up, by doubling or quadrupling the same, and passing the mass through a pair of hand rolls one or more times. The formation of air bubbles must be avoided in this operation, and should any be enclosed by misadvertence in the mass they must be destroyed with a bradawl. Templates of the exact size of the sides and bottom of the boxes are now made, and with the aid of these similar pieces are cut from the prepared mass. The pieces so cut are next carefully covered with indiarubber solution along the edges which are to be joined together and are then dried. In the meantime, zinc sheet moulds, whose external dimensions are equal to the required internal dimensions of the box about to be made, are prepared, allowance being made for the fact that a shrinkage of about 2 per cent. will occur in the completed box on vulcanisation. The sides and bottom are placed in position on this inner core, or mould, and the joints are made tight by pressure and warmth. The overlapping portions are now trimmed even, and the completed box is vulcanised for one hour before removing the core, and again after removing the same.

The manufacture of boxes provided with ridges and grooves requires the preparation of more elaborate moulds, consisting of an inner core, four side plates, top and bottom plates, and three screw clamps for holding all seven pieces in position. The core for small boxes can be made out of sheet iron, for larger ones it is cast; but in this case care must be taken to see that it is free from surface pittings or holes. The side and top and bottom plates are cut from sheet iron 30mm. to 40mm. in thickness. The grooves or ridges required upon the walls of the completed box are provided for by corresponding elevations or depressions on the sheet iron core or walls. The inner core is now attached to the top plate by screws, and the slabs of material cut to the requisite size are built up round the core in the manner already described. When external ridges are required, strips of material are rolled and cut to the desired length and width, and after coating with india-rubber solution and drying, are laid in the grooves provided in the iron containing walls. These are fixed in position round the central core, and the whole is screwed up tight. Projecting edges are now cut away, and the slab of material forming the bottom of the box is placed in position. The bottom casing plate of iron is superimposed, and is clamped against the top-plate first fixed in position. The box is now ready for the preliminary vulcanising operation, which lasts one hour. Working a 12-hour day, one set of moulding pieces can thus serve for the production of 10 boxes. The second and final vulcanising follows, as in the case of the boxes with flat sides, and lasts from six to eight hours.

The boxes after the second vulcanising, and before cooling, are placed upon suitable wooden moulds, and by the aid of flat pieces of wood and a wooden mallet are dressed into perfect shape. If the boxes are provided with grooves or ridges the wood used must be similarly provided. Projecting edges or corners are finally trimmed down, and to improve the appearance of the exterior the sides may be rubbed with pumice-stone and finally with linseed oil. In some cases the finished boxes receive a coating of asphalt varnish.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Transport de Énergie Là Grandes Distances par L'Électricité." By F. Loppé. (Paris: E. Bernard & Co.)

"The Elements of Physical Chemistry." By J. Livingstone Morgan. 2nd edition. (New York: John Wiley & Sons. London: Chapman and Hall, Ltd.). $2.

"Geleisalose Elektrische Bahn mit Oberleitung." By Thomas Marcher. (Halle: C. O. Lehmann). 1m. 80pf.

"Études Pratique sur le Différents Systèmes d'Éclairage." By J. Defays and H. Pettit. (Paris: Gauthier-Villars.) 2fr. 50c.

"Die Gleichstrommaschine." By E. Arnold. Vol. I.: Die Theorie der Gleichstrommaschine. (Berlin: Julius Springer.) 16m.

"Annual Catalogue of the Massachusetts Institution of Technology, Boston, 1901–1902." (Boston: G. H. Ellis Co.)

"The Generators of Electricity at the Paris Exhibition of 1900," by C. F. Guilbert. (Paris: C. Naud.) 30fr.

"Proceedings of the Royal Society." No. 459. (London: Harrison & Sons.) 2s.

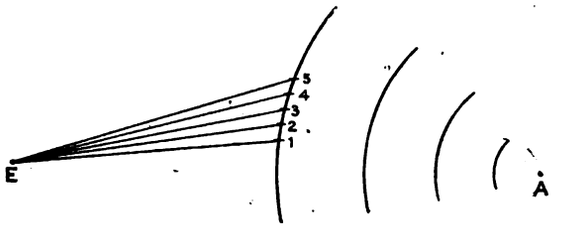
* Translated from the *Centralblatt für Accumulatoren und Elementenkunde*, March 15, 1902.

CORRESPONDENCE.

ETHER WAVES OF ANY LENGTH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I suggest the following arrangement for the production of monochromatic light or heat directly from Hertzian waves produced in the ordinary way by an oscillator, the method being simply to cause each wave to be successively reflected or refracted and afterwards brought to a focus. In the sketch below, if A be an oscillator producing waves, and lines numbered 1 to 5 suitable reflectors of same, then each wave should produce at E a train of five waves by successive reflection.



If this idea can be carried out, the length of the waves at the focus E will depend simply on the ratio of the length of the path of each ray to the one preceding it; so that by moving the oscillator a greater or lesser distance from the reflectors, longer or shorter waves should be produced.—Yours, &c., W. S.

TUBE RAILWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of May 9th I am reported as having stated before the Committee of the House of Lords on Tube Railways, that a speed of 16 miles an hour was impracticable. What I did state was that a speed of 20 miles an hour was impracticable under certain conditions, and I shall be glad if you will correct your statement in this respect.—Yours, &c.,

London, May 16. H. F. PARSHALL.

PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

Lord Windsor's Committee.

Thursday, May 15.

Viscount KNUTSFORD, in order to facilitate the drafting of the general compensation clause now under consideration, made the following suggestion. The object of this clause was, as far as he understood it, to place, for a limited period after the opening of a railway, owners of land and houses which had not been taken on the same footing as owners of land and houses which had been taken, who, of course, could proceed under the Lands Clauses Act. He would, therefore, suggest that it would be desirable to insert in the model clause the words "injuriously affected," taken from the Lands Clauses Act. This, he thought, would save the arbitrator a good deal of trouble and time, besides curtailing expense. The opposition to the various Hammersmith-City schemes was then proceeded with:

Mr. A. C. ELLIS, continuing his evidence under examination by Mr. LITTLER, K.C., spoke as to the inconvenience experienced by the Metropolitan Company through being forced to have a circle, and especially at the eastern and western sides, a shuttle system would have proved more remunerative.

Cross-examined by Mr. LLOYD for the Central London Railway, he said the chief objection of his company was on the point of competition.

By Mr. E. MOON, K.C.: He did not think the existing steam lines, when converted to electric traction, would suffer greatly through not having the gradients to facilitate acceleration. The same acceleration on the level could easily be attained. It was a question of more power.

Mr. THOMAS PARKER, the electrical engineer to the Metropolitan Railway Co., said that contracts for the whole of the electrical equipment of the Inner Circle and of the Hammersmith branch had been let, and he was now, in conjunction with the District Company, engaged in working out the details. The proposed acceleration was 2ft. per sec. per sec., and he was of the opinion that this would remain the limit for some time. The electrical equipment would be complete by August, 1903.

Mr. G. H. REDFORD, chairman of the Parliamentary committee of the London County Council, and also of the sub-committee of the Parliamentary committee, said that the views of the Council were that some general

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scheme for locomotion in London should have been considered before any of these schemes were passed, but failing this, that some commission should be appointed, on the lines of the Light Railway Commissioners, before whom all tube proposals should be placed, and only those passed by this body should come before Parliament. This latter view had been expressed to the Board of Trade, which did not view it with favour, but this had not discouraged the Council. There should also be some powers of purchase, as was the case with tramways. At the same time, it was the opinion of the Council that shallow tramways were likely to afford cheaper communication than very expensive tubes, and on this ground also the London County Council would like to see any new tube railways delayed for the present. Apart from these opinions, however, the Council viewed any new system of locomotion as important, and after an impartial examination of the various proposals before this Committee and also Lord Ribblesdale's Committee, the opinion was that the Central London line, as proposed, would form a good system in itself; it would serve the traffic from the west to the east, and would also be capable of working in with the larger systems of London by means of interchange stations. Neither was there the same danger of inflation of capital as was possible with the other schemes. In coming to this conclusion, the estimates of cost for all the lines had been taken into consideration, and even the combination of the London United and the Piccadilly-City railways had not changed the views of the London County Council committee, which had held frequent sittings since this enquiry was opened. They thought it was very important that through routes from places of residence to the centre of the City should be built, but a through route from one side of London through the City to the other side did not seem to be important. The idea of having a special clause in each bill for each particular borough council through whose district the line passed was not favoured by the London County Council. One standard clause should be inserted for all, otherwise, as there were 28 borough councils, there was a strong possibility of having that number of clauses. Such a clause ought to be agreed upon by the London County Council and used. In conclusion, he said the London County Council committee still adhered to the report issued on April 22 (see *The Electrician*, April 25, p. 34).

Cross-examined by Mr. LITTLER, for the Brompton and Piccadilly Railway: None of the promoters of the bills considered had been asked to attend before his committee, as they preferred the impartial evidence of their engineers and Parliamentary agent.

But do you know that the Central London is the most expensive of all?—No, I did not.

Do you know that the capital of the existing Central London Railway was largely in excess of the estimates?—No.

Mr. FITZGERALD, K.C., for the Central London Railway, protested against this cross-examination.

Mr. LITTLER replied that he merely wished to see to what extent witness had informed himself on these matters.

Cross-examined by Mr. BALFOUR BROWNE, K.C., for the London United and Piccadilly-City Railways, Mr. Redford said that the committee had been advised in this matter of its preference for the Central London by their present L.C.C. engineer, Mr. Fitzmaurice, and Sir Alexander Binnie.

Do you think that penny fares are good as compared with an all-round 2d. fare?—Certainly.

Do you not think it would be a great advantage to get from Hammersmith to Charing Cross for 1d. instead of 2d.?—Of course.

Is not that an advantage of our line?—That is so, but it is liable to be over-rated. It is only a promise.

Do you know that the 2d. fare of the Central London Railway, and also on the lines authorised to Mr Yerkes, is merely a promise and not in either of their bills, and that 1d. fares are scheduled to our bill?—No, I did not know that.

By Mr. COURTHOPE MUNROE, for the Borough Councils of Battersea and Kensington: He suggested that the clause for the protection of borough councils ought to be inserted in the name of the London County Council. He did not agree that the tendency of legislation was to increase rather than decrease the powers of borough councils.

Lord ZOUCHE: Have you considered the Brompton and Piccadilly Railway, and that if the Central London is authorised there will be two railways down Piccadilly?—Yes, but we do not consider this important. At the same time, although authorised, we do not feel that the Brompton-Piccadilly line serves any useful purpose to the West End.

Have you considered the case of the North-East London line?—Yes, we have looked at this from the point of view of housing, and are sorry that the City and North-East Suburban Railway has been abandoned. We were very much in favour of both lines to the City, but there does not seem to be any necessity for a line from Tottenham to Hammersmith.

Lord WINDSOR: The London County Council does still consider it important that lines should run from the centre out into the country?—Yes, very important.

Mr. WHEELER, K.C., for the Corporation of the City of London, was similarly favourable to the Central London Railway. The Corporation considered, on general grounds, that the public at large would benefit greatly if this line were sanctioned, and on one particular point it was felt that the stations were more advantageously placed. The only objection to the North-East London Railway was that it wished to terminate at Ludgate-hill, but the Corporation did not think any competition with the Central London Railway in the City was desirable, and, therefore, objected to the North-East London Railway coming further west than Cannon-street, there would be an interchange station with the Central London Railway should be arranged.

Mr. FITZGERALD, addressing the Committee for the Central London Railway, said that the elimination of the Charing Cross-Hammersmith and District Railway left the fight for a new route along Piccadilly between his line and that of Messrs. Morgan, and against the latter there was the great disadvantage of having a portion of the northern line in the open. The original Central London Railway served a district which, up to then, was not accommodated by any railway, and the same applied to the new route. As to the question of the competition of the Metropolitan and Metropolitan District Railways, it was a noteworthy fact that no effort was made to electrify their lines until the Central London showed that it could be successfully done. The extension of the Brompton and Piccadilly line to Holborn he was not in the least opposed to, whereas the evidence of Col. Yorke to all intents and purposes condemned the spur to Charing Cross. If the promoters of the North-East London Railway did not feel justified in building the line if sanctioned, there was no reason why it should not be done by means of capital provided by the Central London Railway, the Great Eastern Company, and perhaps another. Above all other considerations, he would respectfully submit that the Committee ought not to shut their eyes to the combination going on elsewhere by the firm of Messrs. J. S. Morgan, and a pause should be made before introducing into the railway system of London a combination of that kind. Once this were introduced, it would be undoubtedly extended as similar combines had been in other directions.

Mr. LITTLER, replying on behalf of the Brompton and Piccadilly Railway, traversed very much the same ground as did Mr. Pember, in addressing the Committee for the District Company against the other schemes—viz., the forthcoming electrification of the District and Metropolitan Railways, the Brompton and Piccadilly extensions, and the small amount of new capital necessary to be authorised.

Friday, May 16.

Mr. BALFOUR BROWNE, K.C., addressed the Committee for the **London United Electric Railways** and the **Piccadilly and City Railway**. He said that Mr. Fitzgerald, in arguing against financial combinations, had said not a word about the Yerkes combination, and it was quite evident that the last remark in his learned friend's speech for the Central London Railway had been prompted by a spirit of spite. The great value of these lines lay in the fact that they were through routes, and it would be extremely difficult for the promoters to construct the North-East London unless as part of the line through to Hammersmith. It was chiefly due to this isolation that the London, Walthamstow and Epping Forest Railway had never been financed. It did not form part of any route across London. The uniform 2d. fare did not cater for intermediate traffic, and it was noteworthy that on no other railway was such a fare in existence. On the question of speed, there were reasons why this would be greater on his lines than it could possibly be on the Central London. Eight motors were used as against four, there was a better spacing of the stations, and by reason of its being a new line they could improve upon the gradients now existing upon the Central London Railway. On the respective merits of the opposing lines, he maintained that it was quite obvious that the Central London Railway would compete with itself, and for this reason it would never be constructed so long as extensions of time could be obtained. In addition to this, however, there was the important question of how the capital was to be raised. No scheme had yet been put before the shareholders, and, in fact, Sir Henry Oakley himself had admitted that this matter had not been seriously considered. And in conjunction with this must be remembered the statement in the prospectus of the Central London Company that the policy of the directors was not a policy of extension. In the same way the Piccadilly-Brompton line was a block line. It was against the interest of the District Company, who owned it, that it ever should be constructed. Originally it had been promoted as a block line to the City and West-end Railway, and and it now only existed as a block line to any other railway along that route. As to the prevention of extension of the tube lines which he was promoting further west than Hammersmith, this was not the case, as in time the tramways would be taken over from the company by the various local bodies, and then further tubes could be built in competition with the tramways. And if the Central London extension was not sanctioned, that line as at present constructed was capable of extension further west.

The committee room was then cleared, and after three-quarters of an hour,

The CHAIRMAN announced that the Committee had decided not to proceed further with the Central London Railway as far as it related to the proposed railway from Shepherds Bush via Hammersmith to the Bank, but were quite prepared to consider an extension of the existing line beyond the Bank, and small branch lines at the West-end. With regard to the Brompton and Piccadilly Railway, the Committee did not intend to proceed with the portion between Piccadilly-circus and Charing Cross, leaving the other portions for future consideration. As to the London United, Piccadilly and North-East London Railways, the Committee would not proceed with that portion of the London United running from Addison-road via Shepherds Bush to Hammersmith.

The Committee then adjourned until the 26th inst.

In the House of Lords on Thursday, last week, the EARL OF CAMPERDOWN moved that the special compensation clauses being drafted by the Committees on underground railways should be submitted to the House before being inserted in any bill. He himself had suggested that some further protection should be afforded to property owners other than that which they were entitled to under the general law, but as the insertion of such clauses would probably in future be applied to all underground railway bills, this practically involved an alteration in the general law. Therefore, such special clauses ought to come before the House as general bills, inasmuch as they affected the original jurisdiction of their lordships, with which they should be slow to part to Committees.

The EARL OF MORLEY, while agreeing with this proposal, thought it would be better to leave the elaboration of the clauses in the first instance to the Committees, and it would then be open to the House to consider, and, if necessary, alter them. As regards tube railways, there was practically no experience to guide them as to what damage might be done to adjoining property, and he would, therefore, be happy to inform the noble

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Earl Camperdown when the bills were coming on for third reading, when he could call the attention of the House to them.

The LORD CHANCELLOR pointed out that special clauses in a particular railway bill did not involve an alteration in the general law.

The EARL OF MORLEY having given an undertaking that copies of the new clauses should be put before the House when the bills came on for third reading,

The motion was, by leave, withdrawn,

LOCAL AUTHORITY TRAMWAY VETO.

In the House of Commons on Thursday last week, Mr. CHAPLIN (who was President of the Local Government Board of the last Ministry) asked the House to consent to certain amendments in Standing Order 22. This standing order makes it a condition that before a bill relating to tramways can be introduced in Parliament, the consent of the local authorities of the districts through which the line will run must be obtained. Mr. Chaplin drew attention to the Act of 1890, amending the law relating to the housing of the working classes, and pointed out that improved means of locomotion were necessary for carrying out the act. The extension of tramways was a means whereby this necessity was met, but this extension was checked by the provisions of the standing order, which made the consent of local authorities essential to the work. Local authorities had been quick to see this, and ofttimes found their consent a marketable commodity, while they imposed onerous conditions before according it, and in London, where the local authority—the County Council—was not the road authority, matters were of a serious nature. From his deliberations in July, 1900, on behalf of the Government, he had pointed out this condition of affairs, and stated that after conference with the Chairman of Committees in both Houses, he had been in a position to say that the Government were willing to make such alterations as would modify the restrictions. Nothing had been done at the time, and last session he had again reminded the Government of its obligation. He proposed that the Committee on the bill should be given proof as to whether the consent of the local authority had been obtained or not, and if it were proved that consent had been withheld unreasonably, report should be made accordingly. He could not see what valid objection could be raised against these proposals.

Sir A. ROLLIT said that local authorities were strongly opposed to this proposal, and when it was suggested that they either levied blackmail or took an undue view of their own rights, he would answer that they were deeply interested in the tramways. Local government should have local knowledge and opportunities of forming the best judgment, and it ceased to be a local government if a Committee of the House were asked to act at variance with local opinion. Was it seriously proposed that officials from all parts should be summoned to the House on purely local questions, causing much delay, trouble and cost? He believed the local authorities were animated by a spirit of fairness and asked the House to trust them, as in the Education Bill. He opposed the motion as being at variance with the principle of local government.

Mr. BURNS said that, although the action of certain local authorities was a disgrace, the right hon. gentleman sought to coerce the local authority in the interest of the private promoter, at whose mercy they would be, if the motion were carried. Local communities would be put to needless expense in employing Parliamentary counsel and witnesses to watch their schemes, if local veto was abolished. The passing of the amendment would involve indefinite discussions in the House on second and third readings, as the exact opinions of the local bodies would be unknown.

Mr. HALSLEY, as a member of the Standing Orders Committee, thought that local authorities should be trusted even though they made mistakes, and if an appeal was considered necessary he would prefer the adoption of a similar system to that employed with provisional order bills, involving the holding of a local inquiry, this method being far less inconvenient and inexpensive and more likely to arrive at the real truth.

Mr. J. W. LOWTHER (Chairman of Committees) said that justice between parties could not be done, where one of the parties was a judge in its own case and where a local authority could put its foot at once upon a scheme, the promoters of the scheme not having an opportunity of bringing it before the public or obtaining the assent of the House to it. The backward state of communication in London would scarcely be improved if local veto was allowed, and he thought that the public would be best served if the matter were brought before Parliament and the schemes considered regardless of the interests of intervening local authorities. He admitted the evil of greater expense, but considered it a greater evil to leave matters as they stood. No such veto was allowed under the Light Railways Act.

An HON. MEMBER: There is a local inquiry under that act.

Mr. LOWTHER replied that in the present case they would get their inquiry from the local people. He placed more faith in the House of Commons Committees than in the inspectors of the various Government departments. With the former he believed that the intention was to do absolute justice to both parties. He thought the balance lay in favour of the amendment, and he was prepared to support it in case of division.

Mr. BLAKE inquired as to the real interests involved, and if they were confined to the area presided over by the local authority an arbitrary veto was not unreasonable; but if the interests of the local authority were transcended by wider interests, then local veto did not seem to him either logical or reasonable. These wider interests should be investigated, and the local authority prevented from having an uncontrolled disposition of the question of communication between two points between which its area lay.

Capt. JESSEL considered that the local authorities were the best judges in the matter, and in most instances had objected to tramways through their districts because the streets were too narrow. If the clause were altered, endless expense would result from London ratepayers fighting one another with each other's money.

Sir J. DORINGTON thought that, as the law stood, any promoter of a tramway was open to proceed either under the Light Railways or Tramways Acts, but if the standing order were changed, promoters would be encouraged not to proceed by provisional order, but to go to Parliament and incur greater expense. For that reason he would vote against the proposal.

Sir J. DICKSON-POYNDER believed that the change would bring about results worse than the existing evils, and though he was in accord with the objects of the amendment he should vote against it. The standing order had been a great protection against the introduction of superfluous measures; but in London the borough councils were not the best authority to deal with the matter, and he should like to see their veto removed. He suggested that the President of the Board of Trade should take up the subject with a view to substituting for the standing order some authority having the confidence of London, before whom all these bills might go for sanction.

Mr. GODDARD considered that as such undertakings would have to be purchased by local authorities, it would be unwise to encourage private enterprise in tramway schemes.

Mr. Thornton and Mr. Macdona both spoke against the amendment, which was finally negatived without a division.

BRISTOL CORPORATION BILL.

The Private Bill Committee of the House of Lords, presided over by the Duke of Northumberland, have had before them the Bristol Corporation Bill, among the objects of which was to acquire powers to convey electricity from their electricity works to the outlying parts of their city.

Mr. GREGORY, for the promoters, said that the Corporation had expended some £375,000 on their electricity works, and now they desired to have facilities for carrying their electricity to Avonmouth, because they anticipated, when the new docks were built there (it was proposed to expend some 2½ millions on them), there would be a large demand for electricity, both for lighting and power, and it was necessary to have a good supply in order to develop the docks and make them successful. They also desired to carry their electricity to Portishead and to Easton, where they held an estate, and had an infectious hospital. They also sought power to sell electricity in bulk to the outside authorities on the way.

Mr. Edmund J. Taylor, town clerk of Bristol, gave evidence in support of counsel's statement.

Mr. TAYLOR WARRY, who represented the Somerset County Council, said that the County Council had no objection to the supply of electricity in bulk by arrangement to any of the district councils, but they did object altogether to the Corporation having power to break up any of the roads they pleased in any of these districts.

Mr. TREVOR LEWIS, on behalf of Barton Regis District Council, said that the Barton Regis Council had obtained a provisional order to supply electricity, but it had not yet been confirmed. He wished to know whether Bristol proposed to compete with the Barton Regis Council in their own district.

The Witness said certainly not, if the Barton Regis Council had the power and wished to exercise it.

Mr. W. W. Squire and Mr. Thomas H. Yabbicom also gave evidence in support of the bill.

Mr. Ald. GEORGE PEARSON, chairman of the Electricity committee of the Bristol Council, said they had two stations. The old station, which was near the centre of the town, provided a horse-power of 5,860, and the new station at Avonbank gave them a horse-power of 3,532. They had already laid 160 miles of cable in the city. They were now considering a further extension of the Avonbank station. The total capital now expended was about £375,000, and the total authorised capital was, he thought, £405,000. Bristol had no large towns in its immediate neighbourhood, and the electric light undertaking, therefore, formed a natural centre for supplying the small urban district councils and small rural district councils that were near them. It would also be a great advantage to be able to supply power to anyone coming into the district who desired to establish works. The Corporation had spent large sums in the docks, and they thought they ought to have the benefit of those docks in every way they could, but they had no desire to thrust themselves upon their neighbours who were desirous of supplying themselves.

Mr. FARADAY PROCTOR, electrical engineer to the Corporation of Bristol, said he anticipated a large demand for electricity, both for lighting and motive power at the docks. The only practical way of taking the cables would be via the roadways, and not along the river banks.

Mr. SHAW then addressed the Committee on behalf of the Rural District Council of Long Ashton. He said this was a power bill by which the Corporation of Bristol sought power to put down mains in outlying districts, and to sell electricity in bulk, but in this bill there were none of those restrictions which were placed in other power bills after careful inquiry by the Committees which had considered those power bills.

Mr. COTTERELL, a civil engineer, called on behalf of the Gloucestershire County Council, said he was not an electrical engineer, but he understood the voltage in Bristol was not sufficient to supply Avonmouth.

Mr. BALFOUR BROWNE, K.C., (for the promoters): Will you tell me what the voltage is?—500.

Are you aware it is 2,000?—No, I have it from your own record.

Do you mean to say that 2,000 volts pressure will not send the electricity down to Avonmouth?—I understand it is only 500.

Mr. A. A. C. SWINTON said he had seen the route proposed by the promoters for the conveyance of electrical energy, and he suggested that the wires should be overhead.

The Committee came to the conclusion that the preamble so far as it referred to electricity was not proved.

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OTHER ELECTRICAL BILLS.

The Belfast Corporation Bill was read a second time in the House of Lords on Thursday last week.

In the House of Lords, on Friday last, the Preston Corporation Bill was read a second time, and the Manchester and Liverpool Express Railway Bill a third time and passed. In the House of Commons, on the same day, the Lords' amendments to the Cornwall Electric Power Bill were considered and agreed to.

LEGAL INTELLIGENCE.

Read v. Friendly Society of Operative Stonemasons and others.

This case recently came before a Divisional Court, composed of the Lord Chief Justice, Mr. Justice Darling and Mr. Justice Channell, and was an appeal by plaintiff from a judgment of Judge Eardley Wilmot, given for defendants at Ipswich County Court. The action was for wrongfully and maliciously inducing Messrs. Wigg and Wright (of Ipswich), to whom plaintiff had been bound apprentice for three years, to break the contract of apprenticeship. The apprenticeship deed was dated June, 1900, when plaintiff was 25 years of age, and he covenanted to serve Wigg and Wright for three years at 15s. a week, and they covenanted to teach him the trade and calling of a stonemason. Wigg and Wright and the men in their employ were members of defendant society, which had a rule that boys entering the trade should not work more than three months without being legally bound apprentice, and in no case to be more than 16 years of age, except masons' sons and stepsons. In Aug., 1900, it was resolved that if plaintiff started work for Wigg and Wright as a mason, one of their employés was to report the fact to the society in two hours, and, owing to the action of the society, from Aug., 1900, to May, 1901, Wigg and Wright did not employ plaintiff as a stonemason or teach him the trade, but he continued to do labourer's work. In May, 1901, the secretary of the society wrote Wigg and Wright that the members considered the firm's action an infringement of the rule, and if the man started working at the trade they were bound to protest against the firm for introducing an individual not of the trade, and, in accordance with their general rule, the society had empowered their members working for the firm to take prompt action in the matter. Defendants admitted in answer to interrogatories that "prompt action" meant that the masons in Wigg and Wright's employ should give two hours' notice and leave their employ if they thought fit. The County Court judge held that the facts fell short of giving any ground of action against defendants, who acted bona fide in the interests of the society, and not from any improper motive, and that, though defendants' interpretation of the rule might not be correct, they had not acted improperly in their method of enforcing it.

After argument, Mr. JUSTICE DARLING read a written judgment, in which Channell, J., concurred. He thought that the County Court judge was wrong, and that there should be a new trial. Plaintiff had entered into a contract by which he became entitled to demand of Wigg and Wright that they should teach him the trade of a stonemason, and to interfere with that right might give a cause of action against him who did so. He cited Lord Macnaghten's judgment in Quinn *v.* Leathem, where it was laid down that "A violation of legal right committed knowingly is a cause of action, and it is a violation of legal right to interfere with contractual relations recognised by law, if there be no sufficient justification for the interference." It was argued that defendants had justification because they had themselves entered into a contract with Wigg and Wright, the terms of which were inconsistent with the contract between Wigg and Wright and plaintiff. The contract here alleged by defendants was one which, if proved, might, by reason of its being in restraint of trade or otherwise illegal, be incapable of being enforced; and in that case to seek to hold Wigg and Wright to it could not be held sufficient justification. It might be that, though otherwise unlawful, it was legalised by the Trade Union Act, 1871, but that could only appear when its terms and the parties to it were ascertained. Defendants' justification for interference with plaintiff's right must be an equal or superior right, and no one could legally excuse himself on the ground that he acted on a wrong understanding of his own rights or without malice or bona fide or in the best interests of himself, nor even that he acted seeking only the good of another and careless of his own advantage.

The LORD CHIEF JUSTICE also read a written judgment. He was of opinion that the judgment was not satisfactory, but he felt considerable difficulty as to whether the facts before them enabled them finally to determine the question raised. The evidence established that defendants, instead of taking action against Wigg and Wright for a supposed breach of their contract embodied in the rules of the association, did, for their own personal ends, procure Wigg and Wright to commit an actionable wrong. He doubted whether the arrangement embodied in the rules was protected by the Trade Union Act of 1871, but it was possible that sec. 3 was sufficient to prevent the Court from holding that, if the rule amounted to an agreement between Wigg and Wright and the defendants, it was void or voidable. Assuming the rule to be binding on Wigg and Wright, he thought defendants had no right to procure Wigg and Wright to break their contract with plaintiff. There was no evidence to show that the society, or any of its members, would be injured by Wigg and Wright's fulfilment of their contract. The facts negatived any suggestion that the action was taken on behalf of individuals to protect their own interests. For those reasons he thought the County Court judge ought to have entered judgment for plaintiff; but, as his brothers were not prepared to go so far, there could only be judgment for a new trial.

Appeal allowed, but leave to appeal was given.

Isle of Thanet Electric Tramway and Lighting Co. (Ltd.).

At Ramsgate on Friday last this company were summoned by the Ramsgate Corporation for using electric power on the Isle of Thanet Light Railway contrary to the Board of Trade regulations, by propelling a tram at a speed of 16 miles an hour instead of only 8 miles. Evidence was given that the police kept observations on the company's cars for several days, and on April 28 the speed was timed of 52 cars, the average being 12 miles 1,643yds. per hour, which speed was exceeded in several cases.

Mr. H. WEIGALL (presiding justice) asked if the drivers could keep the advertised time and not go beyond the speed laid down by the Board of Trade, as there were numerous stoppages.

Mr. SHARPLEY, for the prosecutors, said he could not go into that question. The Ramsgate Watch committee wanted it to be made clear that the police would take proceedings whenever the maximum speed was exceeded. The company was liable to a penalty of £10 for each offence, but he would withdraw three of the four cases on a conviction being made in the first, the company undertaking not to repeat the offence.

Mr. SHEA, for the company, said they were in a difficult position. On the one hand they had to comply with the Board of Trade regulations, and at the same time provide the public with an efficient service. If any time had to be made up, in order to keep the fixed time of the time-table, it would be done in the country districts where no possible injury could occur to the public.

The Bench imposed a fine of £5 and costs in one case, and intimated that in future the fine would be enforced on every occasion, and would be a continuing fine.

Tynemouth District Electric Tramway Co.

At North Shields Police Court on Wednesday, the above company was summoned for allowing a tramcar to be driven at a rate exceeding 8 miles an hour.

A Police Inspector said he was on duty in company with other officers and saw a driver named Lilley, in the company's employ, drive a tramcar at a higher rate of speed than was allowed by the regulations of the Board of Trade. Witness had previously measured off a distance of 394 yds., and the car travelled that distance in 40sec., the speed being 20 miles 260 yds. an hour. He had not a stop watch, but he timed the car by an ordinary watch. He was standing at a considerable distance from the tramlines but had a good view of the car.

The driver of the car and three other tramway officials denied that the speed of the car exceeded 8 miles an hour.

Mr. B. SIMPSON, manager to the Tynemouth Tramway Co., said it was absolutely impossible for a person standing in the position given by the inspector to calculate accurately the speed of a tramcar. It was a difficult task to time the speed of a car even for very competent men with stop watches. The company had tried in every way to get a reliable speed indicator, but had not yet succeeded. They had informed the Board of Trade that if that department would tell them of a reliable indicator the company would adopt it. The company were at present experimenting with one, but it was of such delicate construction that up to the present they had not succeeded in getting it to work a complete day without a breakdown.

The CHAIRMAN (Ald. Elliott) said the magistrates considered both parties had fair reasons for bringing the case to court, and that the company were taking pains to regulate the traffic on their lines. He advised the company to do their best and not to go too slow, for they heard complaints sometimes on that score also. The case would be dismissed.

Workmen's Compensation.

At Birmingham County Court on Monday, before Judge Whitehorne, a novel point in connection with the Workmen's Compensation Act was raised. On Nov. 25 a labourer named Pickering brought an action for compensation against Messrs. Wilkes, Son and Mapplebeck. The accident happened on Aug. 22, and his Honour ordered that the respondents should pay him 9s. a week as compensation for personal injuries received, such payment to commence from Sept. 5, a fortnight after the accident, and to continue during total or partial disablement, or "until the same should be ended, diminished, increased or redeemed." The 9s. was half the full wages of the applicant. On Dec. 2 Pickering went back to work with the respondents at full wages until Feb. 27, when he was discharged. The respondents were willing to pay the 9s. per week from the date of the discharge, but Pickering claimed to be entitled to payment from the date of the award, notwithstanding the fact that between Dec. 2 and Feb. 27 he was earning full wages, and issued execution against his employers for the payment of £9. 18s. The money was paid into the hands of the High Bailiff, and the respondents now asked that that amount should be allowed to remain in court pending an application to review. His Honour held that the award stood, and was operative unless the Court or arbitrator were satisfied that the total or partial incapacity had ceased to exist, and were satisfied in the way pointed out by sec. 12 of the act, either on evidence of fact, or by agreement existing between the parties. There had been no such agreement, neither was there any evidence to show that total or partial disablement had ceased. He knew of no jurisdiction by which he could review *ex post facto* as long as the award lasted. It appeared to be the simplest common sense and common justice that the award should be enforced, and be operative until it was altered in some way as provided for by the provisions of the act. The money in the hands of the High Bailiff represented the amount of compensation payable under the award, to which, it appeared to him, the workman was plainly entitled.

Last week in the House of Lords (before the Lord Chancellor, Lords Macnaghten, Shand, Davey, Brampton, Robertson, and Lindley) judgment was delivered in the appeal of Cooper and Crane *v.* Alfred Wright. Messrs.

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Cooper and Crane were builders, of Nottingham, and the respondent a slater in business in the same city. The appellant firm contracted to erect a building at Nottingham, and arranged with Wright to provide "and fix" the slates for the roof. On June 29, 1899, while the building was in course of construction, Brady, a slater's labourer employed by respondent, received injuries resulting in his death. Steps were taken by the widow to obtain compensation under the Workmen's Compensation Act, and appellants denied liability on the ground that Brady was not immediately employed by them, and contending that if compensation was awarded against them they ought to be indemnified by Wright. Respondent replied that he was not the undertaker of any work to which the act applied. A County Court arbitration took place, and the judge ordered appellants to pay £217 to dependents of Brady, but by a later award determined that respondent was liable to indemnify appellants. Respondent appealed, and the Court of Appeal set aside the decision of the County Court judge, holding that Wright was not liable.

The Lord Chancellor, Lord Shand, and Lord Davey were of opinion that the decision of the Court of Appeal against the indemnity was wrong, but Lord Brampton and Lord Robertson held that it was right.

The appeal was therefore allowed, and the judgment of the County Court judge restored.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Newport Corporation invite applications for the appointment of borough electrical engineer and tramways manager. Applications to the town clerk (Mr. Albert A. Newman) by May 31. See advertisement.

A shift engineer is required for the Sheffield Corporation tramways department. Applications to the general manager (Mr. A. L. C. Fell), Town Hall, Sheffield, by May 28. See advertisement.

Portsmouth Corporation require a resident electrical engineer for their tramways. Applications by June 3.

A science master is required for the Tunbridge Wells Technical Institute. Applications by June 3.

Mr. A. J. Stubbs, first-class technical officer of the G P O. engineering department, has been appointed superintending engineer of the North Metropolitan District, vice Mr. C. T. Fleetwood, retired, and Mr. G. Cheetham, assistant superintending engineer (provincial), to be superintending engineer of the Northern District of Ireland, in succession to Mr. J. Walby, deceased.

Mr. David Robertson, B Sc., Lecturer in Electrical Engineering at the Municipal Technical College, Bradford, has been appointed Professor of Electrical Engineering at the Merchant Venturers' Technical College, Bristol. Mr. Robertson was educated at the Glasgow and West of Scotland Technical College, under Prof. Jamieson, to whom he was for some time assistant, and was a Sir John Pender gold medallist.

Mansfield Town Council have appointed Mr. E. F. G. H. Hewlett engineering clerk of works in connection with their electricity supply scheme.

Mr. John A. Bucknill, barrister-at-law, has been appointed Commissioner of Patents in the Transvaal.

Aberdeen.—Messrs. Lowdon Bros. have acquired from the liquidator the plant and undertaking of the Cults electricity supply works. The agreement for the public lighting of the village has been transferred to the firm.

Alleged False Pretences.—At Bow-street (London) Police Court on Saturday, Dr. Hans Lausnitz, described as an electrical engineer, of Clun House, Surrey-street, W.C., was charged, on remand, with obtaining £95 worth of mathematical instruments under false pretences. Mr. Purnell, manager to the prosecutors (Messrs. Reeves, Ltd.), said prisoner in April came to him, and on the assurance that he was a director of the Helios Electrical Co., obtained the instruments in question, some of which had been pledged by him. They had never received payment, and had discovered that prisoner was not in any way connected with the Helios Company. Prisoner was committed for trial, bail being refused.

Another London Tube Railway.—A new undeground electric railway, entitled the City and Surrey Electric Railway, is projected. The scheme provides for the use of the City and South London Railway from King William-street to the Borough, and the new line will cross Lambeth to the Croydon district, taking in Caterham, Westerham and Redhill.

Arbitration Court.—Mr. Arthur Serena, chairman of the joint committee of management of the London Chamber of Arbitration, takes the opportunity presented by certain changes recently made in the rules of the Chamber, to call the attention of the commercial public to its constitution and advantages. These are set out in a circular dated from the Guildhall, London, May 20, which, with all further information, can be obtained on application from the Registrar, 5, Church-passage, Guildhall, or from the London Chamber of Commerce, 10, Eastcheap, London, E.C.

Argentina.—The *Review of the River Plate* states that the United River Plate Telephone Co. has presented a protest to the Buenos Ayres Municipality with regard to the tax of 2 per cent. on its gross receipts placed on its underground mains for use of the subsoil. The company states that when permission was granted to place its wires underground it was given in order to improve the service, and if a tax is now imposed the subterranean service will be more costly than the aerial, and the benefit looked for by the public from an improved service will not be obtained.

Cordoba Municipality has granted a concession to the United River Plate Telephone Co. to establish an exchange in that city, with exoneration from all taxes for 20 years.

Government has authorised the Cia Telegrafica-Telefonica to open for public service its telephone line between *Buenos Ayres* and *Rosario*, with intermediate stations in Campana Zarate, San Pedro and San Nicolas. The tariff will be, on working days, from 6 to 8 p.m., $2 per three minutes' conversation.

The River Plate Electric Light and Traction Co. has settled its differences with the *Rosario* Municipality. A new contract has been signed, and the company undertakes to put its cables underground within a stated period, returns $14,000 to the Municipality, and hands over a guarantee of $5,000. The Municipality cancels the existing public lighting contract and will call for fresh tenders.

Bedford.—The salary of the assistant engineer (Mr. C. Barkham) has been increased to £156 per annum.

Belfast.—The City Council have received an application from Messrs. Harland and Wolff for a supply of electric current for power at their Alexandra Dock Works.

Birmingham.—The report of the Electric Supply committee for the year ended March 31 states that the units of current sold were 3,391,099, producing £61,384. 4s. 4d., against 3,040,822 units and £55,810. 4s. 2d. last year, an increase of 11 6 and 9 9 per cent. respectively. The gross profit was £18,514. 2s. 9d., and interest and sinking fund amounted to £23,327. 2s. 3d., leaving a deficiency of £4,812. 19s. 6d. This result is attributed to the charge of £8,731. 11s. 6d. for conversion of a portion of supply system from 110 to 220 volts, with which revenue has been debited. The committee have followed last year's precedent and have charged the total cost of the work against revenue, taking from the renewal fund only the deficit of £4,812. 19s. 6d. thus created. The change to the higher voltage has been nearly completed, only a small district remaining to be dealt with, the cost of which is estimated at £3,000. At the works also considerable modifications in the switchboards and alterations in certain of the generating machinery have been rendered necessary. The increased expenditure for repairs and maintenance of plant was mainly due to work entailed by the subsidence of the ground under four of the boilers at Water-street and to renewing two sets of batteries at Parker-street. Two sets of steam dynamos and three boilers had been installed at Water-street, and with some comparatively small additions this station will be completed. All the works are in good order. Application for sanction to borrow £251,974, less £17,000, estimated cost of work struck out owing to the abandonment of the Harborne tramway scheme, has been made, and on sanction being received there will be no delay in submitting to the Council the final estimates for the equipment of the proposed station in Summer-lane. The committee recommend that the clauses relating to the department which formed part of last year's proposed bill should be re-introduced, providing that the committee may supply electric energy in bulk to adjoining local authorities, and to light railways or tramways, and impose regulations as to the right of consumers to demand supply.

Bolton.—It is announced that though the Corporation gas profits have shrunk, increased profits from the electricity department more than recouped the falling off. There is also a decline in the tramway receipts.

Cadiz.—The cost of carrying out a number of improvements at this Spanish port has been found to be considerably in excess of the grant obtained by the Government for the work. It has, therefore, been decided to carry out only a portion of the operations, including the erection of electric or steam cranes for loading and discharging operations.

Canada.—The number of electric lighting companies in Canada increased from 259 in 1898 to 306 in 1901, arc lamps in use from 10,389 to 12,800, and incandescents from 463,615 to 815,676, the use of electric current for lighting having increased by about 60 per cent. The supply companies are distributed as follows:—Ontario 196, Quebec 50, Nova Scotia 21, British Columbia 14, New Brunswick 11, Manitoba 6, North-West Territories 5, Prince Edward Island 3.

If the applications which the Dominion Legislature has been asked to sanction in 1902 should be granted, and if the projected lines are all constructed, there will be 1,046 miles of track added to

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the electric railway mileage of Ontario alone. These lines (it is stated by Mr. G. Johnson, the Dominion statistician, who has recently compiled some interesting particulars of electrical developments in Canada) will revolutionise transportation in the country districts, and give remote parts of the Dominion market facilities calculated to greatly increase the value of farm and orchard products. In Quebec about 50 miles of electric railways and tramways are under construction, and are expected to be completed before the autumn of 1902. A considerable number of electric railway joint-stock companies have been formed in Canada recently, with the view to a great development of electric railway and tramway enterprise in the Dominion.

Christchurch (N.Z.)—The Auckland representative of the British Electric Traction Co. has submitted alternative proposals to the Borough Council for the construction of electric tramways in the district. The company would form a subsidiary company in London, with a nominal capital of £250,000, having a local board of three, to be appointed by the local authorities concerned. The company to have a 30 years' concession, paying £300 a year to the City Council for street repairs, and £400 a year to the other local bodies. Ten per cent. of the actual net profits would be divisible between the Corporation and the local bodies, who would have the right to purchase at 10 years at valuation plus 10 per cent. Similar offers are made for purchase at 20 years, except that the commission is 5 per cent., and at the end of the term purchase would be effected upon a basis of no commission. The alternative proposal provides for municipal ownership, the City Council and local bodies providing the necessary capital and giving the British Electric Traction Co. a lease for 21 years. The local authorities would acquire the existing tramways, the company guaranteeing payment of interest during the lease, with a sinking fund. The company would receive as remuneration for preparation of plans and specifications, for supervision and construction and equipment of the trams, a commission of 10 per cent. on the actual cost of the whole of the works connected with the conversion and construction of the lines. The company would also pay £50 a year for each mile of line in lieu of keeping it in repair.

Coal-Handling Plant.—It is stated to be the intention of the Portuguese authorities to make Lourenço Marques a great coaling station, and to introduce the most modern description of coal-handling appliances of all kinds. The railway lines at the port are on the 3ft. 6in. gauge. Senhor Albers is chief of the Harbour Commission, and invites written or printed information regarding coal-handling machinery and apparatus.

Coronation Illuminations.—Birmingham Corporation will supply electric current for Coronation illuminations on the evenings of June 26 and 27 at 3d. per 16 c.p. lamp.

Croydon Corporation will give supply at 2d. per unit.

Devonport.—As the result of the Board of Trade inquiry into the accident which occurred in the Albert-road on Feb. 21, the speed of the electric cars on the downward journey has been reduced from 6 to 4 miles an hour, with a compulsory stop at Ross-street.

Dundee—The Fairmuir electric tramway route has been opened for traffic.

Exhibitions.—It is announced that very small response has been accorded the invitations to foreign builders of motor boats, engines and other appliances appertaining thereto, to make a display at the Motor Boat Exhibition, to be held at Wannsee-on-the-Havel, near Berlin, from June to September, 1902.

The German Emperor will visit, about the middle of June, the exhibition of the industries and trades of the Rhineland and Westphalia, now being held at Dusseldorf. The area covered by the exhibition buildings, &c., is 150 acres, and 160 buildings have been erected thereupon. The electrical industries of the districts make an elaborate show on a large scale. Machinery in motion is a conspicuous feature. The machinery hall covers an area of 5 acres, apart from the space occupied by the special buildings devoted to boilers, pumps, &c. The station for the generation of electricity for the lighting and power required is equipped with plant for 15,000 H.P., and all the machinery in the exhibition and grounds is operated electrically. 1,000 arcs and over 40,000 incandescents are used in the lighting of the exhibition and grounds, and an electric railway circuits the grounds.

Fatal Accident.—An accident occurred at the electric tramcar shed Mannofield Station, Aberdeen, on Saturday, resulting in the death of Mr. J. Brown, master plumber, who was engaged in fitting up gas pipes in the shed, when he caught hold of a live wire, and received a shock. In his struggle to free himself he fell from a ladder and his skull was fractured.

Fire.—A fire broke out at noon on Tuesday on the premises of the National Telephone Co.'s branch exchange, Morrison-street, Glasgow. Two inspectors, Joseph O'Hara and James Borland, were badly burned about the hands, and John Bowie slightly. The operators were able to escape without injury. Damage to the extent of between £2,500 and £3,000 is said to have been caused. The damage done was principally to the building and a new switchboard for 50 subscribers, which was being tested, we understand, at the time of the outbreak. A portion of the tramway trolley wires along Paisley-road was ignited, and the tramway system interfered wich for about half-an-hour.

Golborne (Lancs.).—The Lancashire Electric Power Co. has submitted terms for supplying electricity in bulk to the Council.

Guildford—The negotiations between the Town Council and the Guildford Electricity Supply Co. for the acquisition of the company's undertaken have fallen through. At the last meeting of the Council it was reported that the company had offered to sell on the basis of £10,000 to cover goodwill, interest and expenses other than capital expenditure, which amounted to £30,855. This was considered too high, and the offer was rejected.

Hastings.—The Council have rescinded a previous resolution to oppose the clause in the Hastings Tramways Co.'s bill authorising the construction of a tramway line along the sea front.

Huddersfield.—Sanction to a further loan of £99,483 for electric lighting extensions has been obtained by the Council.

Hyde, Stalybridge, Mossley and Dukinfield Joint Electricity Board.—The General Purposes committee reported last week that Mottram Council desired the board to connect the tramways from the boundaries of Stalybridge and Hyde by a line through Matley, Mottram and Hattersley, and also to consider the advisability of constructing lines to Broadbottom and Woolley Bridge; also to consider the question of supplying electricity for lighting in the Mottram district. The engineer to the board (Mr. A. H. Gibbings) was instructed to inspect the districts and submit a report, with an approximate estimate of cost. It was announced that the matters in dispute between the board and the various corporations had been settled. There was now no opposition before the Board of Trade except that of the Lancashire and Cheshire County Councils.

Hythe.—Electricity supply will soon be available for public and private lighting, current being supplied from the works of the Folkestone Electricity Supply Co.

Ilford.—Sanction has been obtained by the Council to a loan of £925 for the removal of the telegraph posts in High-road and placing the wires underground.

Kalgoorlie (W. A.).—The electric tramways have been opened for traffic. Electric energy is supplied by the Kalgoorlie Electric Power and Lighting Corporation.

Leatherhead—Considerable progress has been made with the works of the Leatherhead and District Electricity Co., who hope to be in a position to give supply by July 1. The price of current has been fixed at 7d. per unit for lighting and 4d. for power. A contract has been entered into to light the new Blind School, where an equivalent of 1,200 8 c.p. lamps will be required.

Leeds.—A statement of the financial condition of the electricity department for the year ended March 25 has been issued. The total income was £45,332 8s. 6d., and the expenditure (including generation and distributing charges, management expenses, insurance, interest, &c.) £33,027. 13s. 2d., leaving £12,304. 15s. 4d. Of this £9,134. 15s. 2d. has been appropriated for sinking fund, leaving a surplus profit of £3,170. 0s. 2d. The total capital expenditure to date is £505,029. 9s. 11d., an increase of £136,931. 16s. 2d. during the year. In comparison with the previous year, the revenue for the year ended March, 1902, has been affected to the extent of about £8,000 by a reduction of prices and the abolition of meter rents

Light Railways.—The Bentley and Bordon (Hants.) Light Railway Order has been submitted to the Board of Trade for confirmation. Objections by June 7.

An inquiry was opened at Colchester on the 9th inst. into the application of the Southend and Colchester Light Railways Co. (Ltd.) for an order to construct light railways connecting Southend Burnham and Colchester. The scheme was estimated to cost about £300,000, and the company's engineer (Mr. M. N. Ridley) stated that the overhead trolley system of traction would be adopted. The line would be constructed to standard gauge. On the following day the inquiry was resumed at Southend. Opposition was offered by Southend Corporation and by the Great Eastern and the London, Tilbury and Southend Railways. Owing to this opposition, the promoters withdrew the suggested line from Southend to Shoeburyness. The Commissioners reserved decision.

An inquiry has been held into the application of the Cheltenham and District Light Railway Co. for power to extend their light railway to Charlton Kings and Leckhampton. The Commissioners decided to issue an order, a portion of the High-street route between Cambray and Bath-road being eliminated from the scheme.

The Light Railway Commissioners have issued an order for the construction of a light railway between Canterbury and Herne Bay.

An extension of three years has been granted for the construction of the Saltfleetby to Grimsby light railway.

Lombardy.—On the Mediterranean Railway Co.'s line between Milan and Varese, over 37 miles in length, the whole of the pas-

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senger traffic is now conducted by electric traction on the third-rail system. Six months' experience of this service has given the travelling public every satisfaction. Power for working this line is at present steam-generated at the power station at Tornavento, some distance from the starting-point of the line. The water-power works at Tornavento, which will, when completed, utilise the water of the Ticino, are not yet finished.

Another important experiment in electric traction has been made by the Adriatic Railway Co. on a portion of their system between Sondrio, Chiavenna and Lecco, a distance of 66 miles. The line was to have been worked on the overhead system, and was ready for working, the water-power station being completed and equipped for commencement of operations in October last, but technical difficulties arose for which the engineers were unprepared, and the commencement of working has been deferred until these difficulties have been overcome.

The electric tramway system of the city of Milan is being steadily extended. The share of the municipality in the net profits of the tramways for 1901 amounted to £50,800, comparing with £49,500 in 1900.

Lowestoft.—Electric current will, in future, be supplied to places of worship at 6d. per unit. Sanction to a loan of £7,143 for a new 500kw. set and condensing plant has been received.

Marienbad (Austria).—Messrs. Ganz & Co. recently constructed and equipped a municipal electric tramway in this town. The line was opened for traffic on 14th inst.

Mono-Railway Extensions.—According to a correspondent of the *Glasgow Herald*, a start has been made with the survey of a route for a mono-railway on Mr. Behr's system between Glasgow and Edinburgh, preparatory to the presentation of a bill in Parliament. It is stated that negotiations are proceeding with the North British Railway Co. with a view to securing the company's support to the undertaking Failing this, the line is to be promoted by a powerful syndicate. It is further stated that the plans for the Manchester and Liverpool Electric Express Railway are almost ready, and that in a few days tenders will be invited for the construction and equipment of the line.

Munich.—Statistics relating to the Munich electric tramways up to June 30 last, show that 584 electric cars were running in the city, with sitting accomodation for 10,412 passengers, and standing room for 9,146. Electric tramways have entirely replaced the horse tramways of the city, the latter having had an innings of a quarter of a century. The tramway system consists of 38,912 miles of single track, and carried in 12 months 44,581,688 at a uniform fare of 1d. There are six accumulator cars running short distances between points not connected up on the overhead system. The lines earned for the period to June 30 a dividend of 11 per cent., the net income being £31,672. A partly electric line runs between Munich and Wolfratshausen in the valley of the Isar.

Municipal Telephony.—At the meeting of the Aberdeen Telephone committee on Tuesday, it was stated that so many ratepayers had intimated their intention to become subscribers to the municipal telephone service that success was practically assured.

Naval Illuminations.—The E.L.B. system of electric lighting has been adopted by the French naval authorities for the illumination of the special squadron which accompanies the President of the Republic to Russia.

New Electrical Engineering Works at Huddersfield.—Last week an important gathering of leading business men of this town was held at Huddersfield to consider a proposal to form a limited liability company to establish works at Huddersfield where the manufacture of electrical machinery, apparatus, fittings, appliances and accessories, including cars and other requirements for electric traction would be conducted. The project was sponsored by Messrs. Witting Bros. (Ltd.), of London, representing Messrs. Kolben, of Prague.

Mr. ARMITAGE (Messrs. Armitage and Norton, C.A.) presided and introduced the scheme to the meeting. He said it had been many times suggested that new industries were required for Huddersfield, and when the present matter was put before him he consulted several leading business men in Huddersfield, who were favourably disposed to the project, which consisted of forming a company with a capital of £120,000, of which Messrs. Witting Bros. would subscribe £20,000. Works would be constructed to employ 500 workmen at the start.

Mr. WHITTING explained that at the present time Continental firms were supplying a large amount of machinery and appliances to this country at a profit, and this, notwithstanding that the difference in cost of manufacture between the Continent and England, should be considerably in favour of the latter, as raw material was quite as cheap here as on the Continent. The only item that was heavier was labour. He however considered that the English workmen, by their skill and exactness in their work, very nearly equalised this if properly supervised and directed. Freight would also be saved.

Mr. KOLBEN said he considered the present was the right time to start works in England, as there was a large amount of business coming forward. The company to be formed would have the benefit of his experience, plans, drawings, patterns and models, and he considered that in a few months from commencing the works should be running, as there would be no experimental trials necessary. He had himself some specialities for operating machinery in coal mines and ironworks which were not yet used in England, but were coming forward.

The MAYOR of HUDDERSFIELD proposed and Mr. JOHN SYKES seconded a resolution that a committee should be appointed to make inquiries and to take all precautions that guarantees be obtained that the enterprise would be permanent and profitable, and to report to an early meeting.

The resolution was adopted, and a committee appointed consisting of the Mayor, Ald. J. A. Brooke, and Messrs. John Sykes, W. D. Shaw, E. Crowther and W. H. Armitage.

Newport (Mon.).—For the year ended March 31, the profit on the electricity department was £859. 3s. 1d., against a deficit of £2,760 on the preceding year. There were 579 consumers, an increase of 121. The total receipts were £12,323. 6s. 2d., expenses £5,892. 10s. 6d.; interest and sinking fund, £5,571. 12s. 7d. Capital expenditure for the year was £1,328, making to date £102,882.

Mr. Wilkinson, at last week's council meeting, inquired why Mr. C. D. Copland, the borough electrical engineer, had resigned, but the chairman (Ald. Moses) said he had no explanation to make; Mr. Copland had sent in his resignation, and it had been accepted.

Nice.—90 miles of electric tramways are in operation in this district. The lines have all been completed within the town limits. The system is partly overhead and partly conduit, between 4 and 6 miles of the latter system being laid down in the centre of the town. A large number of additional cars are on order to supplement about 170 cars at present running Some of the lines are utilised for goods traffic. The power station is equipped with about 2,000 H.P. steam driven plant which generates current for transmission over about 20 miles of cables. Current for the conduit service is supplied by rotary converters. The weekly receipts average about £1,400.

The principal municipal authority of the district is considering a comprehensive scheme of additions to the tramway service of the district, including 10 additional routes. When these are completed tramway communication will have been effected with the most distant points, in addition to the provision of one line of an international character from Breil to Ventimiglia.

A British contractor (a Maltese) has secured a concession from the French Government for an auto-trolley line between Nice and Upper Monte Carlo, 12 miles in length, with gradients of from 10 to 11 per cent. The cars will accommodate 16 persons and will be about 4 tons in weight. The following is a description of the system to be adopted, and is taken from notes prepared by Mr. Wookey, British Vice-Consul at Nice, and president of the British Chamber of Commerce in the town:—

In connection with an ordinary electric omnibus, supplied with two motors and standard controlling apparatus, a small three-phase motor is provided. This motor is suspended between the two conducting trolley wires, which are set 12in. apart and supported by cars fixed on a C-shaped double suspension which, as in ordinary under-running trolley construction, is either hung to span wires or supported by a kind of bracket. The motor is hung on a frame supporting two trolley wheels is of a fixed armature type, and its pole places impart a rotary movement through fibre friction wheels to the two trolleys which are fixed on the same axle and run over the trolley wires. An even friction adjustment is obtained by special suspension springs. A flexible cable leads the motor current from the main line to the car, and the three-phase current from the car to the little trolley motor, which itself is fed by the motors which impel the vehicle. For the purpose of feeding the little trolley, motor taps are provided at the back of the armature connected to three collector rings fixed to the shaft. As the trolley motor runs at a speed proportional to that of the vehicle motor, the gearing has been so calculated as to allow the trolley motor to be a little in advance of the car itself in order that the flexible cable may have its proper tension. A small electro-magnetic brake blocks the trolley motor on the wire whenever the car stops on a steep gradient. The trolley motor and all its accessories weigh not more than 401b. As is the case in ordinary trolley roads, the difference of potential on the trolley lines will be 500 to 550 volts, the 10,000 volts three-phase alternating current being transformed through rotary converters installed in three sub-stations, one in the middle and one at each end of the line. Lines are now being constructed on this system in Marseilles and other places, after having been successfully tried. The estimated cost of the 20km. of line, including all sub-stations, 12 cars, and all other material for the working of the line, will it is stated, not exceed £40,000.

Obituary.—Mr. Schutz Wilson, son of Mr. Effingham Wilson, the well-known London publisher, and for several years assistant secretary of the old Electric Telegraph Co., died a few days ago.

Presentation.—On 9th inst. a presentation of a dressing case was made on behalf of the engineering staff and employés of the Manchester Corporation electricity works to Mr. W. F. Long, who is leaving to take up the important position of chief electrical engineer to the Corporation of Cape Town. The presentation was made by the deputy chief engineer (Mr. S. L. Pearce), who alluded to Mr. Long's good work in Manchester during his six years' stay, and expressed the sincere regret of the staff in having to wish him good-bye.

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Proposed Duty on Copper in Germany.—A number of German electrical firms have appealed against the proposed duty on raw copper imported into the country. In the petition it is stated that the German production of raw copper increased 28 per cent. from 1891 to 1900, but that the consumption increased 110 per cent. The electrical industry required during the last three years a yearly average of about 50,000 tons of electrolytic copper, which is only produced in small quantities in Germany, and has to be imported from the United States.

Ramsgate.—In consequence of the recent decision of the bench of magistrates (reported elsewhere in this issue), the Isle of Thanet Electric Tramways and Lighting Co. have decided to reduce the speed of their cars, and the complete journey will now occupy 75 minutes.

Ryde.—Mr. J. G. W. Aldridge has been appointed consulting electrical engineer by the Council.

Salford.—The inquiry by Judge Parry into the working of the electricity supply department will commence on June 3.

Shanghai.—A ratepayers' meeting, held at Shanghai on April 1, confirmed the action of the Municipal Council in extending the time for the receipt of tenders for the construction of tramways to June 30, and at the same time asked the Council to take into consideration any tenders for a motor omnibus service in lieu of tramways, if such a proposal should be submitted.

South Shields.—The financial statement of the electricity supply undertaking for the year ended March 31 has been issued, and in the accompanying report of the borough electrical engineer (Mr. J. H. Cawthra) it is stated that the capital expended during the year was £10,312, bringing the total to £138,801. The equivalent of 41,680 8 c.p. lamps was connected to the mains, compared with 35,025 in 1901, consumers having increased from 680 to 778. The maximum load on the station was on Jan. 25, when the load was 767kw., an increase of 62kw. The number of units sold was 985,646, an increase of 229,820. The number of arc lamps remain the same as last year, but the number of ordinary gas standards converted to electric brings the total public lamps to 283, an increase of 175. Revenue amounted to £13,664, against £12,196 in 1901. The gross profit was £7,750, against £6,261, and the percentage of gross profit to total capital expenditure 5½, compared with 4 8 per cent. Interest and sinking fund required £7,155, against £4,793, and after meeting all charges, including interest and sinking fund, there was a net profit of £594, against £1,468 in the previous year. The average price obtained per unit for current supplied to private consumers was 3·91. per unit, against 4d. in 1901, and for street lighting 1·31., against 1·81. The past year had been comparatively free from breakdowns so far as the generating plant was concerned, not a single interruption in supply having occurred, but in regard to mains, from the commencement of the winter until the end of March there was considerable trouble with the distributors. The King-street arc main gave trouble, and as it was found unfit for further use it has been removed. The actual cost of producing electrical energy sold during the year was 1·291 per unit, against 1·71d. in the previous year, which is claimed to be the lowest cost of production by any electricity supply works, either municipal or company, generating electricity for lighting only. The total cost per unit, including interest and redemption charges, was 3·03d. per unit, against 3·23d. in 1901.

The Council have again resolved to promote a bill authorising the construction of electric tramways. Last year the Corporation bill was rejected on a poll of the ratepayers.

Southampton.—The Corporation have received sanction to borrow money for the erection of new electricity works on the western shore.

Spennymoor.—The formal opening of the electricity works of the Northern Counties Electricity Supply Co. took place on Saturday.

Stonehaven (N.B.).—Messrs. Barlow and Young have given preliminary notice of intention to apply for a provisional electric lighting order.

Sudbury.—An inquiry was held here on Thursday last into the application of the Council to borrow £12,000 for electricity works. Technical details were supplied by the consulting engineer (Mr. W. C. C. Hawtayne). There was some opposition by ratepayers.

Surbiton.—The agreement with Callender's Company for the erection and maintenance of electricity works has been sealed, and the Council have obtained the necessary borrowing powers.

Swansea.—The Anglo-French Nickel Co. has accepted the offer of the Council to supply electric current for power at 1½d. per unit for a minimum of 100,000 units per annum, and 1¼d. per unit up to 200,000 units.

Swindon.—Application has been made by the Council for 12 months' further time to comply with the terms of their tramway provisional order.

Telegraphic and Telephonic Communication with the Continent.—The Association of Chambers of Commerce has received from the Postmaster-General a letter stating that last year an additional cable was laid to the Netherlands, and that the proposed new cable to Germany has now been completed, and a direct line has been opened between Liverpool and Paris. With reference to telephonic communication with the Continent, the Postmaster-General states that provision has been made for a direct telephone service between England and Belgium by a new cable laid this month. Negotiations for an extension of the Anglo-French telephone service to provincial towns in both countries have recently been brought to a successful conclusion, and it is hoped this extension will be opened as soon as the necessary arrangements can be carried out in co-operation with the French administration.

Trieste.—The light railway from Trieste to Scorcola on to Opcina, built by the Austrian Union Electric Co., is to have an extension of over 3 miles, costing about £61,000, which will connect Trieste with the Karst plateau. This extension, which rises to an altitude of nearly 1,200ft., is to be opened during 1902.

Since the introduction of electric traction on the old horse-drawn tramways in Trieste an increase of nearly 70 per cent. is shown in the receipts of the Belgian company which works the lines.

Wigan.—Further sections of the electric tramway system were opened for traffic on Friday, and there are now four complete routes open. The annual report of the borough electrical and tramways engineer (Mr. H. Collings Bishop) for the year ended March 31 states that the deficit on the electricity undertaking amounts to £2,300. 5s. 6d., compared with £4,221. 1s. 2d. in the previous year, but there was a profit of £638. 15s. 9d. on the tramways. Receipts from the sale of current were £5,713. 11s. 1d. and from hire of motors £220. 12s. 11d.

Mr. Bishop states that the progress made has been very satisfactory. The applications in hand for new lamp connections were greater than at the corresponding period last year, and there was every prospect of the demand being maintained. In regard to the tramways the total revenue was £8,771. 10s. 1d., or 10·61d. per car-mile, and the expenditure 9·83d. per car-mile, which included sinking fund and interest, 3·24d.; wages, 3·18d.; traffic expenses (comprising current management, &c.), 3·41d., leaving a profit of 0·78d. per car mile, or £638. 15s. 9d. 1,907,224 passengers were carried, equal to the entire population of the town 31 times. The total length of track in operation was 5 miles 1 chain. Capital expenditure amounted to £69,349. 10s. 10d., or £13,869. 4s. per mile of track open. The electricity supply department generated 725,024 units of current, of which 579,904 were sold and 76,000 used in the works. At the commencement of the year the equivalent of 11,401 8 c.p. lamps were connected, and at the end of the year this total had reached 33,899. There were also 86 motors, aggregating 622¾ H.P., connected to the mains. The total capacity of the station is 1,200kw., and the maximum load demanded was 453kw. The amount expended on motors and fixing same was £5,613. 11s. 3d., and this appears in the balance-sheet as stock in hand. The total capital expenditure on the electricity supply department was £86,312. 2s. 4d.

Marriage.—Mr. Harold Rippon, electrical engineer and contractor, Exeter, was married at St. James's Church, Exeter, on Thursday last, to Miss Miriam Adelaide Stevenson, eldest daughter of Mr. C. H. Stevenson, of Exeter.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week*]

TENDERS INVITED.

London County Council invite tenders for wiring and fittings for the electric lighting of four fire brigade stations at Battersea and Camberwell. Specifications, &c., at the chief engineer's department, County Hall, Spring-gardens, London, S.W., and tenders to the clerk (Mr. G. L. Gomme), by 10 a.m. June 5. An advertisement gives further particulars.

Stretford District Council invite tenders for the supply and erection of steam-raising plant (boiler, superheaters, economisers, &c.), generators (engines, condensers, pumps, &c.), and mains. An advertisement contains further particulars. Plans may be seen and specifications, &c., obtained from the consulting engineer (Mr. C. H. Wordingham, M.Inst.C.E.), 19, Brazennose-street, Manchester. Tenders (addressed Chairman of Electricity committee, Council Offices, Old Trafford) to the clerk (Mr. George H. Abrahams) by June 18.

Greenock Corporation invite tenders for the supply and erection of a 300kw. steam dynamo with steam and exhaust piping. Specifications, &c., from the burgh electrical engineer (Mr. W. M. Nelson), Corporation electricity works, Hunter-place, Greenock, to whom tenders by 10 a.m. June 2. See advertisement.

The Board of Guardians of the parish of *Fulham* (London) invite tenders for the supply, delivery and erection of pipework. Specifications, &c., from the consulting engineer (Mr. F. Hastings Medhurst, M.I.E.E.), 13, Victoria-street, London, S.W., and tenders to the clerk (Mr. Edward. J. Mott), 75, Fulham Palace-road, W., by 10 a.m. June 5. An advertisement gives further information.

Tynemouth Corporation invite tenders for the supply and erection of one reversible booster and a set of condensing plant. An adver-

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tisement contains further particulars. Specifications, &c., from the borough electrical engineer (Mr. C. Turnbull), Tynemouth Electricity Works, North Shields.

The Mayor and Aldermen of the City of *Launceston* (Tasmania) invite tenders for polyphase generating, transmitting and distributing plant and apparatus, transforming apparatus, re-construction of existing plant, and enclosed arc lamps and accessories. Further particulars are set out in an advertisement, and copies of conditions, forms of contract, specifications and drawings may be obtained from the city electrical engineer (Mr. William Corin) or from Messrs. John Terry & Co., 7, Great Winchester-street, London, E.C. Tenders, addressed to the town clerk (Mr. C. W. Rocher), to the Town Hall, Launceston, by 4 p.m Sept. 15.

Poplar (London) Electricity committee invite tenders for about 130 cast-iron arc lamp columns. Tenders to town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, by 10 a.m. May 28.

Poplar (London) Electricity committee also invite tenders for special armoured cables suitable for laying in water. Tenders to town clerk by 10 a.m. May 28.

The Guardians of *Poplar* (London) Union invite tenders for electric wiring and fittings at the Union offices. Tenders to clerk (Mr. G Herbert Lough), 45, Upper North-street, Poplar, E., by 6 p.m. May 28

Burton-on-Trent Corporation invite tenders for supply and erection of three 100kw. high-speed tramway generators and switchboard and three Lancashire boilers, steam pipes, jet condensing plant, economiser and accessories. Tenders to town clerk by noon May 30.

Govan Town Council invite tenders for stores for 12 months from June 1, including fuse-boxes, meters, demand indicators, manhole boxes and connections and joint boxes for armoured cables. Tenders to town clerk by May 27.

West Ham Corporation invite tenders for the construction of about 8 miles of tramway permanent way, copper bonding, &c. Tenders by June 10.

Tenders are invited for wiring and fittings at the Parc Gwyllt and Angelton Asylums, near *Bridgend*, Glam. Tenders to Mr. W. E. Allen (clerk to the Committee of Visitors) by May 31.

The *War Office* invite tenders for a self-propelled lorry for military purposes. Specifications, from Director of Army Contracts (Mr. A. Major), War Office, London, S.W., to whom tenders by noon July 31.

Brighton Town Council invite tenders for points, crossings, tie-bars, bolts, &c., also about 300 tons of steel girder tram rails. Tenders by noon June 9.

The Guardians of *Hunslet* Union (Leeds) invite tenders for two electric ward lifts for their new infirmary at Rothwell Haigh, near Leeds. Tenders to clerk by 10 a.m. June 3.

Bury (Lancs.) Tramways committee invite tenders for tramway track material—including points and crossings, sole and anchor plates, &c. Tenders by June 24.

Hull Corporation invite tenders for about 20,000 cast-iron holding-down plates. Tenders by noon 30th inst.

Glasgow Corporation invite tenders for an economiser with induced draught fan and condensing plant. Tenders by June 7.

Beckenham Electric Lighting committee invite tenders for incandescent lamps. Tenders to chairman by noon June 6.

Dudley Electric Lighting committee invite tenders for incandescent lamps and oil. Tenders to chairman by noon June 6.

Blackpool Corporation invite tenders for lubricating oils. Specifications from borough electrical engineer.

Liège municipal authorities invite tenders until 26th inst. for construction and equipment of an overhead electric tramway between Pont d'Avroy and Place St. Lambert. Tenders to Le Bureau Administratif des Travaux, Annexe de l'Hotel de Ville, Liège.

TENDERS RECEIVED AND ACCEPTED.

Willesden District Council have accepted the tender of the Gilbert Arc Lamp Co. for the supply of 100 arc lamps with automatic switches and other accessories for £1,968; and that of the British Insulated Wire Co. for the supply, fixing and painting of 100 arc lamp pillars (85 of which are to be fitted with incandescent brackets), including excavation, re-instatement and connections to mains at £1,553. 3s. 6d., the contract for the pillars being sub-let to Messrs. Rowland Carr & Co.

The contract for replacing the storage battery at Bromley electricity works has been let to Messrs. Pritchetts and Gold (Ltd.), Feltham, Middlesex.

A further supply of "Ark" lamps have just been supplied by Messrs. Johnson and Phillips for the lighting of Boer prisoners' camps, quick delivery being a condition of the order.

Kensington (London) Borough Council have accepted the tender of Messrs. C. Oliver Clark & Co. for wiring their Warwick-road stables at £205. 10s. 6d. Five tenders, varying from £205. 10s. 6d. to £379. 10s. were received.

Halifax Town Council have accepted the tender of the British Thomson-Houston Co. for the supply of two 100kw. rotary converters for £1,304, and a high-tension switchboard for £332; also the tender of the British Electric Transformer Mfg. Co. for seven 75kw. single-phase transformers for £798.

The contractors for the electric lighting of Limerick (Allgemeine Electric Co., Berlin and London) have placed with Messrs. Rowland Carr & Co. the order for the arc lamp columns required.

The National Telephone Co. have accepted the tender of Messrs. Rowland Carr & Co. for the supply of insulating compound for the six months ending Dec. 31.

Swindon Corporation have accepted the tender of Messrs. W. T. Glover & Co. for the supply, delivery and laying of feeder and distributing cables, conduits and accessories for £5,411. 1s. 1d.

St. Helens Cable Co. have received a contract from the London and North-Western Railway Co. for rubber goods.

Messrs. Babcock and Wilcox have received a supplementary order for the supply of 16 boilers of about 8,000 H.P. for the generating station of the Metropolitan District Traction Co.

Broughty Ferry Town Council have accepted the tender of the Electrical Power Storage Co. for the supply of a storage battery, and that of Messrs. Lowdon Bros. & Co. for a switchboard.

Wolverhampton Corporation have accepted the tender of Messrs. Dempster, Moore & Co. for machine tools, &c., for their tramcar repair shops at £472.

Mansfield Town Council have accepted the tender of Messrs. Crompton & Co. for pipe work at £2,486.

The tender of the British Electric Transformer Mfg. Co. has been accepted by Bedford Town Council for the supply of 28 30kw. transformers at £1,764.

BUSINESS NOTICE.

Messrs. Connolly Bros., Blackley, Manchester, have appointed Messrs. R. A. Whyte & Co., 140 and 144, Bath-street, Glasgow, agents for Scotland for their insulated wires and cables, insulating tape, Blackley tape, &c.

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 2s. 1½d. will be payable on 27th inst. at 14, Chapel-street, Preston, in the bankruptcy of R. Foster and W. Baker (trading as Robert Foster & Co. and the Nelson Electrical Engineering Co.), Burnley and Nelson.

The discharge of L. J. Lawrence (trading as Lawrence and Butcher), electrical engineer, 5, Stafford-street, London, W., is suspended for two years.

The Westralian Electric Lighting and Supply Co. (Ltd.) is to be wound up voluntarily. Mr. Gordon Saies, Pearl Assurance-buildings, Liverpool, is liquidator.

Winding up Petition.—A petition for the winding-up of the Meyra Electric Co. (Ltd.) has been presented by Mr. B. Bridgwater, and will be heard in the High Court on 28th inst.

Plant, &c., for Sale.—Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Leyton Electric Lighting committee, having adopted steam plant, wish to dispose of their gas-driven plant, including dynamos, gas engines, Dowson gas generators and accessories. Offers to the engineer and manager (Mr. F. Harman Lewis) by June 25. See advertisement.

Businesses, &c., for Sale.—The receiver and manager of the British Electrical Manufacturing Co. (Ltd.), Fulham Electric Works, Putney Bridge Station, S.W., advertises the undertaking for sale as a going concern, with the manufacturing plant and an extensive stock of switches, &c. Further particulars of Mr. James E. Ward, C.A., 122, Cannon-street, London, E.C., and 58, New-street, Birmingham.

The electrical patents and business recently carried on by the Doe Electric Light and Power Syndicate are for sale. Some particulars are set out in an advertisement.

Oil Separators.—A subject of first importance in connection with large engineering undertakings is the treatment of exhaust steam, and a pamphlet just issued by Baker's Patent Appliances Co., of Melrose-street Works, Scarborough, in reference to the well-known "Baker" oil separators for treating the exhaust steam of condensing or non-condensing engines, or for purifying live steam, will be welcomed. Much new and original information with regard to this class of apparatus is given, and the names of those using Baker separators are a guarantee of the suitability of the device for the work it is constructed to perform. There is an imposing group of

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electricity supply and electric tramway undertakings in the list, including a large proportion of repeat orders.

Electric Fans.—A list of "Freezor" electric fans, enclosed type, for continuous current, is issued by the General Electric Co., describing desk and bracket fans, ceiling fans, &c. A combined electric fan and motor for forcing or exhausting, for direct and alternating currents, is also listed.

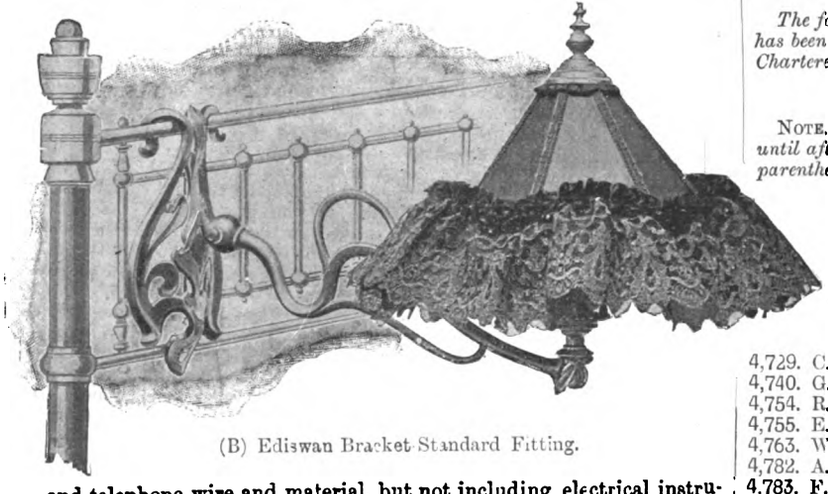
Ediswan Fittings.—We referred recently to an excellent list of Ediswan electric light fittings just published. Our illustration (B) shows an adjustable bracket standard which can be used either as a standard or as a bracket. On p. 14 of the list it is shown in both positions. It is made in polished brass or oxidised silver, and the price of the fitting complete puts it well within the reach of the ordinary consumer of electric current. The illustration (A) shows a single-light hammered pendant made in antique copper, antique brass, or oxidised silver. This is supplied with a patent chain already wired. The workmanship and finish of these fittings is, notwithstanding their low price, of "Ediswan" quality—a sufficient guarantee.

(A) Ediswan Hammered Iron Pendant, with Wired Chain.

Multiphase Installations.—The A.E.G. vorm. W. Lahmeyer & Co., of Frankfort-on-Main, have recently put down a number of multiphase installations. Amongst these may be mentioned the equipment of the St. Gallen station and a station at Wangen, both in Switzerland. In Roumania, electricity works in the city of Sinaia have been similarly equipped, and large electricity works near Augsburg have also had multiphase plant installed. The agents in this country for this system are the Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C.

Electrical Standardizing, Testing and Training Institute.—Prof. C. A. Carus-Wilson, M.A., M.I.E.E, commences a special course of lectures to the senior students of this Institute on "Motor, Dynamo and Transformer Construction," on Monday next, May 26.

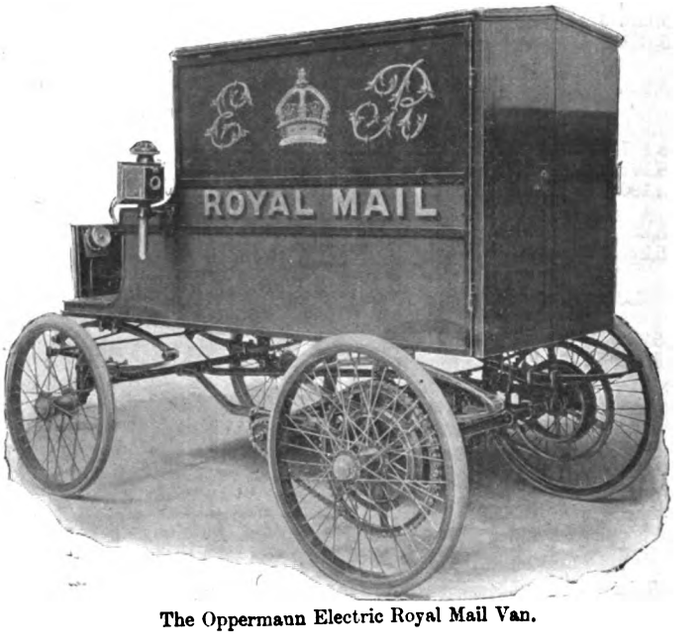
Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 14 to May 21, with the ports of destination :—



(B) Ediswan Bracket Standard Fitting.

Africa—Cape Town, £3,590 (including £20 telegraph material); Durban, £734; East London, £836; Port Elizabeth, £1,048. *Argentina*—Rosario, £35. *Australasia*—Brisbane, £85; Christchurch, £14; Melbourne, £100; Sydney, £244; Wellington, £148. *Belgium*—Ostend, £80. *Ceylon*—Colombo, £50. *Channel Islands*, £85. *Colombia*—Santos, £250 (telegraph material). *Denmark*—Copenhagen, £36 (telegraph cable). *Gibraltar*, £121. *Holland*—Amsterdam, £110. *Hong Kong*, £49. *India*—Calcutta, £581; Madras, £40. *Japan*—Yokohama, £650. *Russia*—St. Petersburg, £75. *Straits Settlements*—Singapore, £50. *Sweden*—Gothenburg, £243. *Uruguay*—Monte Video, £20. Total (for eight days), £9,274, against £19,646 for seven days last year (May 15 to 21).

Electric Royal Mail Van.—As mentioned elsewhere, Mr. Carl Oppermann, of Wynyatt-street, Clerkenwell, London, E.C., has placed at the disposal of the Postmaster-General his new electric mail van for a series of trials to test its suitability for post office work. A view of the car is given herewith. It is of English make throughout, and built on Mr. Oppermann's patent tubular frame principle. It weighs 19 cwt. and has a carrying capacity of 3½ cwt. Motive power is provided by 40 25-ampere A.B.C. cells (Albion Battery Co.) with a charge giving a running limit of from 40 to 50 miles. The van is silent in running, without vibration. It is speeded up to 12 miles per hour. We understand that so far as the test has proceeded the car has given every satisfaction. The trials are to be extended for a period of three months, and the car will be engaged on Post Office depôt work in the London area. The journeys taken by the van average from 25 to 30 miles per day. Mr. Carl Oppermann has been an enthusiast in electric vehicle work for many years, and we hope the result of the tests will lead to the adoption of the Oppermann vehicle for Post Office work.



The Oppermann Electric Royal Mail Van.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, of 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Where not otherwise stated, the application is made in London.

February 25, 1902.

4,704. W. R. V. MARSHALL. Glasgow. Poles of dynamo-electric machines.

4,717. H. T. BOOTHROYD. Liverpool. Portable electric drilling apparatus.

4,720. W. BUCKLEY. Manchester. Trolley poles.

4,729. C. E. KNOWLES. Manchester. Lamp-holders.*

4,740. G. L. HOGAN Supporting devices for electric lamps.

4,754. R. LUNDELL. Field-magnets.*

4,755. E. MCOUAT. Incandescent lamps.*

4,763. W. CRUDINGTON. Birmingham. Arc lamps.

4,782. A. B. TUBINI. Telephony.

4,783. F. RAWLINGS. Switches.

4,793. T. SLOPER and J. H. PARSONS. Intercommunication telephone systems.

4,794. J. F. MAGORIS. Cutouts for electric traction.

4,804. O. KÖNITZER. Interrupters for high-voltage conductors.

4,805. R. ZIEGENBERG. Electro-dynamometers.

February 26, 1902.

4,814. J. MCKERNAN. Bolton. Electrical arrangement for turning points and crossings automatically.

4,861. A. N. GOTENDORF. Overcoming alternating currents in direct-current circuits.

4,865. V. BARRETO. Automatic circuit-breakers for induction apparatus.

4,871. M. RAILING and G. H. IDE. Duplex link chain for electric fittings.

4,896. G. BOWRON. Induction coils.

4,906. A. L. SIMPSON. Controllers for electric vehicles.*

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February 27, 1902.

4,930. P. H. Jauncey. Birmingham. Supports for incandescent lamp globes.
4,936. W. Oates. Halifax. Conduits or pipes for electric cables.
4,999. T. H. Hadfield. Electric igniting plugs for internal combustion engines.
5,010. A. Blanchet. Electricity meters.
5,018. J. W. Mackenzie. Two-fluid electric batteries. (La Société Anonyme L'Eclairage Electrique sans Moteur, Belgium.)
5,032. J. P. O'Donnell and E. C. Irving. Pole change for use in railway signalling.

February 28, 1902.

5,043. W. Hunt. Stockton-on-Tees. Trolley bracket and head combined.
5,057. H. Oppenheimer. Telephone transmitters or microphones. (A.-G. Mix and Genest, Germany.)
5,065. J. P. Cribb. Portsmouth. Overhead trolley wires.*
5,083. T. W. Graves. Maximum demand indicator.
5,095. E. H. Tyler. Conductors for electric traction.
5,103. Callender's Cable and Construction Co. and J. C. A. Ward. Connecting conductors or armour cables to junction boxes, earth plates and other parts.*
5,104. La Société G. et P. de Mestral. Arc lamps. (Date applied for, Sept. 4, 1901, date of application in France.)*
5,118. J. G. Maardt. Insulating material.
5,129. W. Loewen. Commutators.*

March 1, 1902.

5,134. Sherard Cowper-Coles & Co. and Sherard Cowper-Coles Electro-deposition of metals.
5,146. J. F. Gill. Liverpool. Electrical ignition or sparking apparatus.
5,147. E. W. Wynne. Liverpool. Trolley collectors.
5,177. H. W. C. Cox. Current collectors for electric tramcars.
5,190. A. Vaudam and T. H. Marsh. Electric switches and combinations of the same with wall plugs.
5,209. F. J. King. Magnetic ore separators.
5,211. R. Lawton and Albion Clay Co. Conduits.

March 3, 1902.

5,228. J. Atkinson. Cheshire. Continuous-current dynamos, motors and converters.
5,245. J. Gray. Enclosed arc lamp with four carbons vertically in series.
5,263. J. E. Doughty. Portable electric light for examining drains and pipes.
5,290. R. E. B. Crompton. Preparing flattened metallic coils for electrical magnets, solenoids, &c.
5,292. R. Feilendorf. Igniting devices for miners' lamps.
5,294. D. A Caspar. Electric rammer for foundry use.
5,296. R. Chauvin and R. Arnoux. Automatic checking devices for electricity meters.
5,301. A. J. Boult. Lubricant for electrical purposes. (Carl Ulbrich, Germany, and G. Pommerhauz, Austria.)
5,308. F. Tremain. Submarine cables.
5,312. R. Chauvin and R. Arnoux. Instrument for measuring differences of temperature, electrical potential, current and the like.

March 4, 1902.

5,320. E. M. Munro, H. Brecknell and H. J. Rogers. Bristol. Swivelling contacts.
5,323. F. E. Ward. Birmingham. Automatically reversing current-conducting poles.
5,329. J. T. Pearson. Burnley. Preventing accumulation of ice or snow on telegraph wires.
5,341. F. J. Cooper. Glasgow. Electricity mains.
5,366. J. E. G. Mérau. Electric accumulators.*
5,374. Hon. C. A. Parsons. Dynamos, motors and the like.
5,375. F. L. Muirhead and J. Parr. Field magnet winding.
5,425. J. H. Walker. Trolley pole harp.

March 5, 1902.

5,464. A. Reame. Hull. Switch device providing instantaneous motion from stud to stud.
5,468. W. Willenbücher. Manchester. Trolley heads.*
5,483. T. J. Howell. Combination of electric, magnetic and carbon microphones.
5,505. H. Leitner and R. N. Lucas. Electric lighting of trams and trains.
5,512. G. G. M. Hardingham. Electric cables. (Felten and Guilleaume Carlswerke A.G., Germany.)
5,530. C. H. Merz. Electricity meters.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

1,156. J. E. Auger and E. H. Claye. Car trucks.
1,527. Clapham, Clapham and Clapham. Automatic electrical attachment for clocks for ringing bells and other purposes.
3,087. Hickley. Starting and regulating switches.
3,438. Spencer. Apparatus for recording the time an electric car passes a station.
3,487. Kingsland. Mechanically-operated electric switches.
4,005. Walker and Walker. Ship log apparatus.
4,422. Hussey and Clarke. Primary batteries.
4,777A. Barker (Murphy Safety Third Rail Electric Co.). Electromagnets. (Date claimed, March 6, 1901.)
6,043. Kleinsteuber. Insulated trolley conductor fitting.
6,624 and 6,635. Lake (Scott). Automatic magnetic circuit-breakers.
6,857. Swinburne and Ashcroft. Treatment of zinc chloride for electrolytic purposes.
7,016. Jandus Arc Lamp and Electric Co. and Jones. Arc lamps.
7,397. Brochet and Ransom. Electrolytic production of caustic alkalies.
8,306. Woodward and Torr. Current collectors for electric railways.
9,350. Grobet. Electric furnaces.
10,191. d'Arsonval and Vaugeois. Manufacture of plates for accumulators.
15,517. British Thomson-Houston Co. (Potter). Motor controllers for electric railways and the like.
20,455. Els. Electrical signalling apparatus for railways.
25,560. Boult (Richards). Automatic controllers for electric motors.
26,340. British Thomson-Houston Co. (Holz). Controllers for electric motors.
26,472. Burke. Single-phase alternating-current motors.
26,524. Thompson (Davis). Laying underground electric conductors.
26,678. Edwards. Electro-mechanical controlling mechanism for looms.
26,690. British Thomson-Houston Co. (Thomson). Arc lamps.
26,695. British Thomson-Houston Co. (Geisenhouer). Dynamo-electric machines.
26,698. British Thomson-Houston Co. (Steinmetz). Systems of electric distribution.
26,729. Bain and Hunt. Electric battery.
26,731. Barry. Controlling attachments for trolley poles.
26,743. Hallberg. Arc lamps.

1902.

77. Isham. Registering consumption of current.
361 and 380. Brown. Contact shoes for electric railways.
1,224. Schmid. Electromagnetic engine governor.

COMPANIES' MEETINGS AND REPORTS.

West African Telegraph Co. (Ltd.).

An extraordinary general meeting of the West African Telegraph Co. was held on Wednesday for the purpose of approving and confirming a contract between the French Government and the Company. Sir John Denison-Pender, K.C.M.G. (managing director) presided.

The SECRETARY (Mr. John Cambrook) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the reason you have been called together in extraordinary meeting is to confirm an arrangement with the French Government. The history of the matter is this. In the concession which was granted to the West African Company, amongst other cables that had to be laid was one which had to be put down between Sierra Leone and Grand Bassam. As one of the associated Companies (the African Direct) already had a cable in those waters and connecting those places, your directors thought there was no necessity to lay a duplicate one. The traffic did not warrant it. Shortly after the granting of the concession a provisional permit was given by the French Government which authorised the suspension of the laying of that cable for the time being. In 1895, however, the French Government gave notice that they would send in a formal request that this cable should be laid. That led to certain difficulties, because we maintain that we had really only the obligation, not actually to lay a cable, but to put those places (Sierra Leone and Grand Bassam) in connection with each other. However, that view was not taken by the French Government, and it led to certain difficulties between us which ended in the Government refusing to pay the subsidy which up to that time had been regularly paid to us. That meant, I am sorry to say, that shortly after the shareholders in the West African Company had to go without their dividends. However, in May, 1896, I went over to Paris, saw the French Government, and entered into negotiations, and an arrangement was come to. However, I am sorry to say that that agreement was never really carried out. Certain events caused its fulfilment to be deferred. The Minister of Commerce of that time went out of office, and the thing lingered on till January, 1900. In May of last year I was over in Paris again and negotiations were resumed, and these have been satisfactorily carried through. Under this arrangement we receive in all £144,000. which is a considerable sum for this Company, and you may think that, as you have been without your dividends for a considerable time, that that would warrant us in paying a bonus which would be equal, perhaps, to a dividend, which you have been so long without. I am sorry to say it is impossible for us to do that on account of the debenture-holders, who, of course, have a prior lien on the property of the Company, and that money will be employed to pay off, on September 1 next, the remaining debentures, which will be drawn in July. However, your property will then be left free, and any available revenue that there is will not, as it has in the past, to the extent of about £24,000 a year, be paid for redeeming debentures and paying the interest on those outstanding. It will all go now to pay a dividend and strengthen the reserve fund of the Company. You may think that these negotiations have been a considerable time in being carried through, and that your Directors have not used every possible means of pushing them on. I can assure you that that is not the case, and I think you will understand it when I tell you that we have had to get the permission of the British Foreign Office, the British Telegraph Department, the Portuguese Foreign Office and their Telegraph Department, and not only to get their permission to certain clauses of the agreement, but to get permissions which have been acceptable to the French Government, and I think this agreement, which is certainly a very satisfactory one, has only been finally pushed through by really hard and continuous work on the part of all those concerned. I now move the adoption of the resolution approving the contract.

Sir HENRY C. MANCE, C.I.E., seconded the resolution which was carried unanimously.

In answer to a question, the CHAIRMAN explained that, after providing for the cost of the cables and the redemption of the remaining debentures, there would be left free from mortgage the £24,000 a

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year which had hitherto been paid for the amortisation and the interest on debentures annually. Although they had been able to pay off more debentures each year, because there was less interest to pay, it had amounted to a tax of £24,000 a year on the Company, and now that this was wiped off completely, that revenue would go to the ordinary shareholders, who would undoubtedly receive a dividend if the figures in the Company remained as they had done in the past.

Mr. HENDERSON thought he might express on behalf of the shareholders their admiration for the manner in which the particular matter under discussion at this meeting had been negotiated by the Managing Director and staff, and moved a hearty vote of thanks to the Chairman, Directors, and staff, for their efficient conduct of the Company's business generally.

The motion was seconded by Mr. EAST and carried unanimously, and after a reply by the CHAIRMAN, the proceedings terminated.

NEW COMPANIES, STATUTORY RETURNS, &c.

ANGLO-BELGIAN CONSTRUCTION SYNDICATE (LTD.)—Reg. May 13, capital £50,000 in £1 shares, to construct, equip and work railways, tramways, light railways, &c., and any undertakings for the generation, utilisation, supply, or distribution of electric or other power, &c.

BOHM SYNDICATE (LTD.)—Reg. April 29, capital £35,000 in £1 shares, to acquire from M. Boyd the benefit of certain inventions relating to electric incandescent lamps, and to carry on the business of electricians, engineers, suppliers of electricity, manufacturers of and dealers in electric lamps and apparatus, &c.

ERIMUS AUTOMATIC SAFETY GUARD CO. (LTD.)—Reg. May 8, capital £2,000 in £1 shares, to acquire patents, inventions, &c., relating to safety guards or other machinery, accessories or fittings to electric tramcars, motor cars, &c., and to carry on business of tramcar and motor car builders and dealers, electricians, &c. The first directors are H. Bennett, C. Griffiths, A. l'Anson, T. Jones and G. C. Mosses. Reg. office: Post Office-chambers, Middlesbrough.

SOUTH AFRICAN WORKS SYNDICATE (LTD.)—Reg. May 14, capital £5,000 in £1 shares, to carry on the business of manufacturers of rolling stock, railway and tramway appliances, engines, machinery, &c., engineers and contractors for railways, tramways and all kinds of works and undertakings, producers and suppliers of electricity, &c. Reg. office: 110, Cannon-street, E.C.

CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY CO. (LTD.)—According to return to April 1 the capital is £75,000 in £1 shares, 47,859 of which have been taken up. £1 per share has been called and paid on 2,859, and 45,000 shares are considered as paid. Mortgages and charges, £50,000.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 23 1/8d. per oz. (May 22). Consols (2¾ per cent.) 95¼—95⅝ for money, 95 3/16—95 5/16 for account; 2½ per cent. 95½—96 (May 22). Consols Pay Day June 2; Stocks and Shares Continuation Days, May 26 and June 10; Ticket Days, May 27 and June 11; Pay Days, May 28 and June 12; Mining Share Carry-over Days, May 23 and June 9.

BARCELONA TRAMWAYS CO. (LTD.)—The directors' report for 1901 states that the traffic receipts from electric traction amounted to £105,461, and sundry receipts £773, total £106,235. Working expenses were £70,035, leaving gross profit £36,200. Deducting loss on exchange, and adding amount from 1900, there remains £25,973. Receipts show an increase over 1900 of £6,714, and expenses £306. The number of passengers carried was 33,787,925, against 27,959,547 in 1900, and 21,736,264 in 1899. The balance at credit of net revenue is £25,973, and of this debenture interest has absorbed £10,264, preference dividend £5,000, and payment of an ordinary dividend share at the rate of 3 per cent. per annum, tax free, is now recommended, the balance (£4,709) being carried forward. The conversion of the Ensanche line, and the construction of the Josepets-Bonanova extension, together with the supply of 40 additional motor cars (26 new and 14 converted), will, when completed, entail an expenditure of about £65,000, of which the sale of certain sites no longer required will produce about £10,000, and it is proposed to issue the reserved balance of 4½ redeemable debenture stock, amounting to £51,900.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—The directors have resolved to pay a further interim dividend of 10s. per share for the year ended Dec. 31, payable June 14.

CASTNER-KELLNER ALKALI CO. (LTD.)—At the meeting last week the chairman (Mr. W. Mather, M.P.) said the works at Weston Point had been established and had given every satisfaction. The demand for bleaching powder had not much improved. The general position was better than that 12 months ago. The board had added materially to the works and plant without increasing the liabilities on capital account. Influenced by the high price of fuel the directors had decided to use gas under the boilers instead of coal, from which they expected considerable advantage. The company's prospects were never so good as at present, and they only required a larger demand for bleaching powder and the settlement of the war in South Africa, where their interests were of some magnitude, to enable them to make good progress.

MUNICIPAL LOAN.—Barnstaple Corporation invite tenders for a loan of £21,600 for the erection of electricity supply works. Tenders to town clerk by 30th inst.

NORTH METROPOLITAN TRAMWAYS CO.—The shareholders of this company have been invited by the Metropolitan Electric Tramways (Ltd.) to exchange their £8 shares for holdings in the latter undertaking, which has an authorised capital of £1,500,000. The British Electric Traction Co., of which the Electric Tramways Company is a subsidiary has acquired leases from the Middlesex and Hertford County Councils for running light railways through suburban and rural districts in the north of London. The North Metropolitan shareholders are offered for each share held four fully-paid £1 4 per cent. preferred and four fully-paid deferred shares in the Electric Tramways Company. The deferred shares are entitled to half surplus profit after the ordinary have received 8 per cent. The proposal is to electrify the North Metropolitan system (which is leased from the London County Council), and to work it in conjunction with the light railways in the north of the metropolis. The offer of exchange emanates, we learn, from the Electric Tramways Co.

RUSTON, PROCTOR & CO. (LTD.)—The profit for the year ended March 31 is £29,925. After deducting for depreciation on buildings, &c., £9,409, directors' remuneration £720, and debenture interest £10,000, there is a net balance of £9,816, added to £1,516 brought forward, and the directors propose that £4,000 be added from equalisation of dividends account, making the amount £15,333, to allow of the payment of a dividend of 8s. per share (4 per cent.), tax free, absorbing £14,000, and leaving £1,333 to be carried forward.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has been asked to appoint a special settling day in the further issue of 7,254 £1 fully-paid shares (Nos. 149,820 to 157,083) of *Marconi's Wireless Telegraph Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	May 17	627	— 46	50	35,351	+ 2,108
Ayr Corporation	„ 17	167	...	34	4,843	...
*Birmingham Tramways.	„ 17	4,802	+ 133	19	88,040	+28,350
*Blackburn Corporation..	„ 16	733	+ 23	20	12,810	+ 1,440
Blackpool Corporation...	„ 15	432	+ 17	7	3,097	+ 65
Blackpool and Fleetwood	„ 17	292	— 121	20	4,870	+ 172
Bolton Corporation	„ 18	1,401	— 26	7	10,174	— 189
Bradford Corporation ...	..	...	...	...	...	...
Brighton Corporation ...	„ 18	694	...	25	14,526	...
Brisbane Tramways.....	Apl. 2	2,491	+ 381	14	32,604	+ 3,552
*Bristol Trams & Carriage	May 17	4,352	— 77	19	78,291	+ 4,104
Burnley Corporation ...	„ 17	675	+ 200	‡7	4,608	+ 1,381
*Buenos Ayres & Belgrano	Apl. 20	2,739	+ 78	16	43,289	— 1,052
Calcutta Tramways Co...	May 17	R21,442	+R1,903	20	R442,469	+R40,672
Carlisle Tramways Co....	„ 17	162	— 12	†20	2,673	+ 21
Cardiff Corporation	„ 17	1,071	...	...	...	...
Central London Railway	„ 17	6,885	+ 486	20	133,769	+ 9,832
City & South London Ry.	„ 18	3,080	+1,171	20	59,587	+19,820
Cork Elec. Tramways Co.	„ 15	513	— 45	§19	7,841	+ 248
Devonport & Dist. Trams	„ 9	410	...	18½	7,130	...
Dover Corporation	„ 17	189	+ 1	7	1,295	+ 162
Dublin & Lucan Railway	„ 18	97	— 25	20	1,849	+ 119
Dublin Southern Dist....	„ 16	1,055	+ 142	¶19	14,693	+ 3,731
Dublin United	„ 16	3,723	— 54	¶19	66,979	
Dudley—Stourbridge ...	„ 9	684	+ 27	18½	12,102	+ 2,036
*Dundee Corporation ...	„ 14	646	— 31	...	...	...
East Ham Council	„ 17	394	...	47	17,001	...
Gateshead & Dist. Trams	„ 9	708	+ 68	18½	11,872	+ 68
Glasgow Corporation ...	„ 17	11,667	+ 226	...	...	...
Greenock & Port Glasgow	„ 9	451	+ 271	18½	7,487	+ 4,222
Hartlepool Tramways ..	„ 9	233	+ 12	18½	3,664	+ 231
Hull Corporation	„ 17	1,618	+ 17	7	11,432	+ 90
Isle of Thanet Co.	...	...	...	...	...	...
Kidderminster & Dist....	„ 9	104	— 3	18½	1,830	+ 146
*Liverpool Corporation...	„ 10	9,149	+ 299	19	170,172	+15,080
Liverpool Overhead Rly.	„ 18	1,433	— 211	‡20	28,090	— 2,721
Manchester Corporation	„ 17	2,607	...	§49	102,103	...
Merthyr.....	„ 9	188	— 50	18½	3,520	— 474
Middleton	„ 9	252	...	6½	1,840	...
Newcastle-on-Tyne Corp	„ 17	2,464	...	...	...	...
Oldham, Ashton & Hyde.	„ 9	497	— 18	18½	8,726	+ 15
Perth (W.A.) Elec. Trams	„ 16	1,077	+ 240	‡46	45,186	+14,672
Poole & Dist.....	„ 9	232	+ 1	18½	3,850	+ 38
Portsmouth Corporation	„ 17	1,296	+ 754	...	...	...
Potteries	„ 9	1,466	+ 39	18½	25,531	+ 1,045
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ..	„ 18	3,790	+ 170	20	73,851	+13,815
Southampton Corporat'n	„ 15	859	+ 99	19	15,428	+ 2,934
Southport Tramways ...	„ 9	236	+ 100	18½	3,097	+ 905
*S. Staffordshire Trams...	„ 9	757	+ 4	18½	13,510	+ 640
Swansea Trams.....	„ 9	438	+ 51	18½	7,636	+ 723
Taunton Trams.....	„ 9	52	...	18½	1,013	...
Tynemouth & Dist.	„ 9	213	+ 27	18½	3,693	+ 230
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 9	143	+ 91	18½	2,485	+ 1,601

(a) These comparisons are with the corresponding period last year. Days.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi. dend.	Name.	Previous Week's Price, May 14.	Price Wednesday, May 21.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 21.
			ELECTRICITY SUPPLY.			£ s. d.		Highest / Lowest
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¼ ⅛	¼ ⅛			.. ...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100 104	100 104	4 6 9	...	... ...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11 12	11 12	5 16 8	...	... ...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	... ...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103 106	103 106	6 5 2	...	104½ 104
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9 9½	9 9½	4 4 3	...	... ...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	8¾ 9¼	3 15 8	March and September	9⅛ 9
20,000	5	3/6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000) xd	8 9	8 9	3 6 8	...	... ...
10,000	5	3/4 1/8	Do (Nos. 20,001-30,000) xd	8 9	8 9		...	... ...
£250,000	Stock	...	Central Electric Supply Co. 4% Guar. Deb. Stock	106 108	106 108	3 14 9	...	... ...
50,000	a	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9 10	9 10	5 0 0	February and August	9⅛ ...
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...	...	... ...
70,000	a	2/3	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	,, ,,	... ...
£250,000	Stock	4/0	Do. 4% Deb. Stock Red.	105 107	105 107	3 15 6	...	105½ ...
44,426	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5 5⅛	5 5⅛	3 12 9	March	⅛ ...
£1[illegible]	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 113	110 113	4 0 2	June and December	... ...
70,595	10	10/0	City of London Electric Lighting Ord.	8 9	8 9	5 5 7	February and August	... ...
80,000	10	6/0	Do. 5 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	... ...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 124	123 128	3 18 10	June and December	... ...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103 106	103 106	4 6 0	...	... ...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8 9	8 9	4 8 11	...	... ...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	... ...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	107 110	107 110	4 3 0	...	1 0 109½
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	6¾ 6¼	6¾ 6¼	3 12 0	...	... ...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	... ...
11,000	a	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	... ...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	10⅛ ...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6¼ 6¾	6¼ 6¾	4 8 11	January and July	... ...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	... ...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104 107	104 107	3 14 11	...	... ...
£111,000	3	...	London Electric Supply Ordinary	1¼ 1⅜	1¼ 1⅜		...	... ...
12,500	5	3/0	Do. 6 per Cent. Preference	4 4½	4 4½	6 13 4	...	... ...
£150,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95 100	95 100	4 0 1	Mar., June, Sept., Dec.	9⅜ ...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16 17	16½ 17½	3 14 4	April and October	16⅜ 16
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 115	111 115	3 18 2	June and December	... ...
£240,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 100	95 101	3 10 4	...	... ...
10,352	10	6/0	Notting Hill Electric Ordinary	14 15	14 15	4 0 0	March	14½ ...
12,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	,,	... ...
£50,000	Stock	4%	Do. 4% Debenture Stock	93 101	93 101	3 19 3	...	... ...
300,000	1	...	Rand Electric	⅛ ⅛	⅛ ⅛	...	...	... ...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	68 72	70 75	...	January and July	... ...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103 105	103 105	4 6 9	April and October	... ...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	... ...
20,000	5	3/6	Do. 7 per Cent. Preference	8⅝ 9⅛	8⅝ 9⅛	3 13 8	,, ,,	... ...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98 101	98 101	3 9 6	...	100 ...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1¾ 2¼	1¾ 2¼	...	...	... ...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	... ...
65,000	5	...	South London Electric Supply Ordinary	2¾ 3¼	2¾ 3¼	...	...	3½ ...
110,000	a	5 6	Westminster Electric Supply Ordinary	11 12	11 12	4 7 6	March and September	1 1⅛ 1 ½
28,141	5	...	Do. 5 per Cent. Cumulative Preference	3½ 4	3½ 4	...	...	... ...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.					
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4 4½	4 4½	4 14 2	April and October	4⅛ 4⅛
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125 130	127 32	4 12 7	...	... ...
20,000	10	...	Barcelona Tramways Ordinary	7½ 8½	8 9	...	...	8¼ ...
10,000	10	5/0	Do. 5% Cumulative Preference	8 9	8 9	5 11 1	...	... ...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95 100	95 100	4 10 4	...	... ...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½ 14½	13½ 14½	4 9 8	...	... ...
75,000	5	...	Brisbane Electric Trams. Investment Ord.	3 3½	3 3½	...	...	3⅛ 3
75,000	5	2/6	Do. 5% Cum. Pref. xd	4½ 5	4½ 5	5 0 0	...	4½ ...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	104 107	104 107	4 4 1	...	105 ...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	... ...
20,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	... ...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	107 110	107 110	3 12 9	February and August	... ...
20,000	10	4/0	British Columbia Electric Railway Ordinary	6¾ 7¼	6¾ 7¼	2 15 2	...	7⅛ ...
20,000	10	5/0	Do. 5% Preference	9⅝ 10	9½ 10	5 0 0	May and November	9⅝ 9⅛
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102% 104%	102% 104%	4 6 9	...	... ...
100,000	10	6/0	British Electric Traction Ordinary	13⅝ 14⅛	13½ 14½	6 4 2	...	14 13⅝
100,000	10	6/0	Do. 6% Cum. Pref.	12½ 12¾	12½ 12¾	4 14 1	February and August	12⅛ 12⅜
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126 125
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅛ 1⅜	1⅛ 1⅜	...	...	... ...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4¾ 5¼	4¾ 5¼	5 14 3	...	⅛ 5⅛
27,500	5	10/0	Do. "B"	4¾ 5¼	4¾ 5¼	5 14 3	...	... ...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 4	...	... ...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 0	...	... ...
34,440	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	13⅛ 14	14 15	2 0 0	...	14⅜ 14¼
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107 109	107 109	4 3 7	...	... ...
440,000	1	1/2½	Cape Electric Tramways Shares	2⅜ 2⅝	2⅜ 2⅝	3 6 2	...	... ...
£1,8 0,014	Stock	4%	Central London Ordinary Stock	103 106	103 106	3 15 11	June and December	105½ 104⅜
£494,093	Stock	4%	Do. 4% Preferred Stock	103 106	103 106	3 15 11	...	1 5½ ...
£494,993	Stock	4%	Do. Deferred Stock	100 103	100 103	3 17 1	...	... ...
£648,201	100	4%	Do. 4% Deb.	116 118	116 118	3 8 0	...	... ...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5⅛	5 5⅛	4 10 11	...	... ...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	... ...
£1,330,000	Stock	2½%	City and South London Railway Con. Ordinary	72 74	73 75	2 13 5	February and August	75 73⅝
37,500	10	1/0⅛	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	,, ,,	... ...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	... ...	... ...	...	...	... ...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 15 5	,, ,,	... ...
£200,000	Stock	5%	Do. (1896)	124 127	125 128	3 18 4	...	127½ 126½
£150,000	Stock	...	Do. (1901)	120 124	120 124	...	...	... ...
£446,463	Stock	5%	Do. 5 per Cent. Perpetual Debenture xd	110 115	113 117	3 10 2	May and November	116½ 115½
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11½ 12⅛	11⅛ 12⅛	4 0 0	...	... ...
52,987	10	6/0	Do. 6 per Cent. Preference	14½ 15⅛	14½ 15⅛	3 17 5	...	... ...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	86 89	86 89	3 10 8	...	... ...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4 4½	4 4½	6 13 4	...	... ...
£75,000	Stock	10/8	Do. 5 per Cent. Debenture Stock (red.)	101 104	1 1 104	4 13 2	...	... ...
78,000	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	...	... ...
30,000	10	8%	†Imperial Tramways Ordinary	26½ 27⅛	26½ 27⅛	3 18 6	March and September	... ...
10,000	10	6%	† Do. 6 per Cent. Preference	13½ 14½	13½ 14	4 4 0	,, ,,	... ...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110 112	110 112	4 0 6	January and July	... ...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4½ 5	4 15/16 4 15/16	3 0 3	February and August	... ...
10,000	10	5%	Do. 5 per Cent. Preference	10⅜ 11	10⅜ 11	4 11 1	,, ,,	... ...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98 99	98 99	4 0 10	January and July	... ...
51,201	10	...	London United Trams 5% Cum. Pref. (£10 paid)	10½ 11½	1 ½ 11	...	...	11 10⅝
10,999	10	...	Do. (£5 paid)	5½ 6	5½ 6	...	...	... ...
£655,341	Stock	...	Do. 4% 1st Mortgage Debenture Stock	104 106	1 5 107	...	...	105½ 105½
£169,659	Stock	...	Do. Prov. Certs. (£50 paid)	53 55	54 56	...	...	... ...
$6,103,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	111 115	111 115	4 6 11	...	... ...
£50,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908)	104 106	104 106	4 14 9	...	101½ ...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	103 105	103 105	4 5 10	...	... ...
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 13 4	...	... ...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½ 4½	3 4	7 10 0	May	3⅜ 3½
£181,800	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96 100	96 100	5 0 0	...	... ...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stck.	100 103	1 0 103	4 12 9	...	... ...
28,334	10	8/0	Potteries Electric Traction Ordinary	9½ 10½	9½ 10½	3 16 2	...	... ...
10,000	10	5 0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	... ...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock xd	105 108	105 108	4 3 0	...	... ...
£50,000	1	...	South Lancashire Electric Traction & Power Ord.	... ...	... ...	...	...	... ...
51,182	1	...	Do. 6% Preference (12/0 paid)	... ...	... ...	...	April and October	... ...
50,000	1	...	Do. 6% Preference (fully paid)	... ...	... ...	...	,, ,,	... ...
£500,000	Stock	...	Do. 4½% Debenture Stock (60% paid)	... ...	... ...	...	January and July	... ...
£540,000	Stock	3%	Waterloo and City Ordinary	91 94	91 94	3 4 0	June and December	94 ...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 14.		Price Wednesday, May 21.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 21	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅜	4⅛	3⅜	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£7,8,840	Stock	12/6	Anglo-American	44	47	44	47	5 19 5	Feb., May, Aug., Nov.	46	44
£3,105,580	Stock	25/0	Do. Preferred	88	90	83	90	6 9 2	" "	89	88½
£3,105,580	Stock	2/0	Do. Deferred	7	7½	7	7½	1 6 8	" "	...	...
£13,333,300	£100	£1¾	Commercial Cable Capital Stock	150	160	150	160	5 0 0	Jan., Apr., July, Oct.		
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	93	96	93	96	4 3 4	" "	95½	94
16,000	10	4/0	Cuba Submarine Ordinary xd	4	5	4	5	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent. xd	12½	13½	12½	13½	7 8 2	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅛	3⅛	2⅛	3⅛	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8⅛	8⅝	8⅛	8⅝	5 5 3	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	98⅞	102⅞	98⅞	102⅞	4 8 3	January and July	...	...
60,710	20	3/0	Direct United States Cable	9½	10½	9½	10½	6 3 10	Jan., Apr., July, Oct.	...	...
£101,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200) (red.)	117	127	117	127	5 10 3	Jan., Apr., July, Oct.	120½	113
£1,930,807	Stock	17/6	Do. 3½ per Cent. Preference Stock	84	87	85	88	4 0 0	" "	87½	87
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.) xd	106	110	106	110	3 12 9	May and November	...	...
300,000	10	6/6	Eastern Extension xd & bonus	12	13	12½	13½	5 3 8	Jan., Apr., July, Oct.	13	12½
£320,000	Stock	8%	Do. 4 per Cent. Debenture Stock	107	113	107	112	3 11 10	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 17 4	February and August		
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	99⅞	102⅞	97⅞	102⅞	3 18 5	May and November	99	...
150,000	10	20/0	Great Northern of Copenhagen	26	28	26	28	5 7 2	January and July	...	...
£75,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos.	99	103	99	103	4 8 3	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red. xd	37	41	37	41	6 1 11	May and November	42½	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 7	June and December	99½	...
15,609	10	...	*West African Telegraph Shares	1⅛	2⅛	2⅞	3⅛	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99	102	99	102	4 19 0	March and September	...	...
30,008	2½	...	West Coast of America	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅛	⅜	⅛	⅜		May and November	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	5½	6	5½	6	10 0 0	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅞	4⅛	3⅞	4⅛		" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	101	104	101	104	4 16 8	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	11⅛	12⅛	11⅛	12⅛	5 16 4	Mar., June, Oct., Dec.	12½	11⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 3	June and December		
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 18 5	...	103½	103½
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3¾	4	3¾	4	6 5 0	August	3¾	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	¾	½	¾	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	...	...
200,000	5	0/1½	Do. Preferred Shares (£3. 17s. paid)	3⅛	3⅜	3⅛	3⅜	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	55	59	55	59	7 12 4	...	55	...
15,000	10	0/0	Do. 6 per Cent. Cumulative 1st Preference	12	14	12	14	4 5 9	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	12	14	4 5 9	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5⅛	5½	4⅞	5½	4 17 7	" "	...	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	94	97	94	97	3 12 5	June and December	95½	94½
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	103	107	103	107	3 15 8	...	104½	...
171,504	1	0/8	Oriental xd	15/16	1 1/16	15/16	1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	4⅜	5⅛	4⅜	5	7 0 0	July	5	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	5 0 0	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 8	June and December	...	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛	¼	⅛	¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛	¼	⅛	¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜	⅝	⅜	⅝	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	8	9	8	9	8 6 8	July and February	...	...
70,000	5	3/0	Do. 6 per Cent. Preference	5½	5¾	5½	5¾	5 4 0	January and July	1 11/16	...
£250,000	Stock	50/3	Do. 4½% 1st Mort. Deb. Red.	102	105	102	105	4 5 11	...	103½	...
150,000	5	3/0	British Westinghouse 6% Preference xd	5⅝	5⅞	5⅝	5⅞	5 2 2	...	5½	...
106,731	2	...	Brush Electrical Engineering	2	1½	2	1½		March	⅜	...
150,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	1½	2	1½	2	4 13 0	March and September	1⅝	1½
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	101	104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	95	100	95	100	4 10 0	January and July	...	...
30,000	5	5/0	Callender's Cable Construction Ord.	17	18	17	18	4 3 4	" "	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111	115	111	115	3 18 4	November and May	...	...
650,000	1	0/4½	Castner-Kellner Alkali Co. (fully paid)	¾	1	⅞	1⅛	2 13 4	...	1	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	90	95	90	95	4 16 0	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	8 0 0	March	...	...
85,000	3	1/9½	Crompton and Co. (Nos. 1 to 54,000)	3	3⅛	3	3⅛	6 8 6	January and July	3 1/16	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103⅜	108⅜	103⅜	108⅜	4 12 8	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅛	⅜	⅛	⅜	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	2	3	2	3		" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	75	80	75	80	5 1 3	June and December	...	...
35,500	5	2/6	Edmundson's Electricity Corporation Ord.	6⅛	6¾	6⅛	6¾	5 3 8	Half-yearly	6 1/16	...
120,000	5	3/0	Do. 6% Cumulative Preference	6	6⅛	6	6⅛	4 12 4	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	107	110	4 2 7	...	109	...
112,100	2	1/2½	Electric Construction Co.	1½	1⅝	1½	1⅝	6 17 2	January and July	...	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅜	3	2⅜	3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97	101	97	101	3 19 3	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾	1⅛	¾	1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	9⅜	10⅜	9⅜	10⅜	4 17	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98	101	98	101	3 19 3	...	...	...
35,000	5	10/0	Henley's Telegraph Works Ordinary	17	18	17	18	4 3 4	February and August	17⅛	17
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	6	5⅛	6	3 15 0	" "	6⅜	...
£18,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	115	111	115	3 18 3	" "	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21½	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
57,350	12	36/0	Telegraph Construction and Maintnce.	34	37	34	37	6 9 8	March and July	33½	35½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	106	3 15 5	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary xd	10	11	10	11	5 9 1	...	1 3/4	...
90,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
66,666	5	5/0	Willans and Robinson Ordinary	8½	9½	...	...	...	April and October	...	...
66,666	5	3/0	Do. 6 per Cent. Cumulative Pref.	6½	6¾	...	...	...	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	105	107	...	...	...	May and November	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	5⅜	5⅛	5⅜	5 9 1	...	...	...
180,227	10	2/6	Globe Telegraph and Trust	8	9	8	9	5 16 8	Jan., Apr., July, Oct.	8 1/16	...
180,042	10	3/0	Do. 6 per Cent. Preference	12½	13½	12½	13½	4 8 11	" "	13	12⅞
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	115½	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption

† The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

THE representations made by the Institution of Electrical Engineers as to the effect on the electrical industry of the present law of electric lighting and traction, have brought about the desirable result that the President of the Board of Trade has been asked by Lord SALISBURY to receive a deputation on the subject. A deputation of members of the Institution of Electrical Engineers will, therefore, wait on Mr. GERALD BALFOUR next Thursday, and we hope that the laying before him of their views will result in a promise of new and rational legislation for electric lighting, power and traction. Since the Institution's report, considerable attention has been paid to the matter in the Press, including a leading article in *The Times* in favour of the electrical engineer's case.

DURING the two sittings of Lord WINDSOR's Committee on Underground Railways in London this week, important decisions were come to involving the fate of the remaining Bills before the Committee, the consideration of clauses being left over until to-day, when probably the important questions of vibration and compensation to property owners will be considered. As foreshadowed in our last issue, the scheme that has found favour for the Hammersmith–City route, recommended by last year's Joint Committee, is the joint scheme promoted by the London United Tramways and Mr. PIERPONT MORGAN. This group of Bills included a line running almost due north from the City to Palmers Green (Southgate), whose preamble has also been declared proved; but it will be remembered that the City and North-East Suburban Railway, which was to run from the City to Walthamstow in connection with these lines, has had to be abandoned for this year. A Bill seeking powers to build a tube railway from Victoria to Putney, under King's-road, Chelsea, another route which received the approbation of last year's Joint Committee, has been rejected owing to the arrangements for providing capital having been deemed insufficient by the Committee. Both Lord WINDSOR'S and Lord RIBBLESDALE'S Committees have shown themselves "difficult" on this point, evidently as a result of the length of time several authorised lines remained unconstructed. An example of this is the Brompton–Piccadilly Circus railway, which was authorised in 1897 and is only just commenced. This railway will now have its extension to Holborn granted, so that the important through communication from north to south will be effected; but the extension from Brompton to Parson's Green, at the other end of this railway, has been refused. Finally, the Central London Railway will be given powers to enlarge its station at Marble Arch and to acquire additional land at Shepherd's Bush, while an increase of capital of £150,000 has been sanctioned by the Committee for the purchase of new rolling stock.

THE formal opening of the Stuart-street station of the Manchester Corporation electricity works, on Tuesday last, marked the close of the first stage in an important extension of that huge municipal undertaking, as well as the practical inauguration of a broader scheme of electric light, power and tramway supply which the Manchester Corporation has taken upon its shoulders on behalf of Greater Manchester. In itself last Tuesday's event consisted in the opening of the station by the Lord Mayor and the starting up of the first completed 2,500 H.P. three-phase generating set. Under Dr. KENNEDY'S scheme six of these sets will bring to completion that portion of the station which comes directly under his control Mr. METZGER, however, will follow up the completion of this set with a series of 5,000 H.P. generators, and, when the whole is complete, we do not doubt that it will be one of the finest, as it will be one of the largest, electricity works in the United Kingdom.

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Great credit is due to all concerned in this scheme. Under Dr. Kennedy's able direction, aided on the spot by Mr. Gunton, the work of erecting the plant and buildings has been pushed forward with phenomenal speed. The scheme, it will be remembered, was placed before the Electricity committee in its final form only in March of last year. Much of the machinery had to be erected under temporary roofing, owing to the necessity to push on before the permanent structure was completed. Yet so successfully has every detail been accomplished, that the first generating set is to be put into regular commission next Sunday to work some 10 miles of new electric tramway which will be opened on that day.

Credit, as we have just said, is due to all whose skill and energy have been engaged in the initiation and perfecting of this scheme. Consulting engineers and contractors were publicly thanked on Tuesday, but not more than they deserved; yet there was one unmentioned name which we should like to have heard fall, in terms of appreciation, from the lips of the Lord Mayor and the Chairman of the Electricity Committee. We allude to the former chief electrical engineer of the Corporation, Mr. C. H. Wordingham, whose ability and persistent energy during the early development of the electricity scheme at Manchester laid a substantial and broad foundation upon which his successors are rearing the present structure. Even powerful municipal organisations cannot afford to be ungenerous, and a thankful allusion at Tuesday's function to the enduring work of Mr. Wordingham would have been graceful and well merited.

We have referred on previous occasions to the progress of the work of electrically lighting St. Paul's Cathedral, and it is now satisfactory to note that the installation is so far completed as to warrant its general use. The Dean and Chapter, as well as the general public, are indebted to Mr. Pierpont Morgan for this generous gift, and, indirectly, it confers a benefit on the electric lighting industry also, as it affords an excellent demonstration of the superiority of electricity over its rivals for the illumination of sacred edifices. The spreading of the work over three years does not seem unreasonable when the age and massive proportions of the building are taken into account, the chief matter for surprise being that no alteration in the original plans for the wiring has been found necessary. Iron gas-barrel for the protection of the wires has been used throughout, and this is quite innocent of insulating linings or other elaborations for the prevention of short circuits. The appearance of the nave presents little alteration during daylight, as the old gas and candle fittings have been converted, the most marked difference being noticeable in the dome and chancel, where elaborate pendants are employed.

Although this latter change is decidedly evident, it cannot with justice be said that the designer has been guilty of introducing fittings in any way unsuited to their surroundings; and from our inspection of the building one evening this week, when the entire installation was switched on, we can accord nothing but praise to the architect and contractors. The appearance of the much-discussed mosaics in the chancel and dome, by the rays of the lamps, forms a striking contrast with the effect from the old gas lights, and in this respect alone the cathedral authorities have reason to be gratified. We are pleased to note that the temporary pendants at present hanging in the dome will be shortly replaced by more substantial fittings, similar to those described in our article on another page, as Mr. Morgan has decided to defray the cost of completing the entire lighting of the building. This circumstance will come as a relief to the Dean and Chapter, for the original estimates, amounting to £5,000, have now exceeded £10,000, the sum presented by Mr. Morgan, and it was thought that the additional expense would need to be met by other private subscriptions.

The Hookham Meter.—The *London Gazette* for May 27th announces the approval by the Board of Trade of the new Hookham continuous-current meter. The method of fixing and connecting up the meter as approved is described.

Cass Technical Institute.—The formal opening of the Sir John Cass Technical Institute, Jewry-street, London, E.C., will take place on Thursday next, when the ceremony will be performed by the Right Hon. Lord Avebury, F.R.S.

Errata.—In our "Contemporary Electrical Science" notes of last week, for "connection of negative ions" in the seventeenth line of the note on "Ions of the Atmosphere," read "convection of negative ions." In the last line but two of the note on "Influence of Inductance upon Spectra" substitute "$1{,}014 \times 10^{-5}$" for "$1{,}014 + 20^{-5}$."

Accident on the Wolverhampton Tramways.—The Wolverhampton tramways killed their first horse last Saturday, the cause being that one of the surface contacts remained charged after the car had passed. As stated in our article last week, one or two cases of slight shock had occurred previously, but had all been traceable to contact-boxes being damaged during fitting.

Incorporated Gas Institute and Electrolysis.—The thirty-ninth annual general meeting of the Incorporated Gas Institute is to be held at Southampton, under the presidency of Mr. S. W. Durkin, commencing June 10th. A civic welcome is to be accorded the members at the opening of the proceedings. The programme includes a lecture on "Electric Traction and Electrolysis," by Mr. James Swinburne.

Royal Institution.—We regret to state that Mr. Marconi will be unable to deliver his lecture on "The Progress of Electric Space Telegraphy" at the Royal Institution this (Friday) evening on account of an attack of influenza. In this emergency Prof. J. A. Fleming has agreed to deliver a lecture on "The Electronic Theory of Electricity," and it is hoped that Mr. Marconi will be able to lecture at a special Friday evening meeting on June 13th.

The Whitechapel–Bow Railway.—This railway, which will be opened to the public to-morrow, 31st inst., as a link between the District Company's system at Whitechapel and the London, Tilbury and Southend Railway at Bow, will be worked by steam power for the present. Eventually it will be electrically equipped and run in conjunction with the Metropolitan–District Railway Company's system, from whose power-house at Lots-road, Chelsea, it will be supplied.

Electro-Harmonic Society.—The annual general meeting of the above society will be held on Wednesday, at 4:30 p.m., at the Institution of Electrical Engineers. During the past season 64 gentlemen have been elected members of the society and 32 old members have resigned. In the same period the society has lost two members by death, while four members have been struck off the register for non-payment of subscriptions. The membership roll now contains 358 names.

Electric Lamps in the German Army.—Portable electric lamps are being introduced into the German Army, and mounted patrols will be supplied with them, according to the *United Service Gazette*. The advantages of such a lamp will

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be very pronounced for field duty, and especially during inclement weather. The medical corps will also find the lamps of great value both in searching the field for wounded and when operations have to be performed in the hospital tent.

Cable Interruptions and Repairs :—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Bolama	April 19, 1902 ...	—
Puerto Plata—Martinique	May 6, 1902 ...	May 28, 1902
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—

Patents and Trade Marks in Cuba.—While the Americans occupied Cuba persons desiring insular protection for inventions and trade marks were required first to patent and register in the United States, and subsequently to record in Cuba certified copies of their United States patents and trade mark registrations. Now that the Cuban Republic is proclaimed, the new Government has made arrangements for granting patents for 17 years' duration and trade mark registrations of 15 years' duration. All documents must be in Spanish.

Wireless Telegraphy.—Mr. Marconi, according to *Electricity*, New York, is to make an attempt to communicate with New York from a prominent eminence in Massachusetts some time next month. It will be his first experiment to signal New York from 150 miles inland, this being the distance of the signalling station to be erected at Mount Morris. The occasion will be marked by the annual convention of the American Institute of Electrical Engineers, and it is expected that many electricians will follow the experiments with considerable interest.

Reduction in Cable Rates.—The Eastern Extension Telegraph Co. announces that the tentative arrangement come to between the Federal Government of Australia and the company for applying to Victoria and Queensland the reduced rates now in force in the four contracting States (South Australia, New South Wales, Tasmania and West Australia) will be extended to New Zealand, New Caledonia, Norfolk Island and Fiji. Consequently the tariffs to those places, on and after June 1st, will be, for ordinary telegrams :—New Zealand 3s. 4d. per word (Press telegrams 1s. 2d.), New Caledonia 8s. 8d., Norfolk Island 3s. 2d., and Fiji 3s. 7d.

Glasgow Corporation Wiring Rules.—A revised set of wiring rules has been issued by the electricity department of the Glasgow Corporation, giving the terms and conditions upon which supply is furnished. These are similar to the rules usually drafted by engineers, and call for no special comment with the exception of the clause on insulation. This requires that a length of 12in. of rubber insulation must be capable of stretching to twice this length without breaking, and although kept stretched for 24 hours, must return to its original length within 15 per cent. after 24 hours' release. Also, the amount of ash left after burning a length of the rubber must not exceed 40 per cent. of the original weight of rubber.

Dublin Section of the Institution of Electrical Engineers.—No nominations for the committee 1902-3 have been received other than the members announced in our issue of the 28th ult, and these are duly elected. In the annual report of the work of the local section, it is stated that the committee has communicated with the Department of Agriculture for Ireland in reference to the utilisation of water power, asking that steps be considered for the collection of data as to the water power available during the different seasons of the year, and also of the sites for power not at present utilised. A sub-committee has been appointed to inquire into the suggestions in Mr. Ruddle's Paper on "Consumers' Installations."

The Marylebone Arbitration Proceedings.—The arbitration proceedings before Mr. C. A. Russell, K.C. (umpire), and Messrs. Robert Vigers and W. C. Ryde (arbitrators) were resumed on Monday, when the examination of Mr. John Conacher, manager of the Metropolitan Electric Supply Co., was continued. Mr. Conacher was followed on Wednesday by Mr. James Swinburne, whose examination was only partly completed. After Mr. Swinburne, Mr. R. R. Todd, chief engineer of the Metropolitan Company was examined, and he was still under examination on Wednesday when the inquiry was adjourned. The proceedings will be continued on June 19th and from day to day for about a week, when a further adjournment will be made.

A New York State Electrical Laboratory.—A commission has been appointed in the State of New York, to consider the necessity of a State electrical laboratory at Albany, N.Y., the persons authorised to deal with the matter being state engineer E. A. Bond, Mr. C. P. Steinmetz and Mr. Harold W. Buck. One of the objects of the proposed laboratory is to select an official electricity meter, which will form a standard for the use of municipalities and companies engaged in the supply of light and power. The law under which the commission has been formed enacts that detailed plans and specifications, together with estimates, for the establishment of the laboratory shall be submitted, if the necessity for the foundation of such an institution shall be proved.

Telegraphic Experiments in Germany.—The Berlin correspondent of *The Times*, writing under date 25th inst., states that experiments made last year at the General Telegraph Office, Berlin, with an octoplex system of typographic telegraphy have led to its being installed for communication between Hamburg and Frankfort. The apparatus is now being fitted up, and will shortly come into use. It is claimed that by this system 20 officials at the despatching and receiving stations can send 18,000 words per hour over a single wire. The despatcher resembles a Remington typewriter, and any letter can be despatched by the depression of a single key, and the receiving instrument, by printing the message direct, enables the official to forward the telegram as soon as it is completed.

Doncaster Corporation Electric Tramways.—The opening of these tramways will take place on Monday next, when five routes will start running, the aggregate length of these being 3 miles. The remaining routes, amounting to an additional 5 miles, will be completed during the summer; 6½ miles of the total 9 miles will be single track, the remainder being double line. The existing lighting station supplies current for the line through vulcanised bitumen cables laid in Sykes conduits between the rails. There are 15 cars of the double-deck pattern, equipped with two brakes, both hand and electric. The gauge is standard, the steepest gradient is 1 in 16, and the sharpest curve 50ft. The work of laying the track was commenced in August, 1901, since when very rapid progress has been made.

Rochdale Electric Tramways.—On Thursday last week the first section of these tramways was opened by the mayoress of the borough (Mrs. S. Turner). The entire system, when completed, will connect up Rochdale with Summit, Heywood, Norden, Royton and Healey. Current is supplied from the Corporation lighting station, a description of which appeared in *The Electrician*, Vol. XLV., p. 955. There are six cars of double and single-deck pattern, and the gauge of the track is 4ft. 8½in., while the usual series parallel control is adopted for the motors. Hand and electric brakes are fitted to the cars, and both span wire and side poles are employed for the suspension of the trolley wires. Lead-covered cables drawn into cast-iron pipes supply energy to the line from the power house. The length of the line just opened is about 1 mile.

The Institution of Electrical Engineers (Students' Section).—The honorary secretary's report of the work of the students' section for the session 1901–2 has just been issued, and we learn that 13 meetings of this section have been held during the session. The average attendance has been 83, and the discussions on the Papers were enthusiastically entered into by the students. Thirteen works and installations of special interest in the neighbourhood of London have been visited by parties of students on various Saturdays during the session. The Council sanctioned a proposal by the committee to visit Newcastle-on-Tyne during the Easter vacation, and 32 students took part in this. The party attended the meeting of the Newcastle Local Section on Monday, April 7th, and also visited Newcastle, Stockton-on-Tees, Sunderland and Jarrow.

Electricity in Manila.—The city of Manila has an electricity works which supplies both the public and private lights, of

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which a considerable number have been installed. Six tandem compound engines of 225 H.P. are belted to 12 Brush alternators and four arc lighting machines, these furnishing the necessary energy for the supply of the lamps. The advantages of electric lighting are greatly appreciated by the inhabitants, as by its aid work can be carried on during the dark hours, when the air is much cooler. An article in the *Western Electrician*, Chicago, describing the installation, also draws attention to the manner in which the natives attempt to copy the work of engineers. Illustrations were given of some of these attempts, which reflect great credit on the Filipinos, though in some cases they would bring disaster on the system of supply.

Electrical Treatment of Nævi.—Dr. Lewis Jones discussed the above subject recently in the *Clinical Journal*, and showed how such marks or eruptions could be removed by electricity. The actual destruction of the nævus was possible by electrolysis or galvano-cautery. In the former instance the caustic chemical substances, which are liberated and accumulate round the needles, devitalised the tissues. The circuit might be completed by means of a wetted pad or by needles inserted into the nævus, but the latter was found more suitable, as the patient was not subject to shock. As a nævus grows round its edge, the needles are preferably inserted at this margin, rather to the outside than the inside of the spot. The larger the nævus the greater the difficulty in treating it, and, once it is apparent that such a thing is growing, the sooner steps are taken to remove it the better.

Transvaal Patents and Trade Marks.—New patent and trade mark laws have been issued by the Administrator, and some important improvements have been promulgated. Under the Boers the renewal fees amounted to £475, but they are now reduced to £49. 10s. for the whole term of the patent (14 years) and may be paid by instalments. With regard to security on opposition, it was necessary under the old law to deposit £100 to secure costs of probable opposition, whereas now, the applicant or objector shall require that security to the satisfaction of the Commissioner may be lodged for the costs, failing which the case shall not be considered. Under trade marks applicants can now register an invented word or words, and a word or words having no reference to the character or quality of the goods. The Government duties being considerably reduced by the new laws there is every inducement for inventors to protect their industrial property in the Transvaal.

Obituary.—We notice with regret the death of Dr. Henry Morton, president of the Stevens Institute of Technology, New York. Dr. Morton had been connected with scientific research since 1857, and was greatly interested in engineering problems. He did much lecturing in the States, with a view to popularising scientific discovery, and as secretary of the Franklin Institute of Philadelphia, he delivered many lectures which attracted considerable attention. In 1870 he became president of the newly-founded Stevens Institute, and held the position till his death. He, however, lavished much of his income upon the institute, fitting up a new workshop and providing money for electrical apparatus. He gave £2,500 for the endowment of a chair of engineering practice in 1898, adding £5,000 more to this in 1892. He had contributed the whole of his salary, as professor of applied electricity, for many years to electrical experiments.

We regret also to announce the death on Saturday last of Capt. Abel H. Chapman, J.P. (late 19th Hussars), chairman of the board of directors of Messrs. Clarke, Chapman & Co. (Ltd.), Gateshead-on-Tyne, aged 66.

Fire at a Telephone Exchange.—As noted last week, a serious fire took place on the 20th inst. at the new South-side branch exchange of the National Telephone Co. at Glasgow. The switch room and test room were entirely gutted, and the outside wires considerably damaged. It is interesting to note with what extreme celerity the work of restoration and repair was carried out. Six new sections of switchboard arrived in Glasgow from the company's factory on the morning following the fire, and these were fitted up in temporary premises adjoining the old exchange. Although the cables and outside wires had to be completely renewed they were practically completed by Saturday, and even by midday on Friday 50 subscribers out of the 800 who had been connected to the new exchange had had the service restored to them. The remaining subscribers are now also reconnected to the exchange, and the service is proceeding as if no accident had taken place.

Fuel, Oil and Power Plants.—The above subject was dealt with recently in a Paper before the South-Western Electric and Street Railway Association, Texas, by Mr. W. W. Reed, and some valuable particulars are obtainable therefrom. In actual tests with boilers supplying engines for electric lighting, it was found that one boiler using oil would do easily what two boilers were required to do with coal. From trials extending over two months the number of kilowatt-hours produced from 1 ton of Montreal "mine run" coal, as compared with those produced from one barrel of Beaumont crude oil, showed that 1 ton of coal was equal to 3·6 barrels of oil. Various burners were also tested, and one form effected a saving of nearly 20 per cent. over others, this difference being due to a device whereby the oil and steam were intimately mixed. A uniform gas flame was obtained and the burner so proportioned that the flame completely filled the firebox. When the fuel oil from the Beaumont fields was first used for raising steam, it was predicted that the sulphur in the oil would in a short time injure the tubes and sheets of the boilers, but tests extending over 10 months had not been accompanied by any injurious effects. In the plant under consideration the saving by the use of oil amounted to 63 per cent., and there being neither smoke nor soot the boiler tubes remained cleaner, and thus allowed more heat to be taken up by the water.

The Melting Point of Manganese.—The melting point of a sample of manganese, prepared by Goldschmidt, of Essen, has recently been determined by Heraeus, of the well-known Hanau firm, in one of this firm's newly-devised electric resistance furnaces. The apparatus used consisted of a porcelain tube 16mm. in diameter and 30cm. in length. A portion of this tube was enclosed in a spiral strip of platinum foil, and the latter was connected, through a resistance box, with the electric current leads of the laboratory. A temperature of 1,400°C. could be reached in three minutes with this tube furnace, and, by gradual diminution of the resistance inserted in the circuit, a steady and slow rise of temperature, suitable for melting point determinations, could be attained. The maximum temperature obtainable with this type of furnace was 1,600°C. The manganese was placed in the centre of the heated portion of the porcelain tube in the form of a small pea, and, a Chatelier thermo couple having been inserted to record the temperature, the current was increased at short intervals of time, and the behaviour of the metal was watched through a small telescope placed in line with the axis of the porcelain tube. As manganese is very active at high temperatures, it was necessary to carry out the test in an atmosphere of hydrogen. A small boat of pure alumina was used to hold the manganese. Silicates proved themselves unsuitable owing to the reduction of SiO_2 to Si. The mean of six tests carried out under these conditions gave the value of 1,245°C. This is lower than the melting point usually given for this metal, and it is probable that the later observation is the more reliable. Further details of this laboratory research will be found in the *Zeitschrift für Elektrochemie* for April 3rd.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 30th.

ROYAL INSTITUTION.

9 p.m. Altered arrangements. Evening Discourse by Prof. J. A. Fleming on "The Electronic Theory."

MONDAY, June 2nd.

INSTITUTION OF JUNIOR ENGINEERS.

7 p.m. Visit to the New Signal Cabin of the South-Eastern and Chatham Railway Co. at Charing Cross.

THURSDAY, June 5th.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting at Burlington House.

RÖNTGEN SOCIETY.

8:30 p.m. Ordinary General Meeting at 20, Hanover-square, W., when the President, Mr. Herbert Jackson, will read a Paper on "The Sources of Phosphorescence."

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Vacuum Tube Apparatus.—The growing importance of vacuum phenomena in electrical science makes their study even in elementary classes a desirable thing. Such study is, however, often hindered by the costliness and variety of the apparatus required. W. B. von Czudnochowsky has, therefore, devised a universal apparatus consisting of a number of interchangeable parts, which may be made to answer most purposes of illustration and research. The main body is a vacuum bulb with four tubes attached, the whole forming a cross. One of the tubes contains the anode, and the opposite one is the tube to be connected to the mercury pump. The two remaining tubes have wide mouths, and are intended for the reception of different cathodes and anti-cathodes, including plane and concave plates, hollow cathodes, after Goldstein, and wire cathodes. The anti-cathode is either a flat table on which various substances can be mounted for exposure to cathode rays, or a slanting platinum plate for producing Röntgen rays. Among the phenomena exhibited are the stratified discharge, luminescence and colouring under the influence of cathode rays, and the deflection and reflection of cathode rays. The exhaustion of the tube only requires some 20 minutes with a good mercury pump, as found nowadays in most physical laboratories.

[W. B. von Czudnochowsky, *Ann. der Physik*, May 15, 1902.]

Observation of Auroras.—When delicate instruments are employed for the detection of auroras, it is found that they are of much more frequent occurrence than is usually supposed. E. Wiechert has, therefore, constructed a special spectroscope of large aperture and power sufficient to separate the two D lines. Observations were made at the new geophysical observatory near Göttingen, where the elevated position and distance from towns offers a fairly clear sky. On the evenings of November 1st to 9th the auroral line was distinctly seen in the northern sky, and the author was led to believe that it is always present, but observations on clear December nights showed that it could be entirely absent. On January 31st, even the more sensitive Rutherford prism failed to detect the slightest indication of an aurora. On February 28th and March 3rd the line was seen all over the sky, and most brightly in the eastern portion of it. On the latter date, the sky was sometimes overcast, with the exception of small gaps between the clouds, and through these gaps the auroral line was distinctly observed. In all these cases, nothing was to be seen by the naked eye except a faint general luminosity of the sky, not half as bright as that of the Milky Way. If the phenomena happen at a height of not less than 80 miles, they should be discernible by the same method as far as the south of Italy.

[E. Wiechert, *Physikal Zeitschr.*, May 15, 1902.]

Conductivity of Insulating Liquids.—G. di Ciommo has studied the effect of mixing two insulating liquids upon their electric conductivity. In the case of liquids of very high resistance the author connected one of the electrodes of the resistance vessel with a battery of 100 Daniells, and the other with the needle of an electrometer. The resulting conductivity was calculated from the charge dissipated from the needle. Benzol, toluol, hexane and ethane, were examined in this manner. More conducting liquids, like carbon bisulphide and chloroform, were studied by finding the loss of charge undergone in a given time by a condenser having the liquid for a dielectric. Two liquids were then mixed in a certain proportion, and the resulting conductivity was calculated on the supposition that the conductivities would be in proportion to the constituents. But this was found not to be the case. When the liquids had separate conductivities of nearly the same amount, the resultant conductivity was found to be higher than anticipated, and the difference was greatest when equal proportions were mixed. When the two original conductivities differed widely, the usual process was that the difference between calculated and observed values began at zero, increased with further solution to a maximum, passed through zero, went down to a minimum, and tended again towards zero as the other pure liquid was approached. The results show that ionisations cannot be simply added as they can in extremely dilute solutions of electrolytes, and that the mixture of two dielectric liquids interferes with the normal behaviour of the ions of each separate liquid.

[G. di Ciommo, *Physikal Zeitschr.*, May 15, 1902.]

Reflection of Cathode Rays.—When a pencil of cathode rays impinges upon a surface, some of the electrons penetrate into the surface and are absorbed. The number thus absorbed can be determined by measuring the charge communicated to the surface. The remainder are reflected, with the exception of a possible transmitted portion. The portion reflected may either have been turned back at the first encounter with the surface, or the particles may have penetrated some distance into the surface, having been deflected by central forces, and threaded their way out again. Both these reflected portions depend upon the angle of incidence, and the manner in which they depend upon it has been recently studied by J. Stark. The relation varies from metal to metal, as might have been expected, since some metals, like aluminium, absorb the electrons more easily on account of their large atomic volume. The reflected intensity of the first order increases with the angle of incidence, slowly at first, and then more rapidly, as the interstices between the atoms of the surface diminish in apparent size. This increase is greater for the slightly-diffusing elements like aluminium than for the highly-diffusing elements like platinum. The same applies to the reflected intensity of the second order, but for a different reason. The additional increase of reflective power by polishing also increases with the angle of incidence. As regards the influence of the potential gradient—*i.e.*, the velocity of the impinging electrons—the effect of a high velocity is to make them penetrate more deeply into the surface, and thus to increase their chances of absorption and to diminish the deflection. The reflected particles are also more nearly confined to paths indicated by geometrical reflection. Hence the reflected intensity diminishes with the speed, and the more, the greater the angle of incidence.

[J. Stark, *Physikal Zeitschr.*, May 15, 1902.]

Ions from Hot Wires.—The curious fact that a hot wire is more rapidly discharged when positive than when negatively charged, has led C. D. Child to a study of the velocity of positive and negative ions as discharged by a platinum wire. He found that the positive discharge commenced a little below the temperature of red heat, increased at first rapidly as the temperature rose, remained nearly constant through a wide range of temperature, and then began to decrease. The negative charge, on the other hand, did not set in until the temperature at which the positive discharge began to decrease, and it never became as large as the positive. The wires were stretched along the axis of a cylinder, and it was found that both the positive and the negative discharge increased rapidly as the difference of potential between the wire and the cylinder was increased. Four different methods were used for comparing the velocities of the positive and negative ions. One of them showed the average velocity of the positive ions to be greater. Another showed the maximum velocity of the positive ions to be greater. A third method showed that, at low temperatures at all events, the slowest positive ion has a much greater velocity than the slowest negative ion, while at higher temperatures the result is doubtful. It was also found that at a certain temperature ionisation is produced in the gas about the wire to greater than molecular distances. This is nearly the critical temperature at which the negative ions appear. The experiments also show that particles are present in the tube which load the ions, and thus greatly diminish their velocity.

[C. D. Child. *Phys. Review*, April, 1902.

Optical Properties of Asphalt.—When a thin layer of asphalt varnish is spread upon glass and allowed to dry, and some luminous source, such as the filament of an incandescent lamp, is observed through the film, it is found that a considerable amount of red light is transmitted, the unusual purity of which is readily ascertained by means of a spectroscope. E. L. Nichols remarks that the suddenness with which the

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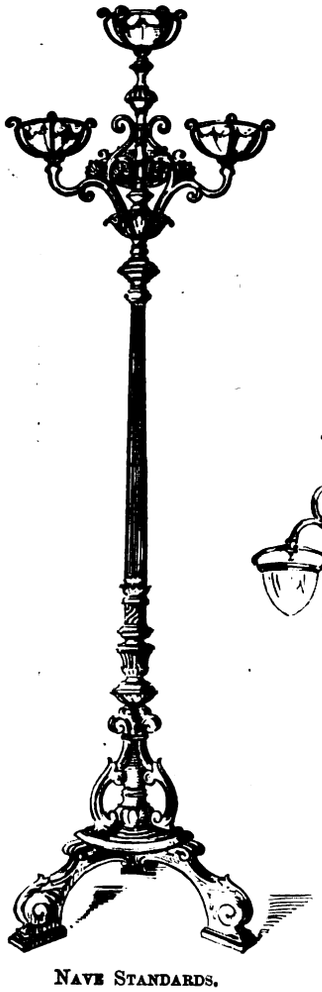
rays beyond the red are cut off indicates the existence of a well-defined absorption band with a very steep gradient on the side towards the greater wave-lengths. He obtained films of the requisite thickness by dipping a piece of thin plate glass into asphaltum varnish, and allowing the coating to dry. He found that anomalous dispersion begins to manifest itself between the yellow and green. In the infra-red there was a maximum transmission at 2,000$\mu\mu$, and a much steeper gradient up to that maximum than in the case of lamp-black. There is much about the optical behaviour of asphalt to suggest that its colour may be due to the presence of carbon particles dissolved, or perhaps suspended, in some other medium. If a wire ring be dipped into the varnish and withdrawn, it carries with it a flat film of liquid, which is very similar to a soap film in appearance. The colouring matter in this film is not uniformly distributed, as in a solution, but tends to gather into streaks and patches as if by capillary attraction. Upon drying it leaves behind a nearly colourless sheet of resinous material.

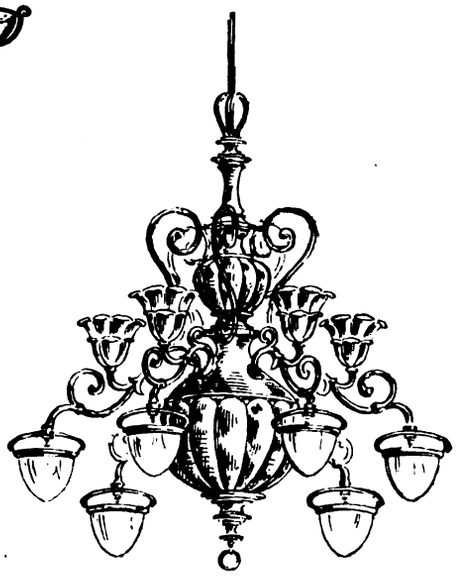
[E. L. NICHOLS, *Phys. Review*, April, 1902.]

THE ELECTRIC LIGHTING OF ST. PAUL'S.

The lighting by electricity of St. Paul's Cathedral, which has been in progress for almost three years, has now reached a stage of partial completion, and the lights in the chancel, dome, nave and crypts were first made use of last Whitsuntide. The wiring of so large a building has naturally presented many difficulties, as the runs have been of considerable length, and much care in piercing thick stone walls and floors, now two hundred years old, has been necessary.



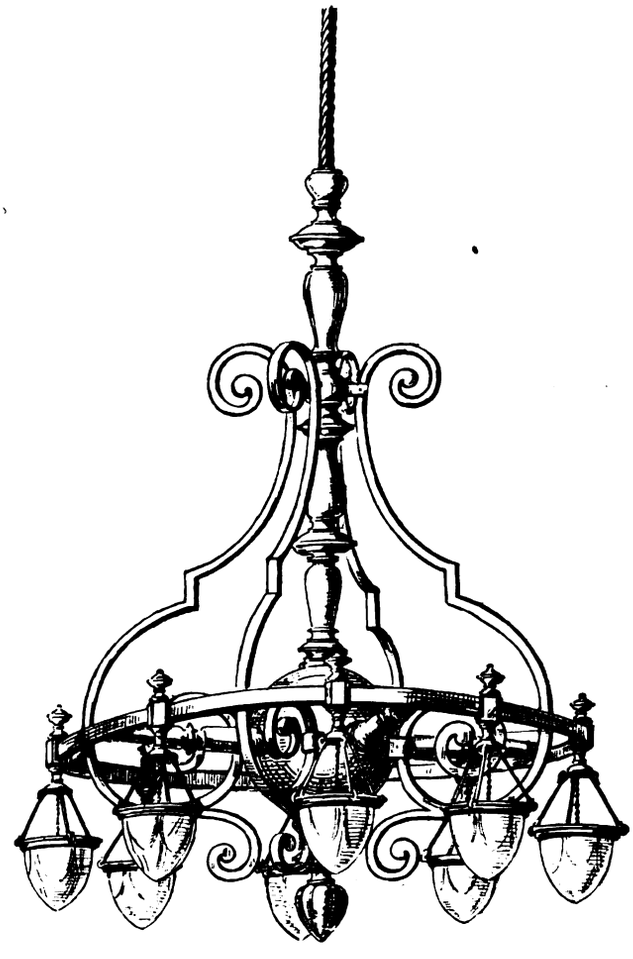
NAVE STANDARDS.



CHANCEL PENDANTS.

The wires have been run in iron barrel, and the lateral distribution is mostly hidden beneath the floor of the crypt, where inspection boxes are placed at frequent angles and intervals. The number of these boxes have been considerably increased by reason of the network of tombs and vaults which had to be avoided. The vertical cables have, where possible, been carried in the hollow centres of the main piers.

The distributing board system of wiring has been employed, on the two-wire system, and current is taken from both the City and the Charing Cross Companies' mains, to provide against all possibilities of extinction in case of failure on the network of either of the companies. Duplicate circuits have been laid throughout the building, so that alternate groups of lamps are fed by the two companies. Two main switchboards controlling the distributing circuits are placed in a fireproof recess off the staircase leading to the Whispering Gallery, and from these sub-mains are carried to various points, the most important of which is in the crypt, where a large board for controlling the chancel lighting is fixed. Smaller distributing boards



PENDANTS UNDER DOME

are fixed in other parts of the crypt and at the head of the Whispering Gallery staircase. The pressure adopted is 200 volts, and very large cables have been used to compensate for the long runs, the current density allowed for being 250 amperes per square inch. The iron barrel is not insulated in any way, the rubber covering of the wires and an additional layer of tape being relied upon.

The fittings in the choir consist of six large pendants (designed by Mr. Somers Clarke, F.S.A., consulting architect to the cathedral) of cast and gilded brass hanging from the vault, the cable which supplies the lamps being used for suspending the fittings. A layer of steel wire armouring around the cables actually supports the fittings, which weigh over 5 cwt. In addition to lighting the floor of the chancel, these fittings also throw a quantity of light on to the mosaics of the vault, by means of upturned lights concealed in cup-like reflectors. Under the dome there are eight heavy bronze pendants supported in a similar manner, and two similar fittings in the transepts. Three-light brackets are fixed on the chancel screens, and in

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the apse is a 10-light fitting, which also illuminates Jesus Chapel. The choir desks are lighted by means of small bracket lights fixed directly to the desks and arranged to throw a light on the music without casting any upward beams. Two lights are placed in each bracket, and on account of their size it has been necessary to arrange them four in series, no two of a group being in a single fitting.

In the nave the original gas and candle standards have been converted to electric lights, and a similar adaptation has been made in the crypt with the handsome old gas fittings in the shape of hanging Roman lamps. The tall standards in the nave and at the west entrance were designed by Mr. Penrose and Mr. Pegram respectively.

All the fittings in the chancel, dome and nave are provided with a special form of moulded glass globe, which is the result of many experiments, and which has been found to act as an excellent dispersant of light. Some original tests with plain lamps and the globes showed that the use of the latter enabled a reduction of about 200 c.p. in the nave to be made for the same illumination. The lamps range from 32 c.p. to 5 c.p., the former being chiefly used in the main fittings.

The choir aisles, entrances, Consistory Court, Whispering Gallery and other points in the Cathedral have still to be lighted or provided with permanent fittings. Several of the large pendants in the dome and transepts have their places filled by temporary structures of wood and iron, these, together with the work of piercing the stone walls, having been carried out by the Cathedral staff of workmen. The wiring has been in the hands of Messrs. W. A. S. Benson & Co., who have carried out all the experiments with fittings, globes, &c., and have been working under the superintendence of Mr. Somers Clarke, F.S.A., the consulting architect to the Cathedral, and Prof. A. B. W. Kennedy, consulting engineer. Mr. C. J. Scott has had personal charge of the entire installation since its inception.

The cost of the installation, which has reached £10,000 at present, will be met by Mr. Pierpont Morgan, who generously made the gift to the Dean and Chapter.

WOLVERHAMPTON CORPORATION ELECTRICITY WORKS.

In our last issue we described in considerable detail the surface contact system of tramways which has been put down at Wolverhampton, and we propose in this article to give a sketch of the recent alterations that have been made in the electricity works to meet the new condition of affairs.* It may be mentioned, however, that it is not the tramways alone that have necessitated the change; with the development and extension of the electric lighting system it was realised that the original "Oxford" system was no longer the most suitable, and it has gradually been changed to the ordinary three-wire system at 2 × 220 volts, with the exception of one out-lying sub-station, which is still fed at 2,000 volts continuous current from the old plant.

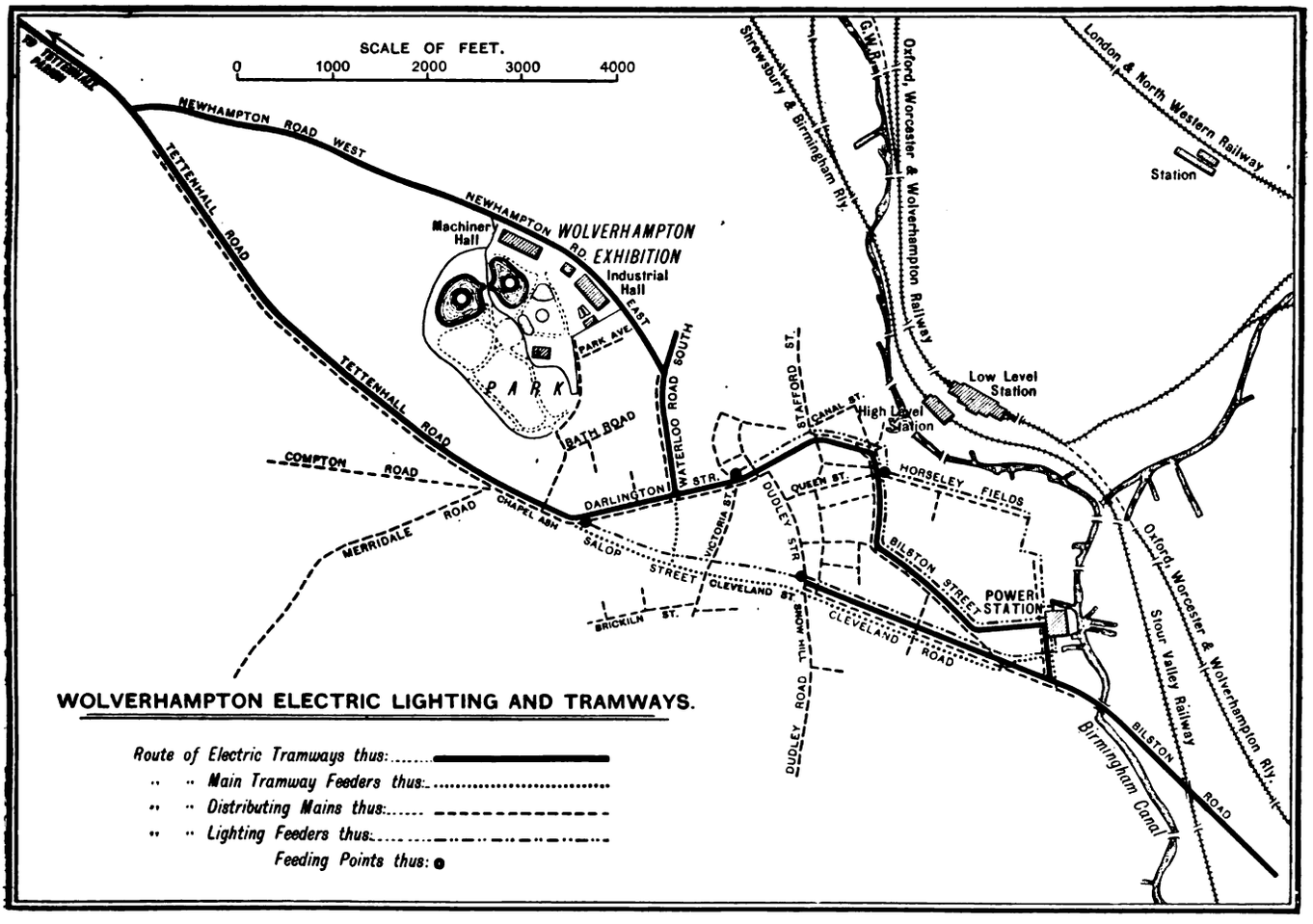

FIG. 1.—MAP SHOWING ROUTES OF TRAMWAYS AND FEEDERS, &C.

As has already been stated in our article last week, the tramway network is fed in much the same way as the usual overhead trolley system. The section feeder pillars, however, are placed at more frequent intervals than is customary, there being about eight to the mile. Fig. 2 shows the connections

* A description of the original station appeared in *The Electrician*, Vol. XXXVII., p. 201.

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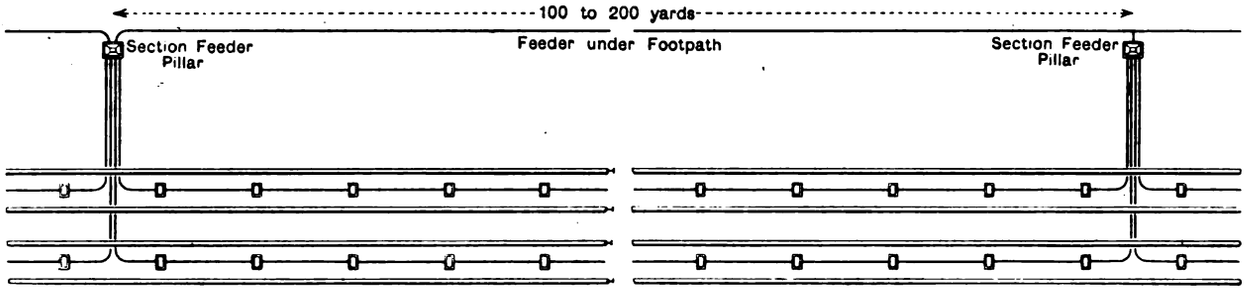
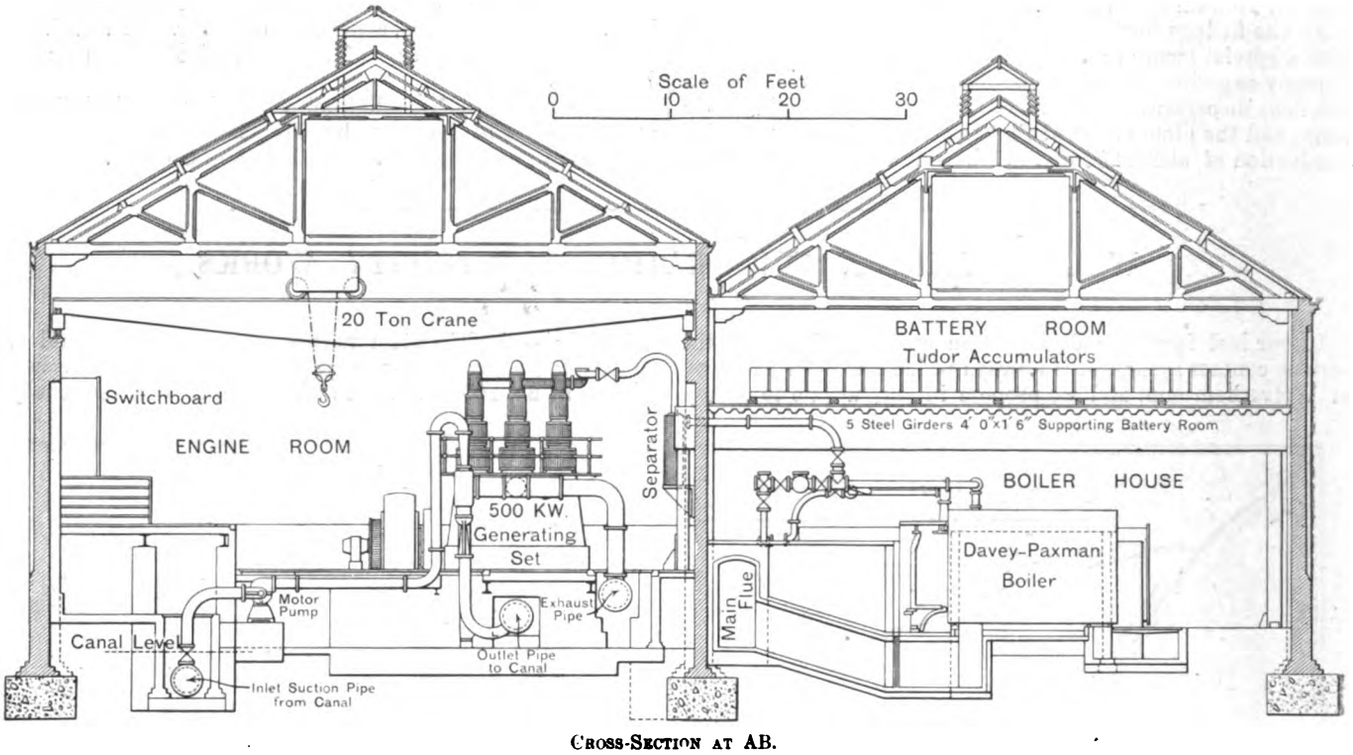


FIG. 2.—DIAGRAM OF CONNECTIONS ON TRAMWAY BETWEEN CONTACT BOXES AND FEEDER.



CROSS-SECTION AT AB.

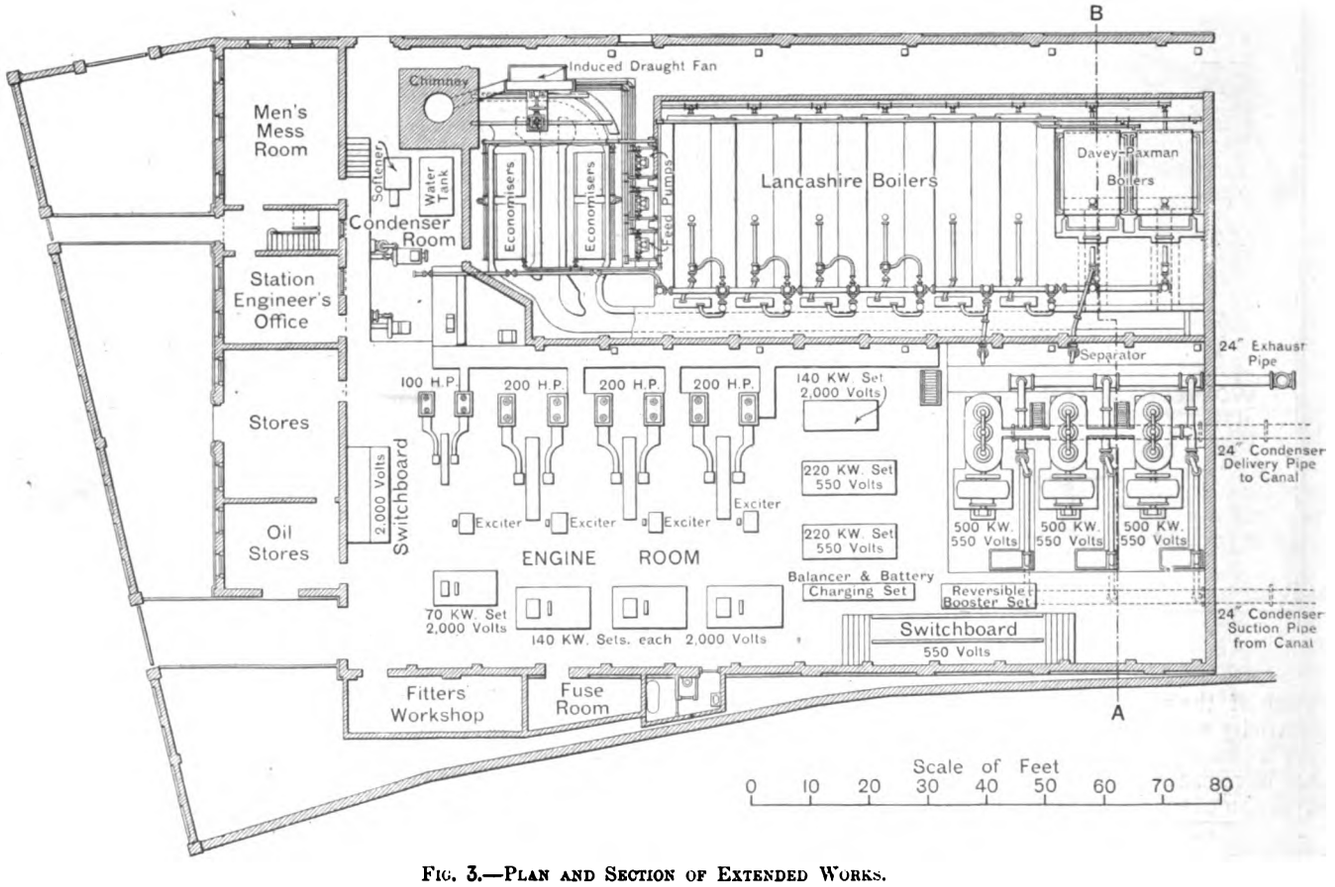


FIG. 3.—PLAN AND SECTION OF EXTENDED WORKS.

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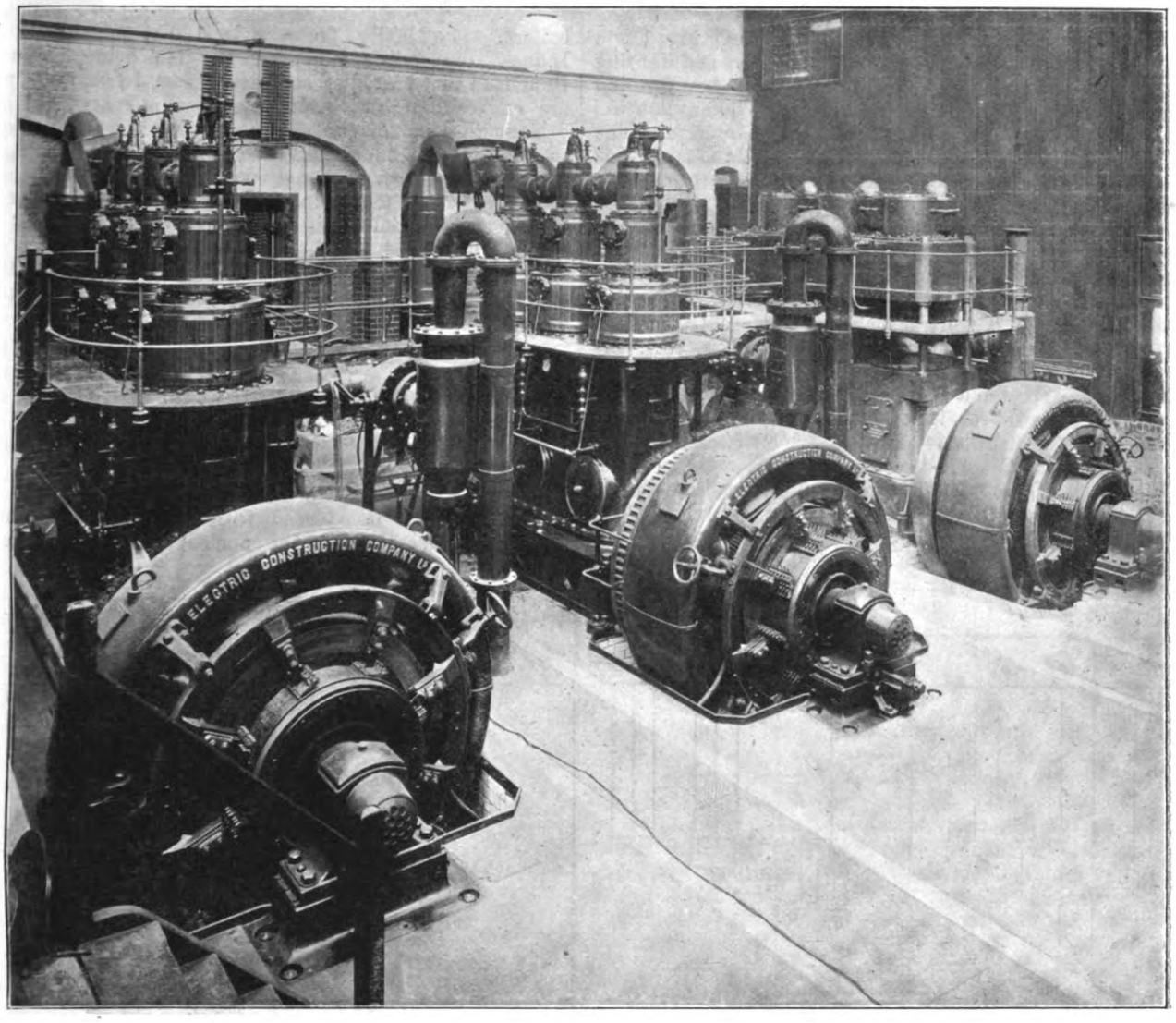

FIG. 4.—VIEW OF NEW GENERATING PLANT.

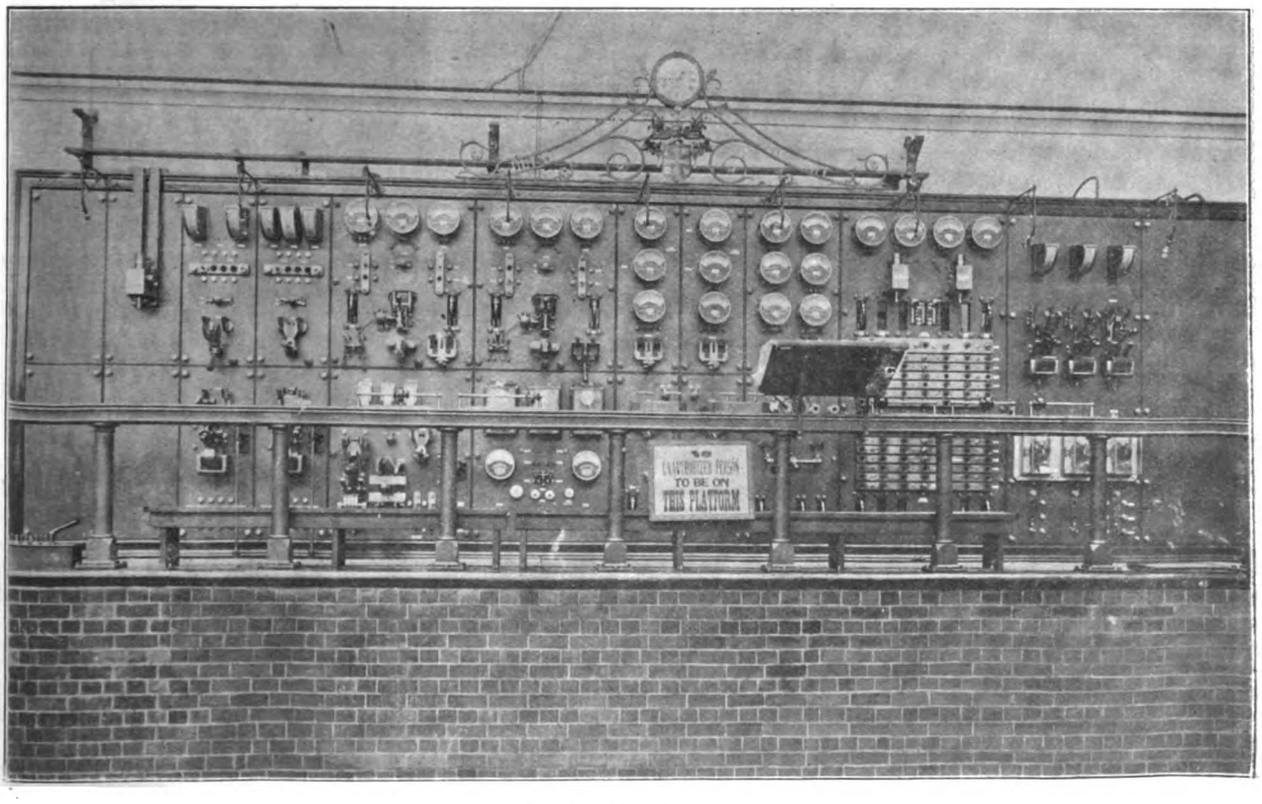

FIG. 5.—THE NEW SWITCHBOARD.

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of the tramway feeders and contact blocks, and Fig. 1 is a map showing the routes of the existing tramways and lighting cables. There are now two two-wire lighting feeders running to the outers and two three-wire feeders. The arc lighting mains are omitted from the map to avoid confusion. The arcs are fed from the old 2,000-volt continuous-current machines in series circuits of 34 each, which are supplied at 1,800 volts.

The new generators at the works, from which practically the whole of the supply for lighting and traction is given, are shunt-wound machines which are simply speeded up when they are required for the traction load. A view of them is given in Fig. 4, Fig. 3 being a plan and section of the entire works. These three machines are each 500kw. sets, the dynamos being made by the Electric Construction Co. Two have Willans engines and the third a Peache engine. For the traction load they will furnish each 1,000 amperes at 550 volts.

A large battery of cells is provided, which is charged and discharged by the aid of a reversible booster. The latter machine is not of the Highfield pattern, but was built up of spare machines resulting from the re-organisation of the works. Fig. 6 is a diagram of its connections. The cells are of the Tudor make, each consisting of 13 plates, but these are contained in boxes large enough to hold 21 plates.

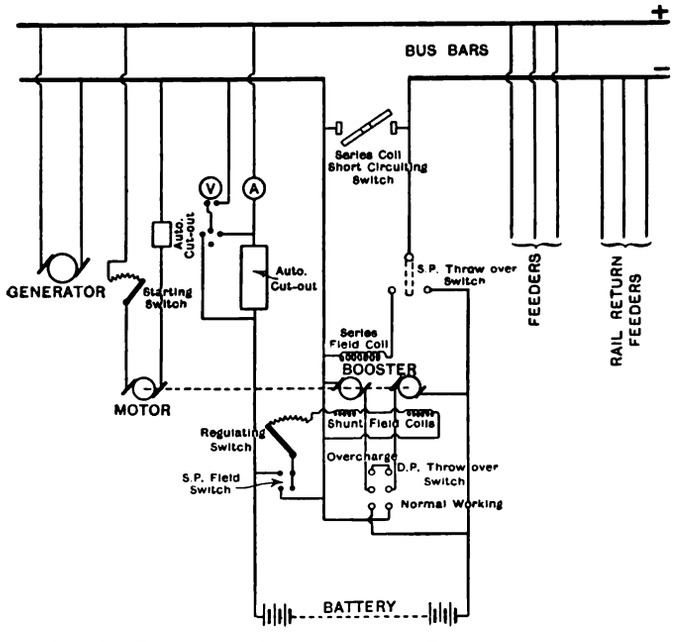

FIG. 6.—DIAGRAM OF CONNECTIONS FOR REVERSIBLE BOOSTER.

The motor and booster are direct-coupled. The booster armature, shown in two parts, is a single armature, wound with two exactly similar windings.

Their present capacity is 700 ampere-hours. Regulating cells have to be employed for the lighting load, however, and as the accumulator room is on the opposite side of the engine room to the switchboard, motors are employed to drive the regulating switch, the latter being placed on the wall of the engine room backing the accumulator room. On the balustrade in front of the switchboard gallery there are motor switches, and a large arrow on the regulating switch can be seen from the switchboard, so that the position of the regulating switch is indicated to the switchboard attendant. As seen in Fig. 5, the switchboard is on a low gallery. It is at the bottom end of the engine room facing the three new sets. The old board was at the other end of the engine room, and is no longer being used, the new one (made by Messrs. T. Parker, Ltd.) having been put in at the same time as the new direct-coupled sets. Two Belliss-Parker direct-coupled 220kw. sets put in more recently than the old rope-driven plant are also in use, supplying current at 500 volts.

The boiler plant has also been considerably extended, and now includes altogether six Thompson Lancashire boilers (30ft. by 8ft.) and two Davey-Paxman "Economic" (14ft. 6in. by 9ft. 9in), all being hand-fired. These are all fitted with Musgrave superheaters built in at the back of the boilers. The boiler pressure is 180lb. per square inch. Induced draught is employed, the fan being driven by a Bumstead and Chandler engine. Steam-driven Weir pumps are employed for feed purposes, and a centrifugal motor-driven pump for the condensers. There is a separate ejector condenser to each engine (both Ledward and Körting condensers are in use), and canal water is employed for condensing purposes, town water being made use of for the boiler feed The latter is passed through a Stanhope softening plant as the water is very hard, and fed through an economiser.

In concluding this article, we desire to express our thanks to Mr. C. E. C. Shawfield for showing us over the works, and assisting us with drawings and other imformation.

STATUE OF DR. WILLIAM GILBERT.

On Thursday, May 15th, the new Town Hall at Colchester was formally opened by Lord Rosebery, amidst civic rejoicings appropriate to the occasion. The façade of the new Town Hall is adorned with six statues of historical persons connected with the ancient borough, the cost of each statue having been defrayed by private subscription. Amongst them is an admirable effigy of the immortal author of the "De Magnete," Dr. William Gilbert, or Gilberd, physician to Queen Elizabeth, who died in 1603. By the courtesy of Ald. W. Gurney Benham, proprietor of the *Essex County Standard*, we are able to give an illustration of the statue. It was sculptured by Messrs. Fabbrucci and Aristide, and its cost was defrayed by gentlemen of the medical profession in Colchester. An oil painting of Dr. Gilbert is also hung in the Mayor's parlour of the Town Hall, while in the muniment room are displayed copies of the Latin folio edition of 1600 of "De Magnete," of Gilbert's posthumous "Nova Philosophia," of the Gilbert Club English version of "De Magnete," and a photograph of the recently-discovered autograph signature of Dr. Gilbert.

STATUE OF DR. GILBERT AT COLCHESTER.

Acquisition of Electric Railway Equipment.—An agreement has been entered into between the Westinghouse Electric and Mfg. Co. and the Lorain Steel Co., whereby the former company acquires the electric railway equipment business of the Lorain Company, and continues to maintain its works devoted to the manufacture of such apparatus.

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THE BALLISTIC MEASUREMENT OF HYSTERESIS.

BY G. F. C. SEARLE, M.A.

(*Concluded from page 103.*)

§10. I will now give the theory of the method I have employed to vary dC/dt in a known manner. Let the poles of a battery of voltage E be joined to the points F, G (Fig. 2), and let the resistance between F and G through the battery be T. Let F and G be also connected through the primary magnetising coil, the fixed coils of the dynamometer, and a choking coil, the resistance between F and G through this part being R. Let the steady current, when F and G are not in contact, be C_0.

Now let F and G be put into contact. The current then satisfies

$$K dC/dt + RC = 0, \quad . \quad . \quad . \quad . \quad . \quad (22)$$

where K depends upon C, since it involves the value of dB/dH for the core of the choking coil. After the current has sunk from C_0 to an infinitesimal value, let F and G be separated again, but before the separation let the battery connections be changed so that E is reversed. The current now satisfies

$$K dC/dt + (R+T)C = -E = -(R+T)C_0. \quad . \quad (23)$$

The current now gradually attains the value $-C_0$. The whole process is practically complete in a fraction of the time of vibration of the dynamometer coil.

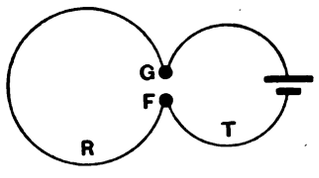

FIG. 2.

Suppose, now, that E, R and T are each increased k-fold. Then C_0 remains unchanged, but for any given value of C, during the whole time of variation, dC/dt is increased k-fold, as appears from (22) and (23). Thus, if the ratio R/T be kept constant as well as C_0, the maximum current, dC/dt, for any value of C is proportional to E. Hence, we may write

$$Z = m\left(\frac{Q}{p\sigma} + \frac{n^2}{Sl}\right)E, \quad . \quad . \quad . \quad . \quad . \quad (24)$$

where m is independent of E. Thus,

$$X = mE \cdot \frac{Q}{p\sigma}, \quad Y = mE \cdot \frac{n^2}{Sl}. \quad . \quad . \quad . \quad . \quad (25)$$

§ 11. The result (24) leads at once to the method of finding Z. For, if U, Z correspond to E, and U', Z' to E', then by (17) $U' - U = Z' - Z$, since W remains unaltered, *unless the hysteresis depends upon the speed at which the magnetic changes occur.* But $Z/E = Z'/E'$, and hence

$$Z = (U' - U)\frac{E}{E' - E}. \quad . \quad . \quad . \quad . \quad . \quad (26)$$

Thus, from the two values of U found in two experiments with two values of E, the values of Z and Z' can be determined. The simplest plan is to make $E' = 2E$; we then have $Z = U' - U$.

§ 12. Since Y, the heat produced in the secondary per cubic centimetre of the specimen, is, by (25), inversely proportional to S, we can determine Y by varying S, while E is kept constant. For if U, Y correspond to S, and U', Y' to S', then, since W and X are unaffected by the change in S, we have, by (17), $U - U' = Y - Y'$. But $SY = S'Y'$, and hence

$$Y = (U - U')\frac{S'}{S' - S}. \quad . \quad . \quad . \quad . \quad . \quad (27)$$

Thus from the two values of U found in two experiments with two values of S, the values of Y and Y' can be determined.

In this determination it is not necessary to find the throw due to the earth-inductor for each value of S. If there were no damping we should have $\phi' = S\phi/S'$. But the logarithmic decrement depends upon S and also upon C' being of the form $\lambda = a + bC'/S$, and hence each throw must be corrected for damping, if great accuracy be required. The easiest way of making the correction is to add to each throw a quarter of the difference between it and the next elongation on the same side when the dynamometer coil is allowed to continue in vibration.

Since $Z/Y = 1 + SlQ/n^2p\sigma$ it would appear to be possible to calculate Z from the value of Y found by the method just described. But in practice this cannot be done, for when a proper choking coil and reversing key are used Y is absolutely inappreciable, in comparison with U, unless the cross-section A is less than 1 sq. mm. It does not, however, follow that Z is inappreciable, since Z/Y may amount to several hundred.

But the fact that Y is inappreciable is important for the reason that—when corrections are made for damping—U is, in consequence, independent of S. We are thus able to trace the progress of W, as B_0 increases from very small to large values, by the simple plan of increasing the resistance S of the secondary, without the necessity of varying the number of secondary windings. An example is furnished by Mr. Wills' results given below in § 20.

§ 13. The value of Q for a circle is easily found. For, if u be the current density at a point at a distance r from the axis of a cylindrical rod of radius a, we have, to the approximation specified in § 8, $2\pi ru\sigma = \pi r^2 dB/dt$, so that $u = \frac{1}{2}\sigma^{-1} r dB/dt$. The rate at which heat is produced per unit volume is $u^2\sigma$, and thus the rate per unit length of rod is

$$\pi a^2 \frac{dX}{dt} = \int_0^a u^2\sigma \cdot 2\pi r dr = \frac{\pi a^4}{8\sigma}\left(\frac{dB}{dt}\right)^2. \quad . \quad . \quad . \quad (28)$$

But $\pi a^2 = A$ and hence, comparing (28) with (15) we find

$$Q = \frac{1}{8\pi} = 0{\cdot}03979.*$$

In the case of strip of transformer sheet of width a and relatively small thickness b, an approximate solution may be obtained by supposing the eddy currents to flow parallel to the longer sides of the section. If y be the distance of a point from the line through the centre parallel to the longer sides, then $2au\sigma = 2ay dB/dt$ and

$$ab\frac{dX}{dt} = \int_{-b/2}^{b/2} u^2\sigma \cdot a dy = \frac{ab^3}{12\sigma}\left(\frac{dB}{dt}\right)^2. \quad . \quad . \quad (29)$$

But $ab = A$ and thus, comparing (29) with (15), we find

$$Q = \frac{b}{12a}.$$

The complete solution, by Fourier's methods, is given in the *Phil. Trans.* Paper for a rectangle of any form. The result is

$$Q = \frac{b}{12a} - \frac{16b^2}{\pi^5 a^2}\sum \frac{\tanh[(2n+1)\pi a/2b]}{(2n+1)^5},$$

where n ranges from 1 to infinity. As a/b increases, this expression very rapidly tends to the form

$$Q = \frac{b}{12a} - 0{\cdot}05255\frac{b^2}{a^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)$$

the error not exceeding 1 in 4,000 even when a/b is as small as 2.†

---

* In § 8, for $\frac{1}{8}\pi$ read $\frac{1}{8\pi}$.

† The value of $\frac{b}{12a}$ is a *superior* limit for Q for a rectangle. The assumed distribution of eddy currents could be secured by fitting perfectly conducting plates to the narrow edges of the strip.

The eddy currents can be made to flow in any *arbitrary* paths by slitting the rod along those paths, and the value of Q for the rod so slit is an *inferior* limit to the value of Q for the rod in its natural state. This is practically what is done in the calculation sometimes made by electrical engineers, in which the lines of flow of the eddy currents are taken to be rectangles similar to the rectangular boundary of the section of the rod. The value of Q obtained in this way is $\frac{1}{16}\frac{ab}{a^2+b^2}$, which tends to the value $\frac{b}{16a}$ when b/a is small.

An exact solution for a rod of elliptical section is easily obtained, and gives $Q = \frac{1}{4\pi}\frac{ab}{a^2+b^2}$, where $2a$, $2b$ are the axes of the section. In this case the lines of flow of the eddy currents actually are ellipses similar to the elliptical boundary of the section of the rod.

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§ 14. The main points in the theory of the ballistic method of measuring hysteresis have now been given, and I may, therefore, pass to a description of the apparatus required in the application of the method to practical measurements.

§ 15. For the measurement of the primary current any good ampere-meter—we used Weston's—may be employed. A Weston millivolt meter, in conjunction with a suitable low resistance, is more convenient, as by suitable resistances its range is capable of very great variations. Since either of Weston's instruments reads in one direction only, it must be placed between the battery and the reversing key.

The earth-inductor used by Mr. Bedford and myself, to produce the known change (P) of induction, is a simple coil of 100 turns, having a mean radius of about 18cm.; we found $P = 8{\cdot}72 \times 10^4$ C.G.S. units. We prepared a non-inductive resistance coil of *copper* wire with resistance equal to that of the earth-inductor; since both coils are of copper their temperature coefficients are equal. By substituting this coil for the earth-inductor, during the observations of the throws due to hysteresis, we were able to get rid of the self-induction of the earth-inductor and at the same time to keep the resistance of the secondary circuit unchanged.

When the specimen is a ring, the primary magnetising coil and the secondary coil will probably be wound on it without bobbins of any sort. But, when a long straight specimen is to be tested, these coils are conveniently wound upon tubes. But neither coil should be wound upon a *metal* tube, since the currents induced in the tube lead to very large errors, as I found in some of my early experiments. The secondary coil should not be heaped up near one spot, but should be wound fairly uniformly over the specimen when the latter is a ring. An electrical engineer would probably use a moving coil galvanometer for measuring the changes of induction in the specimen. We used an astatic vertical-needle galvanometer, the magnetic system being suspended and controlled by a phosphor-bronze wire.

§ 16. The electro-dynamometer employed by us has a pair of fixed coils, each formed of 250 turns of No. 20 B.W.G. cotton-covered wire wound on ebonite bobbins. The mean radius of each coil is about 5cm. and the resistance of the two in series about 4 ohms. To avoid induced currents there were no large pieces of metal near the coils, the frame of the instrument being of mahogany. In the central space within the fixed coils hangs the suspended coil, consisting of 190 turns of No. 40 B.W.G. silk-covered wire, no bobbin being used; the mean radius of the coil is 1·7cm. and its resistance 28 ohms, while the mass of the coil alone is about 7 grammes. The coil is attached, along a diameter, to a stiff brass wire, whose upper end carries a mirror. The suspended system is carried by a phosphor-bronze wire $\frac{1}{1000}$in. in diameter and about 4cm. long, soldered to the upper end of the brass wire. The bronze wire was supplied by Messrs. Johnson and Matthey. The electrical connexion is completed by a second piece of the same bronze wire about 6cm. long, soldered to the lower end of the brass wire, and allowed to be *quite slack*. The time of vibration of the coil, so suspended, is about 9·5 seconds.

To avoid the action of the earth's magnetic force on the suspended coil, the axis of the fixed coils should be at right angles to the magnetic meridian.

A little care is required in soldering the very thin phosphor-bronze wire to its attachments. If the soldering bit comes into contact with the bronze, the solder easily alloys with the bronze to such an extent that the bronze wire becomes very weak. Mr. W. G. Pye showed us how to make a strong joint. The brass wire, to which the fine bronze wire is to be soldered, has a fine hole drilled along its axis; this hole is filled with solder, which is kept melted by applying the soldering bit to the side of the brass wire. The end of the bronze wire is then inserted into the melted solder, and the soldering bit is at once removed. The result is a very satisfactory joint, capable of withstanding quite rough treatment.

§ 17. The choking coil, which is placed in the primary circuit to introduce great self-induction, and so to make dC/dt small, had, in our experiments, a core formed of 149 armature rings 0·0714cm. thick, their inner and outer radii being 8·5cm. and 11·7cm. respectively. If the core had been solid, the eddy currents induced in it would have rendered the coil comparatively inefficient. The core was wound with three independent layers of cotton-covered wire as follows:—

Layer.	B.W.G.	Turns.	Ohms.
1	No. 15	225	0·475
2	No. 15	205	0·50
3	No. 18	265	1·44

Stout wire was used, since the resistance of the primary circuit must be kept low if the choking action is to be efficient.

In the measurement of hysteresis in transformer sheet I should recommend, for reasons given in the *Phil. Trans.* Paper, (1) that the core of the choking coil should be made of good transformer sheet, and (2) that the winding should have approximately the same number of turns per centimetre as the primary magnetising coil.

To reverse the current in the manner described in § 10, a special key is required. The battery is connected through the Weston ampere meter WA (Fig. 3) with the terminals D, E on an ebonite arm turning about a pivot, the motion of the arm being limited by the stops S, S. The terminals D, E are connected to two springs, M, N, one at each end of the arm.

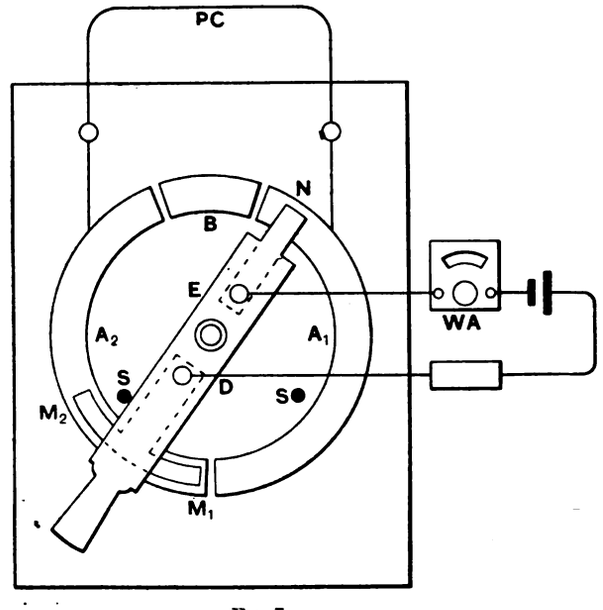

Fig. 3.

These springs slide over three sectors, A_1, A_2, B cut out of a brass ring, about 15cm. in diameter, the sector B being about 3cm. long. The sectors A_1, A_2 are connected to the primary circuit PC, and the sector B is insulated. The spaces between the sectors, about 1·5mm. wide, are filled with ebonite, so that the springs pass smoothly over them. The spring M is so arranged as to touch the ring at its ends M_1, M_2, and M_1M_2 is so much longer than the sector B that M_1 reaches the sector A_1 before N leaves it, and N reaches the sector A_2 before M_2 leaves it. It will be seen that, when A_1 and A_2 are connected by the spring M, the system is in exactly the same condition as the system of § 10 when the points F, G are in contact. The key thus carries out the reversal in the manner required in § 10. The sector B is made of considerable length, so as to give the current in PC time to sink to a very small value before the E.M.F. is applied to PC in the reversed direction.

The resistance between E and D through the battery—the resistance T of § 10—must be large enough to prevent the ampere meter or the battery from being damaged by too strong a current when N and either M_1 or M_2 are on the same sector. If a millivolt meter be used, as suggested in § 15, the resistance T may be comparatively small, since the voltmeter connections need only be completed when M is entirely on A_1 or entirely on A_2.

In finding the energy dissipated by currents in the specimen and in the secondary circuit by the method of § 11,

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the most convenient way is to double the number of cells employed—small storage cells are very convenient for this purpose—so as to make $E' = 2E$. This gives $Z = U' - U$, and $W = 2U - U'$. If the resistance T be made up of known resistances—resistance frames are convenient—it is easy to double it. After T has been doubled, the resistance of PC should be so regulated by adjustable resistances and a rheostat that, although the number of cells has been doubled, the current is brought back to its original value. When this adjustment is complete the resistance of PC has been doubled.

The key actually used by us and by Mr. R. L. Wills was *similar* to the key shown in Fig. 3, but was not so simple as that key, and differed from it in reversing the current only *approximately* in the manner described in § 10.

§ 18. I will now explain, by the help of Fig. 4, how the apparatus was arranged in our experiments. The battery SC, consisting of one or more small storage cells, was connected through the adjustable resistance R_1 and the Weston ampere meter WA to the special key K_1. On leaving K_1, the current passes round the fixed coils of the dynamometer ED, round the magnetising solenoid* MS and the choking coil CC and finally round a compensating coil F, used to annul the effect on the ballistic galvanometer of the current in ED and MS.

The circuit of the ballistic galvanometer BG contains a resistance box R_2 and the earth-inductor EI, as well as the secondary coil U and the key K_2.

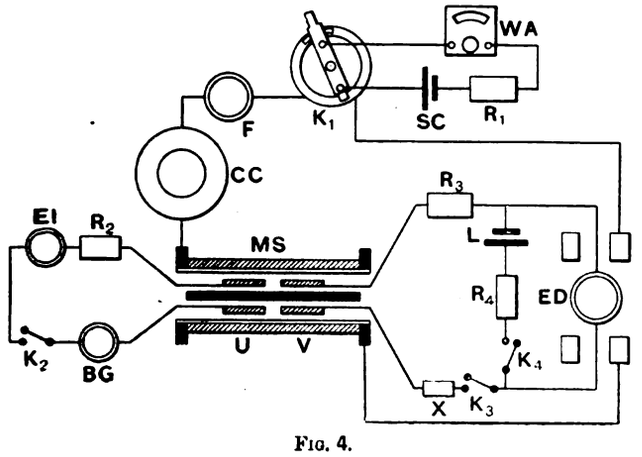

Fig. 4.

The circuit of the suspended coil contains the resistance box R_3, the secondary coil V, the key K_3 and the resistance coil X formed of copper wire and adjusted to equality of resistance with the earth-inductor, as described in § 15.

To bring the suspended coil to rest a very small current was sent through it, at proper intervals, by depressing the key K_4, a Leclanché cell L providing the current, which was controlled by the high resistance R_4.

When the dynamometer is to be standardised, as in § 8, the earth-inductor is substituted for the coil X.

§ 19. To illustrate the working of the method I give a set of observations made to determine B_0, W and Z, for the range $\pm H_0$, for a specimen of soft iron :—

Area of cross-section (circular)	$A = 0{\cdot}178$ sq. cm.
Change of induction due to earth-inductor	$P = 87{,}200$
Magnetic force per unit C.G.S. current	$4\pi N = 212{\cdot}2$
Maximum current	$C_0 = 0{\cdot}0706$ C.G.S.
Maximum magnetic force	$H_0 = 15$
Number of turns on secondary coil	$m = 25$
Throw of galvanometer due to earth-inductor	$\delta = 12{\cdot}73$cm.
Mean throw on reversing primary current	$\beta = 15{\cdot}63$cm.
Mean maximum induction $B_0 = P\beta/2mA\delta = 770\beta$	$= 12{,}030$.
Current when earth-inductor is turned	$C' = 0{\cdot}0527$ C.G.S.
Throw of dynamometer due to inductor	$\phi = 4{\cdot}68$cm.
Number of turns on secondary coil	$n = 300$
Throw, H from +15 to −15 (E = 8 volts)	$\theta_1 = 23{\cdot}85$cm.
Throw, H from −15 to +15 (E = 8 volts)	$\theta_2 = 23{\cdot}30$cm.

Hence $U = \frac{C'PN}{An\phi}(\theta_1 + \theta_2) = 311{\cdot}8(\theta_1 + \theta_2) = 14{,}700$ ergs per cubic centimetre per cycle.

* In most of the experiments made by Mr. Bedford and myself *straight* wires were used.

To find Z, the observations for θ_1 and θ_2 were repeated with other voltages (§ 11) with the result

E = 8	E′ = 12	E″ = 16 volts.
U = 14,700	U′ = 15,130	U″ = 15,540.

From U and U′, $Z = (U' - U)E/(E' - E) = 860$
From U and U″, $Z = (U'' - U)E/(E'' - E) = 840$.

Mean value of Z = 850 ergs per cubic centimetre per cycle.

Hence $W = U - Z = 14{,}700 - 850 = 13{,}850$ ergs per cubic centimetre per cycle.

§ 20. Mr. R. L. Wills has employed some of our apparatus in a series of experiments made by the ballistic method, at the Cavendish Laboratory, upon the effects of temperature upon hysteresis. His specimens were solid rings of iron, and the eddy-current loss was consequently much greater than if the specimens had been laminated. One specimen was a portion, 2·49cm. in length, of a tube of radii 3·810cm. and 3·185cm. The results for this ring, given in the following table, show that the eddy-current loss, X, can be determined with some accuracy by the method of § 11. For each value of H_0 three determinations of U were made with batteries of 8, 16 and 24 volts, and the value of W was deduced from the three values of U by the formulæ $W = 2U - U'$, $W = 3U' - 2U''$, which follow from § 11 :—

H_0.	B_0.	S ohms.	U E = 8.	U′ E′ = 16	U″ E″ = 24	2U − U′.	3U′ − 2U″	W mean.	X E = 8.
0·34	194	23	5·9	7·3	8·8	4·5	4·3	4·4	1·5
1·02	1,205	23	154	169	185	139	137	138	16
1·70	4,629	123	1,528	1,640	1,736	1,416	1,448	1,432	96
2·38	7,139	223	3,396	3,714	4,017	3,078	3,108	3,093	303
3·06	8,749	523	5,159	5,702	6,211	4,616	4,684	4,650	509
4·02	10,150	523	7,297	8,146	8,960	6,448	6,518	6,483	814

The agreement between 2U − U′ and 3U′ − 2U″ is satisfactory; it may be taken as evidence that the theory of § 11 is practically applicable even to such specimens as were used by Mr. Wills. In these experiments it is really Z which is determined, but since Y was quite negligible in comparison with X, it follows that X and Z are practically equal.

Now the sides of the rectangular section of the ring, made by an axial plane, are $a = 2{\cdot}49$, $b = 0{\cdot}625$cm. Thus $a/b = 4$, and hence, by (30), $Q = 0{\cdot}0176$. If the specimen had been built up of 50 rings, each ½mm. thick, the value of a/b for each ring would have been 12·5, making $Q = 0{\cdot}0063$. Dividing by the number of rings, we have $Q/p = 0{\cdot}00012$. Hence, if the ring had been laminated, the eddy current loss would have had only $\frac{1}{140}$ of its value in Mr. Wills' experiments, and thus would have been practically negligible.

§ 21. In practical measurements either a ring-shaped specimen or a very long straight specimen must be used. The latter form would not be convenient, since, with specimens whose cross-section exceeds 1 sq. cm., the length must be more than 1 metre unless large errors due to the de-magnetising effects of the ends are to be incurred. On the other hand, the labour of winding a ring with wire, every time a fresh specimen is to be tested, is a great drawback to the use of rings.

But I think that a slight modification of the form of specimen recommended by the German Union of Electrical Engineers* may prove convenient. I hope to make experiments with it shortly.

A somewhat similar plan had occurred to me long ago, but a remark of Prof. Ewing's led me to see that my own plan could be improved.

Wind four similar solenoids on straight tubes of vulcanised fibre 50cm. long and 5cm. in internal diameter, and arrange them along the sides of a square, connecting the windings in series. Then prepare 20 strips of transformer sheet, each 4cm. wide and about 65cm. long, and place five strips in each tube, the ends of the strips projecting from one tube being arranged alternately with the ends of the strips projecting from an adjacent tube, so that the magnetic joint may be as perfect as possible. The overlapping ends should be clamped together at the four corners by wooden clamps. Four secondary coils, fitting the specimen closely, should be provided,

* *Elektrotechnische Zeitschrift*, September 12, 1901.

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one for each side of the square, and should be placed each in the centre of a side.

Arranged in this way, the apparatus would be convenient for tests on a series of specimens, for the insertion of the strips into the coils would be the work of a few minutes only.

If N be the number of turns per centimetre on each solenoid, the magnetic force due to the primary current near the centre of each solenoid can be made to have very nearly the value $4\pi NC$, by placing a coil of m turns and area G at each corner of the square, with its centre at the centre of the line joining the centres of the ends of the two solenoids, and its plane perpendicular to that line, the four coils being in series with the four solenoids. If R be the radius of each solenoid, and D be the distance between the centres of the ends of two adjacent solenoids, then $mG = \pi NDR^2$, provided the greatest diameter of the area G be small compared with a side of the square. Since only the product mG is determined by this equation, these coils can be made to serve a second purpose, for, by making the area G in the form of a narrow rectangle, m can easily be made large enough to secure that the total magneto-motive force in the magnetic circuit shall be $4\pi NC.L$, where L is the effective length of that circuit. The coils could easily be made movable, so as not to interfere with the insertion of the strips.

The same apparatus would serve equally well for tests of magnetic permeability.

Cavendish Laboratory, Cambridge, April 30, 1902.

ON AN INDUCTIVE CIRCUIT WITH A HARMONICALLY VARYING RESISTANCE.

BY T. MIZUNO.

Suppose that there is an inductive circuit with a constant impressed E.M.F., and that the circuit contains a part of the resistance harmonically varying in magnitude. In fact, such a circuit is realised by an inductive circuit with a microphonic contact. Let L be the coefficient of self-induction of the circuit, and let R be its resistance.

If R_0 be the resistance of the circuit when no variation of the resistance takes place, then, during the period of the supposed harmonic variation, the resistance of the circuit is

$$R = R_0 + R' = R_0 + R'_0 \sin \omega t, \quad . \quad . \quad . \quad . \quad (1)$$

where R′ expresses the fluctuating part of the resistance—namely, the resistance which is harmonically varying with the amplitude R'_0 and with the frequency $\omega/2\pi$.

Denoting the current at any instant by i, and the constant current corresponding to the impressed E.M.F. alone by i_0, we have

$$i = i_0 - i' = i_0 - i'_0 \sin(\omega t - \phi). \quad . \quad . \quad . \quad . \quad (2)$$

This equation shows that the existence of the harmonically varying part of the resistance in the given circuit is equivalent to that of a certain imaginary current, i', which also varies harmonically with the amplitude i'_0, lagging in phase by an angle, ϕ, behind the varying resistance.

The equation of the E.M.F.s of the circuit is

$$L\frac{di}{dt} + Ri = E, \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where E is the given impressed E.M.F.

Introducing the value of R given by (1) into this equation, we have

$$L\frac{di}{dt} + (R_0 + R'_0 \sin \omega t)i = E,$$

i.e.,
$$L\frac{di}{dt} + R_0 i + R'_0 \sin \omega t\{i_0 - i'_0 \sin(\omega t - \phi)\} = E,$$

i.e.,
$$L\frac{di}{dt} + R_0 i = E - R'_0 i_0 \sin \omega t + R'_0 i'_0 \sin \omega t \sin(\omega t - \phi). \quad (4)$$

This is the general equation of E.M.F.s of the circuit.

Now let us suppose that R'_0 is very small in comparison with R_0, as is actually the case with the microphone circuit, and consequently i'_0 is also very small. Under this supposition, the product $R'_0 i'_0$ can be neglected, without sensible error, in comparison with the other terms in the above equation, and then we obtain

$$L\frac{di}{dt} + R_0 i = E - R'_0 i_0 \sin \omega t,$$

i.e.,
$$\frac{di}{dt} + \frac{R_0}{L} i = \frac{E}{L} - \frac{R'_0 i_0}{L} \sin \omega t. \quad . \quad . \quad . \quad . \quad (5)$$

Therefore, the current is given by the following integral:

$$i = \frac{1}{e^{\int \frac{R_0}{L} dt}} \left\{ \int \left(\frac{E}{L} - \frac{R'_0 i_0}{L} \sin \omega t \right) e^{\int \frac{R_0}{L} dt} . dt + A \right\}. \quad . \quad (6)$$

Evaluating this integral, we get

$$i = \frac{E}{R_0} - \frac{R'_0 i_0}{R^2_0 + \omega^2 L^2} (R_0 \sin \omega t - \omega L \cos \omega t) + A . e^{-\frac{R_0}{L} t} \; . \quad (7)$$

The arbitrary constant A in the above equation is determined thus. When $t = 0$, we have

$$i = i_0 = \frac{E}{R_0}.$$

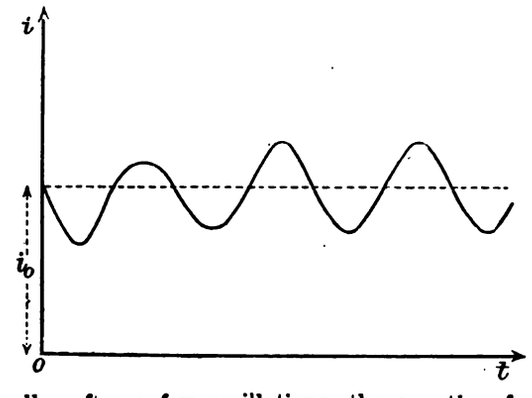
$$\therefore \quad A = -\frac{R'_0 i_0 \omega L}{R^2_0 + \omega^2 L^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Hence,
$$i = i_0 - \frac{R'_0 i_0}{R^2_0 + \omega^2 L^2} (R_0 \sin \omega t - \omega L \cos \omega t) - \frac{R'_0 i_0 \omega L}{R^2_0 + \omega^2 L^2} . e^{-\frac{R_0}{L} t} . \quad (9)$$

This equation can be easily transformed into the following form

$$i = i_0 - \frac{R'_0 i_0}{\sqrt{R^2_0 + \omega^2 L^2}} \sin \left(\omega t - \tan^{-1} \frac{L\omega}{R_0} \right) - \frac{R'_0 i_0 \omega L}{R^2_0 + \omega^2 L^2} . e^{-\frac{R_0}{L} t} . \quad (10)$$

The form of the current is shown in the annexed figure, the part expressed by the exponential term soon dying away under the supposition of small variation of the resistance.



Practically, after a few oscillations, the equation for the current becomes

$$i = i_0 - \frac{R'_0 i_0}{\sqrt{R^2_0 + \omega^2 L^2}} \sin \left(\omega t - \tan^{-1} \frac{L\omega}{R_0} \right). \quad . \quad . \quad (11)$$

Hence, the current in an inductive circuit with an impressed constant E.M.F. oscillates about the line $i = i_0$ when the part of the resistance of the circuit undergoes a harmonic variation. One important conclusion which can be drawn from the last equation is that an inductive circuit is almost indifferent to harmonic variation of the resistance, when the variation is small and the frequency is very great.

PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society, held on May 23rd, Prof. S. P. Thompson, F.R.S., president, in the chair,

A Lecture Experiment on the Ebullition of Rotating Water was shown by Mr. T. C. Porter. If the water in a beaker, having approximately vertical sides, be caused to rotate about an axis concentric with the vertical geometrical axis of the beaker, it is obvious that in any horizontal section of the water the pressure is least in the centre, and increases from the centre outwards. If the temperature of the water is just below boiling-point and heat is supplied to it whilst it is rotating, steam is formed only in the region of least pressure, and a gaseous core is produced. The rotation can be given to the water by stirring it with a glass rod covered with a piece of indiarubber tubing, and maintaining the stirring motion during the act of withdrawal of the rod. Some curious phenomena are shown by the column of steam, if the water is first stirred and

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then left to come to rest whilst the heating is continued. At first there is a markedly concave surface to the water in the beaker, and the column of steam is practically continuous from base to summit. After this stage pulsations set in. The course of events during a single pulsation is as follows :—1st phase, the surface of the water flattens and when most nearly level a column of steam springs up with great rapidity from the base of the beaker to the surface of the water, heaving this up in its central portion. Immediately after the eruption of the steam, and whilst the column still stretches from the base of the beaker to the surface of the water, follows the second phase. The steam column seems to condense, and breaks up, leaving only a few small bubbles, which either hang stationary or move downwards in the liquid ; whilst if the water has dust in it, the motion of the dust particles shows that a curious kind of annular wave, concentric with the steam column, traverses the water from top to bottom, apparently causing in its course the almost complete condensation of the steam, and the curious brief downward movement of the bubbles left. At the same time the surface of the water in the beaker becomes deeply indented. After this the apex of the surface vortex rises, and the first phase of the phenomenon recurs. The curve of the surface of the water throughout is never a parabola, the divergence indicating that the water rotates more rapidly as it nears the axis. The pulsations can also be produced by stirring cold water in a beaker-shaped jar, having a small hole in its bottom through which a stream of air bubbles can be blown. The forms of the steam columns in some cases present a likeness to those of solar prominences ; and Mr. Porter suggested that the immediate cause of the latter might be the diminution of pressure on the sun's surface at or near the centre or centres of depressions caused by violent cyclonic disturbances in the solar atmosphere. He asked for an explanation of the pulsations.

Mr. C. V. Boys exhibited

A Small Heat Engine in which Rotating Water Evolved Steam without Ebullition.

Mr. T. H. BLAKESLEY expressed his interest in the apparent want of buoyancy of the steam bubbles in the second phase of the pulsation. He said that in filtering liquids he had sometimes noticed what appeared to be large bubbles of air which lacked buoyancy. They were really drops of the liquid surrounded by a film of air. He suggested that the curve of the water surface could be made parabolic by rotating the beaker. In this case the vertical distance between the highest and lowest points of the surface would be a measure of the velocity of rotation.

Mr. W. WATSON said that, as the viscosity of water changed rapidly when nearing the boiling point, small variations in the temperature of the liquid might alter the parabolic form of the surface. Any bubbles of steam formed away from the axis of rotation would be driven to the axis on account of the greater density of the water.

Mr. PRICE said he had seen some similar experiments illustrating the formation of waterspouts. The appearance was like the effect shown, but the pulsations were absent.

Dr. A. GRIFFITHS, in suggesting an explanation of the oscillation of the water, pointed out that if the distance of a rotating body (held in position by a spring) from the axis be forcibly diminished, the conservation of the moment of momentum indicates an increased rate of rotation. On releasing the body, the increased centrifugal force causes it to shoot past its original position. Beyond the position of equilibrium, the conservation of the moment of momentum indicates a diminished speed which decreases the centrifugal force. Thus the body oscillates radially. When the water in the beaker is flat, the mass of the water is at a less average distance from the axis of rotation than when it is heaped towards the sides. Thus the outward-driving force is probably larger when the depression is small than when it is large. The outward force drives the water beyond the position of equilibrium which it would hold in the absence of oscillation.

The CHAIRMAN said it would be interesting to observe the effects produced by varying the method of supplying the heat to the water.

A Paper by Mr. J. A. Erskine on

"The Conservation of Entropy,"

was read by the Secretary. Heat energy may be expressed as the product of two factors—a quantity factor (entropy) and an intensity factor (temperature). The conservation of entropy holds in thermodynamics when dealing with reversible processes, and is analogous to the conservation of other quantity factors such as momentum, moment of momentum, and electric quantity. The author shows the completeness of the analogies by considering Carnot cycles carried out on electrostatic and hydraulic engines. Prof. Wiedeburg has proposed to extend the doctrine of the conservation of entropy to irreversible processes by introducing a new quantity analogous to electric resistance.

The Secretary read a letter from Mr. SWINBURNE, in which he stated that the author had got hold of what was no doubt Clausius's original idea of entropy. The science of thermo-dynamics, as far as it deals with reversible processes, depended upon what the author called the conservation of entropy, but reversible processes did not exist in practice. The author's treatment was quite in accordance with orthodox thermo-dynamics.

A Paper by Sig. G. Giorgi on

"Rational Units of Electromagnetism"

was read by Mr. Price. Mr. Price prefaced the reading of the Paper by saying that both Prof. Fleming and Prof. Fessenden had advocated a partial change of units which would leave the most important ones unchanged, and the method employed by the author was similar to that adopted by Prof. Fessenden. The author starts with a set of three equations, which contain explicitly the four concrete units of E.M.F., M.M.F., electric current and magnetic current, together with that of activity, and considers them as fundamental in electromagnetism. Two fundamental units are required to express these quantities, and their product must reproduce the mechanical unit of activity. If the watt is assumed as unit of activity, there are two units ready made, the volt and the ampere, which satisfy the condition and may be considered fundamental. All concrete units in electricity and magnetism can be expressed in terms of these and the second as unit of time. In order to complete the system, a unit of length is required. The metre and kilogramme are consistent with the watt, and putting them together with the units enumerated in the Paper, the author has built up an absolute metre-kilogramme-second system which comprises electric, magnetic and mechanical measures in a consistent frame.

The Secretary read a letter from Mr. SWINBURNE stating that most physicists who love simplicity would be glad to get rid of "4π," but schemes for suppressing it generally moved it somewhere else. He asked if the author had really got rid of 4π or merely chained it up in another place. If a change in units were to be made, it would be an advantage to get rid of the terms E.M.F. and M.M.F.

Prof. EVERETT said he had arrived at the following determinations of the author's meaning :—

When μ and K are taken into account, we have the two following identities :—

1. The dimensions of current are the same as those of magneto-motive force, or H × length, called f in the Paper.

2. The dimensions of E.M.F. are same as those of quantity of magnetism divided by time—called by the author magnetic current, and denoted by g.

In connection with (1), the line-integral of H for a path singly linked with a circuit carrying a current of C amperes is to be called C. This gives the unit for H in terms of the ampere and the unit of length (the metre).

In connection with (2) we are to use the equation for magneto-electric induction in a circuit

$$\text{electromotive force} = -\frac{dN}{dt},$$

together with the rule that a quantity of the magnetism m gives the total flux $N = m$. The unit quantity of magnetism is thus defined in terms of the volt and the unit of time (the second).

The CHAIRMAN said he had received a Paper from Sig. Giorgi, giving a number of illustrations of the application of his theory to calculations. There were also some further explanations, and the dimensions of many physical quantities were tabulated in terms of the volt, ampere and second. The author claimed to have based an absolute system on the metre, kilogramme and second, while leaving the practical units unchanged.

The Society then adjourned until June 13th.

COMPENSATION FOR THE WEAKENING OF PERMANENT MAGNETS.

Permanent magnets of measuring instruments are used either as a controlling force (as in the Deprez type of instrument represented, Fig. 1) or as a deflecting force (as in the well-known Deprez-

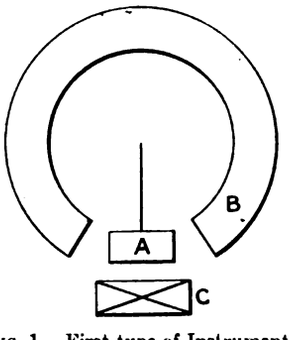

Fig. 1.—First type of Instrument. A, Moving Iron ; B, Permanent Magnet ; C, Actuating Coil.

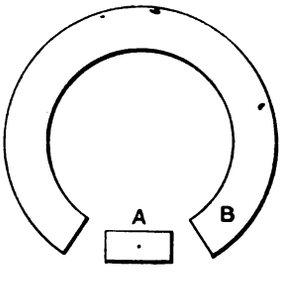

Fig. 2.—Second type of Instrument. A, Moving Coil ; B, Permanent Magnet.

d'Arsonval form of instrument, illustrated Fig. 2). The weakening or time variation of their field gives great trouble to manufacturers and users of instruments, as it is by no means an easy matter to make it negligible. The result is a proportional weakening of the controlling force in the first type of meter, and a proportional weakening of the deflecting force in the second type, so that the deflection of the needle for a given current is increased in the former and decreased in the latter type of instrument.

A new type of instrument has been devised by M. Weiss, and has now been constructed in France by M. Japy, with a view to elimina-

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ting this error. This new compensated instrument (Fig. 3) was presented by M. Weiss before the Société Internationale des Electriciens at the meeting on April 9, 1902.

It is a modification of the Deprez-d'Arsonval type, Fig. 2, being essentially composed of a moving coil *b*, actuated by the field of a permanent magnet NS. The controlling force, however, is not due to the elasticity of suspension wires, as in the d'Arsonval instrument; this elastic force is made as low as possible, and the controlling force is obtained by means of a small piece of soft iron suspended in the axis of the moving coil. The greater part of the controlling force results from the field of the magnet NS, acting on the induced magnetism of iron M. A weakening of the magnet NS will thus decrease the controlling force at the same time as the deflection force.

The time variation of the magnet will, therefore, have no effect if a proper relation exists between the dimensions and magnetic density of the magnet NS, the iron piece M and the elasticity of the suspension wires. The time variation in these latter will have no influence either, since their action has now been made practically negligible. M. Weiss states that as much as 20 per cent. variation in magnet strength does not result in any change in the calibration curve. An aluminium spool carries the coil, and this damps the oscillations of the coil. Moreover, the light weight, when pivoted on jewels, allows the apparatus to be placed in any position without any sticking or perceptible friction. Thermic variations are avoided by the use of manganin wire.

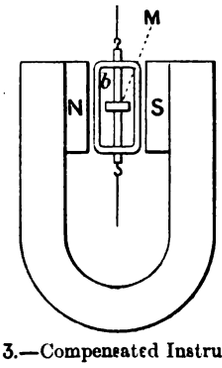

FIG. 3.—Compensated Instrument.

ELECTRICITY WORKS ACCOUNTS.

Liverpool Municipal Tramways.

In our first table are summarised the accounts of the first year in which the Liverpool tramway system has been worked exclusively by electricity. The tramways undertaking was acquired by the Corporation for a purchase price of £567,375, and the transfer was made from the Liverpool United Tramways and Omnibus Co., on August 31, 1897, when the lease of the lines in the city, which were the property of the Corporation, had over 17 years to run. At that date the total length of single-track was about 68 miles in the city, 6 miles in Bootle, and ¾ mile in Litherland, with a service of 267 cars. In the following table we give the figures of the traffic from that time up to the present :—

Year.	1897.	1898.	1899.	1900.	1901.
Passengers, total	38,409,084	41,772,034	63,771,450	82,367,958	101,108,780
Electric cars	...	785,064	15,853,160	58,068,531	100,076,789
Horse cars	30,596,229	31,985,158	39,321,946	19,051,875	218,166
Omnibuses	7,812,855	9,001,812	8,596,344	5,247,552	813,825
Mileage, total	6,013,182	6,279,758	7,600,546	9,100,866	10,970,063
Electric cars	...	53,197	1,473,750	5,584,357	10,771,461
Horse cars	4,674,609	4,736,103	4,758,652	2,571,163	46,247
Omnibuses	1,338,573	1,490,458	1,368,144	945,346	152,355
Receipts, total	£290,743	£314,207	£359,929	£417,574	£468,760
Electric cars	...	4,087	77,145	284,759	463,164
Horse cars	239,399	250,975	234,756	105,212	717
Omnibuses	51,344	59,145	47,658	27,603	4,502

After the acquisition, the Dingle route was equipped on the trolley system as an experimental line and opened for traffic on November, 16, 1898. The reconstruction work for changing all the lines over to the trolley system began in January, 1899, and the last horse car within the city was taken off on December 15, 1900.

The tramway system is supplied with energy from the Corporation lighting and power stations, and power is delivered to the tramway feeding boxes by the Electric Power and Lighting committee at an inclusive cost of 1·2d. per unit. The total energy used on the tramways for lighting and hauling during the year covered by our table was 13,679,222 units.

As the supply is thus bought at what must be an arbitrarily fixed price, it is not much use comparing the total costs per car-mile with those at other places. Account has to be taken of the passengers carried per car-mile run when any such comparison is to be fairly made, while the average gradient perhaps has the greatest effect in differentiating one place from another.

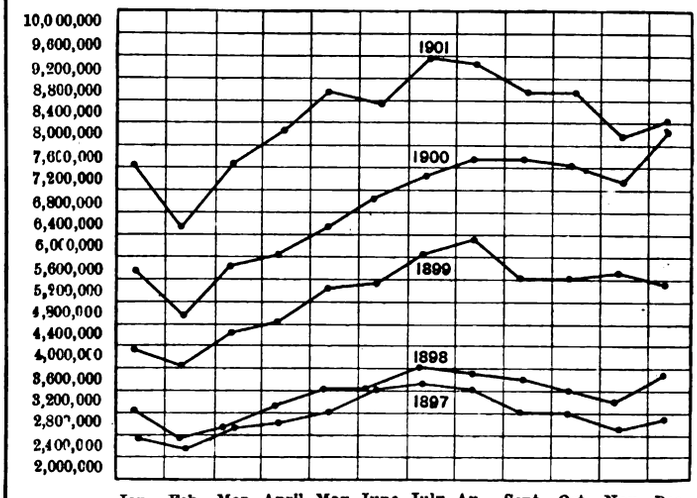

Diagram showing Passengers carried per Month during the years 1897, 1898, 1899, 1900 and 1901 inclusive.

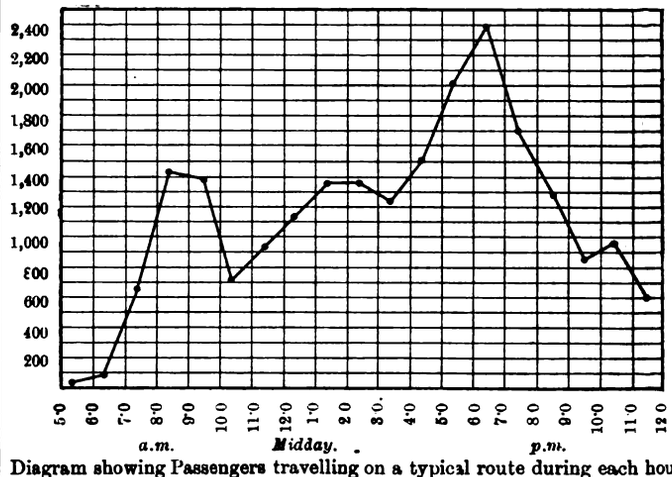

Diagram showing Passengers travelling on a typical route during each hour between 5·0 a.m. and 12 p.m. over an average of one week.

The Corporation tramways at Blackpool carried barely 10 passengers per car-mile, at a total cost of 8·54d. per car mile. The number of passengers per car-mile at Liverpool was 9·2. At Liverpool the general charges per car-mile were proportionately much lower in relation to the total costs than at Blackpool, but it is to be remembered that the car mileage at the latter place was, during the year, less than a twentieth that at Liverpool.

The City of Birmingham Tramways Co. (Ltd.).

The chief particulars contained in the official accounts to hand of the Birmingham tramways are embodied in our second table. Two years' results are given, but unfortunately the data available is very scanty and hardly admits of useful discussion. When the tramways shall have been more extensively changed over to the trolley system, the present accounts will afford an interesting comparison. We believe there have been no less than five different systems at work on these lines and four at least simultaneously. There have been horses, cable-worked sections, steam and electricity. Even with the latter, two methods have been employed—the accumulator system and the trolley. It is to be hoped that the last-named will survive and will be extended to displace all the other forms of power at the car.

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	LIVERPOOL TRAMWAYS.	BIRMINGHAM TRAMWAYS.	
Worked by	Liverpool Corporation.	The City of Birmingham Tramways Co. (Ltd.).	
Date of Commencement of Electrical Working	November, 16, 1898.	May 14, 1901.[a]	
System	Overhead trolley at 500 volts.	Overhead trolley at 500 volts.	
Tramway Manager	C. R. Bellamy.	F. W. Warren.	
Engineers	J. A. Brodie. A. B. Holmes.	H. W. Pinkerton.	
Year ended	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES.			
Car mileage	10,771,461 electric 10,970,063 total	3,515,716 total	3,723,257 total
Passengers Carried	100,076,789 electric 101,108,780 total	44,594,458	46,384,291
Length of tramway route	47 miles double, 7 miles single	25 miles[b]	27·3 miles[c]
Rolling stock, number of cars	452[a]	12 electric (motor)	21 electric (trolley)
CAPITAL.			
Authorised (Total)	—	£1,500,000	£1,500,000
Authorised (share)	—	1,000,000	1,000,000
Authorised (loan)	—	500,000	500,000
Received (Total)	£1,452,278	584,188	584,188
Received (share)	—	284,188	284,188
Received (loan)	1,452,278	300,000	300,000
Capital Expended (Total)	1,749,428[b]	520,106	569,714
Sinking fund	184,265	145,688	170,102
Reserve, renewal and depreciation fund	68,827		

	Total.	Per car mile.[c]	Per total car mile.	Total.	Per total car mile.	Total.	Per total car mile.
REVENUE.							
Total	£474,509	—	10·39d.	£231,326	15·79d.	£238,076	15·35d.
Traffic receipts (Total)	*468,760*	—	*10·26d.*	*229,293*	*15·64d.*	*236,957*	*15·21d.*
Electric traction	465,521	10·34d.	10·14d.	—	—	—	—
Horse cars	743	0·897d.[g]	0·016d.	—	—	—	—
Omnibuses	4,496	5·433d.[g]	0·098d.	—	—	—	—
Other Receipts	*5,749*	—	*0·126d.*	*2,033*	*0·139d.*	*2,019*	*0·130d.*
EXPENDITURE.							
Total Costs	£327,452	—	7·166d.	£170,760	11·66d.	£180,921	11·36d.
Working Expenses (Total)	290,434	—	6·355d.	155,882[d]	10·64d.	166,236[e]	10·72d.
Electric Traction Working Expenses	267,936	5·970d.	5·861d.	—	—	—	—
Power (haulage, lighting cars, &c.)	*72,353*	*1·612d.*	—	—	—	—	—
Maintenance, repairs and renewals	*63,226*	*1·410d.*	—	—	—	—	—
Buildings	3,518	0·078d.	—	—	—	—	—
Permanent way and lines	10,202	0·227d.	—	—	—	—	—
Electrical Equipment	8,955	0·200d.	—	—	—	—	—
Cars and fittings	38,356	0·855d.	—	—	—	—	—
Tools, machinery and sundry stock	2,195	0·049d.	—	—	—	—	—
Traffic Expenses	*132,188*[d]	*2·945d.*	*2·892d.*	—	—	—	—
Salaries and wages	108,977	2·430d.	—	—	—	—	—
Car cleaning	3,622	0·192d.	—	—	—	—	—
Cleaning and lighting sheds	1,724	0·038d.	—	—	—	—	—
Tickets and punches	2,523	0·056d.	—	—	—	—	—
Printing and stationery	1,057	0·024d.	—	—	—	—	—
Uniforms	3,841	0·086d.	—	—	—	—	—
Sundry charges	2,361	0·053d.	—	—	—	—	—
Working Expenses of Horse Cars and Omnibuses	22,498	27·17d.[g]	0·492d.	—	—	—	—
General Charges	37,018	—	0·810d.	14,878[f]	1·016d.	14,685[g]	0·946d.
Management and office expenses	5,789	—	0·127d.	—	—	—	—
Rents, rates and taxes	18,804[e]	—	0·411d.	—	—	—	—
Law, compensation and insurance	8,692[f]	—	0·190d.	—	—	—	—

	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.
FINANCIAL RESULTS.						
Working Profit	£147,082	8·98%	£60,566	11·9%	£57,155	10·5%
Net interest on loans	45,328	2·77%	3,588	0·71%	3,370	0·62%
Sum carried to depreciation fund	35,215	2·15%	38,559	7·59%	35,367	6·50%
Sum carried to sinking fund	48,932	2·99%				
Net Profit for Year	17,607	1·08%	18,419	3·63%	18,419	3·38%
Balance from last account	nil	—	2,083	0·21%	2,083	0·38%
Balance available for distribution	17,607	1·03%	20,502	4·04%	20,502	3·76%
Ordinary dividend paid	—	—	10%	—	10%	—
Percentage of total expenditure to revenue	69·1%		73·9%		76·0%	
Revenue per Mile of Route	£8,790		£9,250		£8,720	
Expenditure per mile of route	£6,070		£6,830		£6,630	
Revenue per Passenger from Fares	1·11d.		1·23d.		1·22d.	
Revenue per Passenger (Total)	1·13d.		1·24d.		1·23d.	

LIVERPOOL TRAMWAYS.—REMARKS—*a* 422 double-deck single-truck cars, 12 single-deck American type cars, 3 double-deck American type and 15 single-deck German motor cars and trailers. *b* Includes £504,668 net expended in purchase from old company, £561,587 cost of reconstructing and extending tramway lines for electrical haulage, £102,670 on lands and buildings, and £256,686 on cars and rolling stock. *c* Per electric car mile except where otherwise stated. *d* Includes £2,473 wages and materials in gravelling, &c. *e* Rates and taxes £12,114, rental of tramway lines in Bootle £5,172, and other rents £1,518. *f* Compensation and law charges £6,523, insurance £635, stock management £557, and stamp duty £427. *g* Per horse tram and omnibus car mile.

BIRMINGHAM TRAMWAYS.—REMARKS—*a* On trolley system; accumulator system in August, 1899. *b* Including about 2·9 miles of electrically-worked route on the accumulator system. *c* Including about 3½ miles on overhead trolley system. *d* Includes £8,254 paid to Corporation for maintenance of lines. *e* Includes £8,091 paid to Corporation for maintenance of lines. *f* £10,696 paid to Corporation as rent of lines and sinking fund, £2,151 tolls to Birmingham and Aston Tramways Co. for running over their lines, £1,250 directors' fees, £571 to army reservists' dependants, and £105 auditing. *g* £10,696 paid to Corporation (see *f*), £2,219 tolls paid to Birmingham and Aston Tramways Co. (see *f*), £1,250 directors, £310 to dependants on army reservists, and £105 auditing.

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THE INSTITUTION BUILDING FUND.

It has long been known to a far wider circle than that which includes only the actual members, that the Institution of Electrical Engineers has established a special fund towards meeting the cost of a suitable building as its headquarters and meeting place. This "Building Fund" has attained in the present year, a total of some £10,000, and thus has acquired dimensions sufficiently large to enable it to command attention from the entire electrical profession, and not merely those members directly associated with the Institution. Founded in the year 1894, the growth of the fund to its present magnitude has not been as rapid nor as vigorous as might have been desired. So tardily, indeed, has it developed, that it has been the cause of much disappointment to those who initiated it in the first instance, and who have steadily fostered it since. The origin of the fund, in 1894, was a definite transfer of £3,000 from the general funds to the special purpose. A year later another £500 was transferred to the fund. Since 1895 the fund has slowly increased, partly by the personal aid of members and others, but principally, we believe, by the exercise of rigid economy in the expenses of the Institution, allowing of an annual transfer from the yearly balance standing to the credit of the Institution. Thus grew the fund, in 1896 to £3,528, in 1897 to £4,640, in 1898 to £5,277, in 1899 to £7,044, in 1900 to £8,421, and last year, as we have already said, to £10,000. Comment is not necessary in order to show that at the rate of progress indicated by these figures, the hoped-for palatial residence of the Institution is still a long way off in the future. The figures speak for themselves. If it has taken eight years for the fund to grow from the initial £3,000 to the present £10,000, how long will it be before the figures stand at £50,000? We do not think that any active measures, in the way of acquiring land and planning a building, can be commenced until the fund stands at £50,000. Are we to contemplate anything so ludicrous as that the realisation of this scheme is to be postponed for another 40 years for want of funds? Yet such would appear to be the case if money is not forthcoming at a greater rate than heretofore. We refuse to believe that the electrical profession of Great Britain can be made alive to the true state of affairs and, at the same time, remain as apathetic as hitherto. It must be the wish of every single member of the profession that a suitable pile of buildings should be reared immediately; and it must be within the power of practically every member of the profession to contribute something—if only a sixpence—for the purpose.

Let us look the matter full in the face. Another £40,000 is needed—and needed promptly. Who are there to whom the Institution of Electrical Engineers has a right to look for aid? In the first place, there are the actual members, associate-members, associates and students, at home and abroad.

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These number about 4,500 in all at the present time. Among them must be included the President and members of the existing Council, together with living members of past Councils, upon all of whom there is a greater claim than upon the rank and file. Next to these we may reckon upon the members of allied institutions who are, in an indirect way, dependent upon electricity for their daily bread. There are also a large number of the rank and file of the profession who are not in any way connected with the Institution. We find, on reference to "The Electrician Electrical Trades' Directory and Handbook for 1902," that in the United Kingdom alone there are no less than 12,000 firms and individuals who may be considered as members of the electrical profession. Probably 9,000 of these are not on the roll of the Institution. Added to these there are the hundreds of foremen, workmen and operatives who, though they may not find a place in any directory, are nevertheless members of the electrical profession. We ought to be able to reckon upon modest contributions from at least 2,000 of these workers. From the scores of leading manufacturing firms contributions of from £50 to £250, at least, ought to be expected; while, from the 12,000 upwards of foremen and skilled artizans the contributions should range from, say, 6d. to £1, averaging between 5s. and 10s. Turning from the industrial to the professional side, we find many wealthy men who are dependent, either directly or indirectly, upon electrical work for a large proportion of their incomes, from whom handsome donations should be expected. Many of these men, it is not too much to say, have built up their reputations almost entirely through the medium of the Institution. Within its walls they have read Papers and made speeches that have meant more than *kudos* to themselves. There are other professional men, too, who, though never, perhaps, seen at the meetings of the Institution, are, nevertheless, largely dependent upon electrical progress for their incomes. These include members of the Parliamentary bar and others of the legal fraternity. When we recall the vast amount of electrical legislation and litigation there has been during past years, and when we take into consideration that whether the litigation and the legislation succeeds or fails, these professional gentlemen stand to gain by it, we are sure it only needs that the claims of the Institution should be put before them for them to respond liberally and with exemplary promptitude. Again, let us look at the matter from the point of view, not of men but of capital. Consider the vast amount of capital invested at the present time in British electrical enterprise. From Mr. GARCKE'S "Manual" we learn that the total share and loan capital invested in telegraphs, telephones, electricity supply, electric traction, electrical manufactures, &c., amounted at the end of last year to £165,807,474. What are £40,000 to such gigantic interests as are represented by these immense sums? Surely the huge vested interests, which are thus represented to be dependent upon the science and technique of electrical progress, can afford to provide suitable headquarters and a worthy meeting place for members of the electrical profession. Surely, indeed, they can do more than merely afford it; for are they not, in their own best interests, bound to see that the matter is promptly and properly carried through?

We must look for no multi-millionaire to meet the whole cost by a single handsome donation. The more we look for him the less likely are we of the profession to put our own shoulders to the wheel. If he should appear, so much the happier event; and we shall all know how to thank him. But it is wiser not to count on him. Let us all put our shoulders to the wheel without unreasonable delay, and get the matter settled. The following schedule shows exactly how it can be accomplished, without placing any excessive tax upon the finances of the donors:—

I.—*Members of the Institution*—		
50 members of the existing and past Councils at £50 each	£2,500	
800 members at £1 each	800	
800 associate members at 10s. each	400	
1,800 associates at 5s. each	450	
800 students at 2s. 6d. each	100	
		£4,250
II.—*Professional Men*—		
50 professional men at £100	5,000	
200 „ „ 50	10,000	
		15,000
III.—*Manufacturing Firms, &c.*—		
100 leading firms at £100 each	10,000	
250 firms at £20 each	5,000	
		15,000
IV.—*Managers, Foremen, &c.*—		
2,000 managers, foremen, at £1 each	2,000	
2,000 under-foremen and skilled artizans at 5s. each	500	
		2,500
V.—40 contributions from allied institutions and financially interested commercial organisations at £50 each		2,000
VI.—Interest on present fund and transfer from the general funds of the Institution, say		1,250
Total contributed		£40,000
Amount of fund at date		10,000
Fund at December 31, 1902		£50,000

We feel sure that the above schedule gives a workable basis upon which the "Building Fund" of the Institution can be raised to the requisite figure of £50,000 during the present year, and we trust that each individual member in the various classes above enumerated will resolve to place the sum stated, if not a larger amount, at the disposal of the Institution. To heads of manufacturing firms we suggest the advisability of starting local funds, which might be contributed to weekly or monthly by their staffs and skilled workmen during the rest of the year. A few pence from each every week would effectively swell the amount, and would represent an agreeable total by December next. We shall be pleased to announce week by week in our columns any subscriptions or donations which readers of *The Electrician* may care to make public; and we undertake to forward to the Secretary of the Institution any donations which may be sent to us for this purpose.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

The New Volumes of the Encyclopædia Britannica. 1902. (Edinburgh and London: ADAM and CHARLES BLACK and *The Times*.)

SECOND NOTICE.

The second volume of the "Encyclopædia" supplement which has now been issued brings us half-way through the letter C, and, therefore, all the more important articles on electrical subjects have still to come. We are able, however, to give our readers some general information as to what the contents of the electrical section will be and how the subject is arranged. Prof. J. A. Fleming, who, as we announced in our first notice, is departmental editor for electricity, was so fortunate as to secure the assistance of Prof. J. J. Thomson, who has written the articles on "Electromagnetic Waves" and "Electric Discharge," and also of Dr. Shelford Bidwell, who has written a long article on "Magnetism." These articles, with others by Dr. Fleming and Prof. Callendar, will bring up to date the articles on "Electricity" and on "Magnetism" in the present ninth edition, which were written by Prof. C. Chrystal about 1878 or 1879. To this scientific section Dr. Fleming has contributed the articles on "Electric Current," "Electric Conduction," "Electric Units," and "Electromagnets," and Prof. Callendar one on

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"Thermo-Electricity." The articles on "Terrestrial Magnetism" and "Atmospheric Electricity" have been contributed by Dr. Chree, of the National Physical Laboratory Observatory Department. In the department of technical electricity, the services of Mr. C. C. Hawkins were secured to write the article on the "Dynamo," Mr. W. G. McMillan has written on "Electro-chemistry and Electro-metallurgy," and Mr. E. Garcke on "Electrical Engineering in its Commercial Aspects." The articles on "Electric Lighting," "Electrical Measurements," "Transformers," and "Electric Supply" have been written by Dr. Fleming. "Telegraphy" has been divided between three authors, Mr. H. R. Kempe, writing on "Land Telegraphy," Mr. F. Jacob, on "Submarine," and Dr. Fleming, on "Wireless Telegraphy." It will thus be seen that the subject has been comprehensively treated, and each article or section is by a practical expert or leading authority on the subject, and in no case by a mere compiler. "Electric Traction," "Telephony" and "Electric Welding" have been written by authors in the United States.

Coming now to the articles already published, we find that "Accumulators" has been dealt with by Mr. Hibbert in a clear and comprehensive manner—in fact, twice as much space is devoted to it as to Dr. Larmor's article on "Æther." Mr. Hibbert describes typical cells of the Planté, pasted and "mixed" patterns, and these are sufficiently illustrated,—without the trade blocks which have been admitted, somewhat unwisely in our opinion. Instructions for the erection and maintenance of cells follow in smaller type, and then an excellent *résumé* of the various investigations on the subject that have been published from time to time, no mention being made, however, of the experiments on charging at constant voltage or the recent investigations on the effect of temperature on capacity. After this are sections on the chemistry of the subject and the employment of storage batteries for lighting and traction, but the practical part of the subject is not quite so well done as the theoretical. Edison's new cell is not mentioned, but we must not blame the author for this, as the book probably was closed, so far as alterations and additions were concerned, more than a year ago.

Directly after "Accumulators" comes the article on "Acetylene," by Prof. Vivian B. Lewes, than whom no one better could have been chosen to deal with the subject. This article is not illustrated, and the addition of a detailed drawing of a good acetylene generator—if there is such a thing—would have been an improvement. The same lack of drawings occurs in the article on "Aluminium." Mr. E. J. Ristori includes in his monograph an excellent sketch of the industrial processes used in the production of the metal, but its value would have been considerably enhanced by the addition of some drawings of the plant, for before the next new edition of the "Encyclopædia Britannica" appears, the aluminium industry will have become a most important one.

"Aeronautics," although not an electrical subject, may be mentioned as offering a suggestion as to how the new volumes of the "Encyclopædia" might have been brought out "up to date" in spite of the difficulties in connection with the printing. Count Zeppelin's air-ship is mentioned without any details being given of its design, and we are merely told that in 1901 M. Santos-Dumont carried out some more or less successful experiments with a dirigible balloon in Paris. Yet excellent photographs of both air-ships—one of the latter taken at Nice—have been bound in with the book, although evidently taken long after the article was written. Might not supplementary pages to the scientific articles have been bound in at the last moment also, so as to bring them up to date?

Dr. Larmor's article on "Æther" is worthy of the highest praise, and encourages most hopeful anticipations with regard to the mathematical section of the work generally, for which department, it will be remembered, Dr. Larmor is editor. The introduction to "Æther" would be worthy of Huxley, being couched in simple and easy but absolutely accurate language withal.

Dr. Chree is in a position to write authoritatively on "Atmospheric Electricity." His article is a summary of our present scientific knowledge and of recent research on this subject, and is furnished with numbers of tables and interesting numerical data. It is apparently not intended for the benefit of the lay student, nor for the technical man, both of whom will, presumably, be catered for under "Lightning."

The first article in the second volume which is of interest to electrical engineers is that on boilers, which is written as an appendix to the section on boilers in "Steam Engine" of the Ninth Edition of the "Encyclopædia," and brings the subject down to modern times. "Brakes" has a short section on electric brakes, describing briefly the principle of those employed for cranes and hoisting gears; tramway brakes are presumably to be included in the article on electric traction or that on tramways. The general principles of "Calibration" are given by Prof. Callendar on a later page, and "Calorimetry" is treated fully by the same writer. In "Canals" a short paragraph is devoted to electric haulage.

One of the most interesting articles in this volume is Prof. Armstrong's contribution on "Chemistry," setting forth the progress that has been made in this science during the last quarter century. Among the new elements, radium, of course, occupies a prominent position, and the discovery of radio-active bodies by Becquerel and the subsequent researches of M. and Mdme Curie are duly recorded. Polonium as well as radium is cited as a radio-active element, but we believe that it is now largely regarded as being nothing more than a convenient "Mrs. Harris," in which disguise radium had for some time hidden one of its eccentricities, viz., that of producing induced radio-activity. Different from the majority of articles in the "Encyclopædia," Prof. Armstrong is occasionally inclined to impart a strong polemical flavour to his writing. Thus, dealing with the laws of solutions, he says:—

> The ionic dissociation hypothesis is undoubtedly a conception of great beauty, and the success that has attended its application in the case of dilute solutions is of the most striking character. But it would be unscientific to yield to its charms without having fully considered the probability and sufficiency of the explanation which it affords. . . . It is easy to accept guidance and to yield allegiance to high authority, especially when it is exercised in the most autocratic and dogmatic manner possible hitherto. Unfortunately, the advocates of the dissociation hypothesis have declined even to consider the objections which may be raised against it from the chemist's side.

Prof. Armstrong then puts forward these objections. One of the most valuable features of a book like the present "Encyclopædia" is that in a later article from another pen we shall doubtless have the other side of the controversy put as ably as Prof. Armstrong has stated his case. Prof. Armstrong was rash, however, for, owing to the exigencies of alphabetical arrangement, the other side will have the last word—let us hope, not "in the most autocratic and dogmatic manner," however.

Among the biographical notices are appreciations of Lord Armstrong, Sir Charles Bright and Bunsen. Attention may also be called to other articles in the first two volumes, which, although not directly on electrical science or engineering, will, nevertheless, be of considerable interest to a portion of our readers. Under the heading "Algebraic Forms," Major P. A. MacMahon points out that "at the moment of writing no English work exists on the symbolic methods, so that it has been judged proper to present to English readers a short résumé of those processes, and to refer them for other information to the existing English treatises." He therefore divides his article into five sections: The Theory of Determinants, the Theory of Symmetric Functions, the Theory of Binary Forms, Enumerating Generating Functions, and Restricted Substitutions. Excellent essays are given of the law of arbitration and on arbitration and conciliation in labour, and the article on "Argon" will need no further recommendation than its signature "R." "Building" is rather disappointing, being devoted entirely to steel construction, and neglecting numerous other improvements and alterations in building practice which have been evolved during the last 25 years.

We hope to give our readers an account of the main portion of the electrical section at a later date, but from what has been said already, it will be seen the new volumes of the "Encyclopædia Britannica" will constitute an invaluable addition to the library of every electrical engineer and man of science. In turning over the pages, moreover, we have been repeatedly stopped by interesting articles on other subjects than those which concern our readers and ourselves imme-

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diately. It is particularly for those matters outside his habitual line of thought and study that every man of education values a good work of reference, and the "Encyclopædia Britannica," as supplemented by the present issue of new volumes bids fair to constitute a reference library that few men could assemble by themselves out of existing literature.

An Elementary Treatise on Alternating Currents. By W. G. RHODES, M.Sc. (Vict.). (London: Longmans, Green & Co.) 7s. 6d.

This is a treatise of some 200 pages dealing with the elements of alternating-current work; it deals with all the usual definitions and fundamental laws relating to the properties of single and polyphase machinery and circuits, a large number of exercises and problems being given at the ends of the various chapters, which may perhaps be of some service to university students and others interested in the pure theory of the subject.

The author states in the preface to this work that his aim in writing it has been to put before those interested in the subject the principles of modern alternating-current work in the simplest possible manner, and with special regard to the requirements of engineers and students of technical institutions. He recognises (in the preface) the necessity of avoiding the use of higher mathematics in a work of this character, and refers to the mathematical gymnastics frequently indulged in by writers of other text books on the same subject.

It is, therefore, with feelings of considerable astonishment that the reader of this book finds himself involved in integrations and differentiations in the opening chapters, which deal only with elementary definitions and laws; as he gets deeper into the book, his astonishment will undoubtedly increase, for Mr. Rhodes' work is highly mathematical practically from beginning to end. In many cases the author has gone out of his way to introduce complex mathematical solutions of elementary problems which can readily be solved by easy graphical methods, and in those few portions of the work which deal with certain practical matters connected with the subject, it would certainly appear that the author's ideas regarding the requirements and conditions of actual practice are those of a mathematician, rather than those of an engineer.

The following examples will show that this criticism of well-meant efforts on the part of the author is justified. Consider, for instance, the author's method of designing a transformer—the design for a 10kw. single-phase natural draught transformer of the shell type is worked out in Chapter XII. He starts with the copper circuits, and having fixed the permissible resistances of these (based upon a given full load copper loss), then proceeds to get out the dimensions of the core by means of a laborious calculation involving the ergs lost per cycle in hysteresis, and the watts lost per cycle in eddy currents, both calculations being based upon a value of core flux density, which is assumed before the design is even commenced. Now it goes without saying, that to make such an assumption the starting point of a design is quite wrong, for the correct flux density must be *found* in every case; mate dimensions of the core (generally from manufacturing the logical way of setting to work is first to fix the approxi- considerations), and then to find the permissible value of flux density from considerations of the given iron loss. And this latter must be based upon definite tests made upon batches of iron of similar quality, and not upon old-fashioned tables and formulæ; curves connecting watts lost per pound of iron and flux density are nowadays used by every designer when figuring iron losses. Incidentally, it may be noted that the theoretical formula used by the author for calculating the eddy current loss has proved in practice to give results at least 50 per cent. too small. Again, the temperature rise on the surface of the author's transformer attains the high figure of about 60°C., which is certainly not permissible. This excessive rise is due principally to the abnormal current density the author allows in the coils (1,000 amperes per square inch), and to the insufficient radiating surface of his design. Then, again, reference is not even made to the exceedingly important matter of the regulation of transformers on inductive loads, and to the effect of inductance and capacity on the pressure drop. With large transformers for power work, this matter is frequently so important that it has to form one of the starting points of the design.

For testing the insulation of a finished transformer the author recommends (p. 124) that the insulation should first be determined by any of the known methods, and then the transformer should be run continuously for two or three hours, with twice or three times the voltage for which it is intended, and then the measurement repeated. This is, of course, absurd, as the author could see for himself if he figured out the loss in the core under these conditions. To say nothing of the thoroughly uncommercial nature of the test recommended, it is certain that the windings would be seriously damaged before the expiration of the period in question.

That portion of the book devoted to the induction motor is also disappointing, especially when practical matters are touched upon. The theory is incomplete, and, being after Steinmetz, is wholly out of place in an elementary work; that for the single-phase motor is particularly so, and can only cause confusion in the mind of the reader. Many of the statements made in this part of the book are most misleading, and in several cases quite inaccurate. Thus, for instance, the statements "to produce a good starting torque in any induction motor the rotor resistance should be low," "unless considerably overloaded an induction motor will run quite cool compared with direct-current motors of the same weight and output" and (referring to the slip rings of a rotor) "three brushes rub on these rings, and are held by holders connected to the end shields of the case" speak for themselves.

The subject of polyphase transformers is dismissed in a few lines, while to the rotary converter is allotted another abstract from Steinmetz; the subject of the measurement of the power in single-phase circuits is treated in the orthodox way, not forgetting the three voltmeter, three ammeter, and other methods never used in the practice of to-day.

The author's treatment of the synchronous motor is elegant mathematically, but of little practical use, as the quantities in question are in such a form as to be useless to the designer or user of such a machine. The mathematical treatment of the transformer is of the same nature.

The first nine chapters of the book, dealing with definitions and fundamental laws, are by far the best, but here again, a very good knowledge of higher mathematics is absolutely necessary on the part of the reader, in order to follow the author's reasoning and working. Chapters VII. and VIII., dealing with elementary vector algebra, are well and clearly written, and may be useful to those who wish to know something about the subject, the importance of which in these days the author does not overstate.

To sum up, we are compelled to say that the book is disappointing, and not what we should have expected from its author. It is practically of no use to the engineer nor to the student who wishes to become acquainted with the practical theory of the subject, but it may be of limited use to those whose sole interest in the subject lies in its mathematical possibilities. The author falls into the pitfall of "cumbersome mathematics" which in the preface he is so anxious to avoid, and his remarks in the preface on this head make a perusal of the book all the more remarkable.

THE DISTRIBUTION OF MAGNETIC FLUX IN LARGE ELECTROMAGNETS.*

BY W. M. THORNTON, M SC.

In this Paper the author describes a method of determining the magnetic flux in large electromagnets, such as the field magnets of dynamos, whose large time-constant precludes the use of the ballistic galvanometer method. The essential part of this method consists in observing a prolonged induced voltage in a secondary exploring coil when the current in a primary is made or short-circuited. The main difference between this and the ballistic method is that it is essential in the latter that the time of discharge should be as short as possible; in the former, as long as possible. It has been one object to make the

* Abstract of a Paper read before the Newcastle Local Section of the Institution of Electrical Engineers.

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method independent of direct personal observation, beyond the adjustment of resistances, so that the records which were taken photographically should all be within the width of film used; to do, in short, for magnetic observations what the indicator diagram does for engine testing. After the calibration of the elastic control, which is necessary in both cases, the measurement of flux is similar to that of work by the *pv* diagram, in that it only involves the measurement of an area.

Consider, first, the arrangement of the primary circuit, which in general must be such that the fields are separately excited, in order that they may be dealt with independently of the armature or secondary circuit. Since it was frequently necessary in the course of the experiments to excite and destroy the magnetism many times in succession, the connections were so arranged that the coil current, instead of being broken, was short-circuited. If the permeability of the cores were constant, the rate of change of flux at any instant would be the same at short-circuit as at make, the curve of coil current being merely inverted. Using a three-way switch with a non-inductive resistance across the break whose value is that of the coil resistance or less, there is no spark if the throw over is made by a spring release. Fig. 1 shows the actual arrangement. The centre arm *a* is first placed in contact with *b*, when the coil current passes, practically none going by the non-inductive resistance. When the steady state has been reached the arm is thrown over to *c*, and if the break is slow there is an arc from *b* following it. With a spring release the action is so rapid that the current passes by the non-inductive resistance (and the smaller this is the better, the lower limit being that which gives the safe maximum current for the battery or leads), no spark appearing at *b*. The battery circuit may

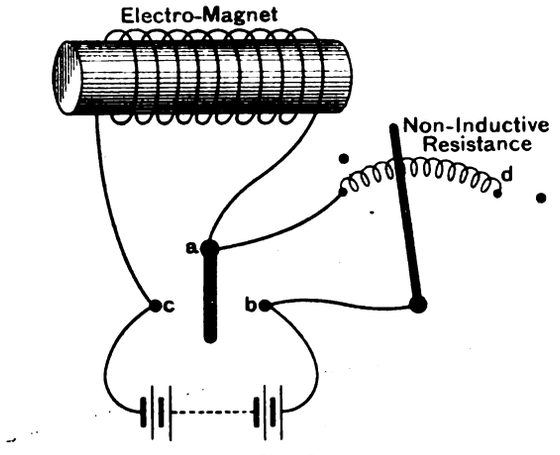

FIG. 1.

then be opened by increasing the non-inductive resistance and breaking on the last stop. This is, in the writer's opinion, the only safe way of destroying the magnetism in very large electromagnets.

On making the contact *ac* the coil current will decay according to an approximately logarithmic law as the energy of the field is dissipated as heat in the core and coil, the current being maintained by a voltage due and proportional to the rate of change of the flux as it is dissipated. In the establishment of a uniform magnetisation in a large solid core eddy currents are produced coaxial with the core, which retard the action for many seconds—in some cases minutes. Heaviside has fully discussed the process for circular cores of constant permeability, and his analysis thus includes the action at short circuit ("Electrical Papers," Vol. I., p. 353). It is necessary, however, to have recourse to experiment to find the influence of variable permeability on the rate of change of flux at any instant.

To observe variations of magnetisation the most convenient way is to note the voltage induced in an exploring coil wound to surround the core. It is not, of course, possible to observe the voltage induced in the magnet coils themselves, but a dead-beat ammeter in the circuit will give readings proportional to the induced voltage if the resistance remains constant.

Let e be the voltage generated in each turn of the windings as the lines shrink into the core. Then

$$e = 10^{-8} dN/dt,$$

N being the total flux. Thus

$$N = 10^{8} \int e dt,$$

or,

$$N = 10^{8} \bar{e} T, \quad \ldots\ldots\ldots (1)$$

$\bar{e}$ being the average voltage during the total time, T seconds, of decay. The measurement of a flux is thus that of a voltage and of a time. When an ammeter is used,

$$N = 10^{8} r \bar{i} T / s,$$

s being the turns on the winding. In every turn of an exploring coil surrounding the core, the relation (1) also holds, and by observing e from start to finish, N, the total flux, can be obtained at any cross-section, and the distribution of magnetism round the circuit in this way examined. It is evident that the accuracy of the result will depend upon that of measuring the voltage e, and the greater part of the time spent in developing the method has been given to the design and construction of apparatus for this purpose. Great difficulty was experienced in finding a recording instrument sufficiently accurate and dead-beat. Photographic records were first obtained using a Ewing's curve tracer, but the mirror was too liable to stick, and no results of more than rough comparative value were obtained. A Hartmann-Braun Kohlrausch ammeter was then tried, but was not sufficiently free from friction or dead-beat. It might, however, be made a very serviceable instrument for this class of work. After the usual failures a galvanometer was obtained which proved satisfactory, and with this, after the preliminary trials had been made with a specially-designed ammeter, most of the experiments were conducted.

The instrument, together with the recording arrangement, is by Pitkin, and is of the Holden-D'Arsonval pattern. Its resistance is 144·3 ohms, and the coil consists of 100 turns wound upon a copper former. The suspension strips are of phosphor-bronze, soldered to the coil wire and clamped by screws top and bottom, the top end having a screw adjustment for increasing the tension in the strips, and the lower attached to a movable head by means of which the zero may be changed. The mirror receives a narrow beam of light projected by a right-angled prism from an arc lamp placed at the side of the case. The reflected beam is thrown half through a long slot provided with a shutter, or to a recording drum carried in a separate box, which can be removed and the photographic paper renewed without disturbing the rest of the apparatus. The other half is projected upwards by a long narrow mirror on to a scale in the top of the case, so that the motion of the spot can be observed at the same time that it is being photographed. It is necessary to use arc light to get a record of the very rapid changes during the initial rush of current. The paper used was 20in. by 16in. Barnet extra rapid bromide, the sheets being cut to 10in. by 16in. The records were about 8in. wide in most cases. The drum was arranged so that it could be wound, stopped and started without light entering the case.

In carrying out the experiments the 50kw. "Castle" continuous-current dynamo used for lighting the college was separately excited from a set of 52 storage cells. An exploring coil was wound round the core and connected to the galvanometer. Any induced current flowing round the core helps to prolong the decay of the magnetisation, thus the extra 50 ampere-turns added to the coil is an advantage when the ammeter is used instead of the galvanometer. When the galvanometer was used one turn of 18 S.W.G. copper wire was sufficient, this being connected through a standard resistance-box of 1,100 ohms maximum.

Table I.

Curve.	Position.	Fig. 2.		Fig. 3.	
		Area, sq. in.	λ.	Area, sq. in.	λ.
I.	Armature	7·4	1·0	7·85	1·0
II.	L.H. bobbin	10·2	1·38	10·05	1·28
III.	Yoke.....	8·3	1·12	7·2	1·0
IV.	Top L.H.B.....	...	...	9·75	1·35
VI.	Surface L.H.P.	0·81	0·109	...	...
VII.	C.R.H. bobbin.....	8·68	1·172	...	...
IX.	Bottom R.H.B.	8·6	1·16	...	...
XI.	R.H. pole on centre line	3·7	0·495	...	...
XII.	L.H. pole on centre line	4·62	0·62	...	...

On making the circuit, allowing the steady state to be reached and then short-circuiting, a series of curves were obtained. It was at once noticed that the curves were more rounded than by theory one would expect, and an analysis of them led to the conversion of the galvanometer suspensions from unifilar to a partial bifilar. The relative influence of the damping was thus greatly reduced, and the records of Fig. 2 and Fig. 3 are believed to be as perfect as can be obtained from a moving-coil instrument. The closeness of the relation between the actual and recorded values may be seen from Fig. 4, curves *d* and *e*, where *d* is the theoretical exponential curve of rise with constant permeability, and *e* the record of the actual current as observed with the galvanometer shunted. Since at low magnetisations the current should be greater and at high values less than that with the permeability constant, it will be seen that the galvanometer record must fit very closely the true changes of current.

The primary object of the work being to find the leakage coefficient of the machine—that is, between the windings and armature—Table I. was prepared, which gives the comparative values of λ not only for the windings, but other important sections of the circuit. It is not, however, the leakage coefficient at no load which is important, but that under the normal working conditions. To find this, it is necessary to wind an exploring coil round the armature which does not foul it when the machine is running. (In the case of revolving magnet types a special pair of slip rings must be temporarily attached to the shaft to carry the exploring coil connections

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to the galvanometer.) It is now impossible to obtain the curves at make, but by short-circuiting the field the magnetism dies slowly out of the circuit, and the records can be taken as before. The machine is in a state of considerable mechanical vibration, and strong residual magnetism is rapidly shaken out. There is no sudden change at short-circuit either in the field or armature current, less shock, in fact, than by breaking the armature circuit with any load on when there are compounding turns. With self-exciting machines the same process may be adopted, provided a fuse is placed in the connection to the armature. For high-voltage machines a magnetic blow-out should be employed, but for 100 or 240 volts soft fuse wire goes at the short-circuit before the brushes show any sign of sparking. In finding the leakage coefficient under load for small machines,

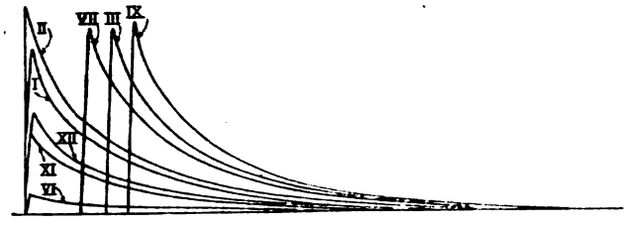

FIG. 2.

the connections should be so arranged that the field and armature circuits are broken simultaneously. With large machines as above, the armature current is left to die out with the field. In a compound machine at full load the magnetic action is due to the shunt and series windings and the cross and demagnetising effect of the armature current. The resultant magnetomotive force directly applied to the circuit can be found knowing the lead of the brushes, and the cross magnetisation by exploring the commutator by the twin pilot brush method.

Experiment on the Castle dynamo shows a decrease in the value of λ with increase of load. From Fig. 3 it is seen that the ratios of

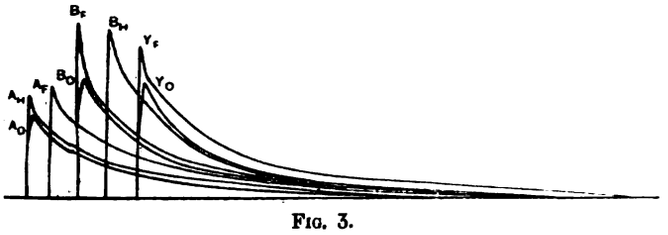

FIG. 3.

the flux at the centre of the left-hand bobbin to that through the armature are thus :—

Table II.	λ
No load	1·4
Half-load	1·35
Full load	1·28

The probable explanation is that the flux in the right-hand limb is much more irregularly distributed at no load than in the left. The reason for this is that there are 1,637 shunt turns on the left and 757 on the right. At full load the compounding turns add an equivalent 585 turns to the right-hand winding. The leakage is clearly greater from the right than from the left at no load, and the

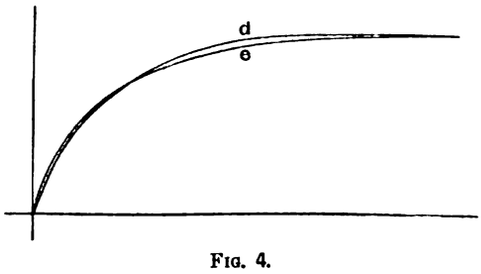

FIG. 4.

proportion of the total flux passing through the centre line section of the poles is less on the right-hand side than the left. The action of the compounding turns is to straighten the lines, as a long orifice directs water flow better than a short, and the distorting effect of the armature current is also in the direction of strengthening the lower half of the right-hand pole. Thus there is leakage above the top of the armature between the bobbins or pole tips ; and since that from the sides of the poles passes in great part through the prolonged armature conductors where they are attached to the spirals, which are active in generating voltage, there will be less waste field.

The actual performance of the machine is as follows :—The voltage at no load and 494 revs. per min. is 103·1, and since there are 90 conductors on the armature, the flux is then $13\,95 \times 10^6$ lines through the core and end connections. At full load the brush voltage is 100, and the drop in the armature is 6·5 volts, the speed being 462. Thus the flux has risen to $15·3 \times 10^6$ lines, in a ratio of 1·097. The windings cold have a resistance of 9·7 ohms, and 10 5 hot. The ratio of the total ampere-turns at full load to those at no load is, adding 5,000 ampere-turns for the series coils, less 1,750 for armature reaction, 26,050/25,700 = 1·014. The increase of flux corresponding to this is found from the curve of magnetisation to be 0·008. Thus the leakage coefficient is reduced in the ratio $\frac{1·008}{1·097} \times 1·4$—*i.e.*, 1·285—which agress with the ratio of the areas. It will be noted that the decrease of λ is proportional to the increase of load—that is, to the current in the compounding turns. It is not suggested that there is in all machines a fall of the leakage coefficient with load, but in the compound bipolar type with series turns immediately above the pole to which the top of the armature is running, there will probably always be an action of this kind.

So far the results have been only comparative ; they may be made absolute by calibrating the galvanometer and the speed of the recording drum. The latter need not be known accurately for every curve, if the time of rise is taken once for all for any particular machine. The mean of many experiments on the Holmes dynamo gives 33 seconds as the time for the full magnetisation to be reached when the circuit is excited from storage cells at 104 volts. The galvanometer was calibrated by placing in series with the windings of the machine a Crompton standard 0 01 ohm resistance and connecting the galvanometer across it. The current was observed by a portable type Weston ammeter calibrated by the potentiometer. The voltage per centimetre deflection is thus known. The size of the curves can be readily controlled by a resistance box in the galvanometer circuit. The readings should be calibrated for every set of curves, the mechanical shock of carriage changing slightly the tensions of the suspensions. It is, however, advisable in tests on completed machines to check the areas by finding the armature flux with the machine running on open circuit.

(To be concluded.)

RAILWAY BLOCKS AND TELEGRAPHS—RECENT PRACTICE.*

BY A. T. KINSEY.

(*Concluded from page 182.*)

The electromagnet controlling the principal lock has four coils, one pair being connectable at will to the line by means of a switch, which by the same operation puts the local battery through the pair of coils fixed on the other yoke piece. The cores of these electromagnets have common iron connecting pieces, XX, Fig. 4, which

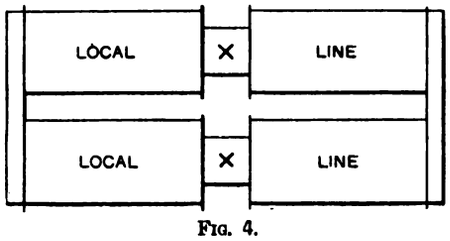

FIG. 4.

extend downwards and rest on their armature in the centre disc, locking the whole five discs as stated. When all the staffs are in the magazines and it is desired to release one at either end, the station wanting the staff signals his request, which, as in the case of other blocks, is audible upon a bell. The distant station holds down his signalling key, sending a current to line, and the calling station seeing this by means of the galvanometer in his line circuit turns his switch to "For staff," which diverts the incoming line current through the "line" coils of the electromagnet, and at the same time puts his "local" battery through the other pair of coils. Strong magnetic fields are excited at XX (Fig. 4), and the armature is held fast to the electromagnets. The staff at the top of the magazine is lifted to the head of the instrument by hand, and then drawn evenly towards the left. In its passage it first meets the projecting tail-piece, which is pivoted centrally, and carries on its upper extremity the electromagnets, and this it pushes upwards out of its way and towards to the right, as will be seen from Fig. 5. This results in a tendency to lift the the electromagnets, and with them the armature forming the electric lock. This then enables the rings on the staff to engage the pawls of the other locks and to lift them also, and the whole of the discs are thus released together, and describe a quarter-circle (in the opposite direction to that when a staff is inserted), travelling now in the same direction as the hands of a watch.

* Paper read at the Dublin Local Section of the Institution of Electrical Engineers.

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The switch which deflects the line and local currents through their respective electromagnets is restored to its normal position automatically, and this is the function of the first disc (Fig. 6), which, in making its quarter turn to the right, pushes back the switch lever to the vertical position, breaking the local battery circuit, thus preventing the waste of the local battery, which otherwise might be useless when wanted if the switch had not been restored. The action of the fifth disc is of the greatest importance. On its periphery rests a lever pivoted near its other extremity. The configuration of this disc causes the lever to rise on one quadrant, and to fall on the next alternately, and its free end thus reverses the line and earth connections on two switch levers. It will be seen that the withdrawal of a staff has thrown the instruments out of phase with each other, and it is thus not possible to energise the electromagnets at either end until the staff is returned to one of the instruments—it does not matter which—as the line electromagnet and the local electromagnet oppose each other at both stations. The direction of the local current through the coils does not vary, but flows always the same way. If the staff should have been withdrawn for siding operations, and is afterwards returned to its own magazine, the discs make a quarter-turn in the reverse direction, and the instrument then takes its original position. If, however, the staff be inserted in the magazine at the opposite end of the section, then that instrument is reversed, and both instruments are in phase, the discs in each having made a quarter-turn, but in reverse directions, and being relatively as they were originally. The return of the staff to the magazine is acknowledged on the bell, and either station can then get out another staff.

It will be observed that from the construction of the instrument one staff only can be obtained at any time, and that even if the circumstance be overlooked and the necessary signals exchanged, it is quite impossible to release another staff at either end so long as one staff is out. I have not described the functions of the other two discs. They have mechanical locks merely—the fourth disc having two—and cannot be operated until the electromagnetic lock has been

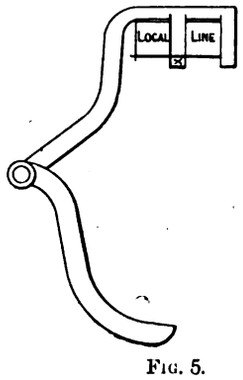

Fig. 5.

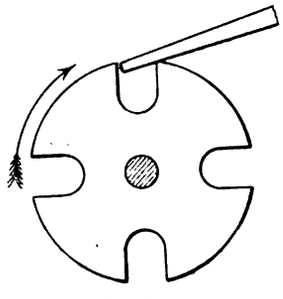

Fig. 6.

released. It will be observed that with such an instrument great possibilities of handling traffic are presented, it being no longer necessary to carefully arrange the points at which trains shall pass each other. Sixteen "staffs" in most cases are sufficient for any section, and these if placed at the up end would distribute themselves, but if by any contingency they all got to one magazine they could be withdrawn mechanically in pairs, but not singly, and restored to the other instrument. It is possible to have double magazines made for as many as 30 staffs in a section; all that is necessary is to have the magazines both coming to the one slot under the discs in the head. It is a detail, but I should perhaps mention that there is a disconnecting switch and galvanometer in the line circuit of each instrument, which are used to show that the staff has been obtained. This switch also is self-restoring. There are also various kinds of safety devices, but as they do not affect the principle of working I need not dwell upon them further. The "staffs" are made so that they cannot be placed in a wrong pair of train staff instruments, a slight alteration in mechanical detail being all that is necessary. The staffs are, I need not say, properly labelled also.

The question of "switching out" a train staff block section, as is done on double lines controlled by means of Harper's or Preece's blocks, is, therefore, out of the question, as the staffs if over-carried would not fit the more distant instrument, and when such a switching-out arrangement is essential additional train staff instruments must be fixed. The alternative is to fix a separate loud bell, say, on the station platform outside, where it can be heard by anyone employed about the station on other duties. One bell could be used to indicate the call from all the staff circuits. In some very exceptional cases it may be that a suitable bell is placed in a station-master's house or bedroom. By the use of this instrument any number of trains can be sent in either direction and in any order. If there is an intermediate siding in the section, a key is fitted on to the end of each staff, and the siding is thus absolutely controlled beyond any possibility of accident.

I have stated that one conductor only was used to connect the two instruments—instead of two conductors for a metallic circuit, as originally specified in 1889—but by means of the condenser method this solitary conductor is available also for telephone working, and each signal cabin can thus speak to its nearest neighbour on each side without any fear of risk to the block working, a single conductor thus sufficing for absolute staff block and telephone working. It may, however, happen that there is between the stations, and out of sight of both of them, a movable bridge, such as those over the Shannon, having a span lifting from the horizontal to the vertical position, thus cutting out a section of the bridge and of the rails to enable the navigation of the river to proceed without limiting the height of the masts and funnels. Whilst such a bridge is open and the rails not continuous, train staff signalling ought to be impossible, and this has been very ingeniously arranged by locking the bridge electrically from the two train staff instruments controlling the section. At the

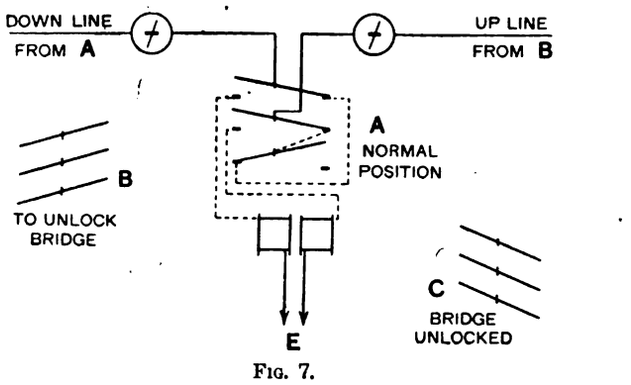

Fig. 7.

bridge cabin itself the lever in the signal frame which operates the ponderous bolt locking the bridge is itself locked electrically, so that the lever cannot be drawn.

This electrical lock consists of two pairs of electromagnetic coils mounted exactly as in a train staff instrument, one pair being joined by means of a switch to the up side and the other pair to the down side of the staff circuit, and their opposite ends earthed. In ordinary circumstances A works to B through the switch at the bridge cabin without touching the electromagnet coils there, but when it is desired to open the bridge and the usual preliminaries have been gone through, the signalman at the bridge cabin turns his switch, and so deflecting the current from A through one pair of the electromagnet coils and to earth, and the current from B through the other pair of electromagnet coils and to earth. The electrical lock is thus released and the lever can be drawn. This, of course, supposes that the "staffs" belonging to the section are all in the magazines and the

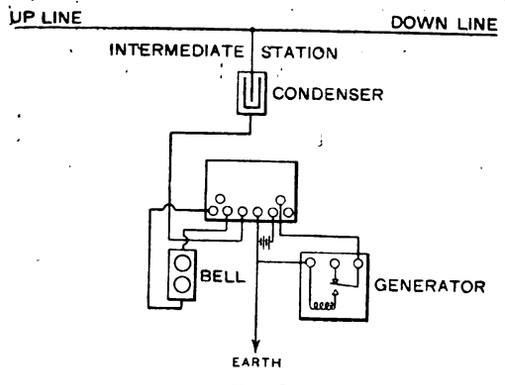

Fig. 8.

instruments in phase, otherwise it is not possible to take off the electric lock. The lock having been taken off, the circuit between A and B becomes disconnected, as shown in the diagram (Fig. 7, C), and must remain so until the bridge has been restored and locked mechanically from the lever frame, when the line circuit between A and B can again be completed by the switch. A and B then, on being requested, lock the bridge electrically from their staff instruments, and the section over the bridge is again open for train staff working. It will be observed that the man actually in charge of the bridge is powerless for mischief, whether wittingly or not. He can do nothing if the staff is out at either end. It is often the case that there is an intermediate station in a staff block section without any block or telegraph, and it may be most desirable to give it communication with the two signal cabins controlling the staff section. This can be done by leaking-in a telephone set, using condenser working for speaking and a magneto-generator for ringing (Fig. 8). The ordinary

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working of the staff would thus not affect the intermediate apparatus in any way, nor would their telephone working by the condenser method be affected by it, as when the terminal stations wanted to speak to each other they would use the train staff instrument and bells for calling purposes, and so not disturb the intermediate bell, which would respond to alternators only. A choking coil is used in the block bell circuit. It will be understood that a single conductor could thus be used for: (1) block signalling; (2) telephonic speech—condenser method; (3) bridge locking; (4) telephonic speech, intermediate station—magneto-ringing; and that each of these circuits would practically be independent of the other, and the whole having as the first consideration absolute safety and freedom from breakdown.

In all these block circuits it is usual to employ Leclanché batteries both for the line and the local circuits, and they have proved exceedingly reliable and trustworthy under very indifferent housing and in all conditions of weather, the difficulty as to their being accidentally left in short circuit on the train staff having been provided for by the first disc cutting off the local battery from the coils the moment it has completed its duty (Fig. 6). Earthenware jars of quart size are used, with zinc plates bent into the form of a cylinder. These plates were originally 4in. in diameter and 6in. in length, but the present practice is to use a shallow zinc of the same diameter and hang it from the top of the earthenware cell. The greatest depth of zinc is 3in., and the plate tapers to ½in. The weight of zinc in each plate is only one-third of the former quantity, whilst in all essential respects the cell is the same. No difficulty is found in the maintenance of these modified cells. The shallow zincs wear gradually until they resemble the blade of a pocket-knife, the lower edge of the zinc becoming quite sharp.

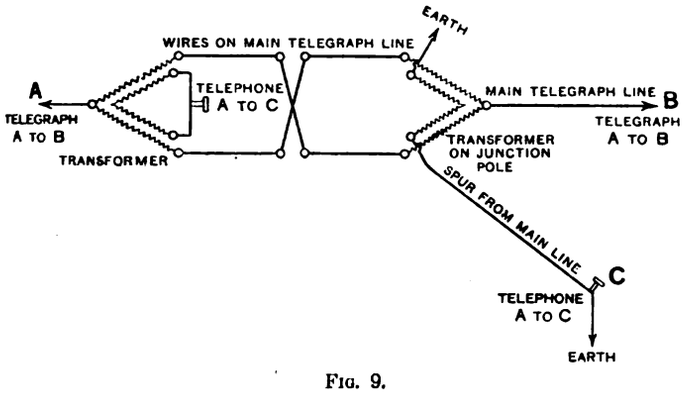


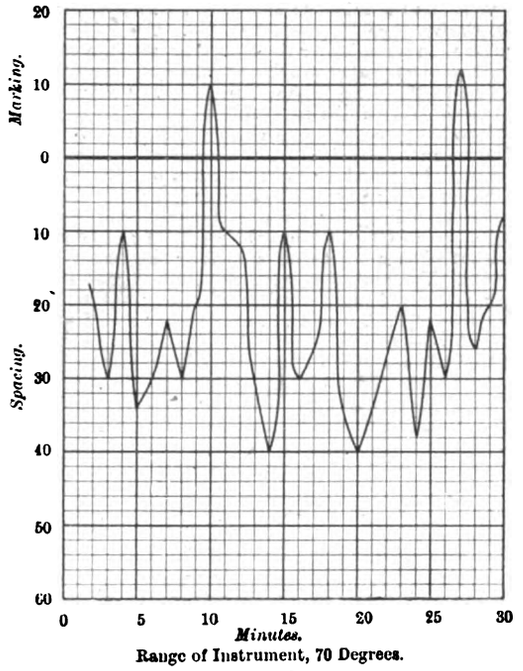
FIG. 9.

Unusual conditions have arisen in the maintenance of the train staff instruments, partly on account of the current being several times as large as that used on telegraph and telephone circuits—150 milliamperes being usually allowed—and also partly on account of its case and supports being of iron. It is quite possible that in drier climates than this such difficulties have not been felt, but originally a deal of trouble in some localities was caused by disconnections in the electromagnet coils due to leakage through the case to earth. Drier battery accommodation has, however, been provided, and a much higher standard of insulation obtained in the coils themselves, so that this difficulty, which was excessively local and not general, has disappeared, and these instruments are causing very little interruption to traffic from failures of any kind. They have so increased the capacity of a single road that we shall probably see no new double lines of railway track in Ireland in our time.

Before I conclude, perhaps, I ought to mention the introduction of superimposing—*i.e.*, a telephone circuit being superimposed on a Morse telegraph circuit in order to obtain freedom from inductive disturbances on the former without using more than the two conductors for the two circuits. Such circuits exist on our main lines of telegraph which run along the railways. There is more than one method of superimposing, but I am illustrating one only (Fig. 9). The Morse circuit is joined to the centre of the "inner" ends of the primary coils of a transformer, and, after passing through them in multiple, is taken off again and passed over both conductors until the point is reached where superimposing is no longer necessary. The two conductors are then joined to the two "outer" ends of the primary coil of a similar transformer and taken off from the centre of the "inner" ends, and so made one conductor once more. The telephone circuit goes continuously through both secondary coils in the same direction, and is then earthed where it joins the single conductor. The ringing is by magneto-generators and magneto-bells. In order to get perfect silence it is also necessary to resort to the usual method of crossing the conductors until the noise from the adjacent circuits is got rid of, as the conductors used for the Morse circuit are on the same arm and run straight and not twisted. I have been more than surprised personally with the result so far as freedom from induction is concerned. It will require to be heard to be fully appreciated.

And one other matter I would like to mention, and that is our common struggle to live, continuing to use the earth as everyone's return for all sorts of circuits, irrespective of their working conditions, power, or length. It seems to me to be only yesterday since conductor-resistance tests were readily made from this city to "earth" at any point in Ireland, and readings taken quite easily by means of a Wheatstone bridge. Alas! the galvanometer needle will not now stand still for a fraction of a second. "Earths" in parts of Dublin quite away from any tramlines—even some of them in the centre of the yards of railway termini, with many surface lines of steel rails on each side of them—and "earths" 30 miles away show constant difference of potential. I suppose if the telegraphs were worked as "closed" circuits without any battery it would be a case of stealing current.

Fig. 10 may be taken as an actual record typical of a telegraph circuit at rest. The diagram is made in the actual degree values of a



Range of Instrument, 70 Degrees.

FIG. 10.

"lineman's detector," and not in volts. I thought this might interest us all, as we see it from different points of view and interpret it from totally different premises. And on this common ground I will conclude. I hope I have not been tedious.

DISCUSSION.

Mr. F. GILL said that so far as he knew only one of the railways in Ireland ran its own telegraph system. The fact that it was not found necessary to provide an extension alarm in case the line broke down, spoke volumes for the maintenance of the lines. He considered the condenser method of working the telephones very interesting. His experience had been that it was possible to speak through a ⅓rd microfarad condenser. He was rather in doubt as to how the arrangements shown in Fig. 1 were provided with Webb and Thompson staff instruments, as Mr. Kinsey had stated this was a difficulty; but, perhaps, he simply faced the difficulty and accepted the impossibility of switching out. With regard to the locking of bridges, he thought the method was a very ingenious one indeed. As he understood the drawing, it was necessary for both A and B to send current to the line in order to release the locking bolt, but he would like to enquire what happened if A and B were not requested to unlock. Was the arrangement absolutely fool-proof? Mr. Kinsey mentioned a circuit of only 5 miles having to be duplexed to guard against inductive disturbance; he would like to know where the necessity for duplexing arises. He also wished to ask Mr. Kinsey whether he had experience with two or more duplex circuits on the one route of poles, and if so, what system of transposing they carried out? Some little time ago he was looking into the question of the difference in potential from earth, and came across some curious things. There was a difference of 2·3 volts between the Lucan tramway rails and the Dublin United rails, both at Kingsbridge. There was a very small difference between Dublin and Kingstown, the maximum obtained was 2·9 volts; he thought this spoke well for the bonding of the rails. Mr. Holbrook writing from Sligo said "the needle won't stand still, even here."

Mr. J. W. TOWLE said that with regard to the trouble arising from the variation in the earth's potential, there might come a time when the railway authorities would consider the question of putting metallic circuits throughout on railways. The principal thing which struck him about the block signal instruments was how reliable the interlocking arrangements were, one signal proving the other correct.

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Mr. W. TATLOW said that many people had a poor opinion of the saw-tooth lightning arrester. He asked whether Mr. Kinsey had had any experience with the vacuum tube lightning arrester, which would not give a short-circuit after discharging.

Prof. W. F. BARRETT, F.R.S., inquired how many volts were represented by Fig. 10, and also the extent of the variation of the potential of the earth. He said that great disturbance was going on from this cause, and supposed that effects had been noticed on telephone cables. He would like to obtain some information with regard to the difference in conductivity of the earth at different seasons of the year. He considered it was a matter of very great importance, from the agriculturists, point of view, to know the constants at different periods of the year, and it would be very valuable if data were obtained showing the variation in the resistance of the soil at different periods for the use of agriculturists to determine the amount of moisture present in the earth.

Mr. A. T. KINSEY said, in reply to Mr. Gill, that there were various ways of overcoming the difficulty of using the Webb and Thompson train staff instruments at night. If there was a night service, one method was to provide a relay to a large bell on the station platform. With regard to the locking arrangement of bridges, he explained that without troubling to go near to the electrical apparatus, the signalmen restored the bridge to its horizontal position mechanically; and unless both stations sent their current, the block signals could not be operated. The bridge was fool-proof. With regard to the necessity for duplexing, he said the induction from a reversal of 50 volts on the telegraph circuit was considerable, and could be quite overcome by the method shown in Fig. 9. He knew of no case of duplexing two circuits on the same line of poles, but considered that in such event it would be necessary to change this method. With reference to the difference in potential between Dublin and Sligo, he said that a difference would be found between all parts of Ireland. Sometimes it might be a negative current and sometimes a positive current. He had found vacuum tube lightning arresters very fickle in their action. He remembered a case of 60 of these arresters having been put on one side as defective, but when again tested a week or two afterwards were found to be all right. Vacuum tubes were used by the Post Office for underground work, and were found to work satisfactorily, but required periodical testing. In reply to Prof. Barrett, as to the approximate value in volts of Fig. 10, about 3 volts represented the dip on either side of zero. It would be a rather difficult matter to obtain records of the earth's potential at different seasons of the year, as Prof. Barrett suggested.

FERRANTI METERS.

Messrs. Ferranti (Ltd.) have issued an illustrated pamphlet of their continuous-current meters, and we give below a description of

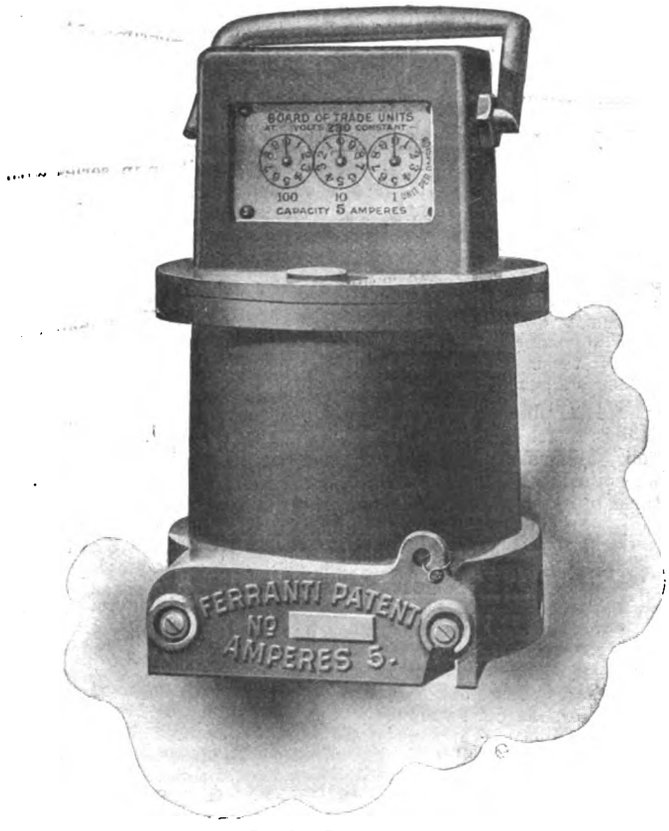

Fig. 1.—5-Ampere Meter.

the latest improved pattern of these instruments. Ferranti meters have been on the market for many years, and were the forerunners of the motor type of meter for direct currents. A section through a 10-ampere instrument is shown in Fig. 2. Current enters the meter at T+, passes up the steel pole SP to the mercury bath MB, contact with the mercury being made at C. It then flows radially through the bath to the iron ring IR, which is connected to one end of the coil CC, of copper wire, finally leaving the meter at T−. The mercury bath is insulated both at the top and bottom by means of vulcanised fibre, and thus forms the armature, as in a motor of the unipolar type.

The electromagnetic action between the magnet and the current passing through the mercury causes the latter to revolve. The driving torque varies as the square of the current, but the resisting torque, due to fluid friction, as the square of the velocity, consequently the velocity is directly proportional to the number of amperes passing through the meter. The motion of the mercury is communicated to the counting train by the fan F and the worm W. A swing train ST is arranged at the back of the counting gear, and with this set of movable wheels two adjustments are possible: (1) by

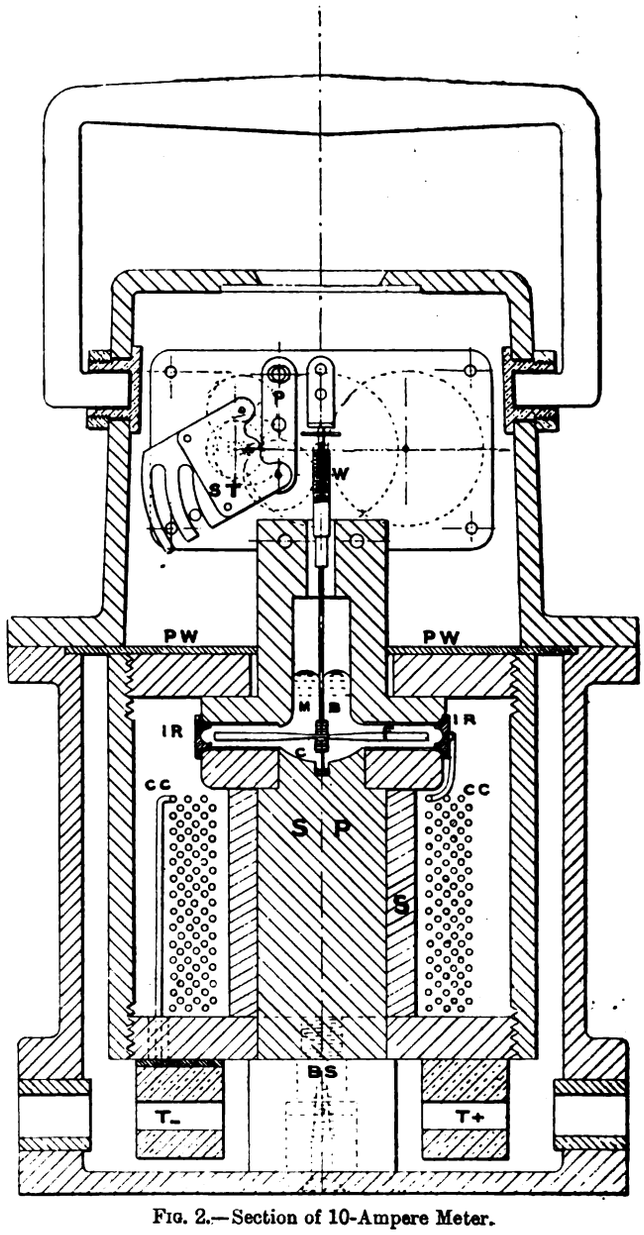

Fig. 2.—Section of 10-Ampere Meter.

means of the swing plate P which carries the train, the first wheel can be brought into gear with the worm of the spindle, and (2) the train can be turned round the centre of its first wheel, bringing the ratio pinion, which is fixed on the last spindle of the swing train, into gear with the ratio wheel, fixed to the first spindle of the front train. This communicates the motion of the mercury to the train of wheels operating the fingers at the front of the meter. The dials read directly in Board of Trade units. A certain amount of permanent magnetism in the steel pole is required to start the meter with very small currents, and formerly, a short circuit current passing through the meter for a second or two would so over-magnetise the pole as to cause the meter to run too fast with small currents for some time afterwards. This trouble has been removed by means of the soft iron sleeve S, and it is now possible to pass 100 amperes through a 10-ampere meter for a short time without in way damaging the

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instrument or affecting its constant. The insulation resistance between meter and case is usually high ; 30 megohms can be guaranteed, though 200 megohms have been obtained, and the insulation will successfully withstand a test pressure of 2,000 volts alternating. Handles are now fitted to all meters (100 amperes and under), and these assist materially in preventing the spilling of mercury when the meter is being carried.

THE WORLD'S COPPER PRODUCTION IN 1901.

Messrs. H. R. Merton & Co., the well-known firm of metal brokers, have recently issued their annual statistical circular relating to the supplies of copper in 1901, and from this circular we take the following figures :—

The total output of copper in 1901 was 512,131 tons, as compared with 486,039 tons in 1900 and 472,244 tons in 1899. The largest contributors to this enormous total are the American mining companies, the output of the Lake and Western Mines for the three years having been 262,206, 268,787 and 267,410 tons respectively. These totals show that the control of the Amalgamated Copper Co. has served to check the output of the American mines, the lessened production being most marked in the case of the Montana mines, which produced 9,000 tons less copper in 1901 than in the previous year. Had there been no growth in the production of other countries, the total output of copper in 1901 would, therefore, have been about the same as in 1900, and the break in price which has relieved the consumer would most probably not have occurred. The outside countries and mining companies have, in fact, saved the consumer from a permanent price of £70 per ton.

The production of the mines situated in Spain and Portugal during 1901 was 53,621 tons, as compared with 52,872, and 52,168 tons in the two previous years, and the output of these mines is unlikely to show any marked increase in the future. Australasia comes third in order of production, with an output of 30,875 tons in 1901, as compared with 23,000 tons in 1900 and 20,705 tons in 1899. This large increase in production is, of course, a direct consequence of the high price of copper in 1900 and 1901, and of the flotation of many new mining companies. We are doubtful whether this level of output will be maintained, now that copper is once more selling at £50—£55 per ton. Chili occupies fourth place with a production of 30,000 tons,as compared with 25,700 and 25,000 tons in the two previous years. The increased price has here, again, led to new mining developments, which may not be permanent. Japan follows Chili with an output of 27,475 tons in 1901, a decrease, since this country produced 27,800 tons in 1900 and 28,310 tons in the preceding year. Mexico occupies sixth place with a production of 23,795 tons, as compared with 22,050 tons in 1900, and 19,335 in 1899. The increase of 4,000 tons is in the output of the outside mines, for the production of the famous Boleo mine remains stationary at about 11,000 tons. The German mines have produced 21,720 tons in 1901, as against 20,410 tons in 1900 and 23,460 tons in 1899. Here, again, there is a decrease to record in the figures for the three years, and Germany has sunk from the fifth to the seventh place as a copper-producing country. Canada, with an output of 18,800 tons in 1901, now ranks eighth in order of production, and the figures for 1901 show a striking advance upon the totals for 1900 and 1899, which were 8,500 and 6,730 tons respectively. In this case the activity in the Sudbury mining district of Ontario is partly responsible for the increased production of copper, many of the mines which have been bought and worked chiefly for their nickel ores producing also cupriferous ores. Peru has produced 9,520 tons of copper in 1901, as compared with 8,220 and 5,165 tons in the two preceding years. Here, again, rapid progress is marked by the totals for the three years.

The Russian production in 1900 and 1901 is estimated to have amounted to 8,000 tons, as compared with 7,210 tons in 1899, but these figures lack the weight of official returns.

South Africa ranks eleventh with an output of 6,400 tons, a decrease upon the figures for 1900 and 1899, which were 6,720 and 6,490 tons respectively. The remaining countries each produce less than 5,000 tons annually, the output of the United Kingdom being given as only 600 tons.

The average price of "G.M.B.'s" on the first of each month in 1901 was £67. 19s. 3d., as compared with £72. 16s. 6d. in 1900 and £51. 7s. 10d. in 1899.

In conclusion, the foregoing list of copper mining companies floated in London during this period of high prices in 1899-1900 may be of interest to our readers, since the collapse of the Amalgamated Copper Co.'s control of the copper market is largely due to the mining developments which followed these flotations in London.

No.	Name of Company.	Locality of Mines.	Capital.	Date of flotation.
1	Le Roi Mining Company.....	Brit. Columbia	£1,000,000	Dec., 1898
2	*Copper Corporation of Chili.	Chili	200,000	Do.
3	Mid-Moonta Copper Mines ...	S. Australia ..	160,000	Do.
4	M. Lyall Comstock Copper Co.	Tasmania	500,000	Jan., 1899
5	Copper King, Ltd.	California	350,000	Do.
6	*Balla Balla Copper Mines	N.W. Australia	250,000	Feb., 1899
7	*Colonial Copper Corporation.	New S. Wales .	125,000	April, 1899
8	Einashleigh Freehold Copper Mine	Queensland ...	200,000	May, 1899
9	*Tablas Finana Copper Co. ...	Spain	150,000	Do.
10	†Panuco Copper, Ltd.	Mexico	500,000	Do.
11	*Lloyd Copper Co.....	New S. Wales..	250,000	Do.
12	Copper Co. of British Columbia	Brit. Columbia	100,000	July, 1899
13	Ardilla Copper Mines	Portugal	120,000	Do.
14	Mt. Lyall Blocks Copper Cor.	Tasmania	300,000	Aug., 1899
15	Caledonia Copper Co.	New Caledonia	750,000	Do.
16	Mt. Chalmers Copper Mines...	Queensland ...	150,000	Do.
17	Le Roi, No. 2, Ld., Copper Mines	Brit. Columbia	600,000	June, 1900
18	Velvet (Rossland) Mine	Ditto	200,000	Do.
19	Rossland & G. W. Mines	Ditto	500,000	July, 1900
20	Wandilta Copper Mines	Australia	120,000	Dec., 1900
		Total ...	£6,525,000	

* Old mines re-opened. † In liquidation.

THE CAPILLARY ELECTROMETER.*

BY G. J. BURCH, M.A.

What may be called the insulation resistance of the capillary electrometer is important for two reasons—first, as to its bearing on the theory of the instrument, and, secondly, as affecting the method of using it in dealing with electrical charges or quantities of limited amount. I propose briefly to record some of my own experiments on this head. In many capillary electrometers, if an excursion of the meniscus is produced by touching the terminals with a source of E.M.F. and then removing it, leaving the circuit open, the meniscus returns in a comparatively short time to the position it would occupy if the instrument were short-circuited. In other words, the charge, which, as Lippmann showed, is contained in the instrument as long as the meniscus is deflected from its zero position, gradually leaks away. The question naturally arises whether this leakage is accidental, like that of a gold-leaf electroscope, or essential, in the sense that some small current may be necessary to maintain a deflection. Lippmann, in his original thesis did not mention any direct experimental investigation of this problem, though his whole mathematical argument is in accordance with the supposition, that no current is required to maintain a deflection. I, therefore, began my practical examination of the properties of the capillary electrometer in January, 1887, with this experiment. I made a quick-acting electrometer, carefully insulating its parts with freshly cut soft rubber, and joined it up in series with a very sensitive galvanometer in the derived circuit of a potentiometer. Both instruments were furnished with short-circuiting keys. On opening the electrometer key, there was a large excursion of the meniscus. As soon as it had come to rest at its new position under the action of the E.M.F., the galvanometer short-circuiting key was opened. There was no deflection. But any thing that caused the meniscus to *move*—whether a slight change in the pressure on the mercury, or a small movement of the rider of the potentiometer, produced a large or even violent, but always temporary, deflection of the galvanometer. I found afterwards that Fleischl had obtained similar results in 1879.

The converse of this experiment is specifically referred to by Lippmann. If a charge is communicated to an electrometer by rubbing the terminals with the finger, and the circuit is left open, the mercury returns to its zero point very much more slowly than if the circuit is closed. And I found that by careful attention to the insulation the capillary electrometer could be made to hold a charge quite as long as a gold-leaf electroscope. Thus another instrument made a few weeks later was left charged with the circuit open, and "no change in the deflection could be detected after 35 minutes."

The most remarkable experiment of this kind was made unintentionally. In June, 1898, I made a new projection electrometer for the work on the electromotive properties of nerve in which Prof. Gotch and I are engaged at Oxford. This instrument is the most rapid and sensitive that I have ever employed, and it is still in use. A few weeks after it was set up, it was accidentally left, charged to about 0·025 volt, with the circuit open, from 1 p.m. on Saturday to 10:30 a.m. on Monday. The image of the meniscus was still, as it had been left 45½ hours before, between two reference lines on the screen corresponding to a difference of potential of 0·0008 volt, so that this represents the maximum loss, and as the zero-position had not altered, at least 97 per cent. of the original charge still remained in the electrometer. And as the circuit included no less than seven keys and

* Paper on "Contributions to a Theory of the Capillary Electrometer, I. On the Insulation Resistance of the Capilliary Electrometer and the Minimum Quantity of Electricity Required to Produce a Visible Excursion" read before the Royal Society on May 1st.

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switches and about 23 metres of wire, it is probable that the instrument was not responsible for all the leakage. Inasmuch as it might be objected that the mecury had stuck in the tube and so maintained its position before closing the circuit, I waved an electrified ebonite tube to and fro near one of the terminals. This causes the meniscus to move up and down by induction exactly as it would cause the gold leaves of a charged electroscope to diverge more widely or collapse. But just as the gold leaves would remain divergent after the final removal of the ebonite at the same angle as when they were first charged, so the meniscus when the ebonite is taken away returns to the position it had assumed in virtue of the original charge put into it, always supposing that no sparks have been allowed to pass. This method is extremely useful in guarding against false readings due to a sticky tube. I have verified this result several times since by observations extending over five or six hours, but I have not cared to risk leaving the key open during my absence from the room.

After a lapse of nearly four years the insulation resistance is naturally less, but it varies greatly with the weather. The easiest way of making comparative measurements is to observe the time required for any charge to fall to half its initial difference of potential. This I shall refer to briefly as the "time of half-discharge," and it answers to the "time constant" of a condenser, but is simpler to use in practice, as it is easier to divide a number by 2 than by 2·71828, and also to observe deflections consisting of a whole number of scale divisions. On March 27th of this year, the time of half-discharge was 13min. On April 14th, just before rain, the weather having suddenly become warmer, the time of half-discharge was only 65 seconds. This is an exceptionally low value. A gold-leaf electroscope in the same room could not be made to retain a charge for 10 seconds. In dry weather the electrometer responds so readily to frictional charges that the greatest care has to be taken to avoid touching the table with the sleeve or coat, lest the mercury should be driven out at the tip of the capillary.

The cause of the leakage is obviously two-fold. Part of it is external, as is evident from the marked influence of the weather. The capillary electrometer is necessarily a difficult instrument to insulate. Glass is, under the most favourable circumstances, liable to attract moisture in a rising temperature, and it becomes still more so when a portion of its surface is in contact with sulphuric acid diluted to such an extent. Varnish cannot be used, but I have thought vaseline round the ends of the tubes diminishes the leakage. The other part of the leakage is internal. The cause of it is easily explained. The acid wets the glass, and the mercury does not. There is, therefore, a tendency for the acid to insinuate itself between the mercury and the walls of the capillary. That it does so is evident on examining the mercury column under the microscope by front light with a high power. A film of liquid can be seen between the metal and the glass, and traced for some distance. When a short column of mercury 2cm. or 3cm. long is used, this film soon passes right up the tube, and in a few weeks acid can be seen above the mercury. Even in the U-tube, where the mercury is beneath the acid, the same action takes place, though less rapidly. For this reason I prefer to have a depth of 8cm. or 10cm. of mercury in the capillary, and 5cm. in the U-tube. The internal leakage is least when the electrometer is new. Instruments which leak badly generally also "creep"—*i.e.*, if left on open circuit the mercury does not remain at zero, but creeps slowly up or down, owing to some E.M.F. within the instrument.

It seems at first sight inconceivable that there should be no current through a circuit consisting of platinum—mercury—dilute sulphuric acid—mercury—platinum, all of which are good conductors. Yet we have this fact: the time of half-charge of a quick electrometer is of the order of $\frac{1}{50}$th second, but the time of half-discharge of the same instrument on open circuit may be counted by days. The resistance to the passage of the current is manifestly not ohmic, but some effect produced at the interfaces between mercury and dilute acid.

The conditions suggest the counter E.M.F. of polarisation, and here we are met by the experiments of Bouty, showing that the sum of the E.M.F.s of polarisation at the two electrodes is always less than the applied E.M.F., no matter how weak it may be, so that there is always a permanent current through the electrolyte. The explanation is, I believe, to be found in the fact that we are dealing with an interface between two liquids which cannot diffuse into each other, and that the electrical and chemical, as well as the mechanical, streasses are in some way distributed evenly over the whole area of contact; so that local action, to which perhaps we should ascribe the permanent current through the electrolyte with solid electrodes observed by Bouty, is prevented. I have already published my opinion that there is no electrolysis, properly so called, in a well-made electrometer.

A point of practical interest arises in connection with the rapid leakage of the charge in damp weather. How far does this defective insulation affect the records obtained with the apparatus? Taking the worst conditions—namely, when the time of half-discharge was 65 seconds, and the severest test, namely, photographing the discharge of a small Leyden jar charged to half a volt into the electrometer, we have the following data:—The passage of the sensitive plate occupies 0·1 second, *i.e.*, $\frac{1}{5}\frac{1}{0}$ of the time of half-discharge. A simple calculation will show that the total loss of charge in 0·1 second would be about one-tenth per cent., and as such a record would be completed in less than 0·01 second, the difference would be quite inappreciable. It may be of interest to give some data as to the quantity of electricity which an electrometer will detect. I took an ordinary gold-leaf electroscope with a brass knob 1in. in diameter, and charged it so that the leaves diverged at an angle of about 20deg. I then touched one of the terminals of the electrometer with the knob of the electroscope—the mercury instantly shot right out of the field. I then tried smaller charges, and found that a permanent excursion of fully 1cm. was caused by a charge that produced a barely visible divergence of the gold leaves.

In order to measure the minimum quantity of electricity required to cause a visible movement of the meniscus, I earthed one pole of a four-cell accumulator, and touched the other with an insulated brass ball 3·3cm. diameter, freshly polished, but not lacquered. There was a sudden upward jerk of the meniscus, not followed by any return. After six such charges, the level of the image of the meniscus had risen fully 1mm. On reversing the charges on the sphere, the direction of the movement of the meniscus was reversed. With 4 volts the excursions were smaller, but well marked, and with 2 volts they were just visible. The total quantity of the charge, therefore, was $\frac{3\cdot3}{2}\times\frac{2}{300}=0\cdot011$ electrostatic unit. But as the screen on which the excursions were observed was placed 81cm. from the lens, whereas the photographs are taken at a distance of 126cm., and as details are discernible on the photographs with a lens that are quite invisible to the naked eye, it may be safely said that a quantity equal to $\frac{1}{1000}$th electrostatic unit will produce a measurable excursion. The capacity of this electrometer is 0·363 microfarad at the part used in this experiment.

PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

Monday, May 26.

CENTRAL LONDON RAILWAY.

On Lord Windsor's Committee resuming, after the Whitsun recess,

The Hon. J. D. FITZGERALD, K.C., for the Central London Railway Co., speaking with regard to the portion of his bill relating to the acquisition of land for the extension of the generating station at Shepherds Bush, the raising of new capital for rolling stock, the enlargement of Marble Arch station, &c., asked the Committee to allow this to proceed, as there was no opposition whatever.

Sir HENRY OAKLEY confirmed the objects sought by this section of the bill, and

The Committee passed the preamble.

CITY AND NORTH-EAST SUBURBAN RAILWAY.

Mr. BALFOUR BROWNE, K.C., referring to the circumstances which had been instrumental in the withdrawal of the City and North-East Suburban Railway (see *The Electrician*, May 15), said that all the local authorities along the route had now passed resolutions of regret for the action taken by the promoters. Everyone of them were most anxious to have a line even to Whitechapel, feeling certain that some means would be found of getting into the centre of the City. In addition to this, the Parliamentary representatives of the districts in question had waited upon Mr. Clinton Dawkins, of Messrs. Morgan, to see if this firm would give more unconditional support than they had been able to offer on the spur of the moment, after the Committee's decision. Therefore, the promoters proposed, if the order now before the House of Lords, giving leave to withdraw the bill, could be discharged, to ask their lordships to hear them in reply, there being now no opposition to the scheme except the Great Eastern Railway Co., which had already been heard, and a question of insulated returns by the East London Railway Co. which was only a clause opposition. The result of the appeal to Messrs. Morgan was an undertaking to give financial support to the railway, provided that the line was satisfactorily connected with the through route from Hammersmith to Palmers Green. The promoters were also informed by another influential financial gentleman, quite independently of Messrs. Morgan, that half the capital could be easily found. Therefore, it was proposed to come next session with a line from Whitechapel by an entirely different route. If the bill was now withdrawn it would waste a year, and it was for this reason, under the new circumstances, that he asked the Committee to hear him if he could obtain the discharge of the order.

Mr. LITTLER, K.C., for the North London Railway, objected to this procedure, which, he said, was entirely irregular.

The CHAIRMAN remarked that the Committee could not give any support to such an application.

LONDON UNITED, NORTH-EAST LONDON AND PICCADILLY AND CITY RAILWAYS.

Mr. BALFOUR BROWNE, in respect of the landowners' opposition, still outstanding, to the through route from Hammersmith to Palmers Green (see map in *The Electrician* of April 25, p. 21), suggested a compensation clause, by which the period was limited to two years. Such

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compensation should be determined by an arbitrator to be agreed upon by the parties, or in default to be appointed by the president of the Surveyors' Institution for the time being, the provisions of the Arbitration Act of 1889 to apply.

The CHAIRMAN asked counsel representing landowners to consider this clause.

Mr. READER HARRIS, K.C., then put his case for the opponents to the combined scheme who lived in Kensington Gore and Princes-gate. This opposition was in reality against the London United Electric Railways, rather than against the Piccadilly and City Railway. He asked that this portion of the bill should not be passed—firstly, because no serious public necessity was proved, and, secondly, that if there was, existing means of locomotion were amply sufficient.

The CHAIRMAN said the decision of the Joint Committee last year in suggesting the present route proved the public necessity.

Mr. READER HARRIS said that, admitting the necessity was there, the existing means were sufficient. In addition to this there were the objections against vibration, and also the fact that the line ran between the Albert Memorial and the Albert Hall.

A large number of property owners were then called. They objected chiefly on the point of vibration. Questioned by the Committee, the majority had no knowledge of the results of the experiments published in the report of the Vibration Committee last year.

Lord ROBERT CECIL, representing the churches of St. Martin's-in-the-Fields and St. Clements Dane, both in the Strand, asked for modified lines of route near these buildings. Any subsidence in respect of these churches could not possibly be met by a compensation clause. He also protested against the vicarage of St. Martin's-in-the-Field being scheduled in the bill.

Evidence in support having been given,

The CHAIRMAN said the Committee had decided to pass the preamble of the bill for the railway from Hammersmith to Palmers Green.

The **Clapham Junction–Marble Arch Railway**, a portion of the London United Electric Railways, was next considered.

Mr. BALFOUR BROWNE, said that what little opposition to this bill there was had been settled with.

Mr. CLIFTON ROBINSON went into the witness box to support the bill, and

The CHAIRMAN announced that the preamble was proved.

BROMPTON–PICCADILLY RAILWAY (EXTENSION TO HOLBORN).

The Brompton–Piccadilly Circus extension from Piccadilly-circus to Holborn (see map in *The Electrician* July 9, p. 107) was then dealt with, and there being no opposition the preamble was passed.

BROMPTON–PICCADILLY CIRCUS RAILWAY (EXTENSION OF TIME).

Mr. TALBOT, for Apsley House and Devonshire House, objected to the extension of time being granted for this line on the ground that two lines down Piccadilly were not necessary. To all intents and purposes the line was a new scheme and ought to be treated as such. The railway was sanctioned in 1897 and practically nothing had been done. Further, the construction of two lines down Piccadilly would place property owners in a difficult position as regards compensation.

Mr. LITTLER, for the Brompton and Piccadilly Circus Railway, thought such opposition ought to have been made against the other bills, and not against his. The Committee had already authorised the extension of the line, and this latter would be useless unless the original Brompton–Piccadilly Railway was built.

The CHAIRMAN intimated that the Brompton–Piccadilly Circus Bill as regards the extension of time would proceed.

Tuesday, May 27.

BROMPTON–PICCADILLY RAILWAY (EXTENSION TO PARSONS GREEN).

Mr. FREEMAN, K.C., on behalf of a large number of hospitals and public buildings along the line of route of the Parsons Green extension of the Brompton–Piccadilly Railway, opposed this line on the following three grounds:—(1) Enormous interference with the hospitals; (2) it was not a part of any through route, but would be worked as a shuttle system from South Kensington to Parsons Green; (3) the district was already sufficiently served by railway accommodation.

Evidence to this effect was given by doctors from the various hospitals. In the case of St. Thomas' Hospital, it was mentioned that an oil engine, driving a dynamo for the electric lighting of the building, although installed in a separate house under the level of the hospital, had had to be taken out owing to the vibration which it caused.

Similar evidence was given by the architect to the Brompton and Chelsea Hospitals.

Mr. G. F. DEACON, a consulting engineer, thought it very undesirable to have these tube railways down main thoroughfares. If they were constructed off the main roads, with entrances to the stations in the main streets, all possibility of damage to such buildings as these hospitals, &c., would be avoided.

Further similar evidence having been given,

Mr. LEWIS COWARD, K.C., opposed the line on behalf of the London County Council. It was deemed unsatisfactory by the Council, he said, from a financial point of view, and also from the point of view of convenience to the public. The cost of the line worked out at something like £700,000 per mile, and the promoters were also proposing the unusual interest during construction of 4 per cent. instead of 3 per cent. But the real fear of the London County Council was that this line, if authorised, would never be made, but would be kept as a block line in the hands of the District Company to block the way for any line coming down King's-road, where such a tube was sorely needed. The Council were not absolutely supporting the King's Road bill, which was to come on, but some comprehensive scheme down this thoroughfare was necessary. As the Brompton–Piccadilly line was in the hands of the District Railway Co., it was incredible that they would have a cheaper fare on the tube from Parsons Green to South Kensington than on the District Railway, which already ran between the same points.

Mr. LITTLER, in reply, said he was very much surprised at the remarks of counsel for the London County Council. Five millions of money was already subscribed for these railways, and the line would certainly be built. With regard to the opposition of the hospitals, he was quite prepared to take any special precaution which the Board of Trade cared to put upon him for their protection.

The CHAIRMAN, after a brief consultation, announced that the preamble of this section of the Brompton–Piccadilly Railway was not proved.

KING'S ROAD RAILWAY BILLS (NOS. 1 AND 2).

Mr. BALFOUR BROWNE, who appeared for this railway with Mr. E. Moon, K.C., said that unlike the line just rejected, it was before the Joint Committee last year, who reported that such a railway would be desirable if an interchange station were provided at Victoria, and, further, that an extension to Putney Bridge would also be desirable. In view of these suggestions, the line now ran from Victoria, down the Buckingham Palace-road, Pimlico-road, King's-road, Eel Brook Common, New King's-road, and High-street, Putney, where it was close to the station of the London and South-Western Railway. At Victoria the promoters were prepared to make an exchange station with the District Company, which would enable passengers to travel to the City on that line. The length was 4 miles 1 furlong, and with the exception of the Borough of Westminster it had the support of all the local authorities. Really, the only question was as to whether the promoters were capable of constructing the line if sanctioned, but this he thought he could prove to the Committee to be beyond question. Of course, the District Company were competed with, but as to the opposition of the London, Brighton and South Coast Railway and the South-Eastern and Chatham Railways he confessed he failed to see the force of this, as the railway could not possibly affect either of these companies. The question of finance was an important one, but there would be no difficulty in raising the capital, which was by no means large. Since last year the estimates for the construction, &c., had been brought to the lowest possible figure, and the capital asked for was £2,598,773, of which £2,000,000 was the share capital, with the usual borrowing powers. There was also included in this a sum of £120,000, financial expenses for obtaining the money. The line was tube all the way.

Mr. J. MCALLISTER, one of the promoters of the bill, said he had guaranteed a large amount of the expenses of promoting the bill, and he intended to follow this up by investing in the scheme. In fact, there was every prospect of the whole of the money being found.

Cross-examined by Mr. E. H. PEMBER, K.C., for the District Company: How much are you ready to invest in the undertaking personally?—I would rather not give the figure unless asked to do so by the Committee, but from the promises of my friends we shall find something like £400,000 or £500,000.

You are not prepared to say that either yourself or your friends singly will find such an amount?—No.

By Mr. LITTLER: The other three promoters and himself were finding the expenses of the promotion.

Mr. LEWIS COWARD: What are you professionally. We have not yet heard?—I live upon private means, and have also other means of income.

Continuing his cross-examination, Mr. Coward produced a circular letter sent out by the Electric Railway Stock and Share Corporation last November apropos of the South and West London Junction Railway, at which time witness was a director of the company, offering shares in that company and mentioning his (witness) name therein.

Witness replied that he had no knowledge of that whatever, and that it was entirely unauthorised. Indeed, he would go so far as to say that it was a trick on the part of an opponent. He was not now a director of the South and West London Junction Company.

Do you know that the South and West London Junction Railway, which is the next bill before this Committee, has, within the last few hours, been withdrawn?—I know nothing about that line.

Mr. PEMBER put a letter before the Committee which had been sent to a client of his, but which was not marked private or confidential, in which it was stated that the **South and West London Junction Railway** would be withdrawn from Parliament for this session.

Mr. S. G. SHEPHERD, a stockbroker of Old Broad-street, thought there was a very fair prospect of raising all the money for this railway, especially as it ran through such a populous thoroughfare. He would recommend the scheme to his clients, provided he had a board of directors which commanded confidence, and there were no objectionable clauses likely to prevent the success of the undertaking.

By Mr. PEMBER: At present he was not prepared to put a shilling into the scheme personally.

Re-examined by Mr. MOON: He had had something to do with the raising of the capital for the City and South London Railway, and the value of these shares was gradually creeping up. He would probably advise the addition of some further directors to those already mentioned in the bill, before endeavouring to find the capital. Sir Richard Sankey, one of the promoters, was chairman of the South Wales Electrical Power Distribution Co.

Mr. PEMBER, who is appearing for several charities against the **South and West London Junction Railway**, remarked to the Chairman that the action of withdrawing this bill was a very gross one indeed after all the expense the opponents had been put to. Technically, it could not be withdrawn, because the House of Lords was not yet sitting again, and he would ask the Committee not to allow the bill to pass out until it had considered

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the claim for costs which he was putting in together with other petitioners against the bill. He believed the House of Lords could go the length of insisting that the bill should be proceeded with, in order that they might declare the preamble not proved, and then to consider applications for costs from any petitioners whom they considered had been vexatiously put to expense.

Mr. FREEMAN, for other opponents, supported this application.

The CHAIRMAN: Do we understand that the financial evidence for the King's Road Railways has closed?

Mr. MOON said it had, but in this way. If it could be proved that the scheme was a good one, financial evidence to the same extent as in the case of a bad scheme was not required. He hoped to prove that this scheme was a good one, and as the capital was not great comparatively, the bill would proceed at the risk of the promoters. He must say that the Committee had been pursuing a somewhat unusual course in respect of these bills, and before this year he did not think any promoter had been asked to "plank down the sovereigns," so to speak, before the bill was passed. All his other evidence would bear indirectly upon finance.

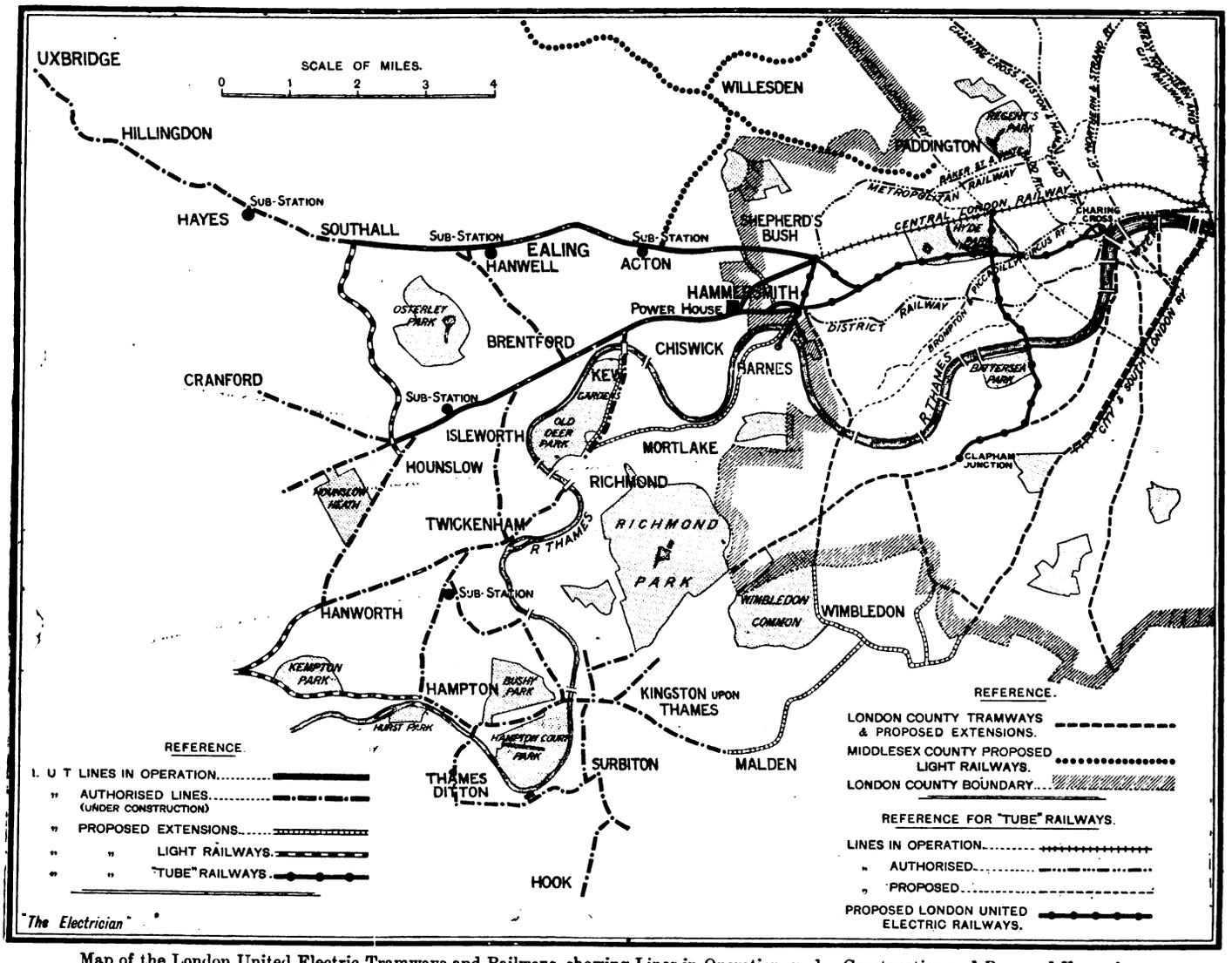
The CHAIRMAN: If the financial evidence is closed, the Committee do not think the preamble proved.

The Committee will meet again to-day (Friday), when the question raised by Mr. Pember as to the South and West London Junction Railway will be considered, in addition to special clauses upon compensation and vibration applicable to all the bills. General clauses will also be adjusted.

LONDON UNITED TRAMWAYS BILL.

The Select Committee of the House of Commons, of which Mr. Compton Rickett is chairman, commenced consideration of the London United Tramways Bill yesterday (Thursday).

16 miles, besides which they had authority to construct 46 miles more. The company were now laying lines through Isleworth, Twickenham, and Hampton Court, and the group of lines in Surrey would be proceeded with immediately. [The tramways for which powers are now being sought are shown as proposed extensions in the map below, which is reproduced from a recent Paper by Mr. Clifton Robinson.] Running from Richmond to Kew Gardens, there was at present a tramway worked by horse traction, which was in the hands of the promoters. It had long been the view of the company, and it was now the view of the local authorities that that should be worked by electricity. There were very important widenings to be made in connection with that line. With regard to the proposal to cross Hammersmith Bridge, the company had an important opponent in the London County Council, in whom the bridge was vested. Some of the company's lines were within the administrative county of London, and they would pass into the hands of the London County Council in a period, he thought, of some seven years. Last year the London County Council objected to a tramway going over that bridge, but Mr. Benn, the chairman of the Highways committee of the London County Council, gave evidence which led to an understanding. Counsel referred at length to the proceedings last year, which showed, he said, that the County Council were willing to let the company have this portion of line on condition that they allowed it to become purchaseable with other portions of line in 1909. Acting on that, the company had prepared clauses, not only embodying that condition, but inserting protective clauses, which the London County Council asked for. Despite these facts, the London County Council had petitioned against the bill. He could not, however, conceive that the County Council would go back on their agreement of last year. The company had arrived at an agreement with the Corporation of Richmond to make some important widenings, in consideration of which Richmond was not opposing. They would, in fact, give evidence to show that



Map of the London United Electric Tramways and Railways, showing Lines in Operation, under Construction and Proposed Extensions.

Mr. BALFOUR BROWNE, K.C., on behalf of the London United Tramways, said the bill was one practically to enable extensions of the company's systems to be made, together with certain widenings and alterations of roads in the counties of London, Middlesex and Surrey. Some small lines in Hammersmith district would connect the lines running into the Broadway at Hammersmith and those running into Shepherds Bush, and to that part of the scheme there was practically no opposition. The total length of the company's electric tramways in operation is

they desired to have the tramway electrically equipped. The fare from Richmond to the Bank over the promoter's line and the tube railway at Shepherds Bush would be 5d., whereas by the London and South-Western Railway — who were opposing — the fare, third class, was 1s. 1d. Certain frontagers were opposing this part of the bill, but all the local authorities affected were in favour of the bill. On the Richmond, Barnes and Hammersmith portion of the scheme, the company had agreed to carry out widenings and improvements which

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would cost £158,752, and on the Wimbledon portion, widenings and improvements which would cost £180,000, a total of £338,808. Besides that, in order to obtain certain extensions of the period of 21 years, at the end of which time, under the Treasury Act of 1870, the local authorities might purchase the lines, the company had agreed to pay to the local authorities certain sums of money, the object being to obtain a longer period within which to recoup themselves for their initial outlay. Thus Richmond had extended the period to 30 years. In Wimbledon the company had to give £100 for every mile of tramway in the district, the period being extended to 25 years, and similar arrangements existed with regard to Mitcham and Merton. The company had also agreed to raise the river front and build a wall in connection with the road running beside the river from Mortlake to Barnes at a cost of about £30,000. The existing road was at certain periods flooded and impassable, and this improvement was necessary to enable the tramway to be constructed.

The Committee adjourned.

OTHER ELECTRICAL BILLS.

In the House of Commons, on Wednesday, on the motion for the second reading of the Electric Lighting (London) Bill,*

Mr. CALDWELL said that the bill did not fulfil the objects claimed for it—viz., make the boundaries of the electric supply areas co-extensive and co-equal with the existing municipal boundaries.

Mr. GERALD BALFOUR said the bill was produced as a consequence of the London Government Act of 1899, but if the memorandum to it implied that every boundary of the electrical areas should be coterminous with the municipal boundaries, it conveyed an inaccurate impression. The bill was never intended to go as far as that. On inquiry, it was found that of the 216 alterations of area made under the Act of 1899, 179 related to small areas in which there were no electrical works and in connection with which no controversy would arise. The remainder, the majority of which would be controversial, were rendered compulsory in this bill. It was clearly advantageous that the bill should pass this session, because with each succeeding year there was the possibility that electrical works would be put down in areas at present non-contentious. The bill left parties to make their own agreements, leaving it to the Board of Trade to ratify them.

Mr. BOUSFIELD, member for Hackney, thought the bill should allow local authorities to enter into agreements for supplying electricity in parts of adjoining areas.

The second reading was agreed to.

In the House of Commons, on the same day, the Huddersfield Corporation Bill was read a third time.

LEGAL INTELLIGENCE.

Stepney (London) Borough Council and the County of London and Brush Provincial Electric Lighting Co. (Ltd.)

ARBITRATION.

The claim of the County of London and Brush Provincial Electric Lighting Co. against the Stepney Borough Council for the sums expended in connection with the obtaining of the order and development of certain works under the County of London (East) Provisional Order, 1897, was recently submitted to the arbitration of Lieut.-Col. R. E. Crompton (appointed by the Board of Trade), whose award under sec. 4 of the Electric Lighting Orders Confirmation (No. 10) Act, 1900, has now been given. It will be remembered that since the granting of the order under which the claim was made, the passing of the London Government Act has incorporated the areas formerly administered by the Board of Works for the Limehouse district and of the Vestries of Mile End Old Town and St. George's-in-the-East in the new Stepney Borough Council, which became the local authority for the combined district. Under an order of the King's Bench Division of March 4, 1902, the period for the arbitrator's decision was enlarged to June 1. The award recites that the arbitrator, having heard and considered all evidence and duly weighed and considered all matters referred to him in the arbitration, and having in the award excluded such legal and Parliamentary expenses as by sec. 4 of the Confirmation Act of 1900 is so directed, awards and determines that the amount of the cost of preparing, obtaining and passing the County of London (East) Electric Lighting Order, 1897, is £710. 6s. 7d., and the amount of so much of the costs properly incurred by the company with the object of affording a supply of electricity within the districts of the local authorities as has been incurred beyond what the company would otherwise have incurred, regard being had to whether any such costs incurred for works have been or may hereafter be utilised by the company, is £5,814. 13s. 11d., making the total amount to be paid by the Council to the company under the said section £6,525. 0s. 6d. The arbitrator continues: "And I further award and determine that the costs of the award shall be paid by the Council, and, if I have power to fix or settle such costs, I fix and settle them at the sum of £386. 4s. 10d." Finally, the award determines that the Council shall pay the company one-half the company's costs of the arbitration, and that the Council shall bear and pay its own costs of the arbitration.

The award is dated May 1, 1902.

* For a summary of the objects of this bill see *The Electrician*, Vol. XLVIII., pp. 287 and 314.

De Dion Bouton & Co. v. Brown Bros.

In the Chancery Division, on Thursday, plaintiffs applied to Mr. Justice Joyce for an interim injunction to restrain defendants from selling as De Dion Bouton, or any description including these names, in connection with motors or motor vehicles, any batteries for motors not of plaintiffs' manufacture, and from representing, selling, or passing off such batteries as goods manufactured by plaintiffs.

Mr. HUGHES, K.C., said that De Dion Bouton were well-known names relating to motors, and articles sold under the names were understood by the public to be goods sold by plaintiffs. Defendants had supplied goods under the name of De Dion which were not manufactured by plaintiffs. Defendants said they were entitled to supply batteries as De Dion pattern or De Dion imitation because plaintiffs did not possess a patent. He asked for an injunction.

Mr. YOUNGER, K.C., for defendants, said Mr. Brown had given strict instructions that no parts not manufactured by plaintiffs were to be sold by the name of De Dion alone. Two batteries had been inadvertently sold under the name of De Dion. It was open to anyone to manufacture and use parts and accessories of the De Dion type, and defendants had sold, and claimed to be entitled to sell, parts not of plaintiffs' manufacture under the name of De Dion if they used in addition the words "pattern" or "imitation." If the plaintiffs sought to restrain the use of the name De Dion altogether, notwithstanding that the same was merely descriptive of the type or pattern of the goods, defendants submitted that it was an attempt to stop a legitimate trade.

Mr. Justice JOYCE thought plaintiffs might be entitled to an injunction to restrain defendants from selling as and for the goods of the plaintiffs batteries or other goods not manufactured by plaintiffs.

Mr. HUGHES said he would be satisfied with such an order.

Mr. YOUNGER gave an undertaking in the terms of his lordship's suggestion, and the motion was ordered to stand till the trial, costs to be costs in the action.

Charge of "Furious" Driving.

At Margate, on Wednesday, a motorman named Mercer, in the employ of the Isle of Thanet Electric Light and Traction Co. (Ltd.) was summoned for driving an electric tramcar at a speed of 3¾ instead of 2 miles an hour, the Board of Trade limit, down a steep hill known as Fort Road. The facts were admitted, but for the defence Mr. Shea, solicitor, urged that the Board of Trade regulations were not to be slavishly adhered to. Evidence of the police showed that the driver had the car under absolute control. The instructions to the drivers were that they should use the electric brake when descending the hill with the hand brake just in the rim of the wheel in case of emergency. The car must be travelling at some little rate of speed, in order to make the electric brake act efficiently, and when the rails were wet, as on this occasion, the electric brake would be inoperative if the train was running at only 2 miles an hour, while if the hand-brake was used with greater power the wheels would lock, and the car would become unmanageable, run down the hill, and probably cause an accident.

The driver bore out Mr. Shea's statement.

The mayor (Mr. J. Hosking), who is an engineer, stated that 2 miles an hour would be safe to run down the hill on a dry day, but not when the rails were wet.

The manager of the company (Mr. R. Humphreys) said the Board of Trade did not make any inspection of the line when the weather was wet. In his opinion the driver exercised sound discretion in descending the hill at 3¾ miles an hour.

The mayor said that, by a majority, the Bench decided to convict, and a fine of £5. and 9s. costs was imposed.

Meyra Electric Co. (Ltd.)

On Wednesday, Mr. Justice Buckley, in the Winding-up Court, heard the petition of Mr. B. Bridgwater for the compulsory winding-up of the company. The petition was unopposed, but there was a question whether the Court had power to wind up a company where no shares had been issued. The company was incorporated in September, 1900. There were seven signatories, and each agreed to take one share, but dissensions arose, and no shares were issued.

His LORDSHIP did not think the question as to the power to wind up need arise. The company had been incorporated, and could be wound up in the usual way.

Mr. ABRAHAMS, for the petitioner, said the company was formed with a capital of £10,000 to acquire certain electric patents, and in particular that of the Meyra battery patent. In September, 1901, petitioner ultimately recovered judgment for £657 odd.

His lordship made the usual compulsory order.

Legal Causes.

The following causes with an electrical interest have been entered for trial at the Royal Courts of Justice during the present Trinity Sittings:—

COURT OF APPEAL.

Chancery General Appeals.

J. Ambler & Sons (Ltd.) *v.* Corporation of Bradford. (Appeal of plaintiffs from order of Mr. Justice Joyce of Aug. 3, 1901.) (Interlocutory Appeal No. 1 to come on with this, by order.)

National Company for the Distribution of Electricity by Secondary Generators *v.* Gibbs. (Appeal of defendant, H. O. Ruelle, from order of Mr. Justice Cozens-Hardy of July 11, 1901.)

Ferranti *v.* British Thomson-Houston Co. (Ltd.). (Appeal of plaintiff from order of Mr. Justice Swinfen Eady of Jan. 30, 1902.)

Acetylene Illuminating Co. (Ltd.) and another *v.* the United Alkali Co. (Ltd.). (Appeal of plaintiffs from order of Mr. Justice Buckley of Feb. 3, 1902.)

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Patent Exploitation Co. (Ltd.) *v.* Siemens Bros. & Co. (Ltd.). (Appeal of plaintiffs from order of Mr. Justice Buckley of Jan. 31, 1902.)

Reason Manufacturing Co. *v.* Ernest F. Moy (Ltd.). (Appeal of defendant from order of Mr. Justice Byrne of April 23, 1902.)

Interlocutory List.

J. Ambler and Sons (Ltd.) *v.* Corporation of Bradford. (Appeal of defendants from order of Mr. Justice Joyce, of Aug. 3, 1901.) (To come on with No. 15, Final list, by order.)

King's Bench Final Appeals.

Wallis Chlorine Syndicate (Ltd.) *v.* American Alkali Co. (Ltd.) (Appeal of defendants from judgment of Mr. Justice Grantham of July 6, 1901, with Middlesex special jury.)

Electrolytic Plating Apparatus Co. (Ltd.) *v.* Henry Holland & Co. (Appeal of defendants from judgment of Mr. Justice Ridley of Nov. 6, 1901, without a jury.)

Same *v.* John Birch & Sons (Ltd.) (Appeal of defendants from judgment of Mr. Justice Ridley of Nov. 6, 1901, without a jury.)

Interlocutory List.

Read *v.* Friendly Society of Operative Stonemasons and others. (Appeal of defendants other than R. E. Saunders from order of the Lord Chief Justice and Justices Darling and Channell of May 3, 1902.)

Workmen's Compensation Appeals.

Chas. Fletcher *v.* the London United Tramways (Ltd.) (Appeal of applicant from award of County Court Judge of Brentford of Oct. 25, 1901.)

Alexander Lee Isaacson and Annie Levy Isaacson, his wife, *v.* the New Grand, Clapham Junction. (Appeal of applicants from award of Deputy Judge of Westminster County Court of Dec. 16, 1901.)

John Wall Holmes *v.* the City of Birmingham Tramways Co. (Ltd.). (Appeal of applicant from award of County Court Judge of Birmingham of Jan. 22, 1902.)

CHANCERY DIVISION.

Before Mr. Justice Byrne.—Cause for trial with witnesses.

In the matter of Elmore's German and Austro-Hungarian Metal Co. (Ltd.).

Walker and Another *v.* Same. (Action.)

Electric Tramways Construction and Maintenance Co. (Ltd.) *v.* Rutterford.

Before Mr. Justice Farwell.—Cause for trial with witnesses.

British Motor Traction Co. (Ltd.) *v.* Outhenin.

Before Mr. Justice Buckley.—Action without witnesses.

Attorney-General *v.* Corporation of Hastings.

KING'S BENCH DIVISION.

Special Jury Action.

W. G. Allen & Sons (Ltd.) *v.* Callender's Cable, &c., Co. (Ltd.). (Contract.)

Common Jury Actions.

Berrenberg Electric Lamp Syndicate (Ltd.) *v.* Lowden. (Goods sold.)

Langdon-Davies Electric Motor Co. (Ltd.) *v.* G. Aston & Son. (Contract.)

Motor Traction Co. *v.* Motor Manufacturing Co. (Injunction.)

Motor Manufacturing Co. (Ltd.) *v.* Goodwin. (Calls.)

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A lecturer on electrical engineering is required for Bradford Municipal Technical College. Particulars from the secretary, Mr. John Nutter. See advertisement.

Portsmouth Corporation require a resident electrical engineer for their tramways. Applications by June 3.

A science master is required for the Tunbridge Wells Technical Institute. Applications by June 3.

Mr. O. A. Pilcher, chief assistant electrical engineer to Blackburn Corporation, has been appointed electrical engineer and tramways manager to the Borough of Ilkeston at a salary of £250. There were 35 applicants.

Mr. J. W. Turner has been appointed senior engineer-in-charge at Huddersfield electricity works at £130 per annum, and Messrs. J. E. Schofield and E. Lunn have been appointed engineers-in-charge.

Aberavon.—A proposal to erect new gas works at a cost of £15,000 caused Councillor Walsh to enter a protest against the expenditure at the last meeting of the Council. He said the advantages of electric lighting were so generally recognised that they should be quite certain of their position before expending £15,000 on gas works. Councillor Owen moved an amendment that the gas works scheme be not proceeded with. They would have quite sufficient gas from their present works if leakages in the mains were stopped. A special meeting is to be called before further steps are taken.

Accident.—We regret to announce that a serious accident is reported to have occurred to Mr. J. A. Fraser, resident electrical engineer of the Oldham, Ashton and Hyde Electric Tramway (Ltd.). Mr. Fraser was crossing one of the main streets in Ashton when he was knocked down by a tramcar and rendered unconscious. He was last reported to be in a critical condition.

Autojinrikshas.—There is stated to be an excellent chance for the introduction into Japan of an auto vehicle to take the place of the hand-drawn jinrikshas, so popular a feature of that country. Of these latter vehicles there were, on April 1, 1901, 206,848 to seat one person each and 17,339 with two seats.

Barnstaple.—The Electric Lighting committee have decided, on the recommendation of the consulting engineer (Mr. W. H. Trentham), to adopt a scheme of wiring premises on the easy payment principle.

Birmingham.—In presenting the minutes of the Electric Light committee on Tuesday, the chairman (Mr. Johnstone) said that the progress made in electricity supply during the past year was satisfactory, and, but for debiting to revenue the cost of the change to the higher pressure, their trading would have shown a reasonable profit. The actual change-over was now nearly complete, and the whole system would soon be working at a uniform pressure. Rates and taxes showed an increase of £1,300, but the cost of coal a considerable reduction. Ald. Martineau asked if the committee had considered the question of hiring motors to manufacturers; he thought their day load was not sufficiently developed, and the committee might find it possible to do a largely-increased business, while there would at the same time be a saving to manufacturers who hired the motors. Mr. Walthall protested against the price of 7d. per unit which was charged to small consumers; he considered a reduction should be made. Mr. Nettlefold thought the result of the municipal trading in electric lighting must be disappointing to those interested in the welfare of the city. The business, when under the control of a company, was paying a handsome dividend, and as soon as it was taken over by the Corporation it became a charge upon the rates. In reply, Mr. Johnstone said the question of hiring motors would be considered. They made no call upon the rates, but, on the contrary, hoped in the course of a year or so to be a help to the rates. The minutes were adopted.

Blackburn.—The Electricity and Tramways committee report a loss on the electric tramways for the past year of about £6,000, and on the electricity undertaking of £1,000.

Blaenau.—The formal opening of the electricity works of the Yale Electric Power Co. took place on Thursday last. Turbine-driven generators are employed. Current for private lighting is supplied at 4d. per unit, and for power to quarries at 1d. The District Council take supply for public lighting and private consumers at 4d. for 15 years. Current was switched on by Lord Newborough, who afterwards presided at an inaugural banquet.

Bournemouth.—The Board of Trade have refused the Corporation's application for a provisional electrical lighting order for Pokesdown, but an order has been granted to the Bournemouth and Poole Electricity Supply Co. The Corporation will oppose the bill unless an agreement can be come to.

Bridlington.—The Council has resolved to instruct Mr. F. H. Medhurst, in conjunction with the borough engineer (Mr. Matthews), to prepare plans, specifications and estimates for carrying out the Bridlington Electric Lighting Order, 1900.

Burmah.—The city of Mandalay is to provided with electric tramways, the working and construction of the line having been granted to the Burmah Electric Works Co. (Ltd.). The construction of the work is to commence before Dec. 6, and is to be completed before Dec. 6, 1905.

Buxton.—For the year ended March 31 the total revenue of the electricity undertaking was £2,496. 10s. 3d., including £1,934 0s. 8d. from private and £500 from public lighting. There were 147,563 units generated, 109,100 were sold (88,700 for private and 20,400 for public lighting) and 9,298 units were used on works. There are 25 public arcs, and the connections to the mains are equivalent to 11,971 8 c.p. lamps. The maximum supply demanded was 180kw.

Cables in the East Indies.—Reuter's Agency states that in response to the report of the Second Chamber on the convention between Holland and Germany concerning cable communication between the East Indian colonies of the two nations, the Dutch Government declares that the convention guarantees the equal influence of the two contracting parties. A direct cable between Batavia and Manila would be too costly. To the French proposal of a cable between Batavia and Saigon, the Dutch Government has replied that it could not subsidise the scheme, but would be willing to hasten the construction of a cable between Batavia and Pontianak. The French Government has submitted a new proposal, which has been discussed in a conference between delegates of the two Governments.

Coronation Postal and Telegraphic Arrangements.—The postal and postal telegraph arrangements throughout the United Kingdom for June 26 will be the same as on Christmas Day in England. Offices will be open to the public during the same hours as on Sundays, and at offices not usually open on Sundays attendance will be given from 8 a.m. to 10 a.m. for general postal and telegraph business. Town sub-offices will be closed. One delivery both of letters and parcels will be made, and one collection for the night

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mail at the usual weekday hour. The arrangements for Friday, June 27, will be those regularly in force on Bank holidays.

Doncaster.—The electric tramway to Balby and Hexthorpe was officially inspected on Tuesday, by Major Druitt and Mr. A. P. Trotter, and the formal opening has been provisionally fixed for June 3.

Dudley.—An inquiry was held on Friday into the application of the Corporation to borrow £22,000 for electric lighting. The town clerk (Mr. H. C. Brettell) said the present loan was to enable the Corporation to meet their electric lighting obligations, and was the third in connection with the electrical undertaking. The first year's operations resulted in a loss of £80. 6s. 10d., and last year there was a net profit (after paying sinking fund and interest) of £92. The consulting engineer (Mr. Reginald P. Wilson) said the tramways were owned and operated by a company, but the Corporation had the right to purchase at the expiration of the lease. The company were under a perpetual arrangement to take current from the Corporation at a price to be determined every five years. The power station had now a capacity equal to 700kw., and to meet the increasing demand it was proposed to lay down a 500kw. steam dynamo, the remainder of the money being required for cables.

Edinburgh.—It was reported to the Electric Lighting committee on Tuesday, that for the first fortnight in May the applications for current represented 5,061 8 c.p. lamps for lighting and the equivalent of 1,416 for motors and 560 for heating. The following figures show the increased lamp connections since 1897:—1897-1898, 58,949; 1898-1899, 67,821; 1899-1900, 69,848; 1900-1901, 81,995; 1901-1902, 85,545.

Electricity in Mining.—At the annual meeting of the Institution of Mining Engineers yesterday (Thursday) the president (Mr. James S. Dixon), in the course of his presidential address, remarked that coal-cutting by machinery was making considerable progress in this country; electricity was becoming popular as an illuminant for mines, and he prophesied that in the future winding, pumping and other operations at mines would be carried on by electricity.

Exhibition.—The annual exhibition of work from the day, evening, continuation, truant, industrial, blind, deaf and special instruction schools of the School Board for London, and also typical classes at work in various practical branches, is to be held in the Examination Hall, Victoria Embankment, London, W.C., on Wednesday, June 18, and will continue open till the 21st. A large number of interesting exhibits will be shown in the various sections into which these are to be divided.

False Pretences.—At the Westminster (London) Police Court on Thursday, last week, William Neale, late storekeeper to the St. Pancras Borough Council, was charged with attempting to obtain money under false pretences from Messrs. Muirhead & Co, electrical engineers, Carteret-street, Westminster.

On the previous afternoon prisoner called at Messrs. Muirhead's office, and presented to Mr. Wilkins, the manager, what purported to be a list of subscribers towards an outing of men employed in the electric lighting department of the St. Pancras Council. Mr. Wilkins, seeing the document (including names of subscribers) was in one handwriting, told prisoner to call again. Inquiries were made by telephone, and on the return of prisoner Detective Harvey was waiting for him. Mr. J. T. Baron, resident engineer to the Council, said prisoner was discharged last April, and had no authority to collect subscriptions. Prisoner was remanded until yesterday (Thursday) when he was sentenced to six months' hard labour.

Faversham.—The General Purposes committee recently considered the report and estimates of the cost of establishing electricity works prepared by the consulting engineer (Mr. H. Talbot). The capital cost is put at £24,109, and a sub-committee recommends the Council to apply for sanction to borrow this amount. A canvass of ratepayers has been made, and of 626 papers sent out 135 were returned in favour and 35 against electric lighting, 457 being neutral. The sub-committee's recommendation was adopted.

Fire.—Various exaggerated accounts having appeared of the fire which occurred on one of the trains of the Liverpool Overhead Railway on Monday evening, the manager (Mr. S. B. Cottrell) states that neither the station nor the carriages composing the train were on fire. One of the magnets fused; the electric current was at once cut off and the ignition of cable extinguished by the station staff with little or no damage. The whole occurrence occupied a few minutes, and caused no dislocation of the service.

Great Yarmouth.—Trial trips are being run on the municipal electric tramways. The Board of Trade inspection will take place on June 18.

Helouan (Egypt).—Messrs. Thomas Cook & Son (Egypt), Ltd., are making arrangements for the erection of electricity works here. A contract has been entered into for public electric lighting, and an agreement has also been come to with the Cairo-Helouan Railway Co. and the Government. There is at present a small station which supplies current to the Grand and Tewfik Hotels and a few of the principal establishments, and this will be taken over by Messrs. Cook, who will effect considerable extensions.

Hammersmith (London).—A financial statement of the working of the electricity supply undertaking for the year ended March 31, has been supplied to the Borough Council. At the last meeting of the Council Mr. Bendon said the department had maintained its position in a satisfactory manner and had made a small profit.

Hull.—The annual financial statement of the electric lighting department was presented last week. The authorised loans amounted to £244,032. 7s. 10d., and the expenditure to £204,763. 18s. 9d. A reduction in the charge for current of ½d. per unit had been made, in anticipation of a substantial decrease in the price of coal. Owing to increase in rates and other causes the estimated profit had been wiped out, and for the first time in the history of the undertaking they had to report a deficit. The gross receipts were £24,512 5s. 9d., and the working expenditure £14,685. 7s. 1d., leaving £9,286. 13s. 8d., which had to be supplemented by £2,732. 16s. 10d. from reserve to meet interest and sinking fund instalment, amounting to £12,559. 10s. 6d.

Instruction to Elevated Railway Employés.—In a recent issue, the *Western Electrician* (Chicago), described a club and school room just brought into use by the North-Western Elevated Railroad Co., Chicago. In addition to a room containing the leading technical electrical journals, reading and writing tables, &c., there is a large room provided for instructing the men in the use of the braking appliances used on the company's cars. A large model of the apparatus fitted to a truck is arranged in a corner and compressed air is provided for the operation of the brakes. Large diagrams enable the details of the brake work to be explained. A controller for the car motors is also fixed, connected up to banks of coloured lamps which indicate the different effects of the operation. Lessons are given weekly, and the men are subsequently examined, and, if proficient, are put in charge of a train and are granted a certificate, which holds good for 12 months.

Kingston-on-Thames.—The eight annual report of the borough electrical engineer (Mr. J. E. Edgcome), just presented to the Council, states that works expenditure had been reduced from £6,387. 17s. to £5,836. 3s. 5d.; and revenue had increased from £6,562. 11s. 4d. to £7,378. 17s. 1d. The cost of fuel had been £680. 9s. 2d. less than in the previous year, while the total number of units sold had increased from 308,860 to 346,332. The gross profit had increased from £174. 14s. 4d. to £1,542. 13s. 8d. Interest had increased by £310. 1s. 4d., and sinking fund instalment by £631. 14s. 8d. The result of the year's working, after payment of interest and sinking fund, was a debit balance of £2,294. 18s. 4d., against £2,721. 1s. 8d. in 1901. The number of consumers during the 12 months had increased from 376 to 458. The equivalent number of 8 c.p. lamps connected had increased from 18,899 to 22,885, an increase of 3,000, against 2,769 in the preceding year. By means of the deferred payment system of house wiring, Mr. Edgcome hopes that a substantial increase in the number of consumers will be made, and he recommends the committee to also adopt a system of prepayment meters, which he feels sure would prove popular and be remunerative to the Corporation.

Leeds.—The receipts from the electric sections of the municipal tramways for the year 1901-2 amounted to £195,882. 13s. 7d., compared with £133,449. 11s. 5d. in the previous year. The running expenses were £92,719. 16s. 11d., and the administrative charges for the electric, horse and steam lines £26,025. 11s. 4d. The gross profit on the entire system was £81,144. 0s. 9d.; interest absorbed £19,829. 6s. 10d., and sinking fund charges came to £13,073. 8s., leaving a surplus of £48,241. 5s. 11d., against £31,058 last year. The following figures give the comparative cost and earning capacity of each system for the past two years:—

	Electric.	Steam.	Horse.
Cost per car-mile (1901-2) ...	6·63d.	10·41d.	10·29d.
Ditto (1900-1) ...	6·49d.	11·05d.	9 52d.
Earnings per car-mile (1901-2)	11·47d.	10 93d.	6·16d.
Ditto (1900-1)	12·77d.	12·12d.	7·42d.

Light Railways.—An inquiry was held at Preston on Tuesday into the application of the Electric Tramways Construction and Maintenance Co. to construct a light railway between Preston and Lytham. The scheme is a modification of that rejected in September last. Evidence in support was given, including that of the consulting engineer (Mr. H. J. Lawson), who said that the proposed capital of the Preston and Lytham Light Railway Co. was £230,000. The estimated cost of the undertaking was £137,209, leaving £170,000 for electrical equipment and rolling stock. The L. & Y. and L. & N.W. Railway Companies opposed, and on their behalf Mr. Page, K.C., pointed out that sec. 9 of the Light Railways Act provided that where injury would be done to an existing company authorised by Parliament, it reserved the right to itself to decide whether, in the public interest, that injury ought to be done. He submitted that the Commissioners had no power to deal with the application under the circumstances, as the injury would be great, and would have an injurious effect on the joint companies' services. The Commissioners upheld Mr. Page's contention, and rejected the application.

Gloucester City Council will apply for an order to construct and work light railways in the district, extending into the county area.

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The County Council is opposing and is itself also applying for powers, but the local authorities affected are supporting the City Council.

Gloucestershire County Council are applying for an order to construct and work light railways in Wotton St. Mary (Without), Barnwood, Hucclecote and Brockworth.

A syndicate proposes to apply for authority to construct a light electric railway between Burton and Ashby, a modification of the rejected Burton, Ashby and Swadlincote scheme.

Messrs. H. T. Spry, E. Andrews and W. H. D. Mewton are applying for power to incorporate a company to construct a light railway between Padstow and Mawgan, Cornwall.

Middlesex County Council will apply to the Light Railway Commissioners for an order (No. 1) authorising the construction of light railways in Willesden, St. John (Hampstead), Hendon, Wembley, Harrow, Northolt, Wealdstone, Harrow-Weald, Edgware, Little Stanmore and Great Stanmore; and also for an order (No. 2) to construct light railways in Hornsey and Wood Green.

Mr. Geo. Nevins is applying for an order to construct a light railway in Stroud and Gloucestershire over 28 miles in length.

Lieut.-Col. R. E. Crompton, John Trotter and C. F. Tufnell are applying for powers to construct light railways in Leicester, Gilroes, Beaumont Leys, Anstey Pastures, Anstey, Newtown Linford and Groby.

An inquiry was held at Ramsbottom on Wednesday into an application for an order to construct the Ramsbottom, Edenfield and Rawtenstall Light Railway, rather over 5 miles in length, at an estimated cost of £76,851, including £10,000 for the generating station. The promoters are, however, willing to take current from either the local authority or the Lancashire Electric Power Co. Opposition was offered by the Lancashire and Yorkshire Railway Co., and, after hearing the evidence, Col. Boughey said the Commissioners were satisfied that a line through Edenfield was greatly to be desired, but, in view of the decision of the Board of Trade in the Staines and Egham case, it would be useless to carry the application further, and the order was, therefore, refused.

Southend Corporation seek powers to construct light electric railways in Prittlewell and Southchurch.

An inquiry was held at Swansea last week into the application by Glamorgan County Council to construct light railways from the Swansea borough boundary to Morriston, through Clydach to Pontardawe. The line will be 5¾ miles in length, and the estimated cost is £38,000, with £6,110 for overhead equipment and £3,860 for feeders. £4,800 is provided for eight cars at £60 each, £2,000 is set apart for a tramcar shed, making £54,850. Road widening will cause an expenditure of £10,000. It was originally intended to obtain current from the South Wales Electrical Power Distribution Co. or from Swansea Corporation. The South Wales Company are prepared to enter into a lease something on the lines of that between the Middlesex County Council and the companies who work their lines, and they will pay a rent to at least cover interest and sinking fund charges. The County Council are also to share in the profits of the undertaking on terms to be arranged. Mr. J. E. Waller (Kincaid, Waller and Manville) said the railway was a natural extension of the Swansea tramways, and the estimates put in were reasonable. At the outside the working cost of the line should be ½d. per car-mile. Mr. Blandy Jenkins (chairman of the Glamorgan County Council), Mr. Sinnott (the county engineer) and Mr. E. L. Hill (general manager and secretary of the South Wales Electrical Power Distribution Co.) gave evidence in support. The Commissioners decided to recommend an order.

London United Tramways (Ltd.) are renewing their application for authority to construct electric tramways to Colnbrook, Slough, Taplow and Maidenhead with branches connecting the Great Bath Road with the Great Western Railway at Langley, and the South-Western Railway at Datchet-on-Thames.

Luton.—The total receipts of the electricity department for the nine months ended March 31 were £921. 14s., including £790. 14s. 9d. for current supplied for private lighting and power and £111. 7s. 5d. for public lighting; the total expenses were £787. 11s. 9d., leaving £134. 2s. 3d. Interest to date on loan amounted to £1,041. 11s. 2d., and sinking fund instalment to £760. The total capital expenditure is £25,165. 13s. During the nine months 53,129 units were generated; 10,338 were supplied to public lamps, 40,634 were sold to private consumers and 2,157 were used on the works. There are 10 arcs and 24 incandescents employed for public lighting, and the total maximum supply demanded was 92kw.

Mendoza (Argentina).—The Mendoza Gas Co. has stopped the public lighting service, for which the municipality refuse to pay. The yearly lighting costs $51,000, and the company is already a creditor for $84,000. Some time ago public electric lighting was stopped for the same reason.

Merthyr.—A report on dust destructors, prepared by Messrs. Handcock and Dykes, is under consideration by the Council. According to the report, three courses are open to the Council—viz., (1) To erect two dust destructors at £16,800, with an annual charge of £2,775, less revenue from clinker sales; (2) if suitable arrangements could be made with the Merthyr Electric Traction Co. to erect one destructor at Penydarren, selling the steam to the company, and the second at Pentrebach, at a capital cost of £17,100 and an annual charge of £482; and (3) to incur an outlay of £68,000 to £70,000 in erecting one large destructor at Pentrebach, with suitable power house, and laying down and equipping an electric line from Merthyr to Merthyr Vale, to enable the Council to dispose of refuse up to 160 tons per day free of expense to ratepayers. This latter scheme is estimated to leave an annual surplus of about £1,650 for repairs and reserve.

The Local Government Board have extended the time for completing the Merthyr Electric Traction and Lighting Co.'s lines.

Municipal Telephony.—Lancaster Town Council have informed the local Chamber of Commerce that they do not consider the present an opportune time to establish a municipal telephone service.

Swansea Municipal Telephone committee have obtained 398 signed agreements to support the proposed municipal service, as well as 117 written promises of support. The committee suggested £5 as a minimum charge, but the Postmaster-General has advised £4. The solicitors to the parties are to consult on this point.

Newstead (Notts.).—At a meeting of ratepayers on Tuesday, it was decided to adopt electric lighting.

Nottingham.—Clauses were inserted in the omnibus bill of the Corporation now before Parliament, empowering them to raise additional capital for the extension of their electricity undertakings, including boilers and generating plant for completing the equipment of the first section of the St. Ann's power station (£38,750), meters, house connections, &c. (£16,250), and extensions of mains (£30,000); also for the erection of an additional station in connection with refuse destructors (£2,000), generating machinery, cables, mains, switch gear and battery (£13,500), a total of £100,500. On the advice of the Parliamentary agents these clauses have now been withdrawn, the Corporation having decided to apply to the Local Government Board for sanction to borrow such moneys in the usual way. On Monday a recommendation will be submitted to the Council by the Electricity committee that application be made for sanction to borrow £20,000 for the St. Ann's station, and £13,500 for the second station.

Post Office London Telephone Service.—The Post Office telephone exchanges at Putney and Kingston were opened for public service last week, and the exchanges are both connected to the trunk telephone service of the country.

Presentations.—Mr. J. W. Kempster, on leaving Messrs. W. H. Allen, Son & Co., Bedford (where he has been chief electrician for 14 years), to take up a similar position with Messrs. Harland and Wolff, at Belfast, has been presented by the members of the firm with a collection of Sheffield plate over 100 years old, and by the staff with two etchings by Rone. During his connection with Messrs. Allen, Mr. Kempster has had 280 vessels in his hands for installing electric light, including the "Oceanic" and the "Celtic."

Mr. W. F. Stamp, A.M.I.E.E., late assistant electrical engineer at Wimbledon, having been appointed chief assistant at Devonport, was entertained by his friends at Frascati's Restaurant, London, last Thursday evening, when Mr. J. W. A. Binner, chief assistant at Bermondsey, presented him with a dressing case on behalf of those present. A silver cigarette case was presented by the working staff at Wimbledon works, an address from the men accompanying the gift. At a send-off on Saturday, Mr. Stamp received a further present from some personal friends.

Mr. W. A. Wilkes, assistant engineer of the Wolverhampton District Tramways Co. (Ltd.) was presented last week with a silver cigarette case and matchbox, on the occasion of his departure to take up the position of electrical engineer at Rothesay.

Projected London-Dover Electric Railway.—It is stated that as a result of preliminary surveys of the alternative routes for this railway (through Maidstone and through Chatham and Canterbury), the latter route has been selected. The promoting syndicate intend to put down a broad-gauge double line, the entire journey to be performed in 50 minutes.

Rochdale.—The first section of the municipal electric tramways was opened on Thursday last.

St. Anne's-on-Sea.—66 applications have been received for the position of resident engineer in succession to Mr. P. J. S. Tiddeman.

St. Helens (Isle of Wight).—The St. Helens Electric Lighting Co. are commencing the laying of lighting mains in the district.

Salford.—The Council have refused a request for legal assistance on behalf of Mr. Wheatcroft and Mr. C. L. Turner (late borough electrical engineer) at the forthcoming inquiry into the working and development of the electricity undertaking.

Southwark (London).—Up to date, the equivalent of 22,117 8 c.p. lamps has been connected to the electricity supply mains for lighting and 2,436 for power.

Spennymoor.—We refer elsewhere to the report of the directors of the Northern Counties Electricity Supply Co., owners of the

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Spennymoor electricity works, which have just been opened for the supply of current. The light was switched on by Mrs. Clark, wife of Mr. R. Clark (Messrs. Clark & Co., electricians, Spennymoor). Building operations were commenced about five months back, the building contract having been placed with Messrs. Douglas Bros., of Heaton-on-Tyne. The works cover an area of 5,000 sq. ft. The machinery and equipment includes Babcock boilers, Allen-Crompton generating sets, Dorman and Smith switchboards, Callender cables, and Chloride batteries. There are already between 2,000 and 3,000 lights connected up, and the Northern Counties Company have been invited to tender for the public lighting of the district in competition with the two local gas companies.

Stafford.—There was a deficiency of £1,100 on the working of the electricity department for the past year.

Sunderland.—The Electricity and Lighting committee are considering a scheme for the supply of electric current for power to the shipyards, large engineering works and graving docks of this important district. In 12 months it is estimated double the present output of the works will be required, which is now about 2,250,000 units per annum. The net profit upon last year's working was £1,938. The aggregrate profits of £4,015 for the last four years have enabled the committee to repay the money taken from the rates in the preceding three years, leaving a credit balance of £1,346.

Telegraphic Communication with Martinique.—It is announced that during the interruption of the direct cable route, telegrams for Martinique can be sent over the lines of the Eastern and the Direct Spanish Telegraph Companies or via France.

Telephone Trunk Lines and the Public.—The Postmaster-General was recently approached with the view to allowing attendants at the Post Office telephone call offices to accept written messages to be telephoned over the trunk lines when these were free, and to so save the long waiting at these call offices now so generally complained of. Having considered the matter, the Postmaster-General has replied regretting his inability to adopt the suggestion.

University College, London.—A conversazione will take place at University College on the evening of Thursday, June 19.

Zante.—Electric light has been introduced into this town under the patronage of the mayor, Mr. Macie.

TRADE NOTES AND NOTICES.

[Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.]

TENDERS INVITED.

The Board of Guardians of the pariah of *Fulham* (London) invite tenders for the supply, delivery and erection of pipework. Specifications, &c., from the consulting engineer (Mr. F. Hastings Medhurst, M.I.E.E.), 13, Victoria-street, London, S.W., and tenders to the clerk (Mr. Edward. J. Mott), 75, Fulham Palace-road, W., by 10 a.m. June 5. An advertisement gives further information.

The directors of the *North-Eastern Railway Co.* invite tenders for telegraph stores, particulars of which are set out in an advertisement. Tender forms of Mr. Graves, telegraph department, York, and tenders to Mr. C. N. Wilkinson, secretary, York, by noon June 9.

Glasgow Corporation invite tenders for 12 months' supply of electricity meters. Specifications, &c., from the chief electrical engineer (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow, and tenders to the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, by June 7. See advertisement.

Glasgow Corporation also invite tenders for an economiser with induced draught fan and condensing plant. Tenders by June 7.

Worksop Urban District Council are prepared to consider schemes for "free" or assisted wiring. Particulars, with form of proposed agreement, should be forwarded to the clerk (Mr. Geo. H. Featherston), Town Hall, Worksop, by June 10. See advertisement.

Rotherham Corporation invite tenders for tramway and laying feeders, mains and other cables, with road work, boilers and 320kw. steam dynamo. An advertisement contains further particulars. Specifications from the town clerk (Mr. H. Hampton Copnall), Town Hall, Rotherham, and specifications and drawings can be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster. Tenders to Mr. Copnall by noon June 17.

Warrington Corporation invite tenders for tramcars, with motors and electrical equipment complete. Specifications, &c., from the consulting engineers, Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster. Tenders, addressed to the town clerk (Mr. J. Lyon Whittle), Town Hall, Warrington, by noon June 18. An advertisement contains further particulars.

Warrington Corporation also invite tenders for illuminating the town hall and Bank Park by electric light. Tenders to chairman of Coronation committee by noon June 2.

Stockton-on-Tees Corporation invite tenders for the supply, delivery and erection of a 350kw. steam generator, two Lancashire boilers, one switchboard panel and instruments, surface condenser and cooling plant, pipework and valves, extension feeders, economisers and feed pump. Specifications from the borough electrical engineer (Mr. J. J. Smith) and tenders to the town clerk (Mr. Arthur B. Crosby) by noon, June 10. Further particulars are given in an advertisement.

London County Council invite tenders for wiring and fittings for the electric lighting of four fire brigade stations at Battersea and Camberwell. Tenders to clerk (Mr. G. L. Gomme), by 10 a.m. June 5.

The *War Office* invite tenders for a self-propelled lorry. Specifications from Director of Army Contracts, War Office, London, S.W., to whom tenders by noon July 31.

The Guardians of *Hunslet* Union (Leeds) require two electric ward lifts for new infirmary at Rothwell Haigh. Tenders by 10 a.m. June 3.

Stretford District Council invite tenders for steam-raising plant, generators and mains. Tenders to chairman of Electricity committee by June 18.

Greenock Corporation invite tenders for a 300kw. steam dynamo, with steam and exhaust piping. Tenders to burgh electrical engineer (Mr. W. M. Nelson), by 10 a.m. June 2.

Tynemouth Corporation invite tenders for one reversible booster and a set of condensing plant. Specifications from borough electrical engineer (Mr. C. Turnbull).

Bermondsey (London) Council require main switches, cutouts, distributing boards, electrical fittings and shades, casing, conduits, &c. Tenders by 4 p.m., June 16.

Manchester Electricity committee invite tenders for cast-iron troughing, bends and capping. Tenders by noon, June 9.

Nuneaton Electricity committee invite tenders for a water-tube boiler and pipework. Tenders by June 18.

West Ham Corporation invite tenders by June 10 for construction of about 8 miles of tramway permanent way, bonding, &c.

Bury (Lanca.) Tramways committee invite tenders by June 24 for tramway track material.

Beckenham Electric Lighting committee invite tenders for incandescent lamps. Tenders to chairman by noon June 6.

Dudley Electric Lighting committee invite tenders for incandescent lamps and oil. Tenders to chairman by noon June 6.

Hoylake and West Kirby District Council require electric lamps, oil, waste and engine-room stores for 12 months. Tenders by June 9.

Eastbourne Electric Light committee require a dry-back marine-type boiler and fittings. Tenders by June 6.

Worthing Corporation invite tenders for the erection of a circular brick chimney shaft. Tenders by noon June 16.

The Mayor and Aldermen of the City of *Launceston* (Tasmania) invite tenders for polyphase generating, transmitting and distributing plant and apparatus, transforming apparatus, re-construction of existing plant, and enclosed arc lamps and accessories. Specifications, &c., from the city electrical engineer (Mr. William Corin) or from Messrs. John Terry & Co., 7, Great Winchester-street, London, E.C. Tenders to town clerk (Mr. C. W. Rocher) by 4 p.m. Sept. 15.

Tenders are invited until June 8 by the municipal authorities of *Pradelles* (Haute Loire), France, for the establishment of electricity works. Tenders to La Mairie.

TENDERS RECEIVED AND ACCEPTED.

Southwark (London) Borough Council have accepted the tender of the General Electric Co. for the supply of 1,000 Robertson incandescent lamps at 11½d. per lamp (8, 16, and 25 c.p. lamps) and 1s. 2d. per 32 c.p. lamp. Jackson Bros. and Baxter and Caunter tendered for Ediswan lamps at 1s. 0½d. for 8, 16 and 25 c.p. and 1s. 2d. for 32 c.p.; the Edison and Swan Co. and Malcolm and Allen quoted 1s. 1d. and 1s. 3d.; and Royce Limited 1s. 2d. and 1s. 5d.

Prof. A. B. W. Kennedy, who was recently called in to report on the tenders submitted for steam dynamos for extensions to the Blackburn electricity works, has reported in favour of the acceptance of the tender of Messrs. Dick, Kerr & Co., which specifies Belliss engines. The Electric and Tramways committee have adopted this recommendation, subject to satisfactory guarantees as to steam consumption.

A contract for the supply of a storage battery has been placed with the Electrical Power Storage Co. by the Broughty Ferry Town Council.

Luton Town Council have accepted the tender of the St. Helens Cable Co. for the supply of distributing mains at £250. 16s. 4d. Ten tenders, varying in amount from that of the accepted to £399, were received.

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Barnsley Corporation have accepted the tender of the Electrical Power Storage Co. for the supply of a storage battery.

Fulham (London) Guardians have accepted the tender of Messrs. Williamson and Joseph for the supply and erection of a switchboard at £344. 9s. 13 firms submitted 17 tenders, the amounts varying from £316. 15s. to £605.

BUSINESS NOTICES.

The General Electric Co. announce a reduction in the price of Stanley-D'Arsonval moving coil deadbeat ammeters and voltmeters, and also in cheap lampholders designed for illuminating devices.

Mr. William M. Furniss, formerly with Messrs. Handley and Shanks, Birmingham, has been appointed representative of the Electric Construction Co. (Ltd.) in South Wales and district, with temporary offices at 70, Beauchamp-street, Riverside, Cardiff.

Mr. J. B. C. Kershaw, F.I.C., has opened the West Lancashire Laboratory, at Waterloo, Liverpool, where he intends to make a special feature of fuel and gas analysis.

Messrs. Gambrell Bros. have removed their office and works to more extensive premises at Durham House, 23, North Side, Clapham Common, S.W.

The registered address and general offices of the Charing Cross and Strand Electricity Supply Corporation (Ltd.) will be removed from 15, Maiden-lane, to 60, St. Martin's-lane, London, W.C., on and after 31st inst.

The Brush Electrical Engineering Co. are removing their London offices to their old address, Victoria Works, Belvedere-road, Lambeth, S.E., where communications should be sent after June 1.

LIQUIDATION.

The Electric Lamp Supply Co. (Ltd.) is being wound up voluntarily. Mr. A. M. Day, 33, Glasshouse-street, W., is liquidator.

Plant, &c., for Sale.—Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Leyton Electric Lighting committee, having adopted steam plant, wish to dispose of their gas-driven plant, including dynamos, gas engines, Dowson gas generators and accessories. Offers to the engineer and manager (Mr. F. Harman Lewis) by June 25. See advertisement.

Businesses, &c., for Sale.—The receiver and manager of the British Electrical Manufacturing Co. (Ltd.), Fulham Electric Works, Putney Bridge Station, S.W., advertises the undertaking for sale as a going concern, with the manufacturing plant and an extensive stock of switches, &c. Further particulars of Mr. James E. Ward, C.A., 122, Cannon-street, London, E.C., and 56, New-street, Birmingham.

The electrical patents and business recently carried on by the Doe Electric Light and Power Syndicate are for sale. Some particulars are set out in an advertisement.

Lightning Rods.—The American Consul at Rouen considers there is an excellent opportunity for introducing lightning rods into France, where there is a conspicuous absence of these protectors.

Catalogues.—The complete illustrated catalogue of the Genera Electric Co. is now to hand, and is a bulky volume made up of the various sections issued by the company from time to time, plus a quantity of added material, which goes to make up one of the most imposing and complete compendiums of electric machinery, plant, apparatus, material and accessories ever prepared for the use of the trade. A very careful classification of this vast array of goods is a feature of the book, and one which will be appreciated by those who are compelled to consult such volumes. Recent additions to the company's work's premises, in the Manchester district and elsewhere, justify the inclusion of a number of illustrations showing the extent to which the enterprise of the company has developed the business. At the works and branches over 5,000 hands find employment. In a book extending to over 900 closely-packed 4to pages a vast assortment of goods can be described and illustrated, and here the most has been made of the space at the command of the compilers. To help both the engineer and the retailer, the book has been divided up into 12 sections, and, in addition to the information which such lists usually contain, there has been provided a quantity of popularly written technical details as well as miscellaneous matter which will help to make the book easy of ready reference. We have referred in these columns, at the time of issue, to the various sections which go to make up the complete volume, and it is, therefore, not necessary now to particularise, but it may be pointed out that in almost every division of the book particulars are included of a number of patented articles which can only be obtained by the trade through the General Electric Co. We give below the sections into which the book is divided. It only remains to be stated that the printing and arrangement leave nothing to be desired, and that the General Electric Co.'s complete catalogue for 1902 forms a conspicuously successful continuation of the volumes which have been issued bi-annually by the company for nearly 20 years past. The sections of the book are :—

S. Switchboard and Electric Light [Supplies.	P. Electrical Plant.
W. Wires and Cables.	H. Electrical Heating and Cooking.
M. Instruments, Meters, &c.	L. Electric Bells, &c.
E. Arc Lamps and Engineering Specialities.	K. Telephones, &c.
	O. Electro-Medical Apparatus.
T. Traction Supplies.	F. and G. Fixtures and Glassware.

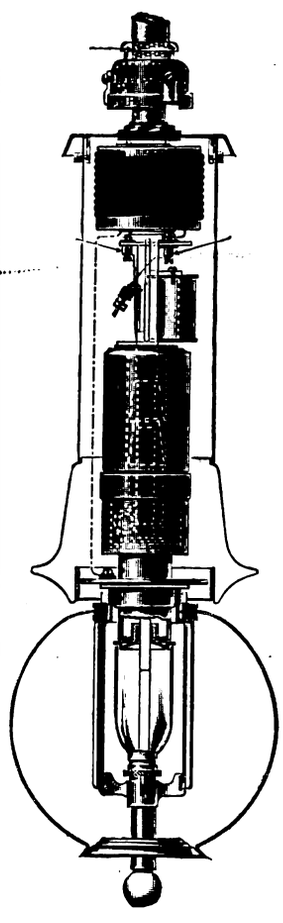
Messrs. Frederick Braby & Co. have ready a useful catalogue of corrugated iron roofing sheets, rustless airtight manhole covers, &c. The catalogue is well illustrated, and describes a large variety of goods, including complete temporary buildings, workshop and tramshed roofs, telegraph cable station buildings for hot climates, &c. Some particulars are also furnished of the "Barffing" process of rustless iron and steel, and it is stated that Messrs. Braby & Co., having satisfied themselves of the probable demand for articles in metal treated by this process, have put down large plant at Glasgow for working the process, by which it is claimed that a magnetic oxide (Fe_3O_4) is formed on the surface of the metal, completely preventing oxidation. This is not an added cover, as in galvanising, but the iron or steel is itself made rustless. The extent of the new plant enables a large tonnage of metal to be handled promptly.

Messrs. Fraser and Chalmers have ready a new catalougue of Riedler electric and power-driven pumps, for which the firm are sole licensees for Great Britain and the colonies.

A well got-up catalogue of high-class machine tools is just issued by Messrs. Alfred Herbert (Ltd.) of Coventry. A large and varied assortment of labour-saving and other tools is set out, and the list, which is pocket size, can be obtained free by post on application.

"Electric Brake Controllers, with Magnetic Blow-out" is the subject of pamphlet No. 124 issued by the British Thomson-Houston Co. Several examples of the "B" type of these controllers are shown.

Jandus Lamps.—Messrs. Drake and Gorham have recently received an order for 100 Jandus power-circuit lamps, five in series, on 440 volts, for illumination purposes at the forthcoming durbar at Delhi (India). We illustrate the automatic cut-out device of this lamp, which shows this to be a complete mechanism in itself, and, consequently, affords better protection to the main coils and maintains the continuity of circuit in event of the main mechanism failing better than if it were actuated by the main mechanism itself. Both line and substitutional resistances are inside the lamp case. A further advantage is that the lamps are interchangeable, any five out of the 100 lamps installed burning well in series. The carbons are claimed to be of long life, and the lamps are provided with a simple trimming device.



Messrs. Drake and Gorham have also received an order for Jandus lamps of standard type fitted with a special airtight case to meet the difficulties of the South African climate. This batch of lamps is required for Coronation illuminations at the Cape.

Westinghouse Brakes.—In a communication received from the Westinghouse Brake Co. denial is given to certain statements put in circulation relating to the alleged failure of the company's electro-pneumatic braking system. This failure was said to have been caused by the cold weather and snow in the United States last December. In the circular are set out reports from Boston, St. Louis and San Francisco, where these failures were alleged to have occurred. The company claim that it is proved by these reports that their electro-pneumatic system of power signalling has proved satisfactory in spite of the severe weather of the past winter, and that this success is further evidenced by the fact that the largest installation of power signalling yet introduced is on the electro-pneumatic system, and is being erected at Pittsburg for the Pennsylvania and Ohio Railroad. Accompanying the circular is a pamphlet very fully describing the Westinghouse electromagnetic system for the operation of railway points and signals, and examples are shown of a number of installations in this country and abroad.

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Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 22 to May 27, with the ports of destination :—

Africa—Alexandria, £370 : Beira, £241 (telegraph material) ; Cape Town, £15 ; Delagoa Bay, £47 ; Durban, £3,433 ; East London, £1,145 (including £476 telegraph material) ; Port Elizabeth, £256 (telegraph material). *Argentina*—Buenos Ayres, £200 (telegraph material). *Australasia*—Adelaide, £341 (including £242 telegraph cable) ; Fremantle, £240 ; Maryborough, £87 ; Melbourne, £855 ; Rockhampton, £51 ; Sydney, £601. *Azores*, £150 (telegraph instruments). *British Guiana*—Demerara, £35. *Canada*—Halifax, £40. *Ceylon*—Colombo, £58 (including £32 telegraph material). *China*—Foochow, £19 ; Shanghai, £228. *Denmark*—Copenhagen, £36 (including £11 telegraph wire). *Gibraltar*, £184 (telegraph material). *Holland*—Amsterdam, £58. *India*—Bombay, £453 (including £334 telegraph material) ; Calcutta, £6,138 (including £5,160 telegraph material). *Mexico*—Vera Cruz, £4,798. *Siam*—Bangkok, £140. *Straits Settlements*—Singapore, £81. Total (for six days), £20,300, against £22,955 for eight days last year (May 22 to 29).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, of 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Where not otherwise stated, the application is made in London.

March 6, 1902.

5,536. K. Anderson. Leeds. Electricity meters.
5,538. Calico Printers' Association and W. Cotsworth. Manchester. Electro-deposition of metals.
5,560. B. North. Bradford. Electric tramcars.
5,603. G. E. Heyl-Dia. Liverpool Electric cables and casings therefor
5,610. A. C. Cossor and W. U. Hilliar. High-frequency apparatus.
5,611. A. C. Cossor and H. S. Höhn. X-ray tube for therapeutic and dental work.
5,618. J. Beaver. (Caviera). Wireless telegraphy.*

March 7, 1902.

5,651. F. Smith. Manchester. Guard wires.
5,654. T. Corser. Manchester. Electric trolley wire finder.
5,656. H. S. Hunt. Stockton-on-Tees. Safety guard.
5,663. L. M. Waterhouse and Simplex Steel Conduit Co. Liverpool. Fuse boxes.*
5,668. W. R. Laidlaw and G. H. Scholes. Manchester. Pendants for electric lamps.
5,670. T. B. Stewart, W. H. Turner and R. E. Dixon. Controlling and operating electric railway and tramway points.
5,702. J. A. Thümling. Brake and speed controller for electric cars.
5,713. T. Bergmann. Electromagnetic igniter for explosion motors.*
5,715. P. A. Guye. Electrolytic cells.

March 8, 1902.

5,735. H. W. C. Cox. Electrolytic interrupters for X-ray work.
5,743. W. E. Layland and C. W. Dawson. Leeds. Trolleys.
5,779. R. F. Carey and J. Richmond & Co. Controller for electric lifts, tramcars, &c.
5,786. British Thomson-Houston Co. Reverse electric current relays. (E. M. Hewlett, U.S.)*
5,797. Marconi's Wireless Telegraph Co. and A. Gray. Wireless telegraphy.
5,802. Siemens Bros. & Co. Safety fuse appliance. (Siemens and Halske, A.-G., Germany.)*
5,804. L. H. Walter. Wireless electric selecting systems.
5,812. J. H. Woolliscroft. Liquid resistances or switches.
5,818. W. E. Evans. Preventing sudden alterations in periodicity in alternating-current generating plants. (A. E. G , Germany.)*
5,819. J. Holt, C. Holt and J. W. Powell. Birmingham. Hoists and cranes.

March 10, 1902.

5,831. R. C. Clinker. Rugby. Regulating electric currents.
5,851. H. Cooney. Liverpool. Prepayment supply controlling apparatus.*
5,862. J. Lundie. Rheostats. (Date applied for, Aug. 15, 1901, date of application in U.S.)*
5,888. L. S. Osman. Liverpool. Magneto-electric therapeutic appliances.
5,891. V. A. Arcioni. Electrical wattmeters.
5,897. J. W. T. Cadett and E. S. Shepherd. Circuit interrupter.
5,907. Hon. C. A. Parsons. Winding of revolving magnets.

March 11, 1902.

5,913. H. Beemer. Germany. Thermo-electric material.*
5,934. H. Waterson. Birmingham. Combination clock, battery and lamp, with self-contained case for same.
5,944. W. L. Wise. Telegraph systems. (J. H. Peirce, U.S.)*
5,952. W. P. Thompson. Arc lamps. (E. Sander, Germany.)
5,960. W. C. Hunniball and G. Carr. Charlton. Fuse box.
5,962. M. T. Medway. Gear for power-driven lifts.
5,972. E. Dannells. Electrical arrangement for exchanging signals between locomotives in motion, &c.*
5,978. A. Nodon. Rectifiers for single or polyphase alternating currents.
5,981. G. B. Blanchard. Rail bonds for electric railways.
5,982. H. Shoemaker. Telegraphy, particularly wireless systems.*
5,988. D. R. Bruce. Automatic cutout.
5,997. S. Z. de Ferranti. Controlling of electric circuits.
6,000. E. Eisemann. Liverpool. Electric ignition in explosion motors.*
6,009. L. G. Woolley. Fire alarm telegraph repeater apparatus.*
6,024. C. Oliver. Arc lamps.
6,026. J. M. Wilson. Magneto-electric generators.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

3,753. Andrews. Connections for electric conductors.
4,088. Le Mesurier. Safety device for overhead systems.
4,330. Dowsing. Contacts of incandescent electric lamps.
4,820. Duddell and Mather. Switching apparatus.
5,295. Cowan, Still and Miller. Guard wire protection.
5,343. Wright and Reason Mfg. Co. Actuating demand indicators.
5,562. Donaldson. Cutting out broken or short-circuited sections of trolley wires.
6,095. Burnand. Transformers and the like.
6,107. Heap and Smith. Electrical measuring instruments.
6,258. Glass. Electrical switches and like contact devices.
6,393. Wilkinson. Fixing roofs of electric tramcars.
6,946. Haddan (Strowger Automatic Telephone Exchange). Automatic telephone exchanges.
7,015. Jandus Arc Lamp and Electric Co. and Drake and Jones. Suspending mechanism for electric arc lamps.
7,371. Butler. Terminals or bolts and nuts for use in electric batteries as connectors.
7,966. Hill. Electro-pneumatic controlling systems. (Date applied for, Sept. 20, 1900.)
8,475. Lancashire Dynamo and Motor Co. and Wood. Brush holders.
8,478. Eckstein and Angold. Automatic shunt for protecting electric arc lamps.
8,936. Alliott and Paton. Electrically-driven centrifugal machines.
11,537. Jensen (Zanotta). Electric alarm apparatus.
16,175. Grenfell. Escapement for electro-magnetically controlled clocks and like mechanisms.
17,601. Watkins (Consolidated Railway Electric Lighting and Equipment Co.). Controlling electric currents.
17,811. En Holm. Electric clock.
21,337. Parment. Protective appliance for electrical conductors. (Date applied for March 27, 1901.)
22,795. Featherstone. Trolley heads.
25,747. Sachs. Electric fuse switch-boxes.
26,133. British Thomson-Houston Co. (Steinmetz). Glowers for pyro-electric lamps and process of making same. (Post-dated January 20, 1902.)
26,139. British Thomson-Houston Co. (Dean). Arc lamps and electrodes therfor. (Post-dated January 20, 1902.)
26,566. Mayberry. Party-line telephone system.
26,749. Siemens & Co. (Siemens and Halske A. G.). Electric safety fuses.

NEW COMPANIES, STATUTORY RETURNS, &c.

CITY AND SURREY ELECTRIC RAILWAY CO. (LTD.)—Reg. May 17, capital £150,000 in £10 shares, to carry on the business of an electric railway company, to undertake the construction, maintenance and working of electric and other railways and tramways and motors therefor, and their accessories and appurtenances, and to manufacture and deal in vehicles of all kinds and apparatus, producers and suppliers of electricity, &c. The subscribers are A. G. Ashwell, W. B. Langmore, W. Rigby, S. Strickland, S. G. Fraser, C.E., Bernard M. Drake (electrical engineer), R. B. Maltby, and C. S. Oxenburgh.

R. CRUICKSHANK (LTD.)—Reg. May 16, capital £30,000 in £1 shares, to acquire the businesses of chemical manufacturers, electrical engineers, &c., carried on as R. Cruickshank, at Birmingham. The first directors are G. B. Cruickshank (man.), W. A. Bindley and W. J. Gell. Reg. office, Camden Works, Camden-street, Birmingham.

DUNLOP MARINE COURSE SIGNAL SYNDICATE (LTD.)—Reg. May 21, capital £5,000 in £1 shares, to acquire inventions relating to marine signalling and apparatus therefor, and in particular to develop an invention of J. D. Dunlop, and to carry on the business of electrical and general engineers, &c. The first directors are J. D. Dunlop, J. McLees, and W. MacConnal.

FODENS (LIMITED.)—Reg. May 16, capital £100,000 in £1 shares, to acquire the business of Edward Foden, Sons & Co. (Ltd.), and to carry on the business of manufacturers of road locomotives and traction engines, self-propelled vehicles, &c., and manufacturers of electric, telegraphic and other appliances and apparatus, &c. The first directors are C. H. Brunner, E. Foden, W. Foden, E. R. Foden, J. Stubbs and R. Stubbs. Reg. office, Ekworth Works, Sandbach, Cheshire.

PRIVATE TELEPHONE CO. (LTD).—Reg. May 15, capital £10,000 in £1 shares, to acquire and turn to account inventions relating to private telephones, &c. The first directors are A. E. Whipp, S. Taylor, W. H. Feltham, E. Atkins, E. A. Gibson, E. H. Lamp, and A. Reiner. Reg. office, Dashwood House, London, E.C.

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ELECTRIC WORKS CO. (LTD.)—The return to Jan. 14 was filed on May 14. The capital is £10,000 in £1 shares, of which 507 have been taken up. 3s. per share has been called up on 500 and nothing on seven shares, and £75 has been received. Mortgages and charges nil.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 23 1/16d. per oz. (May 29). Consols (2¾ per cent.) 96⅞—96¾ for money, 96⅞—96¾ for account; 2½ per cent. 96—96½ (May 29). Consols Pay Day June 2; Stocks and Shares Continuation Days, June 10 and 23; Ticket Days, June 11 and 24; Pay Days, June 12 and 25; Mining Share Carry-over Days, June 9 and 20.

BARCELONA TRAMWAYS CO. (LTD.)—At the meeting on Wednesday the chairman (Mr. J. B. Concanon) said the traffic receipts showed a gross increase of £6,714, and the expenses an increase of £306. The company carried 33,787,925 passengers, an increase of 5,827,000 passengers, or 21 per cent., on an increased mileage of 4¾ per cent. There was no tramway in Europe with 11 miles of streets that carried anything like that number of passengers per mile of street. The receipts per mile had increased from 7 19/16d. to 7⅝d., and this figure was now over 8d. The average fare was probably lower than any in this kingdom, amounting to only a shade over ¾d. per passenger. The balance at credit of net revenue was £25,973. Debentures and debenture stock charges took £10,264, and preference dividend £5,000, leaving £10,709, out of which a dividend at the rate of 3 per cent. per annum (6s. per share) would absorb £6,000, leaving £4,709 for next account. Their Bonanova line was paying well, but the Ensanche system would have to be given up or be converted to electric traction, which would secure its success. For this and other purposes they propose to issue a further £51,900 debenture stock.

BRITISH INSULATED WIRE CO. (LTD.)—Subscriptions are invited until to-day (Friday) to an issue at par of £250,000 (balance of £500,000) 4½ per cent. first mortgage debenture stock of this company. The prospectus states that the amalgamation of the company's business with that of the Telegraph Manufacturing Co. (Ltd.) and the constantly-growing business of the two companies, requires the provision of this further capital.

BRUNNER, MOND & CO. (LTD.)—At the annual meeting, on Wednesday, the 7 per cent. preference dividend and 32½ per cent. on the ordinary shares were declared. The chairman (Sir John Brunner, M.P.) congratulated the shareholders on the result of the year's working, the gross profits being considerably in excess of those of the previous year. The company's investments showed holdings of £18,000 worth of shares in Mond's Gas Power Corporation and the South Staffordshire Mond Gas Co.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)—Subscriptions have been invited this week, and will be open until this (Friday) evening, to an issue of £10,000 "City undertaking" 4½ per cent. cumulative preference shares of £5 each. These are issued at par, and will be payable exclusively out of the net profits of the corporation's City undertaking, and of any present or future investments by the corporation in the share capital of the Charing Cross and City Electric Co. (Ltd.).

COLOMBO ELECTRIC TRAMWAYS AND LIGHTING CO. (LTD.)—The Anglo-American Debenture Corporation has offered during the week £100,000 of the stock of the Colombo Company at par.

ELECTRICAL FINANCE IN GERMANY.—A report from the British Chargé D'Affaires at Munich (Mr. John Ford) states that amongst 21 electrical companies in Germany, with a paid-up capital of £22,177,500, there has been a loss in value of shares from Jan. 1, 1899, to Oct., 19, 1901, of £13,540,500.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—The first annual meeting was held on Tuesday. The directors' report stated that, during the past year, works had been in construction at Blyth, Cowpen and Spennymoor, and designs for works at Alnwick and Hebburn had been prepared. The expenditure on those to Dec. 31 amounted to £22,130. 11s. 5d. The supply of current began at the end of 1901 from the Blyth and Cowpen works, and steady progress had since been made. Spennymoor was now ready to supply; Alnwick was expected to be ready in July; and Hebburn before the end of the year. The six provisional orders referred to in the prospectus were transferred to the company, which has obtained eight further orders. A contract had been entered into for working the Hebburn Council's provisional order, and application had been made for orders for additional places in the colliery districts of Northumberland and Durham, while a Northumberland tramways bill was being promoted. Since the end of the year the company had secured the transfer of the Whitley and Monkseaton provisional order, and had entered into a contract for working the Felling order similar to the contract for working Hebburn, with which it would be combined. The chairman (Mr. John D. Milburn) moved the adoption of the report, and spoke favourably of the Blyth works, which would gradually extend, and the same remark applied to Spennymoor. At those two places their early success had been largely due to the adoption of the penny-in-the-slot meter and "free" wiring. They had secured the whole of the public street lighting in Hebburn and Felling, and had obtained, or expected shortly to obtain, powers for Consett, Shotley Bridge, Annfield Plain, Stanley and Leadgate for a population of 100,000, for which they would erect a large power station.

RUSTON, PROCTOR & CO. (LTD.)—At Tuesday's meeting the directors' report, abstracted in our last issue, was adopted.

STOCK EXCHANGE NOTICES.—June 11 has been appointed a special settling day in the further issue of 7,264 fully-paid £1 shares of *Marconi's Wireless Telegraph Co. (Ltd.)*, and $397,000 additional 33-year consolidated mortgage 5 per cent. gold coupon bonds of 1906 of $1,000 each of the *Milwaukee Electric Light Co.* are to be quoted in the official list.

JOHN I. THORNYCROFT & CO. (LTD.)—The first annual meeting was held last week. The trading profit was £17,479, from which is deducted depreciation on plant, &c., directors' fees, preference dividend, &c., amounting to £14,530, leaving £2,949. A 5 per cent. dividend on the ordinary shares (£2,038) was recommended, leaving £354 to be carried forward. The chairman (Mr. W. Beardmore) said that they had purchased a rather valuable oil engine patent for marine purposes. They had just built an electric power engine of a novel design, which they intended exhibiting at the Agricultural Hall, London, in July. The directors were of opinion that the design was a good one, and that they might develop a trade in electrical power engines.

WOKING ELECTRIC SUPPLY CO. (LTD.)—At the meeting last week the directors reported that the revenue from sale of current and meter rentals was £4,466. 15s., compared with £4,002. 5s. 11d. in 1900. As the company ceased to supply current for public lighting in May last, and the Inkerman Barracks were unoccupied for the latter half of the year, the directors consider the increase in revenue satisfactory. The full benefit was not derived from the new plant till late in the year, owing to delay in delivery. At the beginning of 1901 the total number of 8 c.p. lamps on circuit was 11,400, and this figure had increased by the end of March last to 15,889, the number of customers increasing from 294 to 417. During the year £3,400 4½ per cent. debentures and £8,790 6 per cent. cumulative preference shares were issued to meet expenditure upon new machinery, boilers, cables, &c. The chairman (Mr. J. Ashby) said the directors were sorry they were not yet able to declare a dividend, but that would come soon. The present number of equivalent 8 c.p. lamps was 16,252, and 800 more were waiting connection. The number of customers had now increased to 460.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	May 24	770	+ 82	51	36,121	+ 2,190
Ayr Corporation	„ 24	261	...	1	261	...
*Birmingham Tramways.	„ 24	5,314	+ 431	20	93,354	+28,781
*Blackburn Corporation..	„ 23	993	+ 302	21	13,803	+ 1,748
Blackpool Corporation...	„ 22	1,166	+ 729	8	4,264	+ 794
Blackpool and Fleetwood	„ 24	1,357	+ 925	21	6,227	+ 1,096
Bolton Corporation	„ 25	2,085	+ 645	8	12,260	+ 456
Bradford Corporation ...	„ 18	2,828	+1,832	7	21,209	+14,366
Brighton Corporation ...	„ 25	952	...	26	15,478	...
Brisbane Tramways.....	Apl. 9	2,294	+ 125	15	34,898	+ 3,677
*Bristol Trams & Carriage	May 23	5,779	+1,099	20	84,070	+ 5,203
Burnley Corporation ...	„ 24	786	+ 333	‡8	5,394	+ 1,714
*Buenos Ayres & Belgrano	Apl. 27	2,762	- 8	17	46,051	- 1,060
Calcutta Tramways Co...	May 24	R21,147	+R2,461	21	R463,616	+R43,133
*Cardiff Corporation	„ 24	1,727	...	...	...	...
Carlisle Tramways Co....	„ 24	194	+ 3	†21	2,867	+ 21
Central London Railway	„ 24	6,899	+ 733	21	140,668	+10,565
City & South London Ry.	„ 25	2,884	+ 1,039	21	62,470	+20,858
Cork Elec. Tramways Co.	„ 22	585	- 37	§20	8,426	+ 211
Devonport & Dist. Trams	„ 16	406	...	19½	7,537	...
Dover Corporation	„ 24	259	+ 54	8	1,554	- 108
Dublin & Lucan Railway	„ 25	153	+ 27	21	2,002	+ 147
Dublin Southern Dist....	„ 23	1,499	+ 533	¶20	16,192	+ 4,478
Dublin United	„ 23	4,017	+ 163	¶20	70,995	
Dudley—Stourbridge ...	„ 16	677	+ 1	19½	12,778	+ 2,096
*Dundee Corporation ...	„ 21	725	+ 4	...	...	...
East Ham Council	...	...	...	...	...	...
Gateshead & Dist. Trams	„ 16	691	+ 256	19½	12,564	+ 323
Glasgow Corporation ...	„ 24	11,940	+ 104	...	...	...
Greenock & Port Glasgow	„ 16	528	+ 313	19½	8,015	+ 4,535
Hartlepool Tramways ..	„ 16	226	...	19½	3,889	+ 231
Hull Corporation	„ 24	1,811	+ 222	8	13,214	+ 312
Isle of Thanet Co.	...	...	...	...	...	...
Kidderminster & Dist....	„ 16	103	- 13	19½	1,933	+ 133
*Liverpool Corporation...	„ 18	9,131	- 761	20	179,303	+14,717
Liverpool Overhead Rly.	„ 25	1,797	+ 232	‡21	29,887	- 2,489
Manchester Corporation	„ 24	3,151	..	§50	105,259	...
Merthyr.....	„ 16	184	- 63	19½	3,704	- 536
Middleton	„ 16	272	...	7½	2,111	...
Newcastle-on-Tyne Corp	„ 24	2,964	...	...	...	...
Oldham, Ashton & Hyde.	„ 16	509	- 14	19½	9,235	...
Perth (W.A.) Elec. Trams	„ 23	1,042	+ 227	‡47	46,228	+14,899
Poole & Dist.....	„ 16	225	- 47	19½	4,076	- 9
Portsmouth Corporation	...	...	...	...	...	...
Potteries	„ 16	1,437	+ 10	19½	26,968	+ 1,055
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ..	„ 25	5 007	+ 435	21	78 858	+14,250
Southampton Corporat'n	„ 22	1,075	+ 277	20	16,503	+ 3,211
Southport Tramways ...	„ 16	220	- 9	19½	3,317	+ 896
*S. Staffordshire Trams...	„ 16	738	- 54	19½	14,248	+ 586
Sunderland Corporation.	„ 25	1,488	...	8	8,579	...
Swansea Trams.....	„ 16	433	+ 29	19½	8,069	+ 752
Taunton Trams.....	„ 16	66	...	19½	1,079	...
Tynemouth & Dist.	„ 16	202	- 28	19½	3,895	+ 203
Wigan Corporation	„ 22	310	+ 217	...	...	...
Wolverhampton District	„ 16	135	+ 81	19½	2,620	+ 1,682

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 21.	Price Wednesday, May 28.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 28. Highest	Lowest
			ELECTRICITY SUPPLY.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½ ⅛	½ ⅛	..		..	..
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100 104	100 104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11 12	11 12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9⅛ 10⅛	9⅛ 10⅛	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103 106	103 106	6 5 2	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9 9⅛	8⅞ 9⅛	4 6 6	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8⅞ 9⅛	8⅞ 9⅛	3 15 8	March and September	...	...
10,000	5	3/6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8 9	8 9	3 6 8	...	8⅞	8⅞
10,000	5	3/4⅜	Do (Nos. 20,001-30,000)	8 9	8 9		...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock xd	106 108	104 106	3 15 6	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9 10	9 10	5 0 0	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...	..	...	...
70,000	5	2/8	Do. 4½ per Cent. Preference	5½ 6⅜	5½ 6⅜	3 18 3	,, ,,	5⅛	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105 107	105 107	3 15 6	...	106¼	105
44,426	5	1/0	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5 5½	5 5½	3 12 9	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 113	110 113	4 0 2	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8 9	8 9	5 5 7	February and August	⅝	⅝
40,000	10	6/0	Do. 5 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 128	123 123	3 18 10	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103 106	103 106	4 6 0	...	-	...
40,000	10	6/0	County of London and Brush Prov. Ordinary	8 9	7½ 8½	4 14 2	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	107 110	108 111	4 2 6	...	109½	109½
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5⅝ 6½	6⅛ 6½	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½ 6⅝	6½ 6⅝	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...	...
£115,000	Stock	4%	Kenstn. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104 107	104 107	3 14 11	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1½ 1⅝	1½ 1⅝	...	...	...	...
25,000	5	3/0	Do. 6 per Cent. Preference	4 4½	4 4½	6 13 4	...	...	...
£150,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95 100	95 100	4 0 4	Mar., June, Sept., Dec.	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16½ 17½	16⅛ 17⅛	3 14 4	April and October	17⅛	16⅛
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 115	111 115	3 18 2	June and December	...	...
£350,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95 101	98 101	3 10 4	...	99⅜	...
10,852	10	6/0	Notting Hill Electric Ordinary	14 15	14 15	4 0 0	March	...	...
12,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	93 101	98 101	3 19 3	...	100½	...
300,000	1	...	Rand Electric	⅛ ⅛	⅛ ⅛	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70 75	70 75	...	January and July	70½	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103 105	103 105	4 6 9	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8⅝ 9⅛	8⅝ 9⅛	3 13 8	,, ,,	8⅛	...
£150,000	Stock	3½%	Do. 3½ per Cent Debenture Stock (red.)	98 101	98 101	3 9 6	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1½ 2½	1½ 2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2⅜ 3⅛	3 3⅛	...	...	...	...
110,000	5	5 6	Westminster Electric Supply Ordinary	11 12	11 12	4 7 6	March and September	1⅛	1 ⅛
28,141	5	...	Do. 5 per Cent. Cumulative Preference	3½ 4	3⅝ 4	...	...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4 4½	4 4½	4 14 2	April and October	4½	4⅛
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	127 132	127 132	4 12 7	...	...	...
20,000	10	...	Barcelona Tramways Ordinary	8 9	8 9	...	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	8 9	8 9	5 11 1	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95 100	95 100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½ 14½	13½ 14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3 3⅛	3 3½	...	...	4⅛	3½
75,000	5	2/6	Do. 5% Cum. Pref.	4½ 5	4½ 5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	104 107	104 107	4 4 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	107 110	106 108	3 14 1	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	6⅞ 7⅛	7 7⅛	2 13 4	...	7⅛	7⅛
20,000	10	5/0	Do. 5% Preference	9½ 10	9⅝ 10⅛	4 17 6	May and November	9⅝	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102¼ 104¼	102⅝ 104⅞	4 6 9	...	...	...
100,000	10	6/0	British Electric Traction Ordinary	13½ 14½	13⅝ 14⅛	6 4 2	...	14½	14
100,000	10	6/0	Do. 6% Cum. Pref.	12½ 12⅝	12⅛ 13	4 12 4	February and August	12⅝	1 ½
£500,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126	...
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅛ 1⅜	1⅛ 1⅜	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅜ 5⅛	4⅜ 5⅛	5 14 3	...	...	...
27,500	5	10/0	Do. "B"	4⅜ 5⅛	4⅜ 5⅛	5 14 3	...	4 13/16	4⅜
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 4	...	105	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 0	...	...	...
34,440	10	6/0	Calcutta Tramways (Nos. 1 to 34,440) ... ex rights	14 15	12½ 13⅛	2 4 6	...	14 7/16	14⅛
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107 109	107 109	4 3 7	...	1 8½	10⅞
440,000	1	1/2⅝	Cape Electric Tramways Shares	2⅝ 2⅝	2⅝ 2⅝	3 16 2	...	2⅞	2⅞
£1,800,000	Stock	4%	Central London Ordinary Stock	103 106	103 106	3 15 11	June and December	105½	104⅜
£494,093	Stock	4%	Do. 4% Preferred Stock	103 106	103 106	3 15 11	...	1 5½	10⅛
£491,993	Stock	4%	Do. Deferred Stock	100 103	100 103	3 17 11	...	102¼	10 ½
£695,201	100	4%	Do. 4% Deb.	116 118	116 118	3 8 0	...	1 7½	117
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5⅛	5 5⅛	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...	...
£ 330,000	Stock	2½%	City and South London Railway Con. Ordinary	73 75	71 74	2 11 1	February and August	75	72
37,500	10	1/0⅛	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	,, ,,	...	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	... ...	... ...	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 15 5	,, ,,	...	...
£400,000	Stock	5%	Do. (1896)	125 128	125 128	3 18 4	...	127½	...
£150,000	Stock	...	Do. (1901)	120 124	120 124	...	...	...	...
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	113 117	113 117	3 10 2	May and November	116⅜	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11½ 12⅜	12 13	3 16 11	...	12½	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½ 15⅛	14½ 15⅛	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...	...
30,000	5	6,0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4 4⅛	4 4⅛	6 13 4	...	...	...
£75,000	Stock	40/8	Do. 5 per Cent. Debenture Stock (red.)	101 104	101 104	4 13 2	...	...	...
78,000	10	8,0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	...	8⅛	...
30,000	10	8%	†Imperial Tramways Ordinary	26½ 27½	27 28	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½ 14	13½ 14	4 5 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110 112	110 112	4 0 6	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	... ...	4½ 5	...	...	4½	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4 13/16 4 15/16	4 13/16 4 15/16	3 0 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10½ 11	10½ 11	4 11 1	...	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98 99	98 99	4 0 10	January and July	...	...
51,561	10	..	London United Trams 5% Cum. Pref. (£10 paid)	10½ 11	10½ 11	...	,, ,,	...	...
10,999	10	...	Do. (£5 paid)	5½ 6	5½ 6	...	...	...	...
£655,341	Stock	...	Do. 4% 1st Mortgage Debenture Stock	105 107	105 107	...	...	105½	105½
£169,659	Stock	...	Do. Prov. Certs. (£50 paid)	54 56	54 56	...	...	...	...
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	111 115	111 115	4 6 11	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908)	104 106	104 106	4 14 9	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	103 105	103 105	4 5 10	...	...	...
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 13 4	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3 4	3 4	7 10 0	May	3⅜	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93 100	96 100	5 0 0	...	...	...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stck.	100 103	100 103	4 12 9	...	102	...
£3,334	10	8/0	Potteries Electric Traction Ordinary	9½ 10⅛	9½ 10⅛	3 16 2	...	...	...
20,000	10	5,0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	...	...
£120,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	105 108	107 110	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	... ...	... ...	...	...	...	...
51,182	1	...	Do. 6% Preference (12/0 paid)	... ...	... ...	...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	... ...	... ...	...	January and July	...	...
£500,000	Stock	...	Do. 4½% Debenture Stock (60% paid)	... ...	... ...	...	June and December	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	91 94	92 95	3 3 5			

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Shares.	Last Dividend.	Name.	Previous Week's Price, May 21.		Price Wednesday, May 28.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 28.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£32,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3½	4½	3½	4½	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...		...	...
£78,840	Stock	12/6	Anglo-American	44	47	44	47	5 19 5	Feb., May, Aug., Nov.	...	...
£3,105,580	Stock	25/0	Do. Preferred	88	90	88	90	6 9 2	" "	89½	88
£3,105,580	Stock	2/0	Do. Deferred	7	7½	7	7½	1 6 8	" "	...	...
$13,333,300	$100	$1½	Commercial Cable Capital Stock	150	160	159	161	5 0 0	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	93	96	93	96	4 3 4	" "	93	94
16,000	10	4/0	Cuba Submarine Ordinary	4	5	4½	5½	7 5 6	February and August	4½	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½	15½	12½	13½	7 8 2	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2½	3½	2½	3½	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8½	9½	8½	9½	5 5 3	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	98%	102%	98%	102%	4 8 3	January and July	...	...
60,710	20	3/0	Direct United States Cable	9½	10½	9½	10½	6 3 10	Jan., Apr., July, Oct.	...	...
£101,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200) (red.)	117	127	117	127	5 10 3	Jan., Apr., July, Oct.	12[illegible]	117
£1,930,807	Stock	17/6	Do. 3½ per Cent. Preference Stock	85	88	86	89	3 19 5	" "	88	87½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	106	110	106	110	3 12 9	May and November	109	107½
300,000	10	6/6	Eastern Extension	12½	13½	12½	13½	5 3 8	Jan., Apr., July, Oct.	13½	12½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	112	107	112	3 11 10	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 17 4	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	99%	102%	99%	103%	3 18 5	May and November	...	...
150,000	10	20/0	Great Northern of Copenhagen	26	23	26	28	5 7 2	January and July	...	...
£75,000	100	4½%	Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos	99	103	99	103	4 8 3	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	37	41	37	41	6 1 11	May and November	38½	...
£100,000	100	0%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 7	June and December	...	...
15,609	10	...	*West African Telegraph Shares	2½	3½	3½	4½	...		...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99	102	99	102	4 19 0	March and September	...	...
30,008	2½	...	West Coast of America	⅛	⅜	⅛	⅜	...		...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅛	⅜	⅛	⅜	...	May and November	...	...
34,563	10	£/0	Do. 6 per Cent. 1st Pref. 6/0 on a/c of arrears	5½	6	5½	5⅞	10 8 8	" "	5⅞	5½
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅜	4⅛	3⅜	4⅛	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	101	104	101	104	4 16 8	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	11½	12½	11½	12½	5 16 4	Mar., June, Oct., Dec.	12½	11½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 3	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 18 5	...	101⅛	100
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3½	4	3½	4	6 5 0	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	½	½	½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	½	1	½	1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	...	...
200,000	5	0/1½	Do. Preferred Shares (£3. 17s. paid)	3½	3⅝	3½	3⅝	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	55	59	53	57	7 17 11	...	54⅞	53½
15,000	£5	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	14	12	14	4 5 9	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	12	14	4 5 9	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	5	5½	4 16 2	" "	5 7/16	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	94	97	94	97	3 12 5	June and December	...	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	103	107	103	107	3 15 8	...	...	...
171,504	1	0/8	Oriental	15/16	1 1/16	15/16	1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	4½	5	4⅝	5	7 0 0	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅝	5	4⅝	5	5 0 0	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 8	June and December	...	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜	⅝	⅜	⅝	5 14 3	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅜	⅝	⅜	⅝	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜	⅝	⅜	⅝	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	8	9	8	9	8 6 8	July and February	...	...
70,000	5	3/0	Do. 6 per Cent. Preference	5½	5⅞	5½	5⅞	5 4 0	January and July	...	...
£250,000	Stock	50/3	Do. 4½% 1st Mort. Deb. Red.	102	105	101	104	4 6 6	...	...	...
150,000	5	3/0	British Westinghouse 6% Preference	5⅜	5⅞	5⅜	6	5 0 0	...	1 15/16	5½
105,731	2	...	Brush Electrical Engineering	⅞	1¼	⅞	1¼	...	March	...	...
150,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	1⅝	2	1⅝	2¼	...	March and September	2	1⅞
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	101	104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	95	100	95	100	4 10 0	January and July	93	...
30,000	5	5/0	Callender's Cable Construction Ord.	17	18	17	18	4 3 4	" "	17½	17½
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	" "	6	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111	115	111	115	3 18 4	November and May	...	...
450,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid) xd	⅞	1⅛	⅞	1⅛	5 6 8	...	1	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	90	95	90	95	4 16 0	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	8 0 0	March	...	...
185,000	3	1/9½	Crompton and Co. (Nos. 1 to 54,000)	3	3½	3	3½	6 8 6	January and July	3 5/16	3½
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103%	108%	103%	108%	4 12 8	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜	⅝	⅜	⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	2	3	2	3	...	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	75	80	75	80	5 1 3	June and December	...	...
35,500	5	2/6	Edmundson's Electricity Corporation Ord.	6½	6¾	6½	6¾	5 3 8	Half-yearly	...	...
120,000	5	3/0	Do. 6% Cumulative Preference	6	6⅜	5½	6½	4 16 0	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	107	110	4 2 7	...	...	...
112,100	2	1/2½	Electric Construction Co.	1½	1¾	1½	1¾	6 17 2	January and July	1⅜	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅜	3	2½	3	4 13 4	July	2 13/16	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97	101	97	101	3 19 3	January and July	...	...
122,585	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾	1¼	¾	1¼	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	9½	10⅛	9½	10⅛	4 17	...	10⅛	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	93	101	93	101	3 19 3	...	...	...
35,000	5	10/0	Henley's Telegraph Works Ordinary	17	18	17	18	4 3 4	February and August	17 1/16	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	115	111	115	3 18 3	" "	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21 1/16	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34	37	34	37	6 9 8	March and July	35½	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	106	3 15 5	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	10	11	10	11	5 9 1	...	1 1/2	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
66,666	5	5/0	Willans and Robinson Ordinary	...		...		...	April and October	...	...
66,666	5	3/0	Do. 6 per Cent. Cumulative Pref.	...		...		...	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	...		...		...	May and November	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5½	5⅝	5½	5⅝	5 9 1	...	...	...
180,227	10	2/6	Globe Telegraph and Trust	8	9	8	9	5 16 8	Jan., Apr., July, Oct.	8 1/16	8 5/16
120,042	10	3/0	Do. 6 per Cent. Preference	12½	13½	12½	13½	4 8 11	" "	13⅜	12½
11,239	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

ALTHOUGH the postponement of Mr. MARCONI'S discourse, arranged for Friday evening last at the Royal Institution, must have keenly disappointed all interested in wireless telegraphy, the discourse provided as a substitute by Prof. FLEMING lifted from the minds of his hearers all regrets. Prof. FLEMING, in a style surpassingly lucid, sketched to a large audience the electronic theory of electricity. He began by showing and discussing in turn the radiant matter in a Crookes tube, the discharging by ultra-violet light of bodies negatively electrified, and the emission of negatively-electrified particles from the hot filament of an incandescent lamp. In each of these cases the existence of extremely minute negatively-charged particles called ions has been established, and their mass and the magnitude of their charge has been estimated. The mass of the ions which constitute radiant matter, which are emitted from metals illuminated by ultra-violet light, and from heated bodies, is the same in all these cases, and is one-thousandth part of the mass of the hydrogen atom dealt with in electrolysis. But the charge carried by the ions, by whatever means these are produced, is the same in magnitude as that carried by the hydrogen atom in electrolysis—namely, about 23×10^{-10} coulombs. This small quantity is Nature's unit of electricity, and has been named the electron.

WHERE do the electrons, or negative ions, come from? To answer this question the lecturer took J. J. THOMSON'S hypothesis, which imagines an atom as consisting of a nucleus clothed by negative ions. Thus an atom less an electron is positive, and may be called a positive ion; and while negative ions, however produced, are all the same, positive ions differ according to the nature of the matter which they constitute when aggregated. Upon this hypothesis, Prof. FLEMING showed that many electrical phenomena can be elucidated. For example, conductors and non-conductors are respectively substances in which the electrons move freely or with difficulty. The electrons diffuse through matter by threading about between the atoms or molecules while these are vibrating with that motion we call heat. Cool a metal, they pass about more freely than before, or, in other words, the electrical conductivity is now greater. And just as it is easiest to cross a busy street when the traffic is at a standstill, so in a metal at absolute zero the electrons pass along more easily than at higher temperatures. But as the atoms are always present, the resistance can never vanish. In different substances the prevailing rates of diffusion are different. Therefore, if two different substances be placed in contact, diffusion of electrons takes place across the junction with unequal rates in opposite directions, just as on occasion more travellers may cross to France than to England. And this process will continue till an electronic pressure is set up which tends to equalise the rates of diffusion. Thus VOLTA'S "contact electricity" is explained. Further, if a piece of copper and a piece of zinc be touched together and then dipped in acidulated water, a flow of positive hydrogen ions starts towards the copper to unite with its surplus of electrons, and thus, if the plates be joined to make a voltaic cell, a continual diffusion of electrons takes place round the circuit, passing from the zinc to the copper through their junction. The old question as to the whereabouts of the seat of the E.M.F. is thus answered. It is equally in all parts of the circuit.

PROF. FLEMING then described how the electronic theory had been applied to account for the observed connection between sun-spots and auroræ. In solar eruptions, which are signalled by sun-spots, quantities of matter are projected from the sun. Any particle is acted upon in opposite directions by the sun's gravitation and by the Maxwellian light-pressure. The smaller the particles the greater becomes the ratio of the latter force to the former. Hence the smallest particles are pushed away into space. Thus great gusts of electrons may be imagined as streaming at these sun-spot periods from the sun. Those which enter the earth's magnetic field will, as is observed in cathode ray experiments, wind

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spirally round the lines of magnetic force, and so descend towards the poles. When, finally, they reach those layers of our atmosphere whose density is that of a low vacuum tube, they produce those luminous effects in circles round the poles familiar to us as auroræ.

Apropos of the suggestion that the resistance of a conductor to electric flow is due to the clogging action of the moving atoms, it occurs to us that if this is the case there must be a time-lag between the change of resistance and the change of local temperature in any small volume-element of the conductor. Consider, first, the conductor to be at absolute zero of temperature, and that the conductor is a simple metal. We know that theoretically the resistance falls to zero at this temperature, but it is evident that if any given small volume-element of a conductor could be instantaneously cooled to zero its electrical resistance would not instantaneously fall to zero. There would be a brief interval of time during which the bombardment of the electrons streaming through the conductor would be knocking the atoms of metal into a position more favourable to a clear flow of electrons. Indeed, it would only be when the electrons had succeeded in clearing straight-through passages between the stationary atoms that the electrical resistance could be said to have fallen to absolute zero. And if this is the case where any volume element of conductor is instantaneously cooled to zero, it is also and proportionately the case when any instantaneous change of temperature occurs. The general inference, therefore, is that in any element of an electrical conductor there is a true time-lag of the local steady resistance behind the local steady temperature. Probably, however, the maximum period of the lag is an immeasurably small fraction of a second.

Our esteemed contemporary the *Journal of Gas Lighting*, although admittedly the leading light in the gas world, is often more misled than leading when it enters the field of electrical enterprise. Usually, when discussing electrical affairs, it essays to correct the erroneous impressions its readers may have allowed themselves by reading the electrical press, as to lighting matters; but in its last issue it seeks to put us all right on the question of electric traction. What electric traction may have to do with gas lighting it is somewhat puzzling to discover; but, be that as it may, our contemporary, after nearly a column of argument, appears to have persuaded itself, and tries to persuade its readers, that "electric power, which cannot beat steam on main lines of railways, cannot beat horses on town tramways, from the point of view of remuneration." Tell that to tramway managers who have tried both horses and electricity; see what answer they will give. The almost universal effect of the replacement of the horse car by the trolley car has been permanently to double the traffic and to reduce the expenditure to below 50 per cent. of the receipts. In America, Europe, the United Kingdom, everywhere it has been the same. Balance-sheet after balance-sheet proves it. Why, then, does our usually careful and cautious contemporary talk so foolishly?

Herren Müller and Friedberger in a recent issue of the *Zeitschrift für Elektrochemie* describe laboratory experiments relating to the electrolytic production of persulphates. After pointing out that Elbs, in his recently-published handbook on the laboratory preparation of chemical compounds by electrolysis, had only referred to the production of the persulphates in acid solutions with the aid of a diaphragm, the authors pass on to a description of their own investigation. The Oettel form of apparatus was used, with platinum electrodes, and an outer vessel for keeping the electrolyte cool by a flow of water. Various additions were made to the solutions of potassium and ammonium sulphate used as electrolyte, all the experiments being carried out in the absence of a diaphragm. The results obtained in the series of 10 experiments, showed that persulphates could be obtained without difficulty under the conditions obtaining in the authors' investigation. The absence of the diaphragm enabled the authors to work with an E.M.F. of 5·9, as against 8 volts required in Elbs' work on this subject. A current efficiency of 35 per cent. was obtained in the formation of the potassium salt in an acid electrolyte, but the efficiency rose as high as 80 per cent. when working with the ammonium salt, in this case chromate having been added to the electrolyte to minimise the reduction losses at the cathode.

Personal.—Sir John Denison-Pender, K.C.M.G., was elected a member of the Royal Institution at a meeting presided over by the Duke of Northumberland on 2nd inst.

Erratum.—In our issue of the 9th ult., in the description of the Bordighera and Ventimiglia tramway on page 92, the deflection of the girders in reinforced cement should read 0·09in. instead of 0·9in.

Royal Institution.—Owing to the presence of Royalty at the meeting to be held at the above Institution on the 6th inst., when Sir Benjamin Baker will lecture on "The Nile Reservoir and Dams," the whole of the available seats will be reserved for the special use of members.

Dublin Section of the Institution of Electrical Engineers.—In our issue of April 25th we announced Mr. F. Gill as vice-chairman of the section in error, he having withdrawn before the annual meeting. Mr. A. E. Porte will fill this position for the ensuing season, and Mr. Gill will continue as local secretary.

Spanish Coronation Honour.—Don Federico Laviña, Director-General of the Spanish State Telegraphs, was publicly thanked by the Duke of Connaught, and presented with the badge of the Order of Victoria in gold and enamel, for his courtesy and services to the Duke and his suite during the recent Coronation ceremonies in Madrid.

The Institution of Electrical Engineers.—We are informed by the secretary that the deputation to the President of the Board of Trade, which had been fixed for Thursday, the 5th inst., has been again postponed. Mr. Balfour had expressed his regret at postponing the deputation a second time, but he had no means of foreseeing the urgent public business which has led to his decision.

Power Distribution in Montreal.—The Lachine Hydraulic and Land Co. have come to an arrangement with the Shawinigan Water and Power Co. by which the latter will deliver its power for the city of Montreal and the surrounding municipalities to the Lachine Company for distribution. The machinery has already been installed at Shawinigan, and it is only necessary to build the lines to Montreal.

Royal Society.—The following were among the Papers down for reading yesterday:—Prof. H. B. Dixon, F.R.S.,

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"On the Movements of the Flame in the Explosion of Gases"; T. C. Porter, on "Contributions to the Study of Flicker." Paper II.; J. C. W. Humfrey, "Effects of Strain on the Crystalline Structure of Lead"; and H. Ramage on "The Spectra of Potassium, Rubidium and Cæsium, and their Mutual Relations."

Obituary.—There passed away on May 27th the founder of the famous Birmingham engineering firm of Tangye (Mr. Joseph Tangye) in his 76th year. It was Mr. Tangye's success in floating the s.s. "Great Eastern" in the Thames that first brought his name into prominence in the engineering world, and from the date of this success the progress of the firm has been a remarkably rapid one. From the possession of very small works in the early fifties the firm has developed till at the present time between 2,000 and 3,000 workpeople are employed.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Bolama	April 19, 1902
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Puerto Plata—Fort de France	May 31, 1902
Hong Kong—Manila	June 3, 1902

South African Cables.—The Eastern Telegraph Co. announced on May 31st, a few hours before the publication of the news of peace, that, owing to a very severe storm in the neighbourhood of Capetown all the Government land lines in that district were disorganised. From the same cause a ship had been driven ashore and had interrupted one of the West Coast cables and damaged the other. In consequence, there was delay on telegrams to Cape Colony. The East Coast cable and the land lines from Durban to the Transvaal worked well, however, and there was, therefore, no delay to either Johannesburg or Pretoria.

Verband Deutscher Electrotechniker.—The annual general meeting of the German Association of Electrical Engineers will take place at Düsseldorf next week as already announced; the members will assembe on Thursday evening and the meeting continue until the end of the week. Düsseldorf, it will be remembered, has been chosen as the place of meeting this year on account of the supplementary attraction afforded by the industrial exhibition there. Among the Papers down for reading are: Asynchronous Single-phase and Polyphase Generators," by A. Heyland; "The Deri System of Compensated Continuous-current Machines," by F. Eichberg; "Field Distortion and Armature Reaction in Continuous-current and Three-phase Dynamos and Converters," by Richard Bauch; "The Starting of Electric Hoisting Machinery," by C. Köttgen; and "What has Electrical Engineering to Expect from Agriculture?" by Dr. Robert Haas. A large attendance is anticipated.

Peace Illuminations.—A considerable amount of rapid illumination work was placed in the hands of the Electric Lighting Boards Co. on Monday. This was a suitable occasion to show how rapidly electricity can be applied as compared with the installation of gas devices. Quite a number of the orders for illuminations did not reach the company until 4 p.m., but they were fully alight by eight o'clock. Amongst the installations was a large display at the P. and O. offices in Northumberland-avenue, at the United Service Club in Pall-mall, opposite the company's own offices, where there was also a large display. A number of the Royal warrant-holders similarly had displays in Regent-street and Bond-street, and among the restaurants illuminated was, notably, the Café Royal. A record fixing in the evening was that of 280 8 c.p. lights in 1hr. 20min. by two men and one boy, including six principal connections, which, taking into consideration the difficulty of working in view of a large and demonstrative crowd, comes very close to the company's French and American time records for rapid illuminations on the E.L.B. system.

Cable Communications Committee.—The Minutes of Evidence before the Inter-Departmental Committee on Cable Communications, with an appendix, has just been issued in bluebook form, and is a document of considerable public interest and importance. Reading the evidence but cursorily, the conclusions to be arrived at are not far to seek, and we regard the volume as monumental evidence of the surpassing ignorance of several men who have posed before the public as experts on submarine cable matters. These include Sir E. A. Sassoon, M.P., and Mr. Henniker Heaton, M.P., whose evidence stands for their severe condemnation, after a lengthy period of unusually bitter agitation on the question of rates and efficiency of service. The evidence generally established beyond question the sound commercial ability and judgment of those who have conducted in the past as well as of those who are now conducting a gigantic enterprise with success and with great public spirit, and exposes in all its crudity the want of knowledge and narrowness of view of the majority of the critics of the cable companies and of those Government departments who are responsible for the conduct of this branch of the public service. The volume forms a fitting sequel to the evidence before the Joint Committee of both Houses of Parliament which sat in 1866, when many important points relating to the conduct of international telegraphic business were settled. The report of the Committee recently issued finds its full justification in the minutes of evidence now published.

Institution of Civil Engineers.—The annual conversazione of the Institution of Civil Engineers was held on Wednesday night, when the President, Mr. Charles Hawksley, supported by several members of the Council of the Institution, received the members and a large number of distinguished guests. The electrical profession was well represented. There were, as usual, several interesting exhibits, the most popular being Mr. A. P. Trotter's demonstration of the harmless nature of 500-volt shocks received under ordinary conditions. Mr. C. E. Stromeyer gave an experimental illustration with an arrangement of glass tubes, of a common fault in the disposition of steam mains which frequently leads to steam-pipe explosions; and not far from him Mr. W. N. Shaw was showing, with another combination of glass tubes, some extremely delicate and ingenious experiments in cloud formation. One of his experiments showed how, through the formation of cloud, a rise in temperature ultimately resulted in a decrease of the thermometer reading, and one of the ladies who was much interested in the experiment, suggested that a large scale practical test might be made of the method immediately, to cool the rooms of the Institution. Mr. J. T. Morris showed an eddy current brake for testing small motors, and also an application of cathode rays to determine the maximum value of an alternating electric current. The rays are deflected by an electromagnet energised by the current to be measured. The period of the induction coil break is then adjusted until the point of impact of the rays upon a screen is no longer oscillatory, and the current through the primary is altered until this point touches the edge of the screen. A continuous current is then substituted for the alternating current through the deflecting electromagnet, and is adjusted until the cathode ray spot again reaches the edge of the screen, and an ammeter in the continuous-current circuit gives the maximum value required. Among other electrical exhibits were a 200-volt double-carbon arc lamp, shown by Mr. J. D. F. Andrews, in which two arcs burning simultaneously in one globe were controlled by a single mechanism, and a model of Mr. J. C. Sykes' electro-mechanical system of signalling on railways.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

THURSDAY, June 12th.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting at Burlington House.

FRIDAY, June 13th.

PHYSICAL SOCIETY.

3:30 p.m. Meeting at the National Physical Laboratory, Bushy House, Teddington. Station: Teddington, London and South-Western Railway. The laboratory will be open until 6 p.m. for inspection.

ROYAL INSTITUTION.

9 p.m. Extra Evening Discourse by Mr. G. Marconi. Subject: "The Progress of Electric Space Telegraphy."

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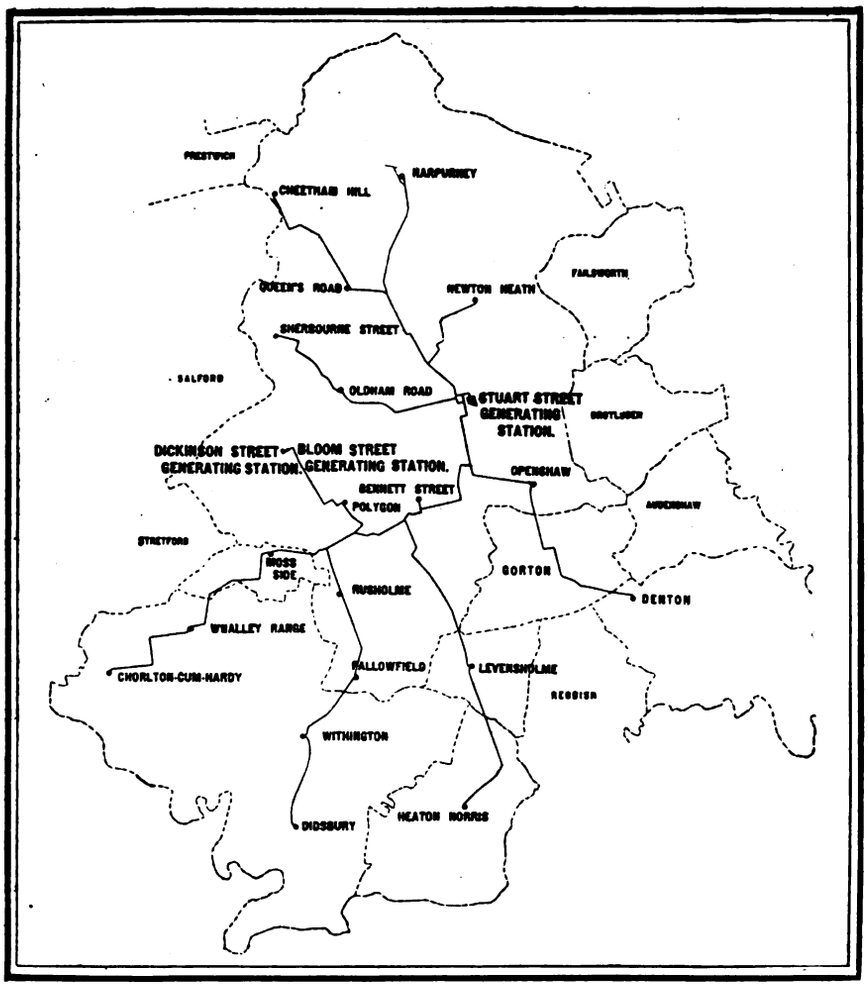
EXTENSION OF THE MANCHESTER CORPORATION ELECTRICITY WORKS.

There has taken place recently an important extension of the municipal electricity works at Manchester. The history of statutory electricity supply in that city dates back to 1890. It has been an eventful history, marking a generally progressive and prosperous yet not altogether unchequered career. Promise of success was early made, in spite of occasional breakdowns and mishaps, when under the able direction of that brilliant engineer, Dr. John Hopkinson. Nor could anyone better than his successor, Mr. C. H. Wordingham, have been selected to carry on and to expand into more magnificent proportions the work which Dr. Hopkinson began. On the engineering and technical side everything promised success, but defects in the practice if not in the principles of municipal control of such undertakings unhappily led to an anti-climax, which for a long time damaged the prospects of the scheme. If Manchester has in some respects shown how, by the aid of able chiefs in the technical departments, municipal trading can be crowned with prosperity and success, it is nevertheless true that it has demonstrated how the misdirection of ambitious and, technically speaking, ignorant persons in authority may go far towards causing shipwreck. We may pass lightly over this phase in the history of the undertaking, merely adding that its effect on the responsible members of the City Council was to cause something like a panic. In their dire distress and overwhelming emergency they were called upon to face a situation the gravity of which they had not had the forethought or courage to contemplate previously, and they paid heavily for their forgetfulness. Having burned their Phœnix, they hurriedly summoned an expert magician to raise the defunct creature from its ashes. The result of the magic wand is the arising, substantial if, as yet, far from complete, of the magnificent power station at Stuart-street, Bradford—an industrial suburb of Manchester—the opening of which we announced last week.



MAP OF THE MANCHESTER CORPORATION ELECTRICITY SUPPLY AREA, SHOWING STATIONS, SUB-STATIONS AND THREE-PHASE MAINS.

The site of Stuart-street station, which has an area of 8 ½ acres, was purchased by the Corporation in October, 1898; after the appointment of Dr. A. B. W. Kennedy, F.R.S., at the end of December, 1900, definite steps were taken for the installation of plant at Stuart-street, and for the equipment of the various sub-stations connected therewith. In March, 1901, Dr. Kennedy submitted to the Electricity committee for approval the details of his scheme for the installation of 15,000 H.P., and immediately afterwards tenders were invited for 24 water-tube boilers, six 2,500 H.P. steam alternator sets, and other plant which will be referred to later to be installed, and for the motor generators, &c., required at the several sub-stations.

The system adopted is as follows:—Three-phase alternating currents of a frequency of 50 cycles per second are generated at an "extra high pressure" of 6,500 volts, and are transmitted at this pressure to the sub-stations. The supply from the sub-stations is at 500 to 550 volts pressure for supply to the tramways, and at 410 and 205 volts pressure for lighting and power purposes.

The generating station is situated on the north-easterly side of the city, and is bounded on one side by the Manchester and Ashton under-Lyne canal, from which condensing water can be drawn. A railway siding, 980yds. in length, will be constructed from the Lancashire and Yorkshire Railway Co.'s line to the works, and it is intended to use electric locomotives to bring the coal trucks from the main line on to the site. The trucks will be emptied direct into the coal hoppers on the siding, and from thence the coal will be carried by electrically-driven conveyers to the bunkers over the boilers. The coal will be weighed before it is deposited in the main hoppers, it will be weighed on the way to the coal bunkers in the boiler house, and before entering the furnaces it will also be automatically weighed and recorded by means of measuring boxes attached to the shoots. The ashes will be removed by conveyors and can be loaded in the empty coal trucks or taken away by barges by the canal. Twenty truck loads of coal will be required per day to supply the 15,000 H.P. installation working at full load. A further 80 trucks per day will be required when the works reach their ultimate capacity of 70,000 H.P. Ample siding accommodation will be provided to deal with this traffic.

Buildings.—The buildings consist of a steel framework, filled in with walls of brickwork, this design having been adopted in the first instance in view, amongst other advantages, of the importance of getting the buildings erected with all possible speed. The brick walls are faced with white-ended brick, and dressings of Ruabon bricks and Yorkshire stone. The boiler house is 94ft. wide and 200ft. in length, and is arranged in three bays. The boilers are placed in the two side bays, and a centre bay, which is about 23ft. wide, provides necessary firing space on the floor level; while overhead are placed steel bunkers of a capacity of about 1,100 tons. Space is provided above the bunkers, and also underneath the firing floor, for two electrically-driven conveyors, which carry the coal to the bunkers from the siding and also take the

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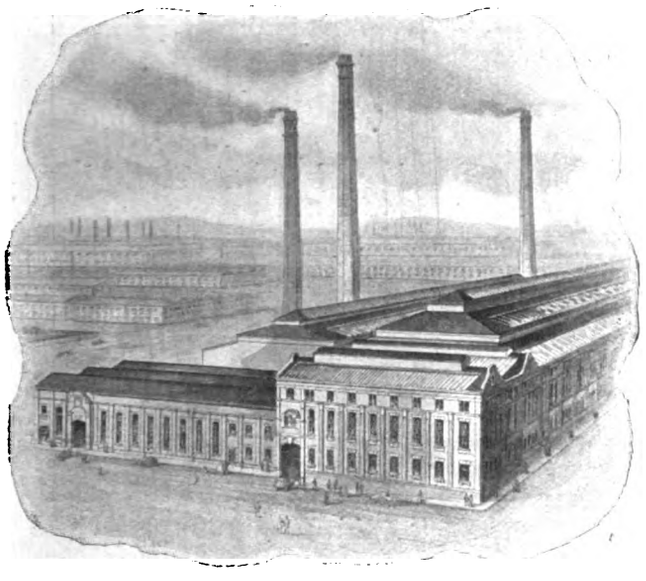
ashes away from the boilers. There are two chimneys, 200ft. and 250ft. in height respectively, the smaller one being 13ft. 6in. and the larger one 18ft. internal diameter. Both chimneys are lined with firebrick to a height of 100ft., and a cast-iron exhaust pipe, 3ft. diameter, is carried up the centre of the 200ft. chimney, and a similar pipe, 4ft. diameter, up the 250ft. chimney. The 250ft. chimney is intended to take the gases from the extension boilers, in addition to the boilers included in the 15,000 H.P. installation. The pump room and the space required for the feed heaters and the pipe work in connection with them, are arranged at the end of the boiler-house next to the engine-house, and between the two chimneys. Over the pump room is carried a feed tank to contain about 25,000 gallons of water.

The engine-house is 114ft. 5in. long and 131ft. wide, divided into two bays, 53ft. wide, containing the main generator sets, and the centre bay of 25ft., which contains the auxiliary and condenser plant, &c. The galleries for the switchboards extend right across the end of the engine-house, remote from the boiler house. The engine house has a clear height of 50ft. to the springing of the roof, which allows of a height of 40ft. to the rails carrying the overhead travelling cranes. The walls are faced on the inside throughout with glazed bricks, the upper portion being white, with a dado of golden brown. The roof of the engine house has principals 12ft. 6in. apart, with forged tie rods; and the principals of the boiler



STUART STREET ELECTRICITY WORKS.

house roof are of the riveted type, spaced 13ft. 10in. apart. Both roofs are provided with large skylights and with lanterns, the sides of which are filled with louvres for ventilation. The engine house is, in addition, lighted by side windows in the side and end walls. Workshops will be provided in a separate building, on the top of which will be provided a large storage feed tank to contain 500,000 gallons of water.

Boilers.—The steam raising plant consists of 24 double-drum Babcock and Wilcox water-tube boilers, each capable of evaporating 12,000lb. of water per hour at a pressure of 170lb. per square inch. The boilers are built in pairs, and are arranged in two rows, one in each of the side bays of the boiler house. Variable-feed electrically-driven mechanical stokers, fitted with chain grates, are provided throughout, but the boilers can also be fired by hand if necessary. For dealing with the boiler feed, for which city water will be used, three Weir compound duplex steam pumps are provided, each capable of delivering 15,000 gallons per hour, against a boiler pressure of 170lb. Each pumping set is so arranged that either the high-pressure or low-pressure side can be used without the other side. The pumps draw from a feed tank arranged in two halves, each of which has a capacity of about 12,500 gallons. The feed pipes are in duplicate throughout, and the feed water can be pumped either direct into the boilers or through feed-water heaters. In either case the feed water can be measured by means of a water meter. The four feed-water heaters through which the exhaust steam from the engines is passed are designed to raise the temperature of 50,000lb. of water per hour 150°F. The system of steam pipes is such as to give a duplicate supply of steam from any or all boilers to any or all engines. In the boiler house each boiler is connected by a branch to each of two main steam pipes which run down the middle of the centre bay, and are connected in the engine house to a complete ring main with a branch to each engine. The main steam pipes are of lap-welded steel, with wrought-iron flanges screwed on and expanded.

Plant in Engine Room.—The engine room plant will include six main 1,500kw. three-phase alternator sets, three in each of the outside bays, and three 200kw. continuous-current auxiliary sets placed in the centre bay. Four 20-ton overhead electrically-driven travelling cranes, by Messrs. Higginbottom and Mannock, are to be provided in the engine room. Two of these, of 49ft. 6in. span, are placed in the north bay. A similar crane is placed in the south bay, and a 23ft. span crane is provided in the centre bay over the auxiliary engine block. The hoisting, travelling and traversing motions of these cranes will be operated by separate motors.

Each of the main engine sets consists of a 2,500 I.H.P. vertical cross-compound engine by Messrs. Yates and Thom, running at 94 revs. per min., and a 1,500kw. three-phase alternator, built by the Electrical Co., generating current at a pressure of 6,500 volts with a periodicity of 50 cycles per sec. The high-pressure and low-pressure cylinders of the engine are 36in. diameter and 71in. diameter respectively by 3ft. in. stroke. They are steam-jacketed, and are fitted with Dobson's "Corliss" valve gear. The main shaft, which is 22ft. long, is 25in. diameter in the main bearings. The cast-iron flywheel, which is built up in four sections, weighs about 70 tons. The generator is placed between the high-pressure and low-pressure cylinders, and is of the revolving field type, the pole pieces being mounted on the external periphery of the flywheel of the engine, and revolving inside the stationary armature, the windings of which are star connected. A special feature in connection with the regulation of the speed of these engine sets is that the governor of the engine can be controlled from the switchboard gallery by means of an electric motor. The barring gear for starting the engines is also electrically driven.

The current for exciting the field magnets of the three-phase generators is supplied either from special exciter sets, one of which is provided for the three generators in each bay, or, as an alternative, from the continuous-current auxiliary sets. Each exciter set consists of a three-phase induction motor (driven direct by the current supplied by the main generators at 6,500 volts) coupled to a low-tension shunt-wound generator which supplies continuous current at a pressure of 220 volts. Each of the auxiliary sets consists of a 300 I.H.P. Willans compound high-speed 3-crank engine running at 350 revs. per min., direct coupled to a 200kw. continuous-current shunt-wound generator by the Electrical Co., which generates current at a pressure of about 220 volts. These engine sets supply the current for lighting, and for the various motors about the power house, as well as providing the alternative source of exciting current for the main generators.

The main engines can either be run condensing or non-condensing. When running non-condensing the exhaust steam is taken either direct or through the feed heaters to the atmosphere through exhaust pipes passing along the condenser bay and up the chimneys. When running condensing, the exhaust steam is taken to the Willans barometric condensing plant, which is placed in the centre bay of the engine house. Each unit (one of which is provided for each engine) of this condensing plant consists of a condensing chamber placed overhead in the centre bay of the engine house, the condensing water, which is drawn from the canal, being pumped up into this condensing chamber by means of electrically-driven centrifugal pumps. The condensed steam and condensing water then pass together down from the condensing chamber into a discharge tank placed in the basement,

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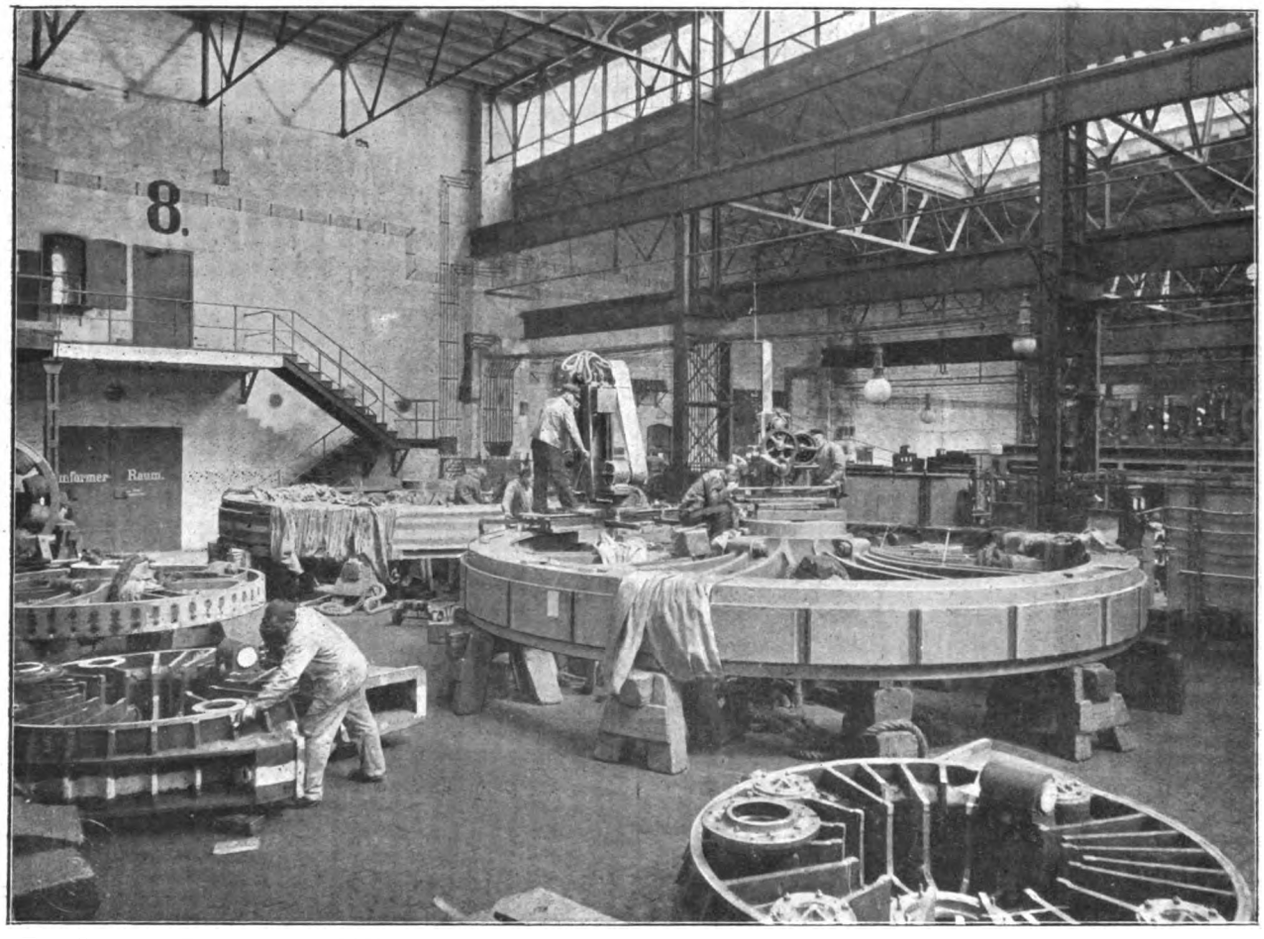
and the discharge water from this tank is then led back through pipes into the canal. The height from the level of the water in the discharge tank to the bottom of the chamber is rather more than 33ft., a special feature of this arrangement of condensing plant, which was supplied by Messrs. Willans and Robinson, being that it is not necessary to use air discharge pumps. As the canal can only furnish sufficient water for a small portion of the plant, it has been necessary to provide four "Klein" cooling towers, with electrically-driven fans and centrifiugal pumps.

Switchboards.—There are two main high-tension switchboards, one in each bay of the engine house, each of which is arranged to control three high-tension three-phase generators, one high-tension three-phase motor (for the exciter set), and seven high-tension feeders. There are two low-tension exciter switchboards, each of which controls the exciting current for three high-tension three-phase generators. There is also a low-tension switchboard for controlling the auxiliary generators, and the lighting and power circuits which they supply. Each of the two main switchboards is arranged in four tiers. The space between the platform at the engine room floor level and the intermediate platform contains the sealing and dividing boxes, into which are brought the high-tension feeders from the cable house and subway, and the cables from the terminals of the main generators and the induction motor driving the exciter set. This space also contains the spark-gaps for the feeders and the field regulating resistances for the main generators. The space between the intermediate platform and the main platform contains the "Oberspree" fuses for the high-tension feeders and the duplex fuses for the main generators and the induction motor. On the main platform are placed the switch panels, with the necessary instruments for controlling the three main generators, the induction motor and the high-tension feeders. Finally, there is an upper gallery carrying the selector switches, by means of which each machine or feeder can be connected to one or other of the two sets of 'bus bars. Normally, the generators and high-tension feeders which are connected to the switchboards in the north bay will be used in connection with the supply to the traction motor generators at the sub-stations, while the generators and high-tension feeders which are connected to the switchboards in the south bay will be used for supplying power to the lighting motor generators at the sub-stations. Means are provided, however, for inter-connecting the 'bus bars of the two main switchboards in such a way as to allow of all or any of the six generators being connected to any or all of the high-tension lighting or traction feeders.

Sub-stations.—The 10 sub-stations in connection with the first installation of 15,000 H P. are situated as follows:—(1) Bennett-street, Hyde-road; (2) Polygon, Ardwick; (3) Elbow-street, Levenshulme; (4) Denton; (5) Heaton Moor-road, Heaton Norris; (6) Wilmslow-road, Rusholme; (7) Denmark-road, Moss Side; (8) Ladybarn-road, Fallowfield; (9) Marriott-street, Withington; (10) William-street, Didsbury. The accompanying map makes clearer this distribution. The size and arrangements of the various sub-stations differ slightly to suit the demands and the available sites in the different districts, but the general design is the same in each case. Taking, say, the Bennett-street sub-station as representing the standard design, the building is divided into two bays of 35ft. 6in. span and 23ft. 6in. span respectively. The larger bay contains at one end the traction motor generators, and also the high-tension and low-tension traction switchboards. At the other end of this bay are placed the lighting motor-generators and balancing sets, and the corresponding high-tension and low-tension switchboards. In the smaller bay, two additional traction motor-generators are placed, and space is provided for further extension traction sets and for extension



TWO INDUCTOR FLYWHEELS OF 3,750KW. ALTERNATORS IN COURSE OF MANUFACTURE AT THE ELECTRICAL CO.'S WORKS, TO MR. METZGER'S SPECIFICATION. WEIGHT OF EACH WHEEL 150 TONS, DIAMETER 27 FEET.

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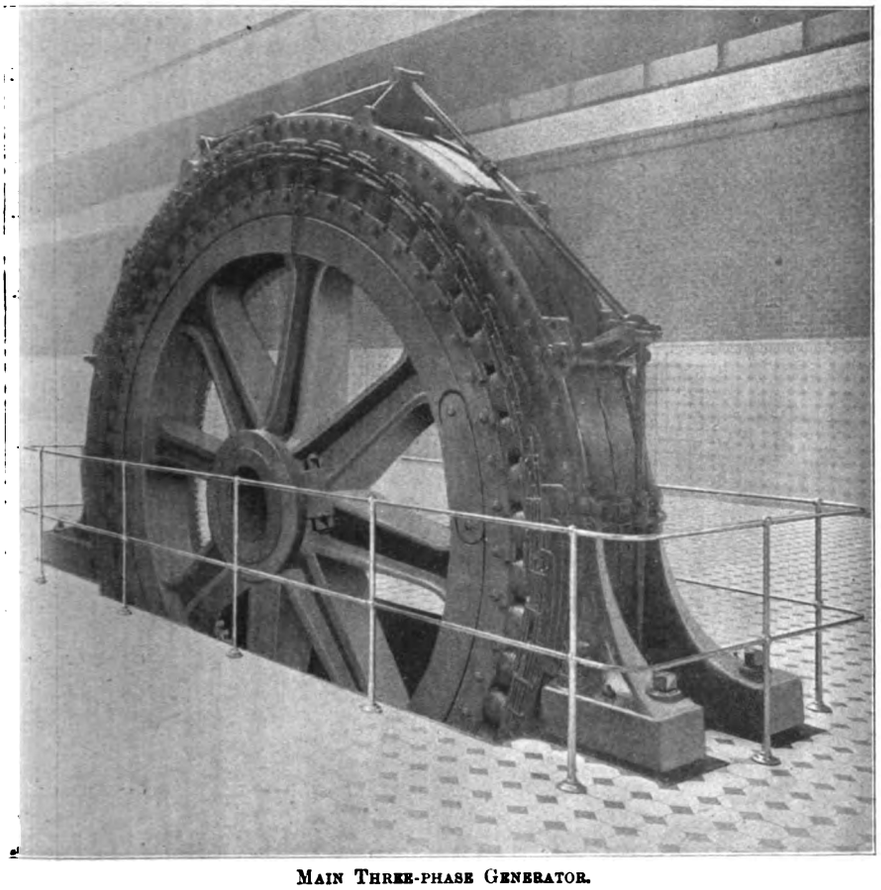
lighting sets. An overhead crane, worked by hand, is provided for each bay.

Each of the traction motor-generators consists of a three-phase synchronous motor, driven by the high-tension current from Stuart-street at 6,500 volts pressure, direct coupled to a 220kw. low-tension, continuous-current, compound-wound generator, supplying current at 500–550 volts for working the tramways. The exciting current for the field of the high-tension motor is obtained from an exciter carried on an extension of the low-tension armature shaft, or, as an alternative, from the lighting 'bus bars.

The lighting sets consist of a three-phase synchronous motor, driven by the high-tension current, direct coupled to a 220kw. continuous-current shunt-wound generator, supplying current at a pressure of 205 volts between the middle and outer wires, and at 410 volts between the outer wires of the three-wire system. The exciting current for the field of the high-tension motor is taken from the terminals of the low-tension generator, which it drives, or, as an alternative, from the lighting 'bus bars.



Main Three-phase Generator.

The balancing sets (one of which is provided in each of the sub-stations) consist of a three-phase induction motor, driven by the high-tension current from Stuart-street at a pressure of 6,500 volts, direct coupled to two 52kw. low-tension, continuous-current shunt-wound generators, placed one at each end of the motor shaft, supplying current at about 205 volts pressure, as balancers on the lighting system, or for starting or exciting the traction motor generators. The traction and lighting synchronous motor generators are started up from the continuous-current side—*i.e.*, by running the continuous-current generators as motors. The induction motors for the balancing sets are provided because such induction motors can be started up direct from the high-tension side, and low-tension current can, therefore, always be provided by these balancing sets for starting or exciting purposes, independently of the low-tension lighting 'bus bars.

Sub-station Switchboards.—Two high-tension switchboards are placed on galleries, one at each end of the main bay, and two low-tension switchboards are placed on galleries along the front side of the main bay, one at each side of the main entrance. The high-tension board at the traction end controls the synchronous three-phase motor for the four traction sets and the high-tension traction feeder from Stuart-street. The high-tension board at the lighting end controls the two synchronous three-phase motors for the lighting sets, the induction three-phase motor for the balancing set, and the high-tension lighting feeder. The general design of these high-tension switchboards is similar to that of the main high-tension switchboards at Stuart-street, and similar means are provided for interconnecting the 'bus bars of the two boards. The low-tension traction switchboard controls the four low-tension generators of the traction sets, and four low-tension traction feeders which supply the trolley wire of the tramways. It also includes a panel for the return feeders which are connected to the tramrails at the same point at which the feeders are connected to the trolley wires. The low-tension lighting switchboard controls the two low tension generators of the lighting sets, the two low-tension generators of the balancing set, and seven low-tension lighting feeders which feed the outside wires of the 3-wire system, and also includes the necessary panels for the connections to the middle wire of the 3-wire system, and for the starting circuit for the traction sets.

Cable Subway.—An interesting feature in connection with this scheme is the subway which has been constructed for the accommodation of the 30 three-core cables, distributors, potential wires, &c. These cables will be carried on brackets which are fixed on each side of the subway. The subway is 10ft. in height, 5ft. in width, and 940yds. in length. It extends from Stuart-street, along Cavendish-place, thence under the canal and terminates at Ashton New-road. It is thoroughly drained and ventilated. The construction of the subway has been carried out by Mr. Edmund Nuttall and Messrs. C. H. Normanton & Son. The provision of this subway will obviate the necessity of frequently opening the ground for laying additional cables from time to time as the works increase in size, and the cables are readily accessible for examination, which is a great advantage in a works of this magnitude. Messrs. W. T. Glover & Co., of Trafford Park, were entrusted with the contract for the supply and laying of 170 miles of cables for connecting the sub-stations with the generating station with high-tension cables and the sub-stations with each other with low-tension cables, telephone cables, &c. This work has been carried out to Mr. Metzger's specifications and under his personal supervision.

Stuart-street Extensions.

A further instalment of plant having been decided on by the Electricity committee as absolutely necessary to meet the demands, Mr. G. F. Metzger, the chief engineer, appointed by the electricity department in March 1901, was instructed to proceed with the work, and he decided to put down plant of 12,000 H.P., using two units of 6,000 H.P. each. These will be the largest of their kind and type so far used in England. The buildings required to house this additional plant are of sufficiently large dimensions to accommodate 24,000 H.P., as although only 12,000 H.P. is being installed at the present time, it is probable that a further extension will be required at a not very distant date. The buildings will consist of a steel framework filled in with walls of brickwork, and generally similar to the existing station. For various reasons, it has been found advantageous to place the new engine and boiler houses at right angles, instead of parallel with the existing portion of the station.

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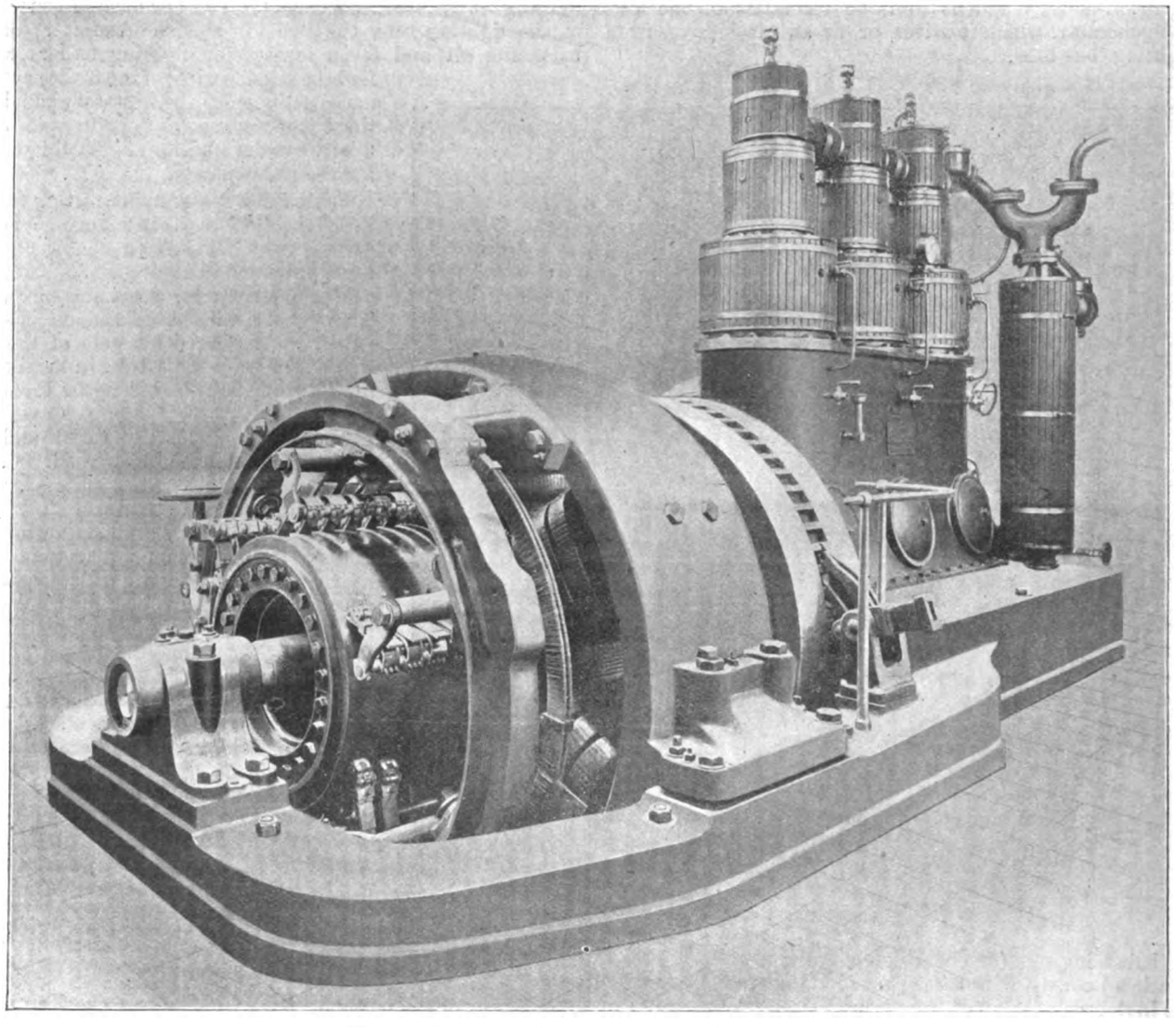
Boiler House.—The boiler house is to be 139ft. wide and 231ft. in length, and 88ft. in height. The boilers and economisers are placed down each side of the house, and a centre bay of about 20ft. wide provides the necessary firing floor; 12 water-tube boilers are being erected in the first instance, but the building will eventually contain 24. Running over the whole length of the house is a coal bunker of about 5,000 tons storage capacity. Two electrically-driven coal conveyors carry the coal from the hoppers underneath the railway sidings to the coal bunkers overhead, and also carry away the ashes from the ashpits into ash bunkers outside the boiler house wall, the two operations being performed at one time by each conveyor. A third chimney will be erected 250ft. high and 20ft. internal diameter, lined to a height of 100ft. with a firebrick lining. The flues are so arranged that part of the gases from the extension boilers pass to the second chimney, which is already erected, leaving the third chimney to further deal with the boilers which will be added in future. Adjacent to the boiler house, on the side remote from the engine room, is the pump house, men's mess room and joiner's shop. Between these and the railway sidings are the other workshops, the latter comprising machine and fitting shops, foundry and forge. The main machine shop is 120ft. long and 40ft. wide, and will contain modern tools of all description for overhauling any portion of the plant. Over the workshops are placed a series of feed-water tanks capable of holding half a million gallons of water.

The engine house is 174ft. long and 115ft. wide, arranged in one bay, and contains the two main engines, generators and exciter sets, and the necessary machinery constituting the Stuart-street sub-station. The present building will also accommodate two further units of equal or larger power. The galleries for the switchboards extend right down on one side of the engine house, remote from the boiler house, in four tiers. The engine house has a clear height of 108ft. to the apex of the roof, and a height of 54ft. to the crane rails. The walls are to be faced throughout on the inside with glazed bricks. Both roofs are provided with large skylights and with lanterns, the sides of which are fitted with louvres. The whole will be of massive proportions.

Boilers.—The boiler plant consists of 12 double-drum Babcock and Wilcox water-tube boilers, each capable of evaporating not less than 20,000lb. with 5,700 sq. ft. of heating surface. Messrs. Babcock's superheaters are fitted to each boiler, giving a superheat of 120°F. at 200lb. per square inch pressure. This size of boiler is the largest, so far, that Messrs. Babcock and Wilcox have built. Twelve economisers of Messrs. Green's standard make are provided, each economiser containing 240 tubes. They are arranged in six batteries of two each.



WILLANS-ELECTRICAL CO. AUXILIARY AND EXCITER SET.

Feed Pumps, Heaters, Tanks, Piping.—Four compound duplex steam pumps, of Messrs. Blake and Knowles' manufacture, will deal with the boiler feed water. Each pump is capable of pumping 12,000 gallons per hour, against a boiler pressure of 200lb. Each set is so arranged that one side of the pump can be used independently of the other. Under normal conditions they will draw from the hot well tank (which is in the pump room, and which receives the discharge water from the air pumps), but connections will be provided to allow of their drawing direct from the feed tanks. Feed piping is in dupli-

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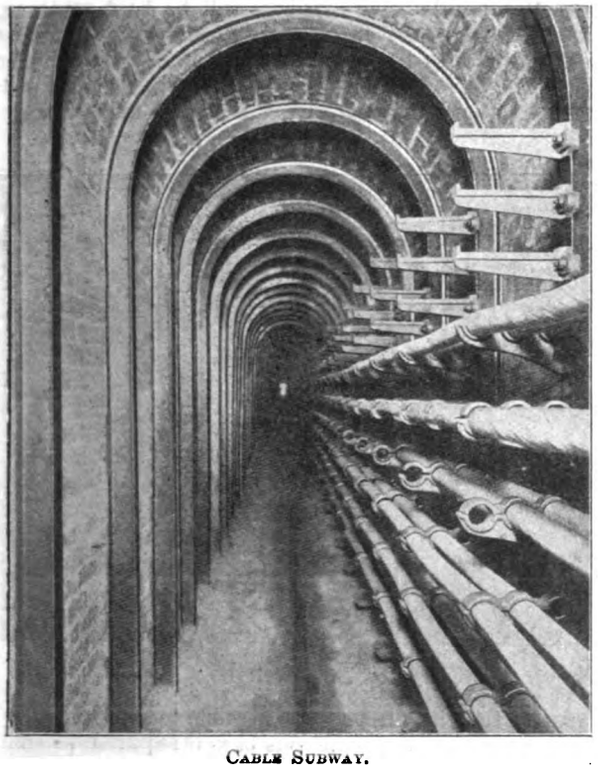
cate throughout, and the feed water, after leaving the pumps, passes first through two Holden and Brooke feed heaters, two Watson feed-water filters, and thence through the economisers to the boiler. By-pass piping is so arranged that either or all of the above can be cut out and the feed pass direct into the cold feed ring.



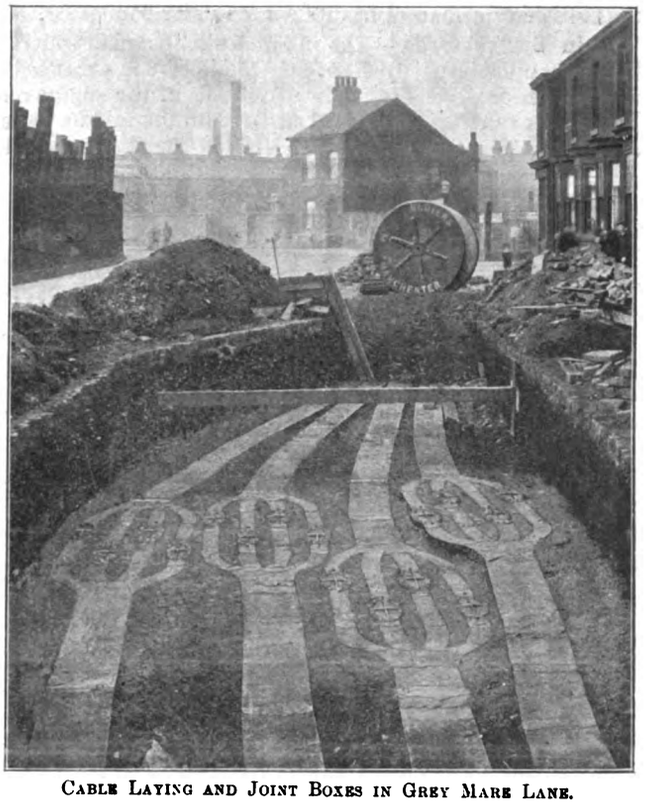
CABLE SUBWAY.

Main Engines.—The engine plant includes two 3,750kw. three-phase alternator sets, and two 200kw. exciter-induction motor sets. Each of the main engine sets consists of a 6,000 I.H.P. vertical triple-expansion engine, arranged on the four-cylinder, four-crank type, running at 75 revs. per min., with 190lb. pressure superheated steam at the stop valve.

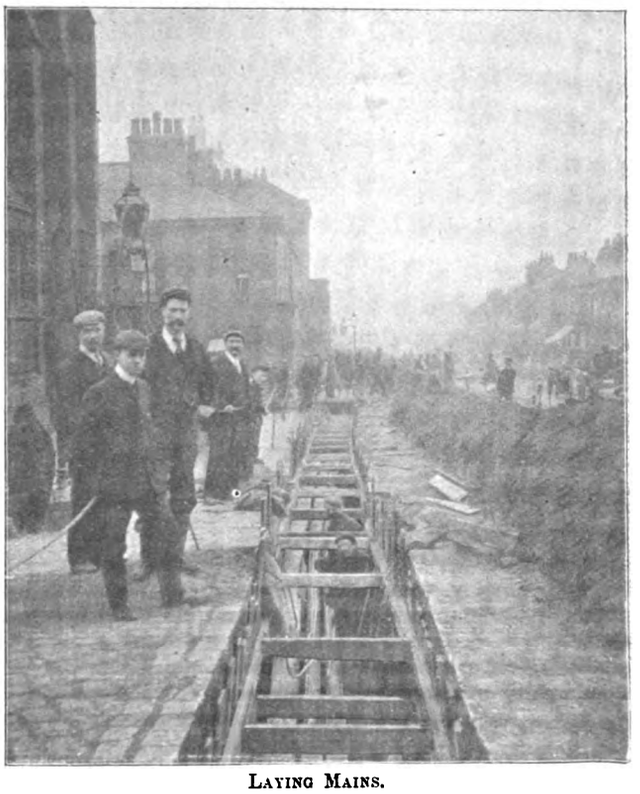
VIEW OF CABLE SUBWAY DURING CONSTRUCTION.

These are being supplied by the Wallsend Slipway and Engineering Co., of Newcastle, and are altogether the largest of their kind contemplated for use in central stations in this country. Corliss valve gear is used, and special attention has been given to the question of balancing the engines and securing as good a turning moment as possible, with a view to parallel running. In case of emergency the output of each engine will be 6,500 H.P. The actual height of the engine above floor level is 82ft. The leading dimensions are as follows :—

H.P. cylinder diameter	37in.
M.P. cylinder diameter	59in.
L.P. cylinders diameter	72in.
Stroke	5ft.
Diameter of shafting at engine journals	21in.
Diameter of generator shaft through boss	31in.



CABLE LAYING AND JOINT BOXES IN GREY MARE LANE.



LAYING MAINS.

Provision is made for jacketing the cylinders if required, and re-heaters are placed between the h.p. and m.p., and between the m.p. and l.p.'s. To facilitate paralleling operations, the governor is controlled by a small motor operated from the switchboard.

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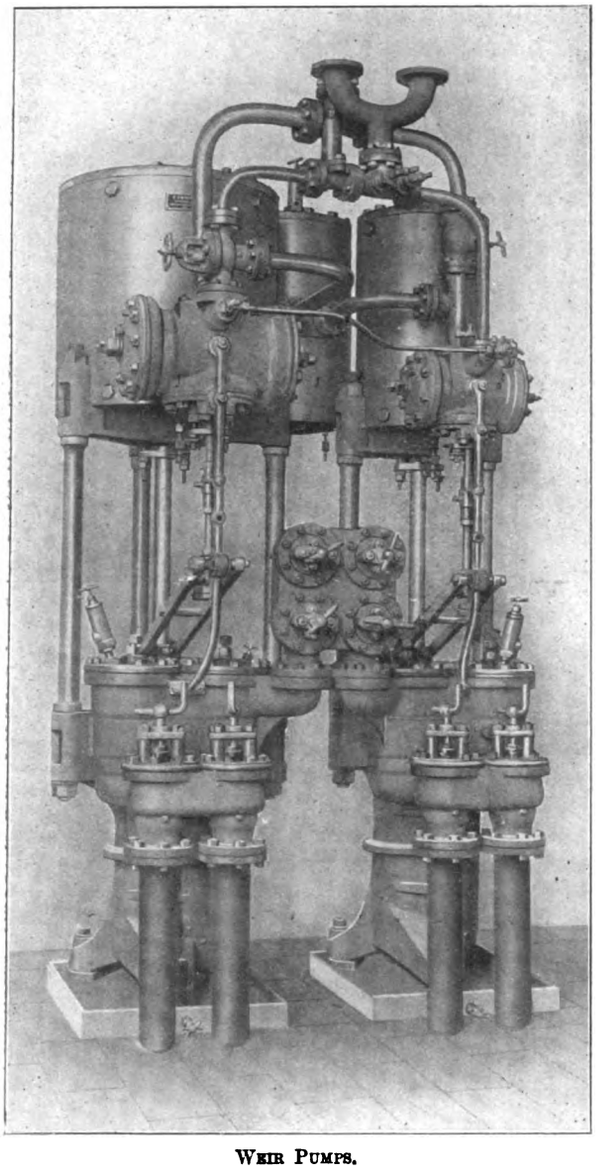
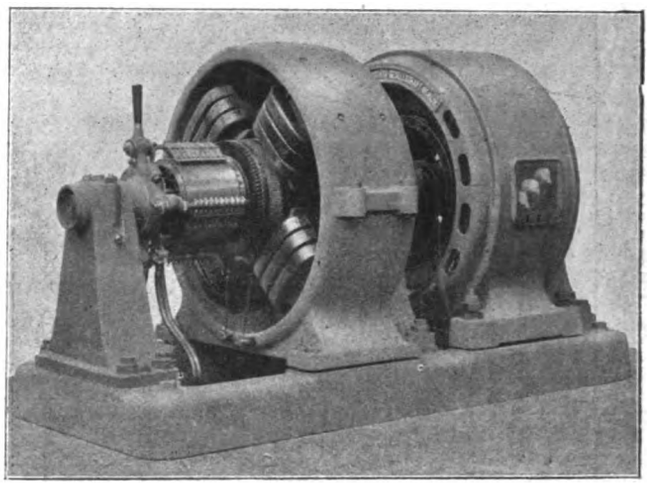
Main Alternators.—The alternators are being manufactured by the Electrical Company, of London, generating current at 6,500 volts between phases with a periodicity of 50 cycles per second. The generators are of the revolving field type, the pole pieces being mounted externally on the periphery of the magnet wheel which serves also as the flywheel of the engine. The weight of this wheel complete is 160 tons. The field poles are provided with Blanc's amortiseur coils, whilst the stationary armature has its winding star connected.

Main Switchboards.—The main switchboards, which are being manufactured by Ferranti Limited, are arranged on three galleries which extend down one side of the engine room. There is one main switchboard situated on the middle gallery, and at the same level as switchboards in the existing station,



Weir Pumps.

which controls the two main 8,750kw. units, 14 high-tension feeders, and the two 200kw. exciter sets. On the top platform are the main 'bus bars for lighting and traction, and change-over switches for enabling a machine to be run on either set of bars, whilst on the bottom platform the main fuses are placed in duplicate. Further along, on the middle or main platform, are the auxiliary lighting and power boards, each controlling 20 circuits and fed from the existing continuous-current sets or from the sub-station at Stuart-street. Immediately beneath the auxiliary boards, and on the lower platform, are the switchboards for controlling the sub-station plant, which consists of four 150kw. synchronous motor generators and one 100kw. induction motor balancer. These units are all situated down one side of the new engine room, and constitute the Stuart-street sub-station. An additional gallery is placed below the level of the engine room floor for the purpose of carrying all the necessary starting, regulating, and feeder-charging rheostats and resistances, which are worked by gearing and extended spindles carried up through the floor to suitable pillars and hand-wheels, thus enabling each to be worked from its own switchboard level. Normally, the traction and lighting 'bus bars will be kept separate, but arrangements are made for coupling them together if necessary, but they will also be connected respectively to the traction and lighting 'bus bars in the existing portion of the station. It will be noticed that the 'bus bars are not in duplicate, as it

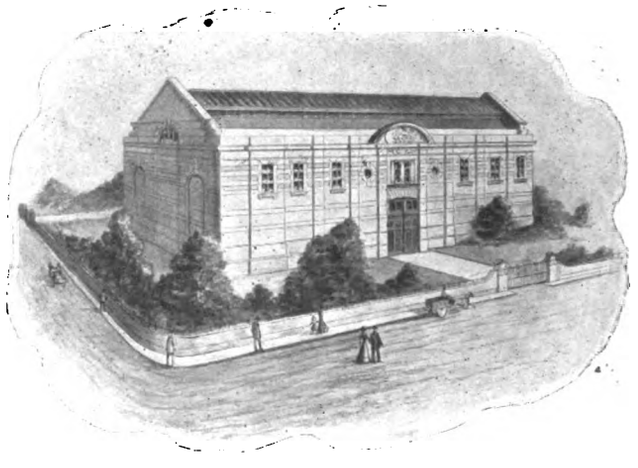


Motor-Generator.

is expected that it will be quite possible to work traction and lighting feeders off the same 'bus bars if required, so enabling the lighting and traction 'bus bars to be coupled together.

Fifty-five feet from the ground level are placed two 50-ton electric overhead travellers, made by Messrs. Higginbottom and Mannock, each having a span of 84ft., separate motors of the B.T.H. type being provided for hoisting, traversing and cross-traversing, each worked by a special B.T.H. controller.

Sub-stations.—The 10 sub-stations in connection with Mr. Metzger's extensions are situated in the following districts:—(1) Stuart-street; (2) Oldham-road; (3) Openshaw; (4) Newton Heath; (5) Harpurhey; (6) Queen's-road, Queen's Park; (7) Cheetham Hill, Crumpsall; (8) Sherbourne-street, Cheetham; (9) Whalley Range; (10) Chorlton-cum-Hardy. The buildings are practically identical in design, and are approximately 80ft. long by 45ft. wide. With the exception of the last two, all are arranged for both lighting and traction purposes. Each station is arranged in one bay, with the switchboards down each side and the various units placed down the centre. The main entrances are placed at the ends. The electrical equipment of a standard sub-station comprises



A Typical Sub-station.

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four 150kw. synchronous motor generators, one 100kw. induction motor balancer. Provision is made for extending the plant within the same building, using units of 300kw. capacity.

We give below a list of the contractors, &c., under each of the two schemes in progress in connection with the Stuart-street station :—

I.—Dr. Kennedy's Scheme.

Stuart-street.

Excavations	C. H. Normanton & Son.
Foundations	
Builders' work in engine and boiler houses	
Foundations for engine beds	
Chimneys	
Steel work in engine and boiler houses	De Bergue & Co.
Steel work, &c., in coal bunkers, gangway and grates and frames in front of boilers for boiler house	
Water-tube boilers	Babcock and Wilcox.
Coal-measuring gear	
Motors and gear for driving the stoker shafting in boiler-house	
Three-phase generators, condensing plant and continuous-current plant, switchboards	Electrical Co.
Engines	Yates and Thom.
Overhead travelling cranes	Higginbottom and Mannock.
Cast-iron work in plates for top of flues, dampers and opening apparatus for boiler-house	Newton, Chambers & Co.
Continuous coal and ash conveyors and ash elevators	New Conveyor Co.
Cooling towers	Klein Engineering Co.
Pipe work, &c.	Sir Hiram Maxim Engineering Co.
Three-phase cables, &c.	W. T. Glover & Co.

Sub-stations.

Buildings	Heaton Norris	A. R. Bullivant & Sons.
	Withington	
	Levenshulme	
	Denton	
	Moss Side	
	Bennett-street	C. H. Normanton & Son.
	Polygon	
	Fallowfield	Executors of Clement Walworth.
	Rusholme	J. H. Billings & Co.
	Didsbury	
Motor generators, &c.		Electrical Co.
Switchboards		
Cranes		Carrick and Ritchie.

II.—Mr. Metzger's Scheme.

Excavations	C. H. Normanton & Son.
Foundations	
Builders' work	
Chimney	
Steel work in engine and boiler houses	De Bergue & Co.
Coal bunkers, &c.	
Engines	Wallsend Slipway Engineering Co.
Three-phase generators and motor generators	Electrical Co.
Boilers	Babcock and Wilcox.
Pipework	
Coal-measuring gear	
Stoker gear and shafting	
Superheaters	
Coal conveyors	
Economisers	E. Green & Son.
Switchboards	Ferranti Limited.
Overhead electrically-driven travelling cranes	Higginbottom and Mannock.
Surface condensers, oil separators and hot well	Mather and Platt.
Feed pumps	Blake and Knowles.
Cooling towers	Wheeler Condensing Co. / Arthur Koppel.
Feed-water heaters	Holden and Brook.
Three-phase cables, &c.	W. T. Glover & Co.

Sub-stations.

Buildings	Harpurhey	A. R. Bullivant & Sons.
	Oldham-road	
	Sherbourne-street	A. Bridge.
	Cheetham-hill	S. Warburton.
	Openshaw	Storrs, Sons & Co.
	Newton Heath	—
	Queen's-road	—
	Whalley Range	—
	Chorlton-cum-Hardy	—
Switchboards		Ferranti Limited.
Motor generators		Electrical Co.
Cranes		J. Carrick & Sons.

When the above plant for both schemes is completed at the Stuart-street works, the total horse power available at the various works of the Manchester electricity department will be 58,000 I.H.P., and the length of cables required to transmit the current no less than 360 miles. There will be few installations in the world which can approach the magnitude of these Manchester works, the Tramways committee alone requiring current for 800 cars when the whole scheme is completed, and the lamp connections amounting to half-a-million 8 c.p. lamps; 10,502,299 units were sold during the last year, and this is expected to be nearly doubled during the ensuing 12 months.

THE WOLVERHAMPTON EXHIBITION.—IV.

Messrs. Alfred Herbert's exhibit of machine tools occupies a prominent position in the machinery hall of the exhibition, and the tools they have on view and at work show a fine finish and excellent workmanship. One of the four examples of automatic screw machines is at work producing a small stud or button from brass bar, these buttons being intended to be given away as souvenirs to represent, on a small scale, the turrets to the firm's hexagon turret lathes. A very complete and ingenious set of tools is in use on this machine, as the operations include not only the boring and the forming of the button, but also the milling of its hexagon faces and the boring of the holes in the centre of the faces. In addition to this, the name of the firm is rolled upon the button. The whole of these operations take place without stopping the spindle of the machine. The machine shown in Fig. 11 is fitted with a standard set of cams and tools for producing any ordinary engineer's bolts, studs, pins, collars,

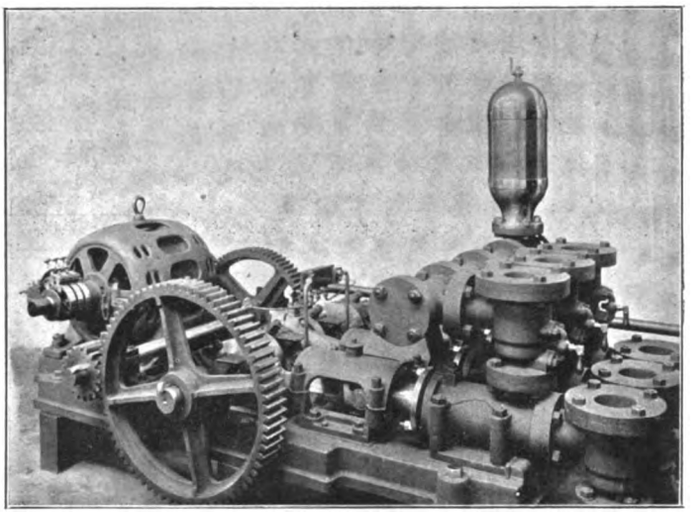

Fig. 10.—Three-throw Pump Driven by Three-phase Motor.

bushes, &c., from the bar. It admits a 2½in. bar. It is intended that this machine shall be changed over from one job to another from time to time, in order to illustrate the great variety of work which can be done upon it without requiring special cams or tools.

A number of capstan lathes are exhibited, and one, with a patent chasing saddle, is at work producing special brass hexagon-headed screws from castings. The arrangement of the chasing saddle is such that one movement of a lever advances the tool to its cut and engages the leader for screw cutting, the reverse movement withdrawing the tool quickly and disengaging the leader. By the use of interchangeable leaders all possibility of cross-threading is avoided when cutting odd pitches. Another of these capstan lathes is machining motor car hubs from malleable iron castings. The design of the hub is somewhat complicated, and the makers state that the time required to produce the hub is under 40 minutes, whereas they estimate that the work would take at least four hours on an ordinary lathe.

A hexagon turret lathe, shown by the same firm, is in operation boring and turning commutator cores. The machine is provided with a massive hexagon turret carrying boring, turning and facing tools, and has also an independent square turret upon a separate saddle. Each of these turrets has independent feed motions and independent automatic stops to each pulley, and six speeds can be instantly obtained at the headstock without shifting the belt upon the cone pulley. This machine is fitted with a chasing arrangement, which chases a large fine thread upon the end of the commutator core. Fig. 12 is another hexagon turret lathe admitting a 2in. bar. It will turn a piece up to 29in. long, and is intended for all kinds of bar

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work within these limits. The equipment of this machine includes a set of standard tools suitable for doing any ordinary work of this nature without requiring any special tools. It is customary to take all reductions in diameter, no matter how great, at one cut, and the tools are so designed that the pressure of the cut tends to bind their various parts firmly together so as rather to increase than diminish the stability of the tools. The tools are of a simple form, which can be easily understood by the workmen, and the same tool holders are suitable for either right or left-hand turning.

Another machine is of very large size, and is capable of dealing with bar work up to 3½in. diameter by 42in. long, or with even larger pieces when made from forgings. Its general type is similar to the two machines just described, but some new features are introduced on account of the large size of the machine.

The turret when running is raised up slightly from its seat, and is supported upon a ball step bearing, enabling it to be rotated with the greatest ease, although the turret and the tools are very heavy. The stop mechanism of this machine is also interesting. The stops are carried upon a hexagon bar at the front of the machine, and this bar is geared so as to rotate with the turret in order to bring the correct stop into operation for each tool. Very complete ranges of feed motion are provided, and in addition a special chasing arrangement by means of a leader is fitted for screw cutting.

Messrs. Herbert also show two milling machines. One of these is

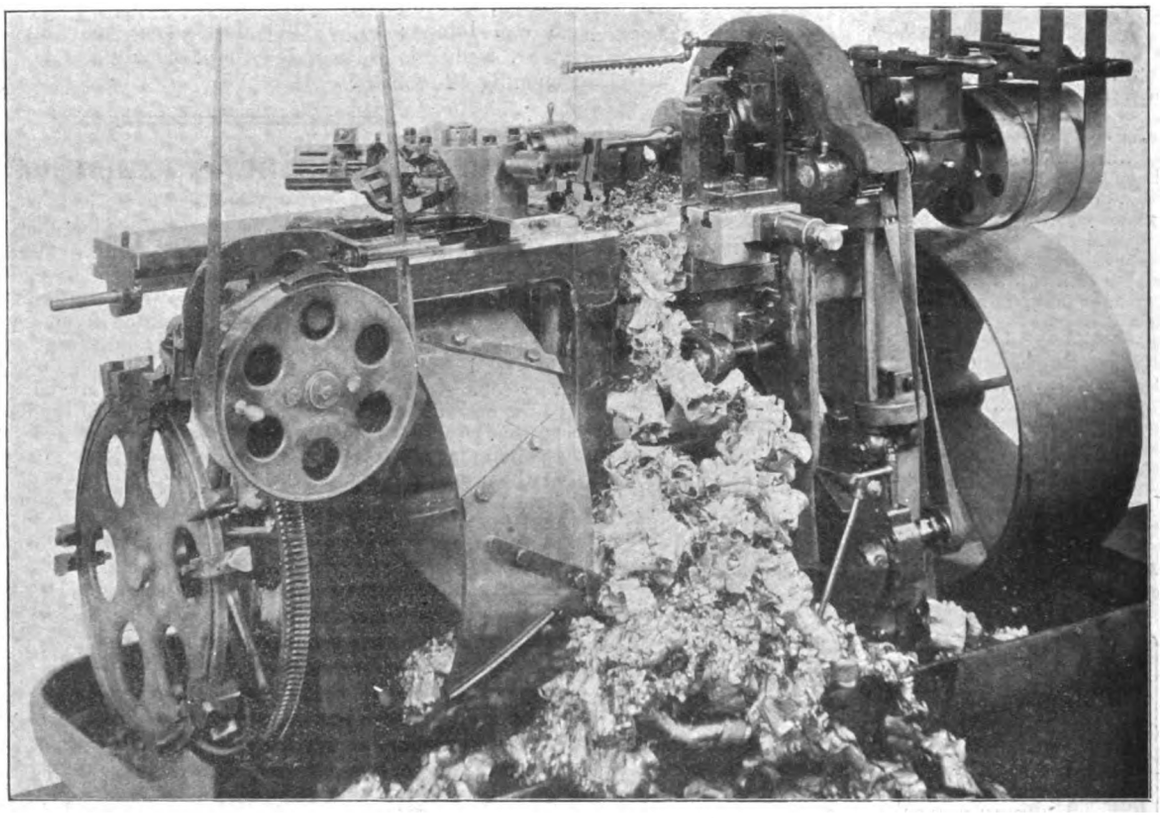

Fig. 11.—Automatic Screw Machine.

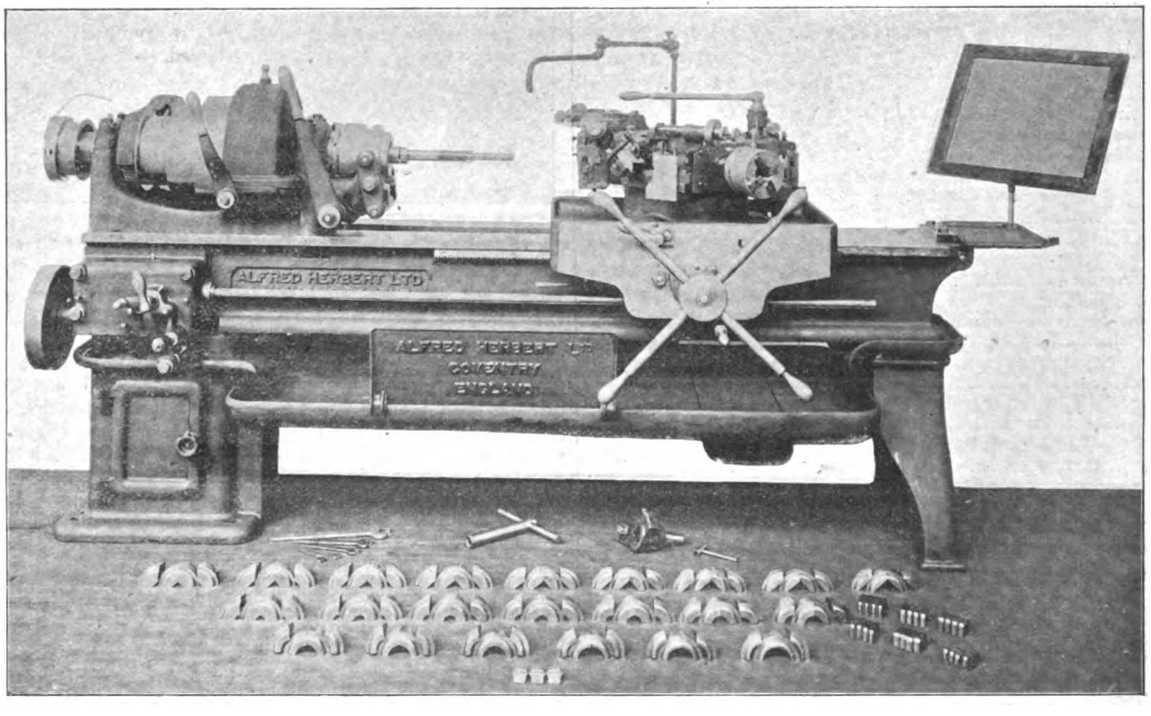

Fig. 12.—Hexagon Turret Lathe.

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vertical with a feed mechanism of very novel type contained inside the body of the machine. All the operating handles are within easy reach of the operator without moving from his position at the front of the machine—a great point in milling irregular forms in which it is necessary to have two motions in operation at the same time.

A noticeable feature is that the gears of all these machines are completely enclosed, the covers in many cases forming an integral part of the design of the machine.

The machinery on this stand is driven by means of a 20 H.P. motor supplied by the Lancashire Dynamo and Motor Co., and motors of smaller size by the same makers are employed to drive several other exhibits in the machinery hall.

No exhibition is complete without a fine specimen of a Willans engine, and at Wolverhampton, as already stated, an engine of this type forms one of the units of the exhibition generating station supplying current for the light and power purposes of the exhibtion. As seen in Fig. 13, the engine is of Messrs. Willans and Robinson's standard triple expansion central valve pattern, having a complete set of cylinders arranged over each of the three cranks, which ensures extremely even turning at all loads. The H.P., I.P., and L.P. cylinders are 340mm. (13·39in.), 520mm. (20·45in.), and 820mm. (32·35in.) diameter respectively, the stroke being 340mm. (13·39in.) The engine runs at 270 revs. per min., and with 180lb. steam pressure at the stop valve gives 825 I.H.P. non-condensing; it will give 1,030 I.H.P. for short periods not exceeding two hours. The engine agrees in every respect with the firm's standard practice, having splash lubrication and constant thrust.

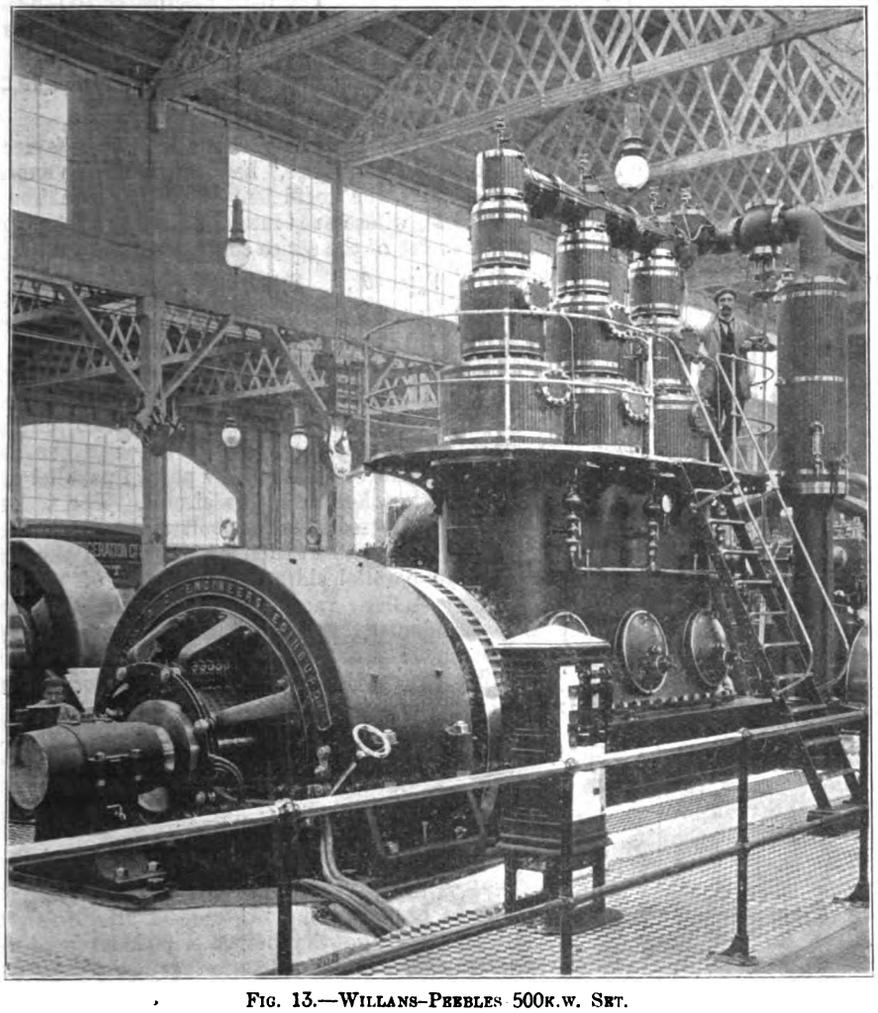

FIG. 13.—WILLANS-PEEBLES 500K.W. SET.

The dynamo of this set is of the Bruce Peebles lighting and traction pattern. It is rated at 500kw., at 500 volts. In addition to this machine, Messrs. Bruce Peebles & Co. have a fine exhibit of their own and Messrs. Ganz & Co.'s electrical plant. Among these is a well-designed electrically-driven three-throw Barclay pump, the motor being a three-phase machine. We illustrate this machine in Fig. 10.

A detailed description of the Sisson engine appeared in our account of the Glasgow Exhibition (*The Electrician*, Vol. XLVII., p. 983), and it will be remembered that, although a two-crank compound engine, the high-pressure cylinder is partially above the low-pressure cylinder, so that the distance between the crank centres is reduced to a small amount (there being only a common web between the two pins), and the rocking moment is diminished. One of these compact little engines is exhibited at Wolverhampton, and is illustrated in Fig. 14. This engine, which is rated at 125 H.P., at 420 revs. per min., is directly coupled to a 90kw. (360 amperes at 250 volts) six-pole dynamo, made by the Lancashire Dynamo and Motor Co., which acts as one of the steam balancers for the exhibition light and power circuits.

The field magnet yoke and poles of the dynamo are of cast steel with pole pieces of special construction to eliminate sparking, the makers claiming that there is a fixed brush position from no load to about 25 per cent. overload. The yoke is fitted with brackets lined with anti-friction metal to support the cast-iron ring carrying the brush gear. The magnet coils are former wound, held in position by brass plates at top and bottom. Each coil is provided with its own terminals, thus doing away with all loose ends. The armature is slot-wound, and its core discs are keyed on to a cast-iron sleeve on one end of which the coupling is cast, and which extends to the bearing at the commutator end, and supports the commutator. The shaft is forced into the sleeve by hydraulic pressure, and, in addition, is firmly keyed to it. The commutator sleeve also is forced on to the armature sleeve by hydraulic pressure in addition to being keyed.

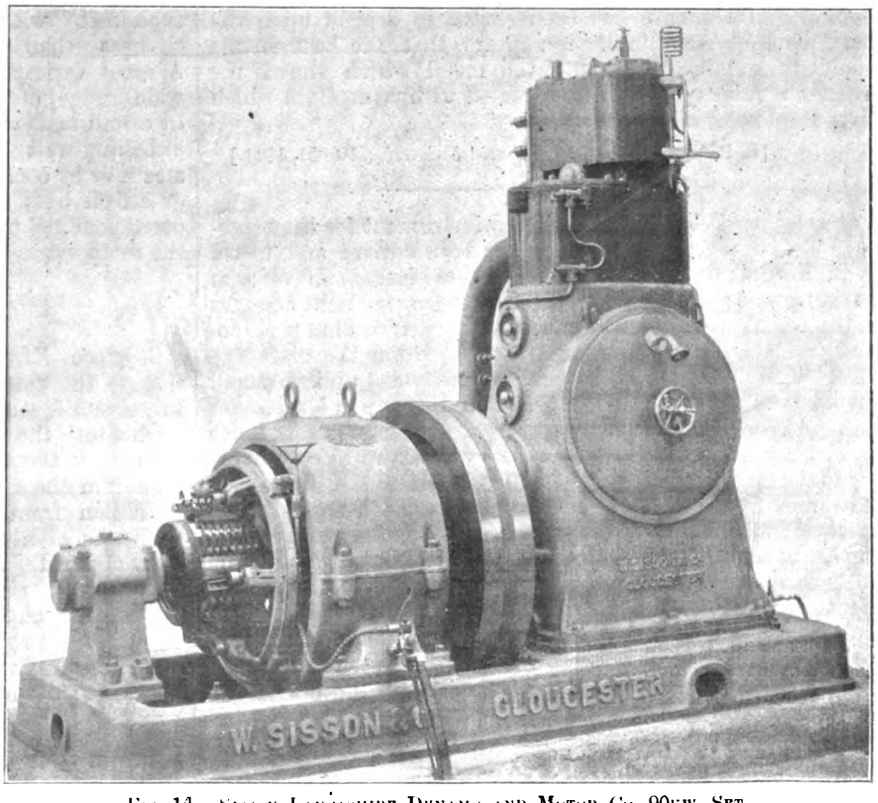

FIG. 14.—SISSON LANCASHIRE DYNAMO AND MOTOR CO. 90KW. SET.

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Another unit of the exhibition generating plant is a slow-speed continuous-current set exhibited jointly by Messrs. Mavor and Coulson and Messrs. Robey & Co. The engine is a horizontal cross-compound machine, and the dynamo, which is one of the largest yet built at Messrs. Mavor and Coulson's works, is mounted upon the crankshaft between the main bearings, and is designed to give an output of 630 amperes at 550 volts (350kw.) at a speed of 90 revs. per min. The dynamo is eight-polar with a slotted drum armature, both the armature and field coils being former wound. The cylinder diameters are 20in. and 35in. by 42in. stroke, and the engine is designed to give 550 I.H.P. at its standard speed of 90 revs. per min. with a steam pressure of 150lb. per square inch. The disc shaft, which also carries the armature between the main bearings, is of steel, and the armature and flywheel are so proportioned as to give an angular velocity of 1 in 200, or ½ per cent. The engine is fitted with Richardson's well-known automatic trip gear, which gives a steam admission from 0 to 0·75 of the stroke according to the load, and is further supplemented by an electric regulator which also controls the admission valve and regulates the E.M.F. of the circuit. In the event of a short circuit in the mains or total cessation of the current, the electric regulator will stop the engine, and when the engine is used for power in factories it can be stopped from any point by turning a switch. The steam consumption per I H P. per hour is stated to be 17lb. at full load non-condensing, and the combined full load efficiency of the set 86 per cent.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Sensitiveness of the Coherer.—E. R. Wolcott has attempted to determine quantitatively the effect of electromagnetic radiation upon coherers composed of metals of various critical potentials, including aluminium, tin, iron, zinc, lead, nickel, copper and silver. He finds that the "electrolytic" theory of Guthe and Trowbridge corresponds most closely with the facts, According to this theory the potential gradient across the coherer causes an attraction of the electrodes to within molecular distances, thus making a continuous bridge. Of all the metals tried, aluminium is the most regular in response. It has been found, however, by Marconi and others, that nickel gives the best results at long distances. This is probably due to the fact that of all metals tried the surface coating of nickel shows the lowest critical potential—that is, it responds to the least energy; but when the intensity of the radiation is sufficient to overcome the greater critical potential of aluminium, the latter gives better results than nickel, for the regularity of response has been shown to depend upon the metal itself. Accordingly, it appears that the best results would be obtained by using the metal which shows the greatest regularity of response, coated with a medium which gives the lowest critical potential.

[E. R. WOLCOTT, *Bull. Wisconsin University*, No. 51, 1901.]

A Selenium Telautograph.—A new instrument for the reproduction of images at a distance has been devised and tested by A. Korn. It is based upon the sensitiveness of vacuum discharges at an exhaustion of 0·2 to 2mm. to slight changes in the resistance of the circuit, and the extraordinary photochemical activity of the rays proceeding from the discharge tube. The picture to be transmitted is divided up into small squares, each of which is projected in turn upon a selenium cell. At the receiver end, a sensitive plate is made to move past an aperture transmitting the X-rays at a rate corresponding to the motion of the original picture at the sending end. The variations in the current produce a variation in the size of a spark-gap, which in turn produces a corresponding variation in the actinic intensity of the vacuum tube. A period of 2 seconds suffices to give a good impression of each square. The manner in which the spark-gap is shortened is ingenious. An astatic galvanometer carries, in addition to the two needles, a small brass needle acting as one of the electrodes of a spark-gap. The greater the deflection of the galvanometer, owing to the illumination and consequent lowering of the resistance of the selenium cell, the more does the brass needle approach a fixed needle representing the other electrode. One of the electrodes of the vacuum tube is attached to the fixed needle, while the other electrode is put to earth, and the movable needle is connected with one of the poles of the secondary coil of a Tesla apparatus. The second pole of the Tesla coil is connected with a large capacity. The author has worked successfully with pictures consisting of 400 squares. He proposes to reduce their size to 1mm., and the exposure to a tenth of a second.

[A. KORN, *Electrotechn. Zeitschr.*, May 22, 1902.]

Coefficient of Mutual Induction.—Maxwell, in the chapter on circular currents in his "Treatise," has shown how to express, in the form of a series, the coefficient of mutual induction for two circular circuits, whose axes meet in a point at any angle θ, the successive terms of the series containing the factors

$$P_0(\cos\theta), \quad P_1(\cos\theta), \ldots$$

where $P_n(\cos\theta)$ is the Legendre coefficient or "surface zonal harmonic" of the nth order. G. F. C. Searle has now, by using a process in principle identical with that of Maxwell, obtained the coefficient of mutual induction when one of Maxwell's circles is replaced by a circuit having two infinitely long parallel sides, the shortest distance between the sides being finite. A telephone circuit with its pair of parallel wires is a practical approximation to such a circuit. The series in which the result is expressed involves the two angular co-ordinates, which determine the direction of the axis of the circle relative to the two parallel sides, in the form of "surface sectorial harmonics," these functions playing the same part in the present problem as the Legendre co-efficients play in Maxwell's problem. If a diameter of the circle lies on a line cutting both long wires at right angles, the expression obtained for the mutual potential reduces to

$$M = 8\pi \operatorname{cosec}\theta(a - \sqrt{a^2 - c^2\sin^2\theta}),$$

where c is the radius of the circle.

[G. F. C. SEARLE, *Proc. Cambridge Philos. Soc.*, May 11, 1902.]

Thermo-electric Hysteresis.—Bachmetieff has described what appeared to him to be a well-defined case of thermo-electric hysteresis. He observed that the thermo-electric force between two metals differs accordingly as to whether the temperature of the hot junction is attained by heating or by cooling from a higher temperature. The theoretical importance of such an hysteresis has led E. Pinczower to repeat the experiment with apparatus of greater accuracy and sensitiveness than Bachmetieff's. The result was negative. A great variety of metallic combinations were chosen, and a wide range of temperatures. The E.M.F. was measured by a null method. The standard "hot" temperature was that of boiling water, and this was reached either by exposure to steam or by cooling from the temperature of a Bunsen flame or an oil bath. The E.M.F. was always found to be that corresponding to the interval of temperature, no matter how the temperatures were reached.

[E. PINCZOWER, *Mitt. Phys. Gesell. Zürich*, No. 1, 1901.]

Repulsive Forces in the Universe.—H. Deslandres calls attention to the astronomical importance of the Maxwell-Bartoli pressure of radiation in the evolution of celestial bodies. Arrhenius' theory of the aurora and of comets may be reduced to the single hypothesis of the projection of cathode rays from the sun. All celestial bodies show a continuity of transition from one type to another. Most nebulæ show evidences of a spiral structure, with two spirals diametrically opposed. Any great protuberance of the sun is accompanied by a similar protuberance at its antipodes. The only difference between the sun and the nebula is that in the latter the repulsive force is strong, while in the solar type the attractive force is the strongest. There may be a periodic oscillation from one type to another. The author points out that a sudden increase in the light of a comet should take place whenever it is exposed to the rays from a large protuberance or facula.

[H. DESLANDRES, *Comptes Rendus*, May 20, 1902.]

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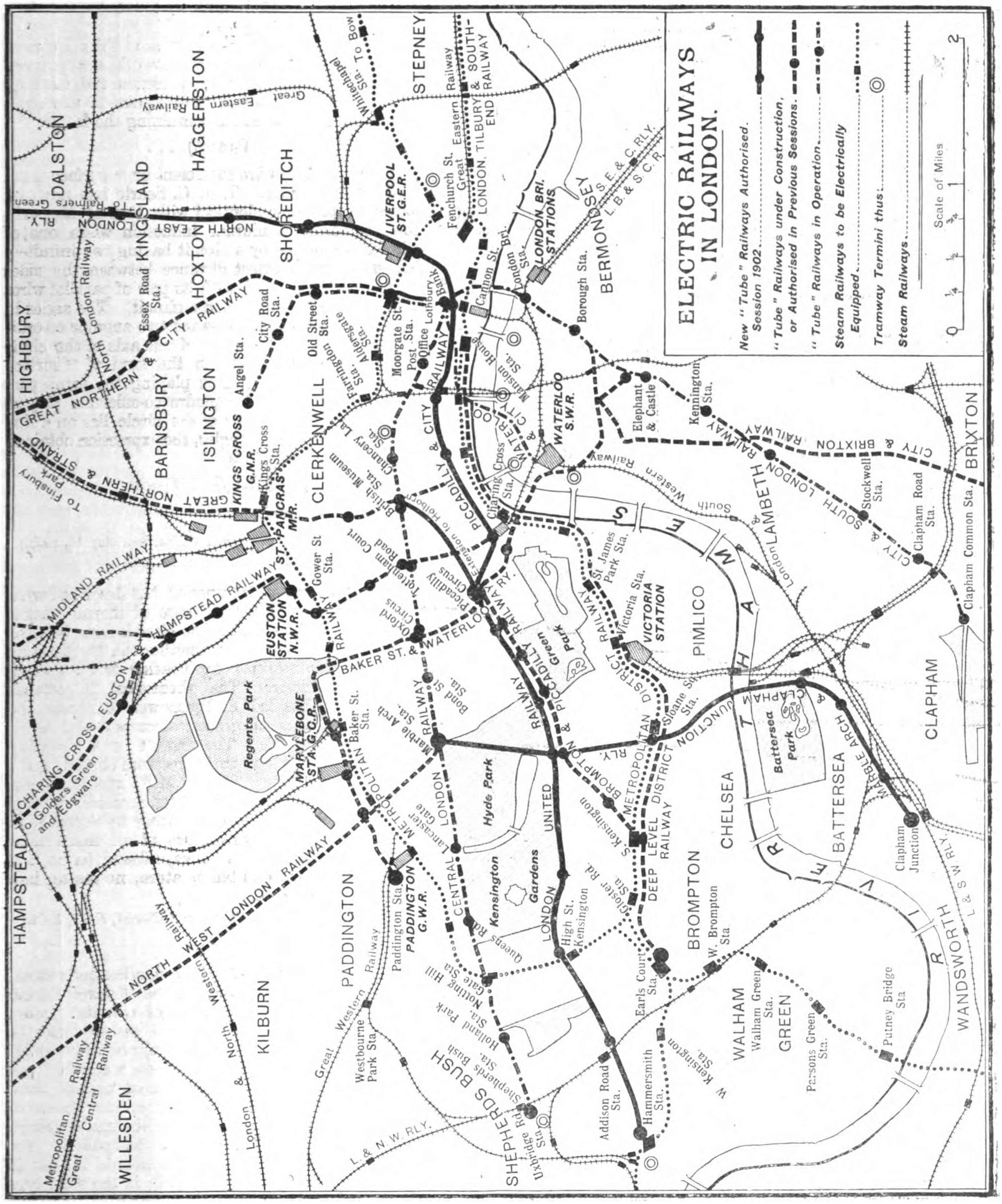
ELECTRIC RAILWAYS IN LONDON.

In the table on page 264 we give a list of the London electric railway bills which have come before Parliament this session and their fate up to the present. Most of the bills mentioned as before, received the sanction of both Houses of Parliament, it is unlikely that there will be any fatal obstacle to their becoming law. The complete map below shows, not only the new lines sanctioned, but also those already running or being constructed, besides the lines which, although power has been acquired to build them, have not yet been commenced. Thus



sanctioned or granted have been passed by Committees of the House of Lords, and the others have passed their Committee stage in the Commons, and although the bills have not, therefore, ... our readers will be able to see at a glance the network of electric railways and the important connecting links for intercommunication with which London will be endowed.

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In our leading article will be found a critical and descriptive summary of the scope of the new lines.

List of London Electric Railway Bills dealt with in the Parliamentary Session of 1902.

Charing Cross, Hammersith and District Railway	Rejected.
City and North-East Suburban Railway	Withdrawn.
North-East London Railway	Sanctioned.
London United Electric Railway (Hammersmith to Piccadilly)	Sanctioned.
Ditto ditto (Marble Arch to Clapham Junc.)	Sanctioned.
Piccadilly–City Railway	Sanctioned.
King's Road Railway	Rejected.
Ditto ditto (Putney Extension)	Rejected.
West and South London Junction Railway	Withdrawn.
Brompton–Piccadilly Circus Railway (Extension of Time)	Granted.
Ditto ditto (Charing Cross Extension)	Rejected.
Ditto ditto (Holborn Extension)	Sanctioned.
Ditto ditto (Parsons Green Extension)	Rejected.
Central Lond. Railway (Shepherds Bush–Hammersmith–City)	Rejected.
Charing Cross, Euston and Hampstead Railway (Golders Green Extension)	Sanctioned.
Edgware and Hampstead Railway	Sanctioned.
City and South London Railway (Euston Extension)	Rejected.
City and Crystal Palace Railway	Rejected.
Great Northern and City Railway (Lothbury Extension)	Sanctioned.
North-West London Railway (Extension of Time)	Granted.
Great Northern and Strand Railway (Extension of Time)	Granted.
Baker Street and Waterloo Railway (Extension of Time)	Granted.
District Deep-Level Railway (Earl's Court to Mansion House) (Extension of Time)	Granted.
London, Tilbury and Southend Railway (Powers to Run by Electricity)	Granted.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Electrical Installations of Electric Light, Power, Traction, and Industrial Electrical Machinery." By Rankin Kennedy. In four vols. Vol. I. (London: The Caxton Publishing Co.). 9s.

"Reports to the Evolution Committee of the Royal Society." Report I. Experiments by W. Bateson, F.R.S., and Miss E. R. Saunders. (London: Harrison & Sons). 10s.

"Problems in Electricity," by R. Weber. Translated from the French by E. A. O'Keefe. (London: E. and F. Spon, Ltd.) 7s. 6d.

"Proceedings of the International Electrical Congress: Paris, August, 1900." Edited by E. Hospitalier. (Paris: Gauthier-Villars.)

"Coal-Cutting by Machinery in the United Kingdom." S. F. Walker. (London: The "Colliery Guardian" Co.)

"Science Abstracts." May, 1902. (London: The Feilden Publishing Co.) 2s.

"Proceedings of the Royal Society of Edinburgh." Session 1901–2 No. 2. Vol. XXIV. (Edinburgh: The Society.)

"Die Elektrolyse des Wassers ihre Durchführung und Anwendung." By Viktor Engelhardt. (Halle A/S: Wilhelm Knapp.) 5m.

"Sichtbare und Unsichtbare Bewegungen." By H. A. Lorentz and G. Siebert. (Brunswick: F. Vieweg & Son.) 3m.

"Formules et Tables pour le Calcul des Conducteurs Aériens." By F. Loppé. (Paris: E. Bernard & Co.)

ELECTRICITY WORKS ACCOUNTS.

Brompton and Kensington Electricity Supply Co. (Ltd.).

This company's accounts for 1901 record satisfactory results. It is true that, while there was a substantially larger output and an improved load-factor, the aggregate costs per unit were practically the same as those of 1900, yet there was a creditable reduction in the works expenses, which would have appeared in the total costs had it not been for the increased rates and taxes arising from the re-assessment. With the exception of wages at the station, the generating items present excellent figures, with the result that both the total generating and works costs are quite 0·5d. per unit under what they might reasonably have been expected to stand at. The management and property charges are somewhat high. The following table gives an idea of the growth of the concern.

Year	No. of consumers.	Equiv. 8 c.p. lamp connections.	Output.	Plant capacity, kilowatts	Max. demand, kilowatts	Total revenue.	Working profit.
1889	78	4,520	...	...	...	...	...
1890	248	13,665	...	300	...	£5,010	£386
1891	373	19,388	247,861	300	250	8,328	2,250
1892	471	23,700	313,484	450	306	10,689	2,837
1893	599	28,429	358,506	550	354	12,064	4,231
1894	755	35,858	400,911	550	410	13,696	6,264
1895	932	44,162	476,714	950	520	15,395	6,841
1896	1,164	55,265	643,693	1,325	658	17,442	9,032
1897	1,416	66,364	811,255	1,410	809	20,811	12,033
1898	1,777	80,301	974.618	1,460	917	24,907	14,066
1899	2,112	95,303	1,241,369	1,810	1,105	30,417	18,181
1900	2,395	108,978	1,494,106	2,160	1,307	36,125	21,324
1901	2,650	121,212	1,702,749	2,510	1,421	41,154	24,249

We add also a table showing the scale of tariff by discounts on the standard price of 6d. per unit for lighting, which came into force at the beginning of this year. The scale is only applicable provided the maximum demand in kilowatts does not exceed 0·075 per cent. of the year's consumption in B.O.T. units (which is equivalent to a 15·2 per cent. load factor):

For consumption per annum of	Discount.	Price.	For consumption per annum of	Discount.	Price.
1,000 units and over	¼d.	5¾d.	5,000 units and over	⅝d.	5⅜d.
2,000 do.	½d.	5½d.	6,000 do.	1d.	5d.
3,000 do.	⅝d.	5⅜d.	8,000 do.	1¼d.	4¾d.
4,000 do.	¾d.	5¼d.	10,000 do.	1½d.	4½d.

Notting Hill Electric Lighting Co. (Ltd.).

It is evident from the figures in our table that this undertaking is being benefitted by taking supply from the joint works at Wood Lane erected for the supply of electricity "in bulk" to this company and the Kensington and Knightsbridge undertaking. In 1900 the amount paid for current thus supplied to the Notting Hill company was £112, last year £2,380 was so paid. At this station as at Brompton, the management and property charges appear to form an unfair proportion of the aggregate costs—the generating and works costs presenting most creditable figures, while the total costs represent a fair average for company stations of like magnitude.

Owing partly to a large capital expenditure on new plant for increasing the capacity of the station, and partly to the larger payments for interest and depreciation and into the reserve and sinking funds, the ordinary dividend shows a decline from 7 to 6 per cent. Included in the figure for interest shown in our table is a sum of £1,593, proportion of interest on the joint debenture stock of this and the Kensington companies, and, similarly, the sinking fund allocation contains £908, proportion of sinking fund in respect of the same stock.

The following table indicates the growth of the undertaking since 1891 :—

Year	No. of consumers.	Equiv. 8 c.p. lamp connections.	Output, units sold.	Total revenue.	Gross or working profit.	Total costs per unit sold.	Ord div. per cent.
1891	77	6,056	30,162	£1,623	- £555	17·34d.	Nil
1892	124	9,438	75,667	3,513	+ 112	10·78d.	Nil
1893	173	12,153	107,580	4,329	+ 1,481	6·36d.	Nil
1894	234	15,669	130,266	5,123	+ 2,102	5·57d.	1
1895	307	20,307	182,327	6,940	+ 3,228	4·89d.	2
1896	396	25,716	230,787	8,552	+ 4,735	3·97d.	4
1897	571	33,000	351,969	11,626	+ 6,854	3·22d.	6
1898	788	46,066	455,871	13,418	+ 7,252	3·25d.	6
1899	1,012	59,154	665,129	17,674	+10,361	2·64d.	7
1900	1,190	68,505	782,215	19,963	+ 9,856	3·10d.	7
1901	1,445	82,054	947,491	24,196	+13,046	2·82d.	6

REMARKS.

BROMPTON AND KENSINGTON.—*a* £7,000 for patent rights. *b* Includes proportion of salaries of manager and superintendents £1,119. *c* Proportion of salaries of manager and engineers £1:25. *d* Secretary and clerks £726, collectors £166 and directors £1,200. *e* Auditing £87, law £65 and insurances £263, *f* Paid in reduction of renewals suspense account. *g* With discounts. *h* By agreement. *i* Includes proportion of salaries of manager and superintendents £1,215. *j* Proportion of salaries of manager and engineers £300. *k* Directors £1,500, secretary and clerks £826, collectors £179. *l* Insurances £228, auditing £102.

NOTTING HILL.—*a* Inclusive of £112 paid for electricity supplied from Wood-lane works. *b* Inclusive of trustees' and directors' fees. *c* £90 to auditing and £107 to insurances. *d* At 200 volts or 8d. at 100 volts. *e* At 200 volts. *f* Exclusive of £908 balance at credit of joint debenture stock sinking fund of Kensington and Knightsbridge and Notting Hill Co.'s. *g* Over-expended. *h* Includes £7,880 paid for electricity received from Wood-lane works. *i* Costs of electricity generated at the Notting Hill station only. *j* Insurances £97, law £67, auditing £93. *k* Includes £908 proportion of sinking fund in respect of Kensington and Notting Hill debenture stock.

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	BROMPTON & KENSINGTON.		NOTTING HILL.	
Undertaking Worked by	The Brompton and Kensington Electric Supply [Co. (Ltd.).		Notting Hill Electric Lighting Co. (Ltd.).	
Date of Commencement of Supply	January, 1889.		May, 1891.	
System of Supply	Alt.-current trans. feeding low-press. network.		Continuous-current, 3-wire, with batteries.	
Chief Engineer	H. W. Bowden.		George Schultz.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	—	—	827,296	—
„ SOLD (TOTAL)	1,494,106	1,702,749	782,215	947,491
„ sold to consumers	—	—	782,215	947,491
„ sold for public lighting, &c.	—	—	—	—
„ sold for traction	—	—	—	—
„ used on works	—	—	21,020	—
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	24·1	23·3	39·1	29·1
Actual maximum supply demanded	1,307 kilowatts	1,421 kilowatts	640 kilowatts	800 kilowatts
Load factor	13·0%	13·7%	14%	13·5%
Number of public lamps	7 arc, 14 (32 c.p.) glow	7 arc, 14 (32 c.p.) glow	nil	nil
Number of consumers	2,395	2,650	1,190	1,445
Connections to mains in 8-c.p. lamps at end of year	108,978	121,212	68,505	82,054
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	2,160	2,510	640	1,440
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£249,500 / £116	£500,000 / £199	£250,000 / £391	£250,000 / £174
Share	199,500 / 92·3	300,000 / 120	200,000 / 313	200,000 / 139
Loan (including Debenture charges)	50,000 / 23·1	200,000 / 79·7	50,000 / 78·2	50,000 / 34·7
RECEIVED (TOTAL)	208,305 / 96·4	250,000 / 99·6	172,000 / 269	181,136 / 126
Share	158,305 / 73·3	200,000 / 79·7	122,000 / 191	131,136 / 91·0
Loan (including Debenture charges)	50,000 / 23·1	50,000 / 19·9	50,000 / 78·2	50,000 / 34·7
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	41,195 / 19·1	250,000 / 99·6	78,000 / 122	68,864 / 47·8
Share (unissued)	41,195 / 19·1	100,000 / 39·8	78,000 / 122	56,000 / 38·9
Share (uncalled)	nil / —	nil / —	nil / —	12,864 / 8·93
Loan (including Debentures)	nil / —	150,000 / 59·8	nil / —	nil / —
REPAID (TOTAL)	— / —	50,000 / 19·9	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	11,000 / 17·2	17,000[f] / 11·8
DEPRECIATION FUND	17,500 / 8·10	30,848 / 12·3	164,990 / 258	196,480 / 136
EXPENDED (TOTAL)	207,701 / 96·1	217,378 / 86·6	30,074 / 47·0	38,336 / 26·6
Lands and buildings	21,754 / 10·1	22,176 / 8·84	41,632 / 65·1	49,069 / 34·1
Plant	110,026[a] / 50·9	109,345 / 43·5	88,395 / 138	103,653 / 71·9
Mains	71,926 / 33·3	75,333 / 30·0	4,890 / 7·64	5,422 / 3·76
Miscellaneous	3,995 / 1·85	10,525 / 4·19	7,010 / 10·9	−15,344[g] / −10·6
BALANCE OF CAPITAL ACCOUNT	604 / 0·280	63,469 / 25 3		
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£36,125 / 5·804d.	£41,154 / 5·800d.	£19,963 / 6·128d.	£24,196 / 6·130d.
Revenue from supply	34,458 / 5·539d.	39,292 / 5·539d.	18,797 / 5·772d.	22,539 / 5·712d.
„ meters, &c.	1,659 / 0·267d.	1,845 / 0·260d.	798 / 0·245d.	950 / 0·241d.
„ public lighting	— / —	— / —	nil / —	nil / —
„ supply for traction	— / —	— / —	nil / —	nil / —
„ miscellaneous sources	9 / 0·001d.	17 / 0 002d.	368 / 0·113d.	707 / 0·179d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£14,801 / 2·378d.	£16,905 / 2·382d.	£10,107 / 3·102d.	£11,149 / 2·824d.
TOTAL WORKS COSTS	9,866 / 1·586d.	10,528 / 1·484d.	6,296 / 1·932d.	6,870 / 1·739d.
Generation of electricity	*9,304 / 1·495d.*	*9,900 / 1·395d.*	*5,780[a] / 1·774d.*	*6,491[h] / 1·644d.*
Fuel (including cartage, &c.)	5,176 / 0 832d.	5,476 / 0·772d.	2,918 / 0·896d.	1,910[i] / —
Oil, waste, water, stores	450 / 0·072d.	529 / 0 075d.	385 / 0·118d.	258[i] / —
Wages at station	3,058[b] / 0·492d.	3,228[i] / 0·455d.	693 / 0·213d.	886[i] / —
Repairs and maintenance at station	621 / 0·100d.	666 / 0·094d.	1,674 / 0·514d.	4,111[i] / —
Distribution of electricity	*562 / 0·090d.*	*628 / 0·089d.*	*516 / 0·158d.*	*379 / 0·096d.*
Wages, &c.	487[c] / 0 078d.	514[j] / 0·072d.	516 / 0·158d.	379 / 0·096d.
Repairs, renewals of mains, &c.	75 / 0·012d.	113 / 0·016d.		
Public lighting	— / —	— / —	nil / —	nil / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	4,935 / 0·793d.	6,376 / 0·898d.	3,811 / 1·170d.	4,279 / 1·084d.
Net rents	*530 / 0·085d.*	*530 / 0·075d.*	nil / —	nil / —
Rates and taxes	*1,304 / 0·210d.*	*2,398 / 0·338d.*	*678 / 0·208d.*	*1,139 / 0·289d.*
Management	*3,102 / 0·498d.*	*3,448 / 0·486d.*	*3,133 / 0·962d.*	*3,140 / 0·796d.*
Salaries	2,092[d] / 0·336d.	2,507[k] / 0·354d.	2,614[b] / 0·803d.	2,573[b] / 0·652d.
Stationery, &c.	163 / 0·026d.	155 / 0 022d.	316 / 0·097d.	309 / 0·078d.
Establishment charges	328 / 0 053d.	332 / 0 047d.		
Law charges &c.	519[e] / 0·083d.	454[l] / 0·064d.	203[c] / 0·062d.	258[j] / 0·065d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£21,324 / 10·8%	£24,249 / 11·4%	£9,856 / 6·52%	£13,046 / 7·22%
Sum carried to Depreciation Fund	6,000 / 3·05%	7,000 / 3·29%		
Sum carried to Reserve Fund	3,000[f] / 1·52%	— / —	792 / 0·524%	2,327[k] / 1·288%
Net interest on loans (incl. Debenture charges)	1,967 / 0·998%	1,184 / 0·557%	1,619 / 1·07%	3,437 / 1·900%
Net profit for the year	10,357 / 5·24%	16,065 / 7·56%	7,445 / 4·92%	7,281 / 4·03%
BALANCE FROM LAST ACCOUNT	229 / 0 116%	488 / 0·23%	nil / —	nil / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	10,586 / 5·35%	16,553 / 7·79%	7,445 / 4·92%	7,281 / 4·03%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	6% / —	8% / —	7% / —	6% / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	41%	41·1%	50·7%	46·1%
Expenditure per mean kilowatt capacity	£7. 9s. 2d.	£7. 4s. 10d.	—	—
REVENUE PER MEAN KILOWATT CAPACITY	£18. 4s. 0d.	£17. 12s. 2d.	—	—
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	7s. 1d.	7s. 2d.	6s. 3d.	6s. 5d.
Price charged for lighting, per unit	6d.[g]	6d.[g]	6d.[d]	6d.
Price charged for power, per unit	3d.	3d.	4d.[e]	6d. less 20 per cent.
Price charged for public lighting	—[h]	—	—	—
Receipts per unit for private supply	5·54d.	5·54d.	5·77d.	5·71d.
„ „ public lighting	—	—	—	—
„ „ traction	—	—	—	—

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ELECTRIC UNDERGROUND RAILWAYS IN LONDON.

With the completion of the labours of Lord WINDSOR'S Committee yesterday, all the electric railway Bills affecting London promoted this session, as well as those deferred from last year, have been disposed of by the Committees either of the House of Lords or the House of Commons. With the object of laying before our readers in a complete and concise manner the result of the work of the Committees presided over by Lord WINDSOR and Lord RIBBLESDALE respectively, we publish on another page a map of the authorised electric railways in London to-day, as well as a tabulated statement showing at a glance the manner in which each Bill has been dealt with. A striking feature of the proceedings has been the importance placed by both Committees upon the financial standing of promoters, and the promptitude with which measures have been thrown out where the slightest instability in this respect has been apparent. A noteworthy instance of the feelings of Lord WINDSOR'S Committee on this point was afforded in connection with the King's Road Railway, when the questions of route, engineering, &c., were not even touched upon. The Bill was rejected at the very outset, the Committee not being satisfied that the public could be relied upon to furnish the necessary two or three millions of capital. Similarly, in the case of the City and Crystal Palace Railway, even promises of financial support by the British Electric Traction Co. and such firms as Messrs. Salmon and Gluckstein, the tobacconists, Messrs. Lyons & Co., the refreshment contractors, and Messrs. White, the mineral water manufacturers, were not sufficient to convince Lord RIBBLESDALE'S Committee that the scheme was on a sufficiently sound basis from the money point of view. In a lesser degree the rejection of the Charing Cross, Hammersmith and District Railway is attributable to this same defect, although probably in this case the question of route also influenced the result. So far, indeed, did this attitude on the part of the Committees control the promoters that one counsel remarked upon this as an unusual course of procedure, and complained that promoters had never been called upon hitherto to "plank down sovereigns" beforehand. Probably the reason for this frame of mind in Parliament is to be found in the numerous applications for extensions of time for the construction of railways authorised some years ago. The North-West London and Great Northern and Strand Railways were sanctioned three years ago, and in both cases extensions of time have been obtained this session. The Brompton and Piccadilly Circus Railway was sanctioned as long ago as 1897, and more antiquated still is the Baker-street and Waterloo Railway scheme, which, although now partly constructed, was authorised in 1893, and has just been granted a second extension of time. In the last-named case special circumstances had arisen, as is well known, to retard its progress, but inability to induce the public to subscribe capital has been the sole cause of the delay hitherto in respect of the other schemes.

Dealing with the engineering of the new lines, inasmuch as both last year's Joint Committee and the Board of Trade have

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expressed themselves strongly against intercommunication on tube railways by means of "confluent" or run-through junctions, the want of uniformity in the proposals of the different promoters does not assume such great importance as it otherwise would have done. Thus, on the tubes under the control of Mr. YERKES, two working conductors are to be employed—viz., the negative inside the running rails and the positive outside, this being the method of working decided upon for the Inner Circle. Not, however, that the ordinary trains of the District Company will run in the tubes; for this will not be so, as by the evidence of Mr. CHAPMAN, the electrical engineer to the Underground Electric Railways Co. of London (Ltd.), the ordinary rolling stock of the District Company will be fitted with larger motors, in order to obtain a higher speed than on the tubes. And since it is not intended to encroach upon the floor space of the coaches, as on the tubes, in order to accommodate these motors, the trains will be correspondingly higher, and the two systems will accordingly be quite distinct from one another.

The system of working put forward by the Morgan combination, while also having the usual 500 volts continuous current for the working pressure and also a completely insulated return, will have the two conductors placed vertically above each other on the wall of the tunnel, protected by one of the two platforms with which it is proposed to equip the latter—one on either side of the train—for the use of passengers in case of breakdown. The roadway between the rails is further to be laid out as a pathway for a similar purpose. The two platforms are the result of the recommendations of the Board of Trade in connection with the view that 13ft. 6in. should be the minimum size of the tunnels, and it is interesting to note Mr. YERKES' disagreement with this. Mr. YERKES prefers 11ft. 6in., and considers that the negative conductor of his system being between the rails, no danger would occur, to passengers utilising the permanent way, through a breakdown or other accident. The larger tunnel also enables the whole of the motor equipment to be underneath the proper floor level of the carriages—a distinction from Mr. YERKES' proposals. The multiple unit system has been universally adopted, and in the matter of the generation and distribution of the current little difference will exist between the various undertakings. High-pressure alternating-current generation, with distribution of low-pressure continuous current through converters at sub-stations will be, in fact, the standard practice.

The recommendations of the Vibration Committee published last year, and the suggestions made by the Board of Trade, have resulted in several important modifications of tube railway working hitherto, such as a deeper running rail, the substitution of the multiple unit system in place of locomotives, equipment of the tunnels with electric lighting circuits (the switches being at the stations for use when required), larger tunnels, and the adoption of the emergency platforms already mentioned.

Proposals also have been made and passed for electric railways on the surface—viz., some three miles at the northern end of the North-East London Railway, and the whole of the Hampstead-Edgware line, which, forming an end-on junction with the Charing Cross, Euston and Hampstead Railway at Golders Green, will run in the open to Edgware, some six miles further on. This latter line, by the way, is not shown in our map. In neither instance, however, have any detailed particulars been vouchsafed as to construction. As regards the latter line, the agreement with the Charing Cross, Euston and Hampstead Railway stipulates that that body shall have control of the railway from Charing Cross to Edgware, so presumably the method of working will be akin to that already announced by Mr. YERKES.

The exact positions of Mr. YERKES and Mr. MORGAN in relation to matters of traction in London have been made more definite by the Committee's proceedings than has heretofore been the case. From the Lots-road (Chelsea) generating station power will be supplied to the following railways, which have come under the jurisdiction of Mr. YERKES—viz., the District Railway, including the Whitechapel-Bow extension, Brompton and Piccadilly Railway, Charing Cross, Euston and Hampstead Railway, District Deep Level Line, and the Great Northern and Strand Railway, between all of which there will be intercommunication chiefly by means of exchange stations. Mr. MORGAN, on the other hand, at present only has the North-East London and Piccadilly-City lines under his own control, besides a half share in the London United Electric Railway running from Hyde Park Corner to Hammersmith—all of which three routes form the Palmer's Green to Hammersmith Railway. From the two power stations which are to be constructed for the purposes of these lines current will also be supplied to the Marble Arch-Clapham Junction Railway, another of the London United Tramway Co.'s projects. An outcome of the ultimate electrification of the new branch of the District Company, extending to Bow, has been another application by the London, Tilbury and Southend Company for powers to electrify such portions, at any rate, of their system as are compatible with the Whitechapel-Bow branch. The company's Bill, however, enables it to adopt electric traction on all its lines, power being generated by the company. The Metropolitan Railway Co. will work from its Neasden generating station both as regards its interest in the Inner Circle and for its outside lines. Practically, only three absolutely new railways have been sanctioned—viz., the through line from Palmer's Green to Hammersmith—consisting of the London United, Piccadilly-City and North-East London Railways, the Marble Arch to Clapham Junction line and the Hampstead-Edgware Railway. Of the remainder of the Bills, three extensions of existing routes and five extensions of time were granted, two schemes were withdrawn and eight rejected. The other measure was the London, Tilbury and Southend Railway Bill mentioned above.

In order to meet the growing opposition to tube railway Bills each year on the part of land and property owners in respect of anticipated vibration, a special compensation clause has been drawn up for insertion in all tube railway Bills, the precise text of which as it stands at present will be found in our report of the Committee proceedings this week. It may be mentioned that questions of subsidence will be dealt with under the common law, and that vibration only is provided for in the above-mentioned clause, to which, however, opposition is anticipated when the Bills come before Parliament, on the ground that the object aimed at by it would constitute an alteration in the general law of the country.

ELECTROMAGNETIC THEORY.—CXXVIII.*

BY OLIVER HEAVISIDE.

(*Continued from page 659, Vol. XLVIII.*)

§ 506. I have shown (v. 2, p. 498) that when the circuital equations are appropriately extended, three sorts of waves arise—namely, (1) the Maxwellian, or electromagnetic wave, (2) the compressional electric wave, and (3) the compressional magnetic wave. But I gave reasons why the compressional waves should not be allowed to appear as possible extensions of Maxwell's system. Now we have just had a

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wave of compression under consideration. But it must not be confounded with either of the rejected compressional waves. It is a pure electromagnetic wave. It is also compressed. It may, therefore, be fairly described as a compressed electromagnetic wave.

Subject to some reservation, the compressed electromagnetic wave might also be considered to be an electromagnetic wave accompanied by a wave of mechanical compression, such as Rankine's classical solitary wave of compression in a fluid, which may, however, be solid. This works by means of a tension varying as the levity of the medium, the tension being the negative of the excess of the greatest over the actual pressure. Our wave resembles the Rankinian wave in respect to the compression and its connection with the actual motion. But the pressure which in Rankine's theory is imagined to have presumably a purely mechanical origin, must be abolished. The place of the excess pressure in Rankine's theory must be taken by the Maxwellian pressure of radiation.

If the pressure of radiation bears the same relation to the density of the ether as the mechanical pressure in the Rankinian waves bears to the density, and if the variations of the pressure of radiation constitute moving force in the same way as the variations of pressure in the Rankinian wave, then it it is clear that the behaviour of the two mediums as regards motion and compression will be identically similar. This is the mechanical part of it. That the electromagnetic circuital equations are also obeyed, by making the ether be compressed in its permittivity and inductivity as well as in its materiality, is a separate matter.

The compressed electromagnetic wave is essentially accompanied by the wave of material compression. Neither can exist alone. For the Rankinian wave will not work without the pressure, and the electromagnetic wave will not work in the manner required without the proper compression of the Rankinian wave. The result is undistorted propagation at constant speed through space, even though the medium may be itself moving at any speed not exceeding that of radiation.

The wave-speed u is the sum of the speed v of propagation through the ether, and of q, the speed of motion of the ether, and this sum is constant. What happens is this. If the induction B increases, so do q and m, the density. Along with increased density come increased μ and c (the electromagnetic constants). This lowers the value of v, since $\mu c v^2 = 1$, and to the same extent as q was increased. The displacement D and induction B may have any values, but there is a greatest pressure and a greatest energy density. The energy density is $2(T + T_0)$, and the energy flux is $2(T + T_0)u$, if T is the magnetic energy and T_0 the energy of motion.

[This corrects equations (41), (42), (43) at end of last section, in which T_0 should be $2T_0$, for reason given below. Therefore, delete from "The equation of activity" to the end.]

In the propagation of an electromagnetic wave through a compressible medium it is necessary in general to consider the moving force to be F + X, where F is Maxwellian and X is due to the strain of the medium as ordinarily considered. Now we found X = 0. But then F performs exactly the same functions as the abolished X of the Rankinian wave. There is, therefore, an alternative way of viewing the matter. The Maxwellian pressure may be regarded as being *the* pressure in the medium. This may be somewhat a matter of convention. To understand fully would need an explanation of how the Maxwellian pressure arises. That is going too far at present. Yet it is necessary to allow for the work done by F in translating and compressing the ether just as if it were the abolished X. That is, not only are the electric and magnetic energies equal, but the energies of translational motion and of compression, as in Rankine's wave.

§ 507. The best way to understand the connections is to take the Rankinian wave alone first. The electromagnetics can be tacked on afterwards. Let q be the speed of the fluid (along the x axis); then the equations of persistence of mass and momentum are

$$-(mq)' = \dot{m}, \qquad -p' = m(\dot{q} + qq'). \tag{41}$$

If there is a solitary wave at constant speed u, then $d/dt = -ud/dx$, so the first of (41) becomes

$$(mq)' = um', \quad \text{therefore} \quad m(u - q) = \text{const.} = mv, \tag{42}$$

if $u = v + q$, so that v is the speed of propagation through the fluid.

Similarly, eliminating $\dot{q}$ from the second of (41), we get

$$p' = mvq', \quad \text{or} \quad \frac{dp}{dq} = mv, \quad \therefore \quad p - p_0 = mvq, \tag{43}$$

if p_0 is the least pressure, when $q = 0$. So the working pressure varies as the speed. Also, since mv is constant,

$$m'v = -mv' = mq', \quad \text{because} \quad u = v + q. \tag{44}$$

Put this value of q' in the first of (43). Then

$$p' = m'v^2, \quad \text{or} \quad v^2 = \frac{dp}{dm}. \tag{45}$$

This makes

$$p_1 - p = mv^2 = \frac{m^2v^2}{m}, \tag{46}$$

if p_1 is the greatest pressure, when $m = \infty$, or $q = u$, and $v = 0$. The deficit from this pressure varies as r, and as m^{-1}.

If m_0 is the least density, when $q = 0$, then $m_0 u = mv$. Then also $p = p_0$, so

$$p_1 - p_0 = m_0 u^2 = \frac{m^2v^2}{m_0}, \tag{47}$$

and

$$p - p_0 = m^2v^2\left(\frac{1}{m} - \frac{1}{m_0}\right) = mv^2 - m_0u^2. \tag{48}$$

The activity of the working stress is $(p - p_0)q$. The convective flux of energy is $q(U_0 + T_0)$. Their sum is the flux of energy. Its convergence is the rate of increase of energy density. That is,

$$-\{(p - p_0 + U_0 + T_0)q\}' = \dot{U}_0 + \dot{T}_0. \tag{49}$$

This applies in general, without specifying the law of pressure or that u is constant. But making $d/dt = -ud/dx$, (49) becomes

$$-\{(p - p_0)q\}' = -\{v(U_0 + T_0)\}',$$

if $v = u - q$. Therefore

$$(p - p_0)q = v(U_0 + T_0) \tag{50}$$

if $U_0 = 0$ when $q = 0$. Putting in the value of $p - p_0$, it follows that $U_0 = T_0$. This value of U_0 may also be directly calculated. Thus, if $m^{-1} = V$, we have

$$U_0 = -\frac{1}{V}\int_{V_0}^{V}(p - p_0)dV = m\int_{m_0}^{m}\frac{p - p_0}{m^2}dm. \tag{51}$$

Put in the value of $p - p_0$ in terms of m, and integrate. The result is

$$U_0 = \tfrac{1}{2}m \cdot m^2v^2\left(\frac{1}{m_0^2} - \frac{1}{m^2}\right) = \tfrac{1}{2}mq^2 = T_0, \tag{52}$$

because

$$q = mv\left(\frac{1}{m_0} - \frac{1}{m}\right). \tag{53}$$

Another expression is

$$U_0 = \tfrac{1}{2}(p - p_0)\frac{q}{v}, \tag{54}$$

as may be seen by (50). So $2T_0u$ is the flux of energy, including the equal stored energies moving at speed q, and the activity of the working pressure.

§ 508. The wave may travel either way. So there may be two waves approaching one another, both travelling at speed u without distortion. On emergence from one another after crossing, they will also follow the above theory. But when coincident, there is mutual influence, and consequently change of type. A classical investigation of Riemann allows us to see what happens in crossing. Go back to equations (41), and put $\lambda = \log m$, and $v^2 = dp/dm$. Then they become

$$-v^2\lambda' = \dot{q} + qq', \qquad -q' = \dot{\lambda} + q\lambda'. \tag{55}$$

Multiply the second equation by v and add it or subtract it from the first. Thus,

$$-v(v\lambda' + q') = \frac{\delta q}{\delta t} + v\frac{\delta\lambda}{\delta t}, \qquad -v(v\lambda' - q') = \frac{\delta q}{\delta t} - v\frac{\delta\lambda}{\delta t}. \tag{56}$$

These are the same as

$$\left\{\frac{d}{dt} + (q + v)\frac{d}{dx}\right\}(q + \int v d\lambda) = 0, \tag{57}$$

$$\left\{\frac{d}{dt} + (q - v)\frac{d}{dx}\right\}(q - \int v d\lambda) = 0; \tag{58}$$

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which show that

$$\tfrac{1}{2}(q+\int v d\lambda) \text{ travels positively at speed } v+q; \quad (59)$$

$$\tfrac{1}{2}(q-\int v d\lambda) \text{ travels negatively at speed } v-q. \quad (60)$$

The sum and difference are q and $\int v d\lambda$, which may be the given data, since the latter is a function of m.

Now in Rankine's fluid mv is constant, where $v=(dp/dm)^{\frac{1}{2}}$, so

$$\int v d\lambda = mv\int\frac{dm}{m^2} = mv\left(\frac{1}{m_0}-\frac{1}{m}\right) = u-v. \quad (61)$$

So, by Riemann's results just got,

$$\tfrac{1}{2}(q+u-v) \text{ is the positive wave; speed } v+q; \quad (62)$$

$$\tfrac{1}{2}(q-u+v) \text{ is the negative wave; speed } v-q. \quad (63)$$

Of course, it is not assumed here that $u=v+q$, but merely that $mv=$constant. The quantities q and v may be the initial data, v being a known function of m. Then (62), (63) show the division into the instantaneous positive and negative waves. Now $q=u-v$ makes the negative wave disappear; and then (62) shows that both q and v travel at speed u. This is Rankine's wave again.

§ 509. Having got back to the solitary wave, we can now introtroduce the electromagnetic part. We must first abolish $p-p_0$ and substitute the Maxwellian pressure of radiation, say p_r. Or else, suppose that $p-p_0$ is p_r. Or equivalently, put $p_0=0$, and then let p itself stand for the Maxwellian pressure. Say

$$p=\mu H^2=2T, \quad (64)$$

where H is magnetic force tranverse to the direction of motion of the wave. Let there be also E likewise transverse, and perpendicular to H. If the intensities are connected by $E=\mu vH$, we have a plane electromagnetic wave. It is the same as $B=\mu vD$, if $B=\mu H$, $D=cE$. We also have $U=T$. Considering the state of things in a thin plane slab, the connections between the electric and magnetic quantities and the quantities q, m, v, u in the Rankinian wave are definite. But in order that the electromagnetic wave should keep up with the wave of compression, not only must v be the same in both, that is,

$$\mu c v^2=1, \quad \text{as well as} \quad v^2=\frac{dp}{dm}, \quad (65)$$

but we require μv and cv to be constant, as well as mv. That is, μ, c and m all vary together, or the compression of the "matter" of the ether (its inertia of the usual kind) involves simultaneous equal compression of the two properties associated with the magnetic induction and the electric displacement. The electromagnetic wave now travels with the Rankinian, at the constant speed u, without change of type.

Remembering that $p=\mu H^2$, we can derive

$$q=\frac{\mu H^2}{mv}=\frac{cE^2}{mv}=\frac{uB^2}{B^2+\mu m v^2}=\frac{uD^2}{D^2+cmv^2}, \quad (66)$$

showing that D and B may go from 0 to $\pm\infty$, but q can only go from 0 to u. In the limit, $v=0$, or there is no propagation through the medium. The pressure is then the greatest possible, for

$$p_1-p=mv^2 \quad \text{makes} \quad p_1=m_0u^2=muv. \quad (67)$$

This p_1 shows also the limiting value of the sum of the equal electric and magnetic energies. But the limiting values of E and H are zero. For

$$H^2=\frac{p}{\mu}=\frac{muq}{\mu}, \qquad E^2=\frac{p}{c}=\frac{muq}{c}, \quad (68)$$

and the ratios m/μ and m/c are constant, whilst $q=u$ makes $v=0$.

An important relation is

$$T_0v=Tq. \quad (69)$$

The complete flux of energy is

$$W=2(T+T_0)u=2T\frac{u^2}{v}=\frac{pu^2}{v}. \quad (70)$$

This tends to ∞ as q tends to u, making v tend to 0. It is the energy of motion that causes this (as in the Rankinian wave), because m has no limiting value. Considering this, it is striking that the electric and magnetic energies should have no similar tendency, but tend to a finite limit.

The above union of the compressed electromagnetic wave and the compressed etherial wave might be suspected to be merely formal, due to superposition or coincidence. But it is more than that. The dynamics of the electromagnetic wave necessitate the mechanical force $-(2T)'$, and this is precisely what is required in the etherial wave of compression.

The electromagnetic equation of activity has also to be harmonised with the above. It is (*El. Pa.*, v. 2., p. 546, equation (121)),

$$\text{conv}\{VEH+(U+T+p)q\}=\dot{U}+\dot{T}+Fq+\frac{\delta}{\delta t}(U_c+T_\mu), \quad (71)$$

where p is the pressure operator, and F the corresponding force. The last terms are required because $\delta c/\delta t$ and $\delta\mu/\delta t$ do not vanish here. In a plane wave this becomes

$$-\{EH+(U+T+p)q\}'=\dot{U}+\dot{T}-p'q+\frac{U}{c}\frac{\delta c}{\delta t}+\frac{T}{\mu}\frac{\delta\mu}{\delta t}, \quad (72)$$

and now p is a pure pressure, and $F=-p'$.

Putting in the values $EH=pv$; $U+T=p$; $q+v=u$, constant; $\mu v=$constant, there is a perfect satisfaction. But for the full interpretation of the equation, especially as regards the terms depending upon the variation of c and μ, I must say a few words about the stress or pressure operator, and its significance in electromagnetics. I have already written much about it. What is now wanted concerns the concrete application at present in question.

Concerning Riemann's solutions (57), (58) above, it may be shown that if the operands $q\pm\int v d\lambda$ are replaced by the electromagnetic $E\pm\mu vH$, the solutions thus obtained are the corresponding ones in electromagnetics, but *only* when μ and c vary as the density of the ether, not in general.

(*To be continued.*)

ELECTRICAL TRACTION ON STEAM RAILWAYS IN ITALY.*

BY PROF. C. A. CARUS-WILSON, M.A.

Italian Railways.

The Adriatica and the Mediterranean Railway Companies together work 80 per cent. of the railways in Italy, the former serving the whole of eastern Italy from Venice to Brindisi, and the latter the whole of western Italy from Turin to the extreme south. The two systems have their chief connecting points at Milan, Florence, Rome and Naples. The number of miles of line worked by each company is about the same—nearly 3,690 miles by the Mediterranean and 3,620 by the Adriatica. Each of these companies, therefore, works about as many miles of line as the Great Western and the Great Northern Companies put together. The railways are now being worked under an arrangement with the Italian Government, by which the Government gives the companies an annual subsidy in return for a certain proportion of the receipts. For the year 1900 the Adriatica Company received from the Government a subsidy of £2,166,000, while it paid to the Government a sum equal to 40 per cent. of the total receipts, amounting to £2,040,000, the balance to the credit of the company being £126,000. This arrangement comes to an end in 1905, when the Government has the option either of buying out the companies or of coming to a fresh arrangement with them.

For a long time past the Italian railways have been suffering from the competition of tramways and economic lines, which have provided a cheaper and more frequent service, seriously affecting the traffic on the main lines in spite of every effort made to minimise the injury thus caused. The map on page 270 shows the network of steam tramways and economic lines that has spread over northern Italy; these not only radiate from most of the large towns, such as Milan, Turin, Verona, &c., but also serve as links to connect one town with another, as for instance the line connecting Milan with Pavia, which is 20 miles long, and that connecting Brescia and Mantua, which is 43 miles long. The railway companies have come to the conclusion that the remedy for this competition lies in providing, by means of electricity, a service of short trains running frequently at high speeds. This Paper will contain an account, written from an economic rather than from a technical standpoint, of what is being done towards carrying out this object, with some comparisons between the conditions of railway working in Italy and in England.

* Paper read before the Institution of Electrical Engineers, May 15th.

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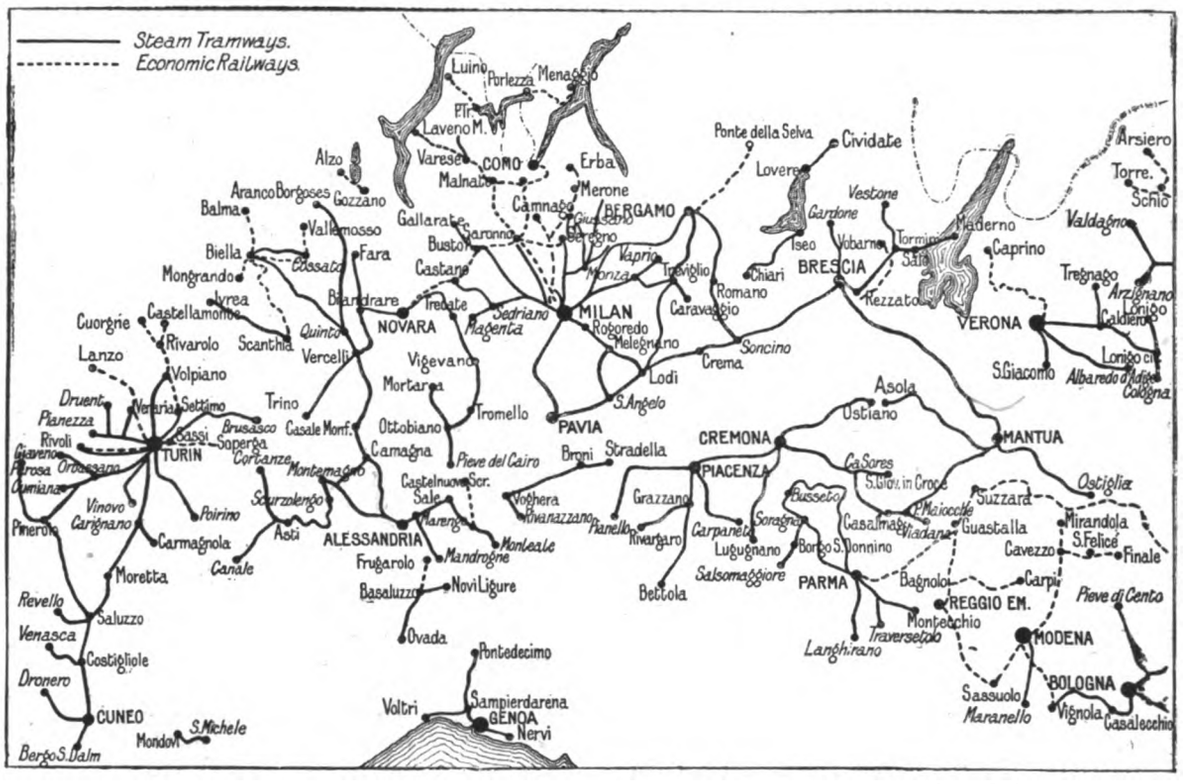
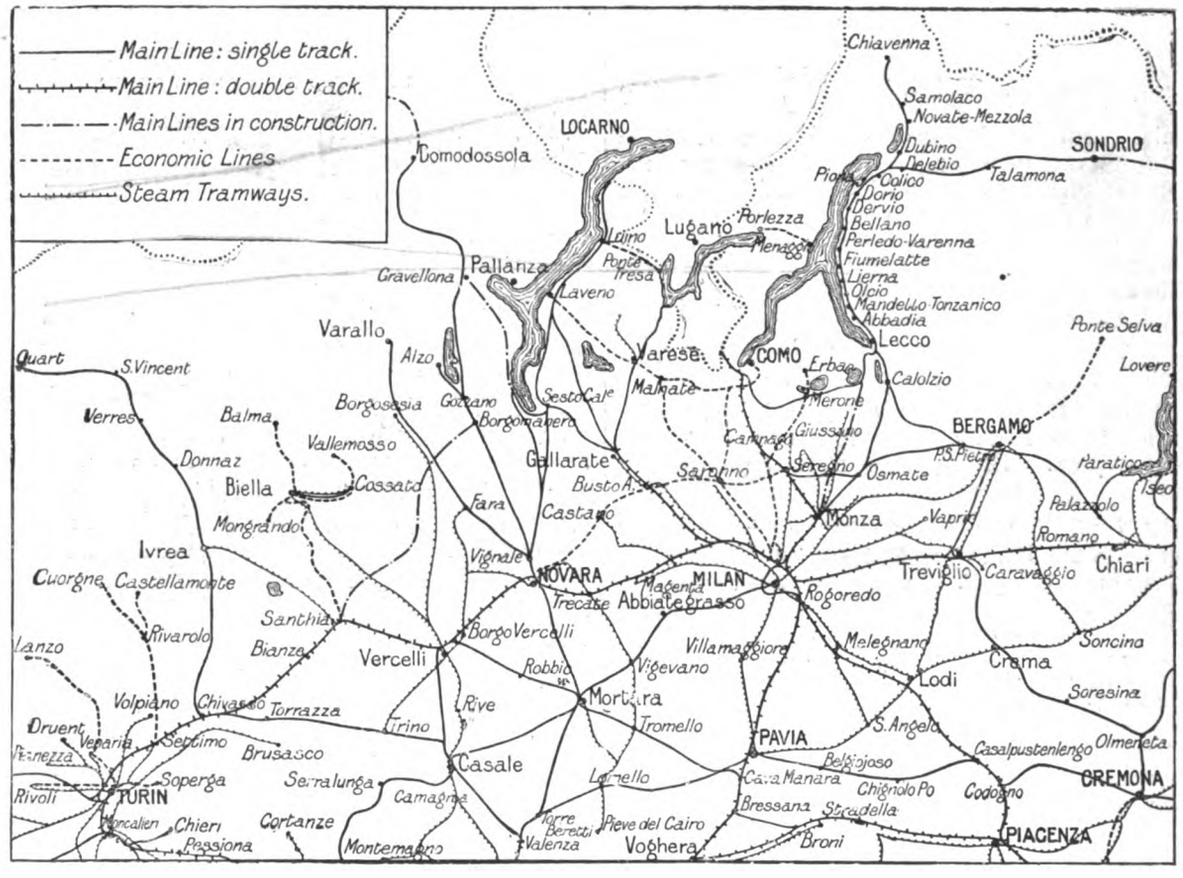
The Adriatica Railway.

The Adriatica Railway Co. has already equipped electrically that portion of its system running from Lecco to Colico, and thence to Sondrio and to Chiavenna (see map). The intention is to extend the system ultimately to Milan. Meanwhile the electrically-driven trains are to work their own way as far south as Lecco, and to be hauled thence to Milan by steam locomotives. Trains are now running experimentally, but not yet in actual service. The total distance at present electrified amounts to 66 miles, all of single track, a large proportion between Lecco and Colico being in tunnel. A profile of the line is given in Fig. 1. The hydraulic power-house with turbines of 6,000 H.P. is at Morbegno, water being taken from the river Adda. Three-phase current is generated at 22,000 volts and carried by overhead conductors to nine transformer stations, where it is transformed down to 3,000 volts and taken to the two trolley wires, the rail forming the third conductor, and thence direct to polyphase motors on the cars.

The motor cars, of which a view is given in Fig. 2, are 57ft. long,



MAP A.—Map showing Network of Steam Tramways and Economic Lines in Northern Italy.



MAP B.—Map showing Railway Connections in the neighbourhood of Milan.

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weigh 53 tons unloaded, and have seating accommodation for 56 passengers. Each car is provided with two high-speed motors of 150 H.P., and two low-speed motors of 75 H.P., each, weighing 3 8 tons and driving direct without gearing. Full speed is 37 miles an hour. The four motors are used in cascade connection at starting; at half-speed the two low-speed motors are switched out, and the car

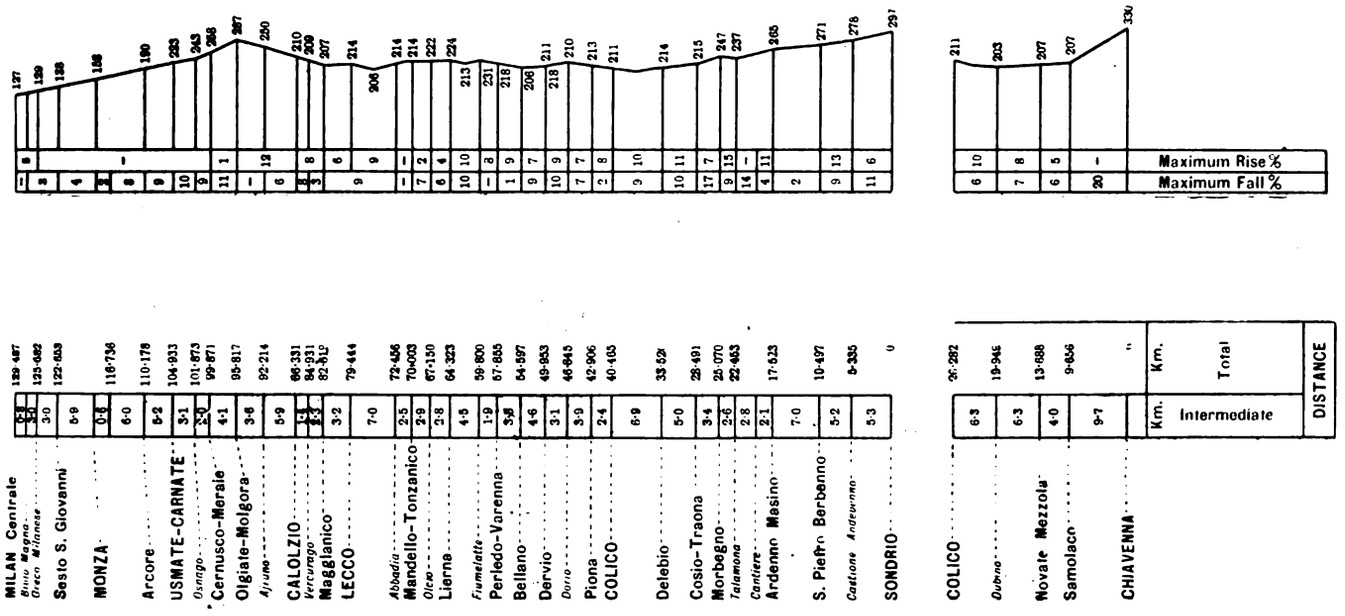

FIG. 1.—PROFILE OF LECCO–COLICO LINE.

is driven by the two high-speed motors alone at full speed. On all grades over 1 per cent. the motors are connected in cascade and the speed thus halved. The trailers used are passenger carriages of the ordinary type. The goods traffic is to be hauled by electric locomotives. The company is introducing a new "economic" system for working the line, by which they hope to reduce the traffic expenses,

Bologna to Verona. In this system the stations are divided into "control" stations and "section" stations. On the Lecco line there are six of the former and 11 of the latter. The responsibility for the control of the traffic rests with the personnel at the "control" stations, the agents at the "section" stations having no direct responsibility for the safe conduct of the traffic, which depends entirely on an automatic block system operated by an electrical apparatus which the agent has to attend to and keep in working order. Each "section" station is in telephonic communication with the nearest "control" station, to which all questions relating to rates, regulations, &c., can be referred. By this means a considerable reduction in the expense of the personnel at the stations is rendered possible.

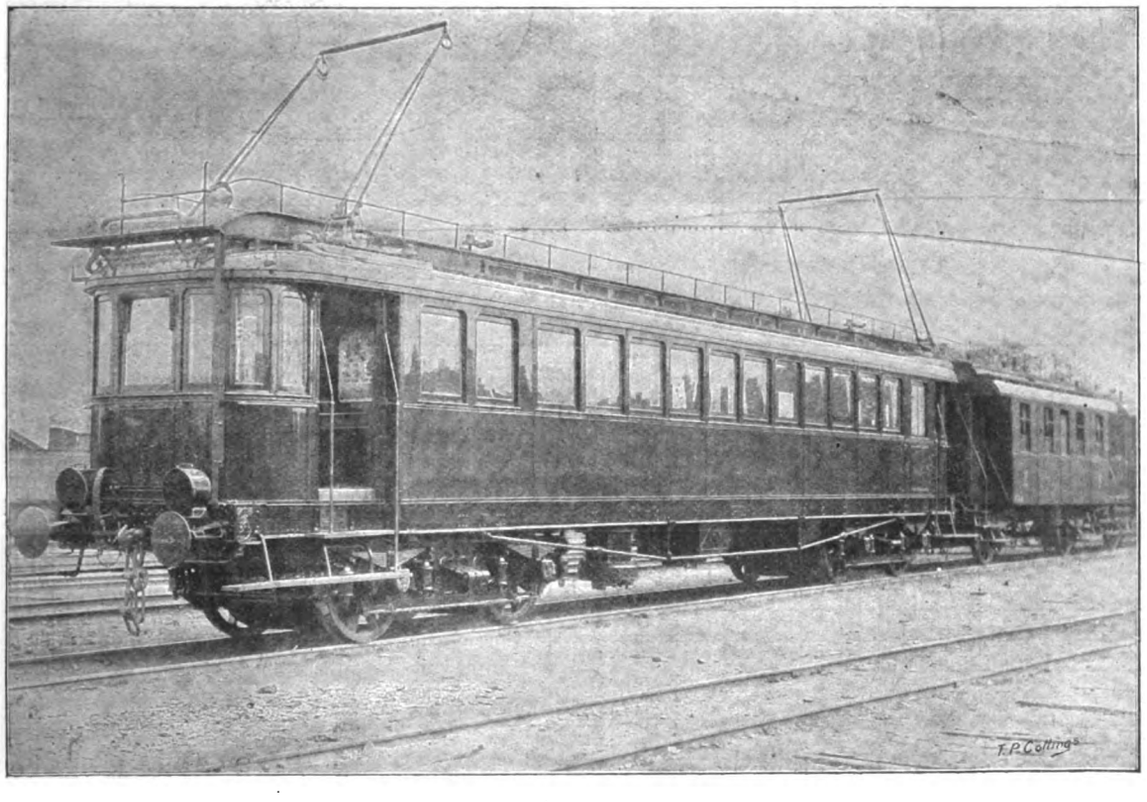

FIG. 2.—Motor Car used on the Lecco–Colico Line.

80 per cent. of which is accounted for by the wages and salaries of the personnel at the stations. This system has been in operation on other parts of the company's lines and has been found to work well, as, for instances on the section of line 27 miles long, between Bologna and St. Felice, part of the projected line from

The block system employed is the Webb and Thompson Staff system, supplemented by an electric interlocking apparatus invented by Signor Olper, the Controller of Telegraphs in the Adriatica Railway Co., combined with an arrangement by which the trolley line at every station is divided into sections, each controlled by a

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switch, the opening and closing of which takes place simultaneously with the movement of the corresponding signal, so that it is impossible for a train to run on to a section against signals.

The Mediterranean Railway.

The Mediterranean Railway Co. is equipping electrically the whole of the line from Milan to Gallarate and thence to Varese, Porto Ceresio, Laveno and Arona. Some idea of the importance of the change now in progress may be gained from the fact that the passenger receipts from these sections of line amount to about 2 per cent. of the receipts for the whole Mediterranean system. The total length of line is 81 miles, made up of sections. Of the whole distance all is of single track except the length from Milan to Gallarate, which is of double track. The maximum grades and minimum curves are given in the table. A profile of the line is given in Fig. 3, and a plan in Fig. 4.

The power house is at Tornavento, about 7 miles from Gallarate. Current is at present being supplied from a steam

Table I.—*Comparing the Weight, Power and Dimensions of the Polyphase Motor Cars on the Lecco Line with the Direct-Current Motor Cars on the Varese Line.*

—	Total wght. empty.	Length of frames.	Seats.	No. of motors.	Maximum H.P. of each.	Total max. H.P.	Weight of four motors.	Full speed on level.
	Ton.	Ft.					Tons.	M.P.H.
Varese	40	52	63	4	150	600	10	56
Lecco..	53	57	56	4	2 of 150 2 of 75	300	15·2	37

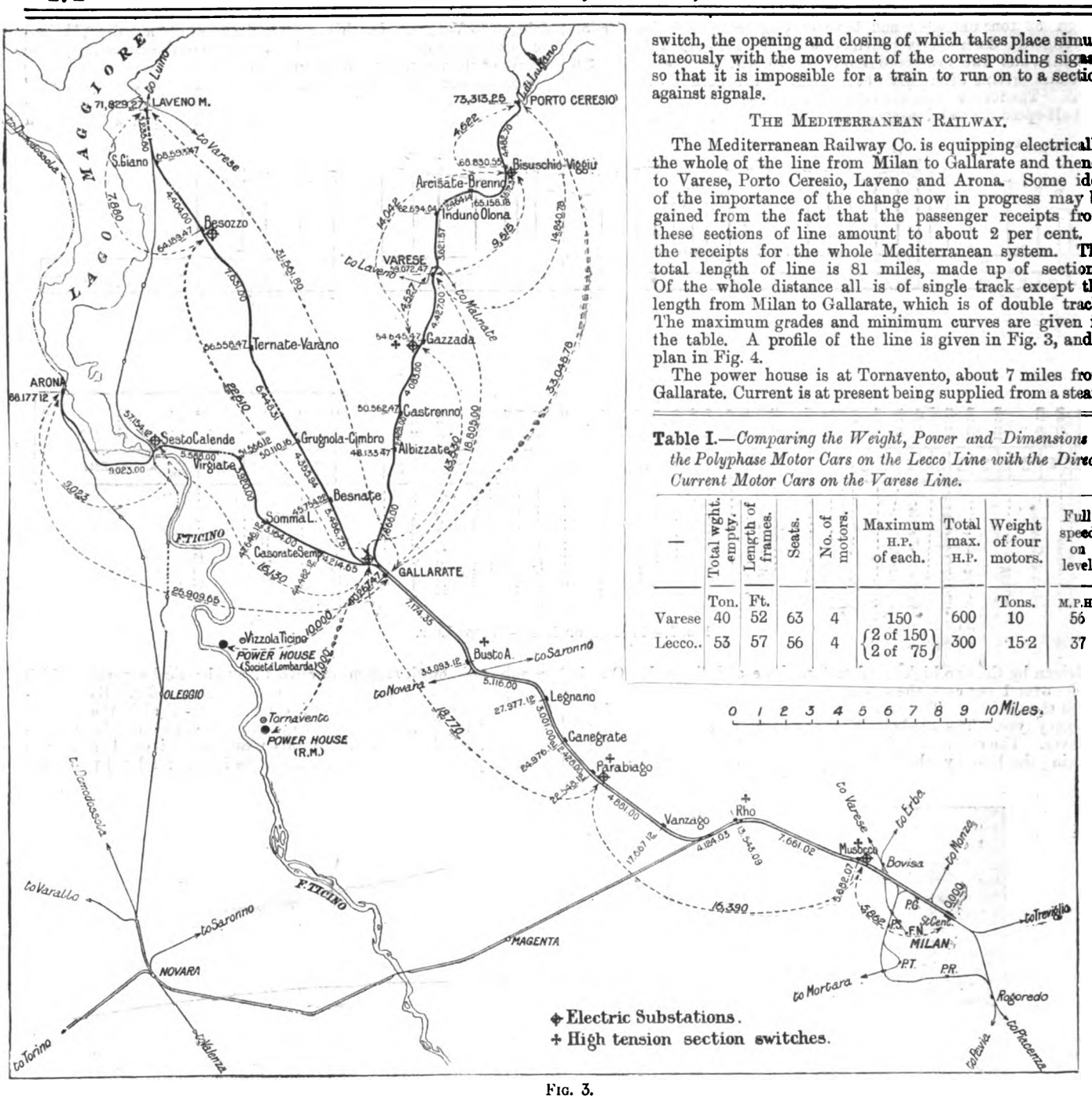

FIG. 3.

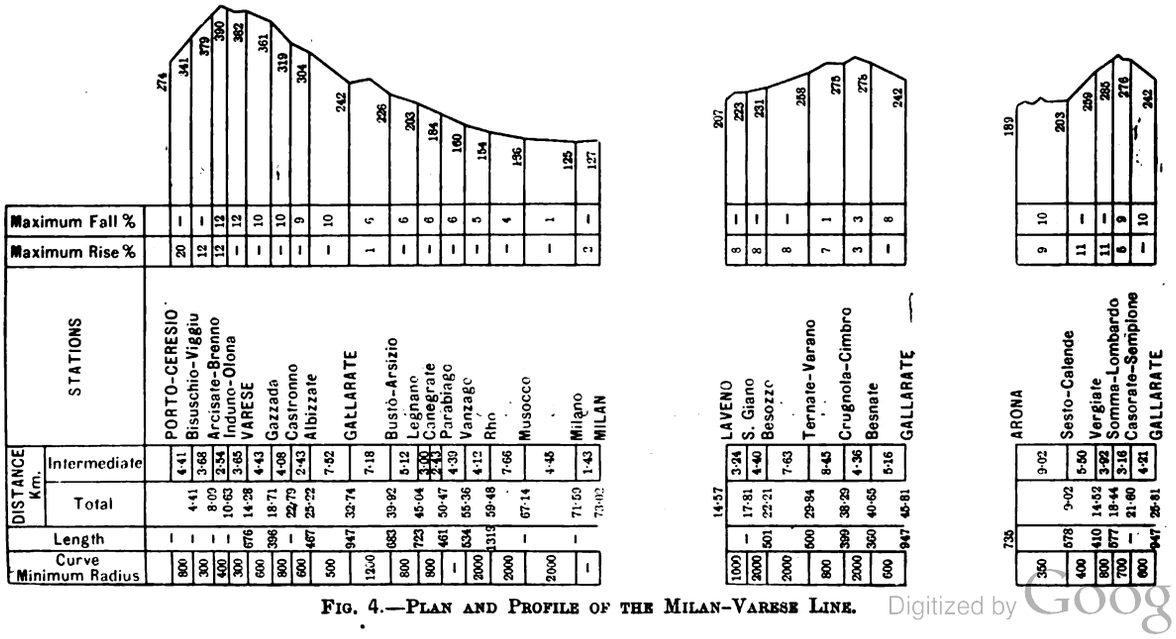

FIG. 4.—PLAN AND PROFILE OF THE MILAN-VARESE LINE.

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generating plant ; but a water-driven plant is in course of construction close to the steam power house, from which the whole line will ultimately be worked. Turbines of a total of 11,000 H.P. will be driven by water taken from the river Ticino.

The power is transmitted as three-phase current at 12,000 volts to seven sub-stations along the line, where the pressure is reduced from 11,000 to 420 volts, and the current is transformed in rotary converters to direct current at 650 volts. From the sub-stations the current is taken to an insulated third rail, as shown in Fig. 5.

The motor cars on the Varese line, shown in Fig. 6, weigh 40 tons unloaded, and have accommodation for 63 passengers seated and 12 standing. Each motor car is driven by four 150 H.P. motors on the usual one-hour rating, and is geared with a 3 to 1 ratio to 41in. driving wheels. Full speed on a level is 56 miles an hour. Each motor weighs 2 5 tons. The trailers weigh 27 tons empty, and have accommodation for 63 passengers seated and 27 standing. The goods traffic is to be hauled by electric locomotives. The electric trains are now running and in regular operation as far as Varese, though the service of trains as contemplated is not yet complete.

(To be concluded.)

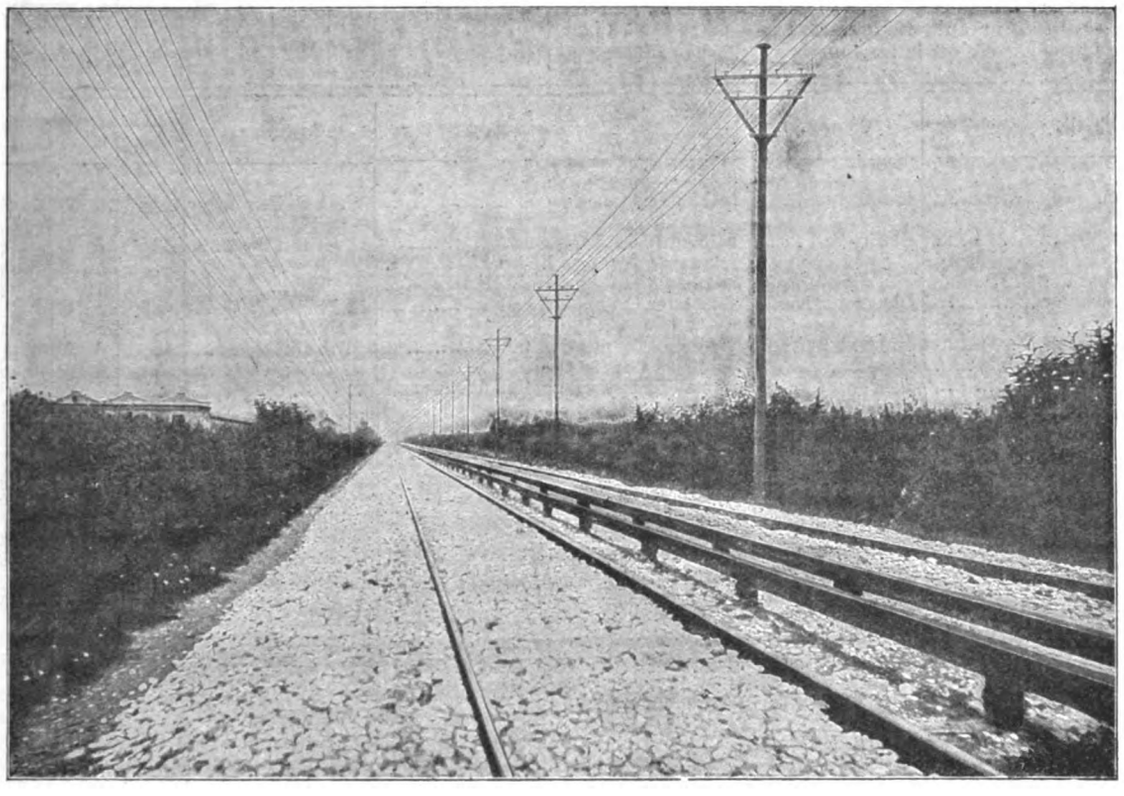

FIG. 5.—View of High-Tension and Third-Rail Construction on the Milan-Varese Line.

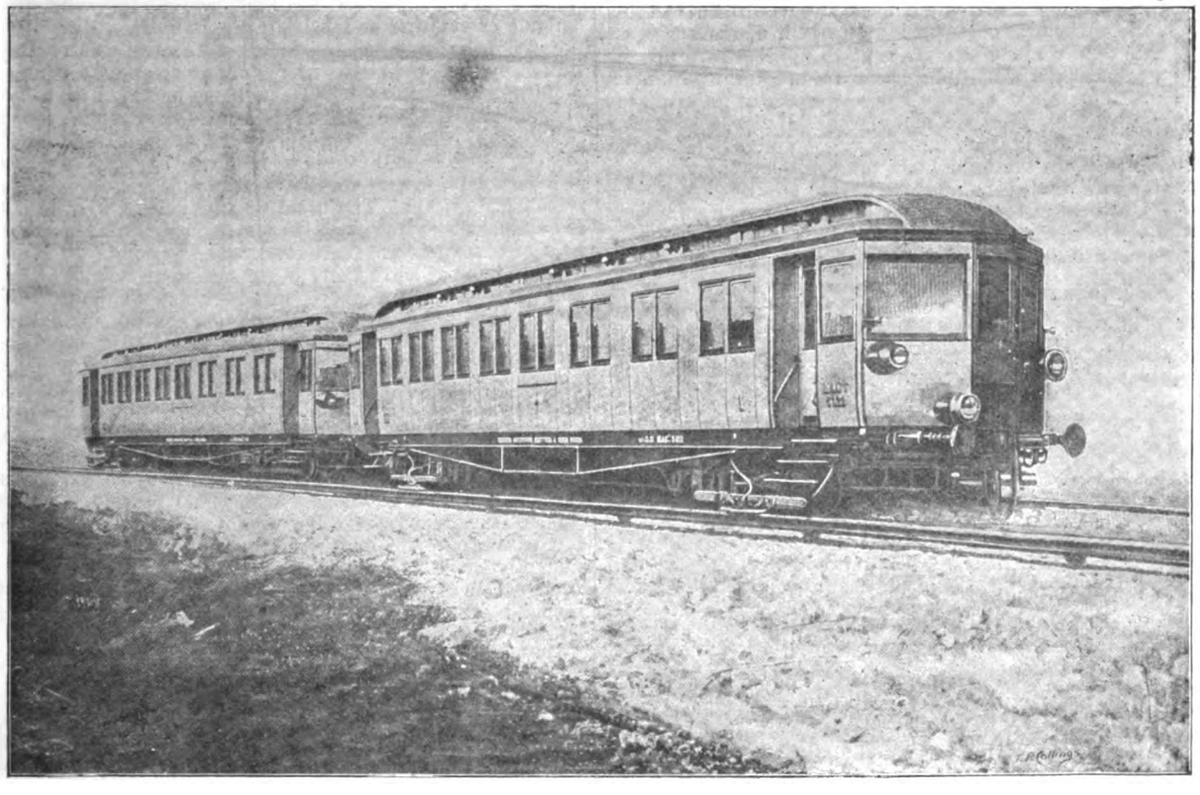

FIG. 6.—Motor Car Train used on the Milan-Varese Line.

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LIGHT ELECTRIC RAILWAYS.

We are able to give in our present issue a complete list of the applications for light electric railways lodged with the Light Railway Commissioners during the past month. There are 21 applications, compared with 44 in December and 26 in May, 1901. Of the present applications three are for amendments or further powers, four for extensions of existing or authorised lines, while there are 12 new schemes, and of the latter electric traction is specified in nine cases.

The following are the figures of the applications since the Light Railways Act came into force :—

—	1902.	1901.		1900.		1899.		1898.		1897.		1896
	May.	Nov.	May.	Nov.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
Total applications	21	44	26	27	24	43	40	54	35	30	28	28
Electric schemes.	16	40	22	19	17	32	21	32	18	16	10	14

Title.	County.	Promoters.	Engineers.	Mileage.	Gauge.	Agents.
					Ft. in.	
Barking (Extensions)	Essex	Barking District Council	W. C. C. Hawtayne and C. J. Dawson	1½	4 8½	Clerk to Barking U.D.C.
Burton and Ashby	Staffs., &c.	Midland Railway Co.	C. H. Gadsby	11½	3 6	Sherwood & Co.
Colne and Trawden (Amendment)	...	Colne and Trawden Light Railway Co.	...	...	...	Addyman & Evans
Colne & Trawden (Further Powers)	...	Colne and Trawden Light Railway Co.	...	...	...	Addyman & Evans
County of Gloucester	Gloucestershire...	Gloucester County Council	R. Phillips & G. P. Milne	3¾	3 6	Lewin, Gregory and Anderson
County of Middlesex (No. 1)	Middx. & London	Middlesex County Council	H. T. Wakelam	16	4 8½	Sherwood & Co.
County of Middlesex (No. 2)	Middlesex	Middlesex County Council	H. T. Wakelam	1	4 8½	Sherwood & Co.
Crystal Palace	London, Surrey and Kent	Crystal Palace Light Railways and Tramways Co.	V. B. D. Cooper	2½	4 8½	Bennet & Chance
Gloucester & District (Extensions)	Gloucestershire...	Corporation of Gloucester	R. Read	2½	3 6	Sharpe & Co.
Leicester, Anstey, Groby and Newtown Linford	Leicestershire	Lieut-Col. R. E. B. Crompton, C.B., J. Trotter and C. F. Tufnell	H. A. Roechling	6¾	4 8½	J. Kennedy
London United Tramways (Light Railway Extensions No. 3)	Middlesex	London United Tramways (1901) Ltd.	J. Clifton Robinson	17¼	4 8½	H. C. Godfray
Maidstone Corporation	Kent	Corporation of Maidstone	S. Sellon	2½	4 8½	Sharpe & Co.
Padstow, Redruth and Mawgan	Cornwall	T. H. Spry, W. H. D. Mewton, and E. Andrews	H. Dalrymple-Hay and C. Gadsby	12	4 8½	Burchells & Co.
Southend-on-Sea and District	Essex	Corporation of Southend	A. Fidler	3¾	3 6	Sharpe & Co.
Stroud and Gloucestershire	Gloucestershire...	T. Nevins	G. P. Milne	28¼	3 6	Ball, Smith & Co.
Trent Valley (Amendment)	...	Trent Valley Light Railway Co.	...	...	...	W. H. Smith & Sons

LIGHTING AND DRIVING TEXTILE MILLS BY ELECTRICITY.*

BY MARSHALL OSBORNE.

The application of electricity to the majority of the manufacturing industries has long passed the experimental stage, and is an established commercial success. This applies equally well to the textile industry, although very little progress has been made in this direction in this country. While this may appear to indicate lack of enterprise on the part of our textile manufacturers, and to some extent this is, undoubtedly, the case, it should be borne in mind that, in most countries where the greatest progress has been made in this connection, the conditions obtaining are more favourable to such progress than with us. There are in this country a large number of new mills being erected, which are arranged for a mechanical drive, although they are for the most part, if not always, lighted electrically.

Lighting.—Until the advent of the enclosed arc lamp illumination by means of arc lamps was not satisfactory for many of the fine operations demanded in weaving and spinning, and incandescent lamps placed in close proximity to the work were generally used. The enclosed arc lamp, however, where it has been tried, has proved both satisfactory and efficient. Its use has been most general in the textile mills in the States, where many large plants have been installed, which are operating to the entire satisfaction of the mill owners.

The principal advantages which the enclosed lamp offers over the open type are :—

(*a*) The fire risk is reduced to a minimum, if not entirely eliminated, by the introduction of the inner globe.

(*b*) Improved diffusion of light, reducing the highly-illuminated zones and increasing the effective illumination over an extended area.

(*c*) The light of the enclosed lamp is more constant and less subject to sudden fluctuations due to feeding, &c., than the open type.

(*d*) The enclosed lamp is practically free from shadows, a frequent source of trouble with lamps of the open type.

(*e*) The light of the enclosed arc more nearly approaches daylight, thereby permitting delicate colours to be matched and ensuring a uniform product during the entire year.

Power.—The application of electric power to the operation of textile machinery has not, up to the present, made much progress in this country, and, although many striking advantages can be demonstrated in favour of the electric drive, it has not received that consideration on the part of our mill owners which, in their own interests, would seem advisable. The most important of these advantages is, undoubtedly, the fact that, with the electric system, it is possible to concentrate the whole of the power required for operating an extensive mill, or collection of mills, which are scattered over a comparatively wide area, *into one central power plant*. By this system great economy in working costs, maintenance and staff is obtained, as by the use of large steam engines and generators of an efficient type the generating costs for power are reduced to a minimum ; also, one staff only is required, instead of several independent staffs, as in the case of isolated steam plants. But even in the case of a single mill, very material advantages can be demonstrated in favour of the electric drive over the mechanical system by means of belt or rope transmission, as a large amount of shafting and belting can be entirely dispensed with by the use of the former operated from one centrally-situated generating station by the application of motors at the points where power is required. The transmission can be so arranged as to give a very high efficieny, although the question of commercial economy, particularly in the first cost, limits the over all efficiency between the engine shaft and frames or looms to 70 or 75 per cent., which is a decided advance on the average efficiency obtained with the mechanical system. The usual practice is to divide the shafting on the various floors into small sections, each section of which is operated by a separate motor. This renders the various sections and floors entirely independent of any other section or floor, which is not the case with the mechanical system, where each floor is driven separately by means of ropes or belts through one continuous shaft. Further, the mechanical system necessitates the introduction of a large number of what may be properly called *power-wasting devices*, such as extra belts, cross belts, bevel wheels and gears of all descriptions, in order that power may be applied exactly where required, in many cases in positions which necessitate drives at right angles to the main drive of the mill. This difficulty is entirely obviated in the electric system.

In many mechanically-driven mills the power is transmitted through various countershafts to the final point of application. In some cases as many as six line shafts are belted together, so that all the power required on the sixth shaft is transmitted through the remaining five. This necessarily results in an excessive waste of power, and increase of slip. The slip on the first belt is transmitted in an increasing ratio to all the others, until it finally reaches the sixth in a much more magnified degree than where it started at the first.

Some of the principal advantages of electric driving, briefly stated, are :—

(*a*) Sub-division of the various points of application of the power, thus reducing the liability to breakdown and stoppage.

(*b*) Sub-division of the various floors and sections, so that any floor, section or group of machines can be operated, independent of any other floor, section or group, for overtime or night-work.

(*c*) Short lengths of shafting, ensuring perfect alignment, and thus saving in friction losses.

(*d*) Improvement in the general lighting by the removal of a large percentage of belting.

(*e*) Saving in first cost of the equipment of the mill, both in the cost of buildings and shafting.

* Abstract of a Paper read before the Dublin Local Section of the Institution of Electrical Engineers, May 29th.

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(*f*) Extreme flexibility of the system, enabling a mill to be erected in any position relatively to the power operating it, thus ensuring that the mill is erected in the most suitable position from the production standpoint only, the electrical system not introducing any limiting factors, as would probably be the case with the mechanically-operated mill.

(*g*) Any extensions or alterations required can be made without interfering with production.

(*h*) The depreciation and maintenance charges are very much less in the electrical system than in the mechanical.

The Paper concluded with practical examples of mill driving by electricity in the United States, Canada, Belgium, Russia and France. In the mills described, three-phase currents were used entirely for power purposes, and in some instances direct current was employed for lighting, in conjunction with a storage battery.

CORRESPONDENCE.

THE SIMPLE ELECTRIC MICROMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the discussion on the above Paper, read by me at the Physical Society on May 9th last, of which an account was given in *The Electrician*, May 23rd, Mr. W. Watson stated that Mr. Russell, of Sydney, had published a method similar to mine.

I knew nothing of this alleged prior publication (*Proc. Roy. Soc.*, N.S.W.), and I said at the time it was remarkable that such a useful method had been allowed to lapse when once published.

After delay, due to the remoteness of the Paper, I have been able to obtain details of it, and I find that Mr. Watson's statement was misleading. The apparatus was quite different in form from mine. Mr. Russell had a screw, turned by clockwork at a very slow rate—say one turn in six hours; the screw-point in travelling forward came into contact with a body whose movement (say thermal expansion) was required. When the two surfaces touched, an electric circuit was completed through an electric recording pen.

The position of the pen record on a rotating drum indicated the amount of the movement. This instrument was used for meteorological work—*e.g.*, recording temperature throughout the day. It differs from the simple electric micrometer in several respects:—

(1) It is so slow as to be useless for the general laboratory work of taking and repeating observations quickly. (2) In accuracy it is limited by the uncertainty of toothed gearing and of the exact position of a pen record. (3) It totally lacks the lever principle which is essential for some measurements. (4) Even if it were quick enough in action, it could not be adapted to many kinds of measurement.

Mr. Watson's statement would have been more precise and fair if he had said that Mr. Russell used the method of measuring by electric touch, but that he had not developed it or made an apparatus, like the simple electric micrometer, adapted for use in practically every kind of small measurement.

PHILIP E. SHAW.

University College, Nottingham, June 2.

Alternating and Direct Current Motors in a Modern Shipyard.—An illustrated description of the shipyard of the New York Shipbuilding Co. was recently given in *Cassier's Magazine*, all the machine tools being driven by electromotors. In designing the plant it was decided to employ direct-current enclosed arc lamps for the yards and shops, as well as direct-current motors for the operation of the cranes, while the machine tools were to be driven by alternating current induction motors. To meet these requirements, double-current generators were laid down, the plant comprising 500kw. sets, arrangements being made for proportioning the amount of current taken from each side of the machines. Some very heavy machinery is operated by the motors, there being, notably, an 88ft.-span gantry crane, with lifting magnets, driven by two 25 H.P. motors, a 16ft. boring mill operated by three induction motors of 3 H.P., 5 H.P. and 10 H.P. respectively, and a set of rolls which can handle a plate 27ft. wide.

PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

Friday, May 30.

THE SPECIAL COMPENSATION CLAUSE.

Mr. BALFOUR BROWNE, K.C., opened a discussion upon the special compensation clause for vibration, &c., which the Committee are endeavouring to draft for insertion in all the bills. On behalf of the companies he represented—viz., the London United, Piccadilly-City and North-East London Railways—he said that very little alteration had been made to the clause which he submitted on the previous Monday (*The Electrician*, May 30, p. 236), the only other provision being to prevent owners from getting compensation twice over, as would be possible unless great care was exercised in the drafting of the clause. In view of the fact that such a clause involved an alteration in the general law, it was quite possible, as had already been hinted in the House of Lords (see *The Electrician*, May 23, p. 196), that that body might be unwilling to accept it, but, as far as he was concerned, he was perfectly willing to put the owners of property which was not taken in the same position as owners whose property was taken.

Mr. LITTLER, K.C., for the Brompton and Piccadilly Railway, submitted a clause very much on the same lines as that mentioned above. In this case, however, it was proposed that the arbitrator should be appointed by the Board of Trade, and, further, that when damage was done to any property or building the railway company should, after notification, have powers to enter upon such property for the purpose of remedying the damage, and this should be taken into account should it not prove satisfactory to the owner, and arbitration proceedings be subsequently taken. The object of this step was to prevent any exaggerated claim for compensation, which claims were not unknown. In addition to this, although not expressly stated in his draft, he was willing to make some compensation to an owner or occupier in the event of an inconvenience being occasioned by the execution of the repairs—say, his having to leave the house for the time being and things of that kind. The main object was, of course, to repair any damage at once, and so prevent it accumulating, such as often happened when arbitration proceedings were pending, and in this respect his clause took in the whole period of construction and two years of working.

Lord ROBERT CECIL, K.C., put in a clause which he said had the consent of practically all the landowners, &c., concerned in these railways. So far as the report of the Vibration Committee was concerned, this only dealt with the Central London Railway, and new circumstances would sooner or later arise by which it was possible fresh dangers would also arise. For instance, in connection with some of the bills before this Committee, a number of lines would cross each other, and the effect of this upon house and other property had never yet been experimented upon. The landowners were quite content that the period of liability of the railway company should be limited in point of time, but they proposed three years, and they also asked that the arbitrator should be appointed by the Board of Trade and not by the President of the Institution of Surveyors for the time being. His clause only related to the working of the railways, his clients preferring to remain under the Lands Clauses Act in respect of construction. But against the words "injuriously affected" for this present clause, he preferred "damage and loss of every description" as more completely covering him. Neither did his clause include subsidence, in respect of which he wished to remain under the ordinary law.

Mr. PEMBER, K.C., thought the go-by ought to be given to whatever had been said and done hitherto under the Lands Clauses Act. What was wanted was a new phraseology sufficiently broad and comprehensive to meet the difficulties which tube railways had caused or might cause. He agreed with the words "loss and damage of every description."

Mr. RAM, K.C., for some landowners, desired to be so safeguarded that at the expiration of the three years proposed he would be entitled to compensation for the prospective damage which might be reasonably expected. He considered that Mr. Balfour Browne's clause took away the rights which he at present had under the Lands Clauses Act, as it only met structural damage.

A good deal of other opposition and consent to the various proposals followed. The City of Westminster wished the time to be extended as long as possible, and thought two years was absolutely inadequate. On behalf of the City of London, it was urged that in the event of a railway wishing to adopt a new method of working, as was not improbable in view of the rapid strides now being made by electric traction, similar protection should be afforded landowners for a period after the commencement of working with the new system, in addition to the protection given when the line first commenced operations.

Mr. LITTLER, replying to some extent upon the criticisms upon his proposal, said the insertion of objectionable clauses had killed similar railways, and if all the suggestions made by the landowners were acceded to, they would absolutely stop all tube railway construction in the future.

Mr. BALFOUR BROWNE, similarly replying, dwelt chiefly upon the suggested words "loss and damage of every description." Under this working it would be possible for the Metropolitan Railway, which had landowner's rights, inasmuch as his line passed under theirs, to claim compensation for traffic diverted in the ordinary course of competition. Further, a man with a shop might claim compensation for loss of trade because the tube railway took him past the shop where he previously walked.

The discussion was at this point adjourned until Tuesday.

SOUTH AND WEST LONDON JUNCTION RAILWAY.

Mr. FREEMAN renewed his application for costs on the ground of being vexatiously put to expense. (*The Electrician*, May 30, p. 237.) Under the standing orders the Committee had power to make an order for costs against the deposit.

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All the other opposition to the bill supported this claim, but

The Committee were of the opinion that they had no powers to do anything in the matter.

Tuesday, June 3.

THE SPECIAL COMPENSATION CLAUSE.

Lord ROBERT CECIL, in connection with the landowners' clause, which he had proposed on the previous day, suggested a slight alteration in the wording of it—viz., in respect of the words "all loss and damage." Having in mind that some exception had been taken to these words, it was thought that it would more nearly meet the wishes of the Committee if compensation was made in respect of vibration "as fully and to the same extent as if part of the property had been taken by the company." This was put in as an alternative to the previous wording, but he was really indifferent as to which was adopted.

Mr. MOON, K.C., for the Great Northern and City Railway, which came before Lord Ribblesdale's Committee, disagreed with this entirely, and thought it would constitute a greater alteration in the general law than the Committee was aware of. There was no limit to the nature of the damage which could be claimed for, and what the Committee were really being asked to do was to put a man, whose property was not taken, in a better position than he would be in respect of any undertaking affecting him which was not working under statutory powers, because in the latter case it was only nuisance for which a claim for compensation could be made. If the wording of the Lands Clauses Act, sec. 68, were used with the addition of the words "and working" after "during the execution of the works," he should have nothing more to say. With regard to the proposal that the arbitration should take place under the Lands Clauses Act, he pointed out that this gave the arbitrator no power as regards costs, the railway company being always bound to pay its own expenses whether successful or not. Of course, for the purposes of this act—viz., the acquisition of land—this was perfectly fair; but in connection with the arbitration proceedings in respect of vibration and damage from a tube railway, it was an entirely different matter, and for this reason he preferred the Arbitration Act of 1889, which gave power to the arbitrator to decide the allocation of the costs.

Mr. BALFOUR BROWNE objected to the words of the new clause "owners, lessees, or occupiers." Under existing law an occupier or lessee had no claim whatever, and this proposed to put these latter in the same position as the owner.

Lord ROBERT CECIL having replied, the Committee adjourned; and on re-entering the room

The CHAIRMAN said that it had been decided to proceed on the basis of the clauses put forward by Lord Robert Cecil. He wished to make it clear that this clause was to apply to railways only so far as they related to tube railways, but the exact wording to make this clear was left to be drafted. The disputed words "as fully and to the same extent as if a part of his property had been taken by the company" would be left out, but in coming to this decision it was not to be taken that the Committee wished to prejudice the fullest discussion in the other House. The clause, which also stipulates two years as the period, gave the Board of Trade power to appoint the arbitrator, and stated that the provisions of the Arbitration Act of 1889 shall apply.

The clause, as amended, reads as follows:—

"In addition to the provisions of the acts incorporated herewith, with respect to compensation for lands taken or injuriously affected, the company shall make compensation to the owner, lessee, and occupier of any land, house, or building which shall be injuriously affected by reason of the working of the railway (including the working of lifts and any other works in connection with the said railway) notwithstanding that no part of the property of such owner, lessee, or occupier is taken by the company.

"Provided that all claims for compensation under this section shall be made within two years from the date of the opening of the railway for public traffic, the provisions of the Arbitration Act of 1889 with respect to the settlement by arbitration of questions of disputed compensation shall extend and apply to and in the case of any such claim, save that the amount of the compensation, if any, payable by the company shall, if not agreed upon, be settled by a single arbitrator, to be agreed upon by the parties, or, failing agreement, to be appointed by the Board of Trade.

"The arbitrator under this section may, with the consent of all parties concerned, hear together any class or group of claims under this section."

Lord RIBBLESDALE remarked that, having been allowed to sit upon this Committee on the last two occasions for the purpose of representing his own Committee in this matter, he entirely concurred with the clause set forth above, and he wished it to be understood that all his bills had been passed subject to the insertion of this clause.

Mr. LITTLER raised the point as to whether this clause would be applicable to authorised railways not yet working, such as the Brompton-Piccadilly and Baker Street and Waterloo Railways, both of which obtained an extension of time this session.

Lord RIBBLESDALE replied that so far as he was concerned he had intended that this should be so.

The Committee then proceeded to consider clauses.

LONDON UNITED, PICCADILLY—CITY AND NORTH-EAST LONDON RAILWAYS.

Mr. RAM, for the branch of the Bank of England next to the Law Courts in Fleet-street, asked for an extension of the special clause to a limit of five years, but the Committee refused to consider this a special building.

Mr. PEMBER, for the London County Council, objected to the site selected at the corner of the new London County Council widening in the Strand, and suggested an underground station as at the Bank. This it was impossible to arrange, however, and the parties promised to endeavour to come to terms.

Wednesday, June 4.

Mr. PEMBER said the matter of the Strand station had been arranged. He next asked for a large number of clauses giving power to the Council, but the majority of these were refused by the Committee. Among them were powers in respect of street widenings, which was vigorously opposed by the respective borough councils, an undertaking that certain interchange stations with other companies should be constructed, and powers to deviate the railway in respect of some new sewers.

Mr. Shiress Will, K.C., for two Strand theatres, obtained a clause under which the owners could appoint engineers to inspect the work, the expenses of such engineers to be borne by the owners.

Mr. Littler, for the City of London Corporation, obtained a similar clause by which the expenses are to be defrayed by the railway company. He was not successful, however, in putting it upon the company to make a substantial start with the line within one or two years.

On behalf of landowners in Piccadilly, where both the Piccadilly-City and Brompton-Piccadilly Railways would be constructed, it was arranged that in cases of disputed subsidence, both railway companies should come before an arbitrator, who would decide if either or both were liable.

Mr. Shiress Will, for the Albert Hall, sought that the period during which compensation was to be made should be unlimited. In opposition to this, it was argued that the railway was over 100ft. away from the Hall, and eventually the Committee decided not to allow the clause.

Thursday, June 5.

BROMPTON-PICCADILLY CIRCUS RAILWAY.

The London County Council again put in a large number of clauses practically all of which were refused.

An application on behalf of the London Hippodrome, under which property the Brompton and Piccadilly Circus and the Charing Cross, Euston and Hampstead Railways cross each other at right angles, for the appointment of an engineer to inspect the work at the expense of the owners was agreed to, but a further request that the time for claims to be made in respect of vibration should be two years from the date of the opening of the railway last completed was refused.

The Committee then considered general clauses which would be applicable to all the bills. The London County Council were the only body which brought forward any such clauses. The list, however, was a formidable one, albeit once more a large number were rejected. The more important ones included an application for jurisdiction in the City of London, which was strongly opposed, and was refused by the Committee. As regards sewers, the Council wished to prevent the companies from making any alterations to these whatever, for the purposes of building the tubes, but, as the companies concerned were favourable to the appointment of an arbitrator to determine the point, the Committee desired this to be done. A long discussion took place upon the relation of street widenings to land bought by the companies. The clause suggested by the Council provided that a portion of any land so bought by the railway companies should be given up without payment for the purposes of such street widenings if necessary, and this was granted, except so far as the Brompton and Piccadilly Bill of 1897 is concerned; the clause will only apply to the new lines of that company. Clauses for the protection of any future tramways, subways, tunnels and other underground works which the Council might undertake were rejected, as also were clauses specifying the materials of which the generating stations should be constructed, and granting the Council control over the subways in connection with the stations. In the course of the discussion on the last-mentioned clause, one of the Committee remarked that the London County Council was endeavouring to constitute itself the sole controlling authority over these railways. However, a clause was inserted in the bills which allows of the payment by the company of the expenses incurred in respect of any inspection which the Council were permitted to do under the bills, and another giving certain powers as to station buildings which have blocks of offices overhead. Finally, it was agreed that all objects of geological or antiquarian interest discovered in the course of construction should be handed over to the London County Council, and not to the respective borough councils.

This concluded the work of the Committee.

LONDON UNITED TRAMWAYS BILL.

The Select Committee of the House of Commons, of which Mr. Compton Rickett is chairman, resumed on Friday consideration of the London United Tramways Bill the objects of which were stated in our last issue.

Mr. E. J. HALSEY, chairman of the Surrey County Council, said his Council had considered the tramway question as it related to Surrey, and the requisite majority to enable the Council to themselves undertake tramway work not having been obtained, they came to the conclusion that if they were not to be the light railway or tramway authority in the county, the next best thing would be to ensure that some responsible body should construct the tramways, and that there should be a well-designed scheme to meet the necessities of the district. The act which the London United Company secured last year, enabling them to construct lines in Thames Ditton, Surbiton, Kingston and Malden, represented to a considerable extent the programme which the Surrey County Council originally contemplated, and was supported by that body. The extensions now proposed would link up the Wimbledon district with the tramways authorised last year, and, as far as he knew, with the tramways of the London County Council. They would also provide communication with Richmond, Mortlake, Barnes and Hammersmith. [See map in our last issue.] The promoters contemplated numerous road widenings and improvements, one of which would be of great importance and would prove very costly—viz., the widening of Barnes-terrace.

Mr. J. CLIFTON ROBINSON, managing director and engineer to the London United Tramway Co., said that the tramways which the company had hitherto constructed had met with phenomenal success. On the 16 miles in operation they were carrying 40,000,000 passengers per annum, which was probably a greater number than that carried by any other

tramway company in the country. The reason for their success was, no doubt, the introduction of electric traction with cheap fares, rapid transport and frequent service. The total mileage of the company's existing and authorised lines covered about 62 route-miles, of which 22 miles were authorised last year. The total mileage of the proposed extensions was 15 miles 1 furlong. The fares would be based on those already existing, which averaged less than ½d. per mile for ordinary passengers. For workmen the fares were made as easy as possible. Thus, from Southall to Shepherds Bush, a distance of 7 miles, workmen, or anyone riding on the cars between four and seven o'clock in the morning, was charged only 1d. The maximum fares chargeable were 1d. a mile, but by agreement with the local authorities the company could not charge more than ½d. per mile, When the lines were completed the company contemplated carrying 200,000,000 passengers per annum, and he expected the lines would be completed in the next two years. The company was now constructing about 1½ miles of line per month and spending £10,000 a week on wages and materials. The line to Isleworth, Twickenham, and well on to Hampton would be opened in the next month. The estimated population of the district through which the lines would run was 412,000.

In cross-examination by Mr. PAGE, K.C., representing the London and South-Western Railway Co., he said he did not think the line from Hammersmith to Richmond competed with the railway company. He was quite sure there would be traffic enough for both. The two lines were parallel only for a short distance. If the line by the side of Wimbledom Common was continued to Hammersmith he did not think there would be any direct competition with the railway.

The CHAIRMAN, interposing, said that the Committee had an open mind as to the tram to the top of Wimbledon hill, which would let people get on to the Common, but they were not prepared to accept the line between that point and the county boundary.

The inquiry was resumed on Tuesday.

Mr. ERNEST PAGE, for the London and South-Western Railway Co., said that, in accordance with the expressed desire of the Committee, the engineers of his company and the promoters of the bill had met in consultation, and though they had not arrived at an absolutely final agreement, there was no doubt that the Committee were not likely to be troubled with any matter of engineering. The main opposition of the railway company to the bill was not based on engineering, but on the question of competition, and this opposition continued in undiminished force despite the agreement.

Mr. CLIFTON ROBINSON put in a table of the low fares to which the company were prepared to bind themselves.

Cross-examined by Mr. WEDDERBURN, K.C., for certain frontagers in Worple-road, Wimbledon, and up Wimbledon-hill, Witness said it was true that electric tramways did very much change the character of a district, but the change was for the better. The service of cars would be limited to requirements, and it was a mistake to suppose that bells would be continually ringing. The Company proposed to cut off 30in. of the forecourts of some of the houses, and the consent of the Wimbledon Council depended on the company obtaining that power. In Worple-road the narrowest part would be 32ft. 6in. wide and that would leave 9ft. 6in. on either side of the tramway. There was no power in the bill to acquire the forecourts, and if the forecourts could not be acquired the trees on the opposite side of the road would have to be taken. It was also proposed to take some of the front gardens, but these were deep and the tramway would improve the road. The company were prepared to accept a clause that if they took any portion of a property they should take the whole.

Cross-examined by Mr. TALBOT, for the London County Council: The weight of the cars when fully loaded would be about 12 or 13 tons, and the company had taken the opinion of Sir B. Baker as to the sufficiency of Hammersmith Bridge to take these cars.

And you arranged a clause with the London County Council, submitting any difference between you and the County Council to the very gentleman whom you had consulted beforehand?—Yes.

Did you say that you had ascertained this gentleman's opinion beforehand?—I do not remember, but I do not think it specifically mentions Sir Benjamin Baker.

Mr. TALBOT said the clause stated "Sir Benjamin Baker or other consulting engineer."

Cross-examined by Mr. EDWARDES JONES, for the Wimbledon Elementary Schools committee, Witness said he could see no element of danger to the school children in the tramways passing the Wimbledon schools.

Re-examined: He wished to protest emphatically against any suggestion that the company, in the clause agreed with the London County Council, put in the name of Sir B. Baker as being favourable to the company. He believed the clause, as a matter of fact, was inserted at the instance of the London County Council.

Sir DOUGLAS FOX, the next witness, gave evidence in favour of the extensions proposed, explaining that they were very necessary additions to the existing system of the London United Co. There would, he said, be no difficulty in carrying out the embankment work proposed at Barnes, and this would be an immense improvement, because by its means the road would be very much widened, without interfering with the existing frontagers, and a large amount of flooding which frequently now took place would be prevented. With regard to the danger to Hammersmith Bridge, which it was suggested the passage of the trams over it would cause, he said there was no doubt the main structure was amply strong enough for this purpose, but a certain amount of bracing might be required. No doubt a protective clause should be inserted for the benefit of the County Council. An arrangement could easily be made by which not more than two cars should be on the main suspension span of the bridge at the same time.

The CHAIRMAN: I suppose the cost of strengthening the bridge, supposing it is necessary to strengthen it, would fall on the tramway company.

Mr. LEWIS COWARD (for promoters): Yes.

Witness, continuing, said both the existing line from Hammersmith to Kew Bridge and the new lines through Barnes and Mortlake to Richmond would be in connection with the tube railway with through booking. The tramway up Wimbledon Hill would have a maximum gradient of 1 in 13, which was well within the limit of working by an electric car.

Cross-examined by Mr. PEMBER, for the London and South Western Railway Co.: The journey by the company's line from Hampton Court to Hammersmith would take about 70 minutes, and thence by the tube to the City about half an hour. How long it would take to get to the City by the London and South Western Railway depended on whether the trains were punctual or not. If the railway did the journey in less time than the tramway the railway would carry more passengers.

Lord ROBERT CECIL, K.C., representing frontagers on the Barnes section of the Hammersmith and Richmond line, cross-examined the witness with reference to the proposal to construct an embankment at Barnes, strongly asserting that an act was necessary, and that the consent of the Thames Conservancy was not sufficient for the purpose. Witness held that similar work had been carried out on the consent of the Conservancy in the past.

On Wednesday, Mr. FITZGERALD, K.C., read the licence which the Thames Conservators had issued to the promoters authorising them to construct the embankment along the river front at Barnes.

Lord R. CECIL urged that the Conservators had no power to give authority to make an embankment without an Act of Parliament.

After some discussion,

The CHAIRMAN said that unless it could be shown that the Conservators were exceeding their powers, he thought the promoters had not to do more than show they had obtained the licence from the Conservators in the way that licences were usually issued. It rested with Lord Robert Cecil to show that that did not fall within the Parliamentary rights of the Conservancy.

Further discussion took place, and in the result the matter was postponed.

Mr. THOMPSON, a member of the Tramways committee of the Town Council of Richmond, and representing the largest working class ward in the borough, gave evidence in favour of the line from Hammersmith to Richmond. The workman's fare from Richmond to Hammersmith by the proposed tramway would be 2d. return, and by the railway 5d. return, so that by the tramway the workman would save 1s. 6d. a week. There were now only two workmen's trains daily from Richmond to Hammersmith, one by the South-Western and one by the District Railway. The trams would run every few minutes. The ordinary railway fare between Richmond and Hammersmith was 9d.; by the tramways it would be 4d. Between Richmond and Barnes, and between Mortlake, Barnes and Hammersmith, there were no workmen's trains at all. There was a large area of land between Hammersmith and Richmond which was just the place where working-class dwellings would be built, but which was unbuilt on owing to lack of communication, and, close by, at Shepherds Bush, there was an overcrowded slum. The tramway would relieve this condition of affairs.

Mr. H. J. BARTON, chairman of the Highways committee of the Urban District Council of Barnes, and Mr. G. W. F. BATES, a member of the Barnes Urban District Council and of the Barnes School Board, and the owner of considerable property in the locality, said that local opinion was strongly in favour of the proposals of the bill.

The CHAIRMAN said that he had received a communication from the Local Government Board suggesting that the Committee should advise itself as to the application of the money which was proposed to be paid by the tramway company to the local authorities.

Mr. FITZGERALD said that was a matter for the local authorities, not for the promoters.

Yesterday (Thursday) the discussion with regard to the Barnes Embankment was renewed In the end, on Mr. Moore, the engineer to the Thames Conservancy, being called and swearing that the land on which the embankment would be constructed was the property of the Thames Conservancy, Lord R. Cecil expressed himself satisfied, and the matter accordingly dropped.

Mr. SKEWES COX, M.P. for the Kingston Division of Surrey, and a member of the Surrey County Council and of the Richmond Town Council, said the local authorities of the district and his constituents were undoubtedly in favour of the tramways.

Mr. PAGE: Do you think it fair that Parliament having given power to the railway company, for public purposes, to invest money in the construction of a railway, a tramway should be allowed to compete with a line which can be constructed for one-tenth the cost of the railway?—I do.

Several witnesses were then called from Barnes, who testified to the benefit the line would be to that district. The train service of the South-Western Railway, it was said, was most inconvenient, and the railway station was a mile distant from Barnes-terrace, the result being that there was at present no convenient communication with surrounding localities. Evidence was then given by a number of witnesses from Richmond as to the desirability of the line from the Richmond standpoint, it being pointed out that if a line across Kew Bridge were constructed, thus giving a through electrical line from Richmond to Hammersmith by way of Chiswick, the inhabitants of Richmond would not have the same advantages as under the present scheme, because in the former case, in order to get to Barnes it would be necessary to go through Hammersmith.

Mr. HOWELL, surveyor to the Surrey County Council, and Mr. BUTTERWORTH, clerk to the Wimbledon Urban District Council, also gave evidence in favour of the bill, which their councils had decided to support.

Question by the Chairman as to why the local authority had consented to extend the period at the end of which they could purchase the tramways in Wimbledon, the latter witness said it was in consequence of the agreement with the Tramway Company. He could not at present say how the Council were going to spend the £100 per mile of tramway in Wimbledon which the company had agreed to pay them.

The Committee adjourned.

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SWANSEA CORPORATION BILL.

This bill came before a Select Committee of the House of Lords on Wednesday last, consisting of Lord Hawkesbury (chairman) Viscount Hill, Lord Saltoun, Lord Digby and Lord Hamilton of Dalzell.

Mr. FREEMAN, K.C., (for the promoters) said the bill was an omnibus bill, one of its objects being the construction of a new tramway, the adoption of new motive power, the widening of streets in many cases in connection with the tramway, and the extension of the electricity station of the Corporation. There were practically only two oppositions, one of which (that of Messrs. Parry and Rock) had reference to the acquisition of property required to be taken for the extension of the electrical station, the other being a petition of burgesses as to certain old rights which were said to be interfered with by the bill. There were originally a good many other petitions against the bill but they had all been satisfied. During 10 years the population of Swansea had increased from 90,000 to 100,000, and the rateable value was now £420,000 on poor rate, and £37,000 on general district rate. It had become necessary that the Corporation electric generating station should be increased in order to meet the growing requirements of the town, and the only way they could do that was by acquiring certain adjoining property which belonged to the petitioners. But by touching any bit of the petitioners' property the petitioners would have power under the Lands Clauses Acts to require the promoters to take the whole of it. Then, the petitioners complained that the promoters proposed to take seven years to carry out the works. The works of a large generating station were of an intricate and delicate character, and it was necessary to have plenty of time in which to carry them out, but the promoters found that they could do all they wanted in less than seven years, so the period had now been altered to five years.

Mr. SHAW (for the petitioners) said that under the circumstances, if it were made clear that there would be no attempt to injure his clients' works by stopping up their ancient lights and taking away the roadway which was essential for the carrying on of their business, they would withdraw their opposition.

Mr. FREEMAN said that that would be the understanding on which the bill proceeded.

The opposition in question was accordingly withdrawn.

OTHER ELECTRICAL BILLS.

In the House Commons on Friday last, the North Metropolitan Electric Power Bill was read a third time.

The Wrexham District Tramways, Edgware and Hampstead Railway, and the Manchester Corporation Tramways Bills were read a third time in the House of Lords on Tuesday.

On Wednesday in the House of Commons the London, Tilbury and Southend Railway Bill was read a third time, and the Northumberland Electric Tramways Bill a second time.

Yesterday (Thursday) the London County Council (Subways and Tramways) Bill and the London County Council (Tramways and Improvements) Bill were ordered for third reading.

LEGAL INTELLIGENCE.

Fletcher v. London United Tramway (Ltd.).

In the Court of Appeal, on Tuesday, the Master of the Rolls and Lords Justices Mathew and Cozens Hardy heard the appeal of Charles Fletcher from the refusal of the late Judge Bagshawe to award him compensation under the Workmen's Compensation Act for personal injuries sustained while in the employ of defendants. The action raised the question whether a tramway was a railway within the meaning of section 7 of the act.

Mr. J. A. COMPTON, for the appellant, said it was admitted that the applicant, who was severely injured, would be entitled to the compensation claimed if his employer was found to be within the act. The respondents had obtained a light railway order to construct an electric tramway from Uxbridge to Hanwell, and afterwards they obtained Parliamentary powers for an extension of the electric tramway from Hanwell to Acton. Applicant was injured whilst laying that portion which is now called a tramway. If he had been injured a little further south he would have had compensation, as he would then have been on that portion of the line designated a light railway. He urged that the portion of the line designated a tramway by the act was in fact a railroad. Why Parliament, in its wisdom, should have called half the line by one name and half by another he was unable to understand. The need for an engineer in laying the tramway rails was quite as necessary as in the case of all railways.

Mr. RUEGG, K.C., for respondents, submitted that if appellant's contention were supported they would let in an industry which the act was not intended to protect. The line was a tramway, not a railway; it was so defined by the Legislature.

The MASTER OF THE ROLLS said the appeal must be allowed. The particular part of the system on which the workman was engaged was known as an electric tramway, and the learned county court judge held that, having regard to the definition in the act, the workman's case did not come within the act, and was outside the definition of the word railway. His Lordship saw no reason to differ with the learned judge on that part of the case. The contention, however, was that if it was not a railway it was an engineering work, and that the definition of engineering work meant any work of construction, alteration or repair of a railroad, harbour, dock, canal or sewer. There was no presumption that the Legislature in using the words "railway" and "railroad" meant the same thing in both cases. The word railroad was certainly capable of embracing a tramway. In recent times railroad was a word commonly used to describe a tramway worked by horse power. There was nothing which would lead him to infer that the word railroad as a larger term was not used deliberately. The Legislature clearly intended to embrace something outside a railway, because the word railroad was used, and it was placed in the same category as harbours, docks, canals, &c. As the applicant was engaged on engineering works on a railroad he was entitled to compensation for injury.

Lords Justices Mathew and Cozen Hardy concurred, and the appeal was accordingly allowed with costs, the matter being referred back to the county court to fix compensation.

Mr. RUEGG asked for a stay pending appeal to the House of Lords, but their lordships refused the application.

Alleged Excessive Speed of Tramcars.

Mr. Thomas Simpson, of Pollokshields, has been many times more or less successful in his actions against the Glasgow Corporation for driving their electric tramcars at excessive speeds. He, however, was not so fortunate in an action tried before Sheriff Fyfe in Glasgow last week. Mr. Simpson charged the Glasgow tramway department with driving certain of their cars at a speed in excess of that allowed by the Board of Trade regulations in February last. The charge was that six cars going in two different directions were run without being fitted with speed regulators, in the terms of the regulations, at speeds varying from 10 to 20 miles an hour. One of the witnesses was Mr. A. Simpson, father of the complainer, chairman of the Glasgow Subway Co., and a director of the North British and Caledonian Railways, each of which, he agreed, competed with the tramways. Mr. Simpson, while allowing that this competition might have had something to do with his interest in the present action, said his supreme interest was "the possibility of the endangerment of his son's children by the excessive speed of the tramways."

On the ground that no evidence had been brought to show that the tramway cars in question were the property of the Corporation, or that at the time of the alleged excess speeds they were run by servants of the Corporation, or, further, that they were not fitted with speed indicators, the Sheriff said he had no alternative but to find the charges not proven. He pointed out that the items upon which his judgment was given were, doubtless, technicalities; but he was dealing with a criminal complaint, and, unless the charges were fully proven, the case must be dismissed. The Corporation authorities were allowed £3 expenses.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A lecturer on electrical engineering is required for Bradford Municipal Technical College. Particulars from the secretary, Mr. John Nutter. Applications by 16th inst. See advertisement.

A demonstrator in electrical engineering is required for University College, Nottingham. Applications to secretary (Mr. Philip H. Stevenson) by June 30. See advertisement.

An instrument maker is required for the Royal Technical Institute Salford. Forms of application from the secretary up to June 23. See advertisement.

A man is required for the East to look after motors and dynamos and to do both inside and outside wiring work under a chief engineer. See advertisement.

Southwark (London) Borough Council require a charge engineer. Applications to resident engineer (Mr. J. R. Blaikie), Penrose-street, Walworth, S.E., by June 14. See advertisement.

The position of principal of the Wandsworth Technical Institute is vacant. Applications to honorary secretary, 4, Galveston-road, Putney, London, S.W., by June 30.

Mr. Jas. H. Clothier, electrical engineer at Stafford, has been appointed electrical engineer at St. Anne's-on-the-Sea, in succession to Mr. P. J. S. Tiddeman, at a salary of £170 per annum. There were 66 applicants, but this number was reduced to six—viz, Messrs. Jas. H. Clothier, W. H. Hall (Bootle), W. Jackson (Manchester), B. S. Hornby (Bolton), G. Heath (York), and S. Jones (Doncaster).

Mr. J. Williams, of Manchester, has been appointed shift engineer at the tramway power station, Sheffield.

Portsmouth Tramways committee received over 80 applications for the post of electrical engineer at the tramway power station, and these have been reduced to four (Messrs. N. E. G. Little, E. Taylor, J. M. Smyth and J. G. Lironi).

Aberdeen.—The receipts of the tramways for the year to May 31 amounted to about £37,000, an increase of £2,225 over the previous year. The whole of the routes have now been converted to electric traction, the last of the horse cars having been withdrawn at the beginning of the current week.

Accident.—Mr. John A. Fraser, electrical engineer to the Oldham, Ashton and Hyde Electric Tramway (Ltd.), who, as reported in our

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last issue, recently met with a serious accident, is, we understand, suffering from concussion of the brain. We are glad to learn that the crisis is past, but Mr. Fraser is not yet in a condition to be removed from the infirmary.

Anglo-French Telephone Arrangements.—An understanding has been arrived at between the British and French postal telegraph authorities for connecting up the trunk telephone system of the two countries in a manner that will enable a large number of the chief cities of France to become in telephonic communication with London and other parts of Great Britain.

Arc Lamp Litigation.—We understand that the litigation which has been conducted between the Jandus Company and the Davy Electrical Construction Co (Ltd) for some years past, with reference to the alleged infringement of the Jandus Company's master patents, has been brought to a close. The Davy Construction Co. have, we are informed, recognised the Jandus patents, and have taken a licence on the ordinary terms.

Aston.—An inquiry will be held to-day (Friday) into the application of the Council to borrow moneys for electricity works.

Asylum Lighting.—The District Board of Lunacy for Roxburgh, Berwick and Selkirk are about to light their asylum at Melrose with electricity. Specification and plans have been prepared by the consulting engineer (Dr. J. T. Bottomley, F.R.S, of Glasgow).

Ayr.—The official inspection of the permanent way of the tramway route between St. Leonard's Church and Burns' monument took place on Thursday last, and the line is now open for traffic.

Bolton.—The chairman of the Electricity committee (Dr. Panton) made a statement on Wednesday regarding the progress of the electric motor load. In the first year the electricity department coupled up 148 H.P. and in the second year 200 H.P. Since the charge for current was reduced, in two months they had put on 90 H.P. They were receiving many applications for power.

Broughty Ferry.—Sept. 27 has been provisionally fixed for the commencement of electricity supply. Current for private lighting will be supplied at 6d. per unit.

Buluwayo.—The Council are considering a scheme for the construction of electric tramways in the district, and a committee has been formed to draft the basis of negotiations and terms of agreement for the construction and working of the lines, and as soon as these preliminaries have been disposed of the Council will ask for tenders for the establishment of a tram service in the town.

Burton-on-Trent.—The accounts of the electricity department for the year to March 31, show total receipts from sale of current, meter rental, &c., of £5,197. 17s. 7d. Generation expenses were £1,725. 12s. 5d., and, with the cost of distribution, rent, rates and taxes, salaries and establishment charges, the total expenses were £4,652. 10s. 11d., leaving a surplus of £545. 6s. 8d. During the year 241,534 units of current were sold.

China.—The *Times* correspondent at Peking notifies that a 60 years' concession for an electric tramway and for the electric lighting of Tien-Tsin city has been granted by the provisional government of the city to one of its own members.

City and Guilds of London Institute.—The report of the Council for the year 1901, presented at the annual general meeting in May, has now been published. It is the twenty-second annual report since the incorporation of the Institute. An offer of £1,425 per annum has been received from the University of London for the use of the Department of Engineering at the Central Technical College, subject to certain conditions. This offer has been accepted subject to certain limitations imposed by the constitution of the Institute. Large contributions to the general funds of the Institute continue to be made by the principal City companies. Reference is given to the important alterations and improvements made by the electrical department at the Central Technical College under the direction of Prof. W. E. Ayrton, and the Council express their regret that the large amount of extra work falling upon Prof. Ayrton and his staff caused a breakdown in Prof. Ayrton's health, when the work of supervision and direction devolved upon Mr. T. Mather. The cost of these extensions and alterations has been £10,000, and they involve an annual upkeep charge of about £1,000, the latter sum being already nearly realised by increased receipts from students' fees. In reference to the Technical College at Finsbury the satisfactory announcement is made that land is now available for a considerable extension of the college premises in Leonard-street. The whole future of this college is under the consideration of the Council. In a report by Prof. S. P. Thompson, forming Appendix B of the main report, it is pointed out that the electrical department at Finsbury remains the largest of the three into which the college is divided. There was a decrease in 1901 in the total amount of fees received from students in this branch. Prof. Thompson points with justifiable pride to the success attained by many past students at Finsbury. These include Mr. L. J. Steele, who has received the appointment of electrical engineer to the dockyard staff of the Admiralty, a position worth from £600 to £850 per annum with quarters. Several past students at Finsbury have been successful in connection with the premiums awarded by the Institution of Electrical Engineers, notably Mr. A. C. Eborall, Mr. M. B. Field, Mr. F. J. Hiss and Mr. T. H. Vigor. During the past 10 years 19 premiums have been awarded by the Institution to Finsbury students.

Coronation Festivities.—Mr. James Paxman, head of the well-known firm of Davey, Paxman & Co., will present the aged villagers of Stisted (Essex) with a newly-minted 2s. piece on Coronation Day, and will entertain the villagers to a meat tea later. The children of the village are also to have a tea, and Mrs. Paxman will present each child with a commemoration mug. The band of the Standard Iron Works will provide music on the occasion.

The Incandescent Electric Lamp Co. are placing at the disposal of the Hammersmith King's Dinner committee the use of their work-people's large dining hall for the holding of the Coronation dinner, this being the largest dining hall in the Hammersmith district.

Coventry.—An inquiry is to be held into the application of the Council to borrow £20,485 for electric lighting extensions and £2,000 for the purchase of motors for hiring.

Crewe.—The receipts of the electricity department for the past year were £4,690, and the expenses £3,741—a surplus of £948. The chairman of the Electric Light committee stated, at Wednesday's meeting of the Council, that negotiations were proceeding with a company for the construction of electric tramways. The committee were desirous of promoting a light railway scheme of their own, but the ratepayers had declined to allow them to proceed with it as a municipal concern. It had been arranged, however, for the company to take current from the Council. A suggestion had been made that the recent fire at the Corn Exchange was due to fusion of the electric light wires, but careful investigation had proved that the statement was incorrect.

Dartmouth.—The Urban Electric Supply Co. has undertaken to supply current by Aug. 15.

Dundee.—The accounts of the electricity department for the past year show expenditure of £18,398, or £1,132 less than estimate. The income was £18,616, against an estimate of £20,382. For the current year the expenditure is estimated at £25,667. 10s., and the income (including a balance forward of £217. 11s. 9d.) a £25,914. 15s. 9d., leaving an estimated surplus of £247. 5s. 9d.

The Tramways committee have decided to effect their own insurance against accidents, &c., and have set aside £500 for the purpose

The charge for public arc lamps has been altered from £16 10s. to £15 per annum, and for current for motive power and heating from 2d. to 1½d. per unit.

Eastbourne.—In submitting a report from the Electric Lighting committee on Tuesday, the chairman (Councillor Maude) reminded the Council that it was now 2½ years since they acquired the electricity works. The net profit was £3,262, which, added to that made last year to March 31, totalled to £5,078. The result had exceeded anticipations. The charge for electric current would probably be reduced from September next, and the committee would shortly make definite recommendations dealing with the surplus.

The Corporation have invited the municipal authorities of Surrey, Kent and Sussex to attend a conference at Eastbourne to discuss the question of municipal insurance.

Frinton-on-Sea.—The Council are considering a tender from the Frinton-on-Sea and District Electric Light and Power Co. for public lighting.

Glasgow.—The tramway receipts for the financial year ended May 31 amounted to £612,704, compared with £484,882 in the previous year, an increase of £127,922. The number of passengers carried was 163,600,000, an increase of about 31 millions on the previous year.

Halifax.—The Council are introducing a system of parcel traffic on the electric trams. For each two stages 1d. per 7lb. will be charged, 2d. up to 28lb., and 3d. up to 56lb.

Holiday Resorts.—This is the time when workers are making arrangements for visiting the seaside in search of ozone, &c. The Deal (Kent) authorities have just prepared an interesting illustrated handbook relating to this ancient and picturesque health resort, and copies can be obtained post free from the town clerk.

Ibero-American Benevolent Society.—The twelfth anniversary dinner of this society was held on Saturday at the Whitehall Rooms, London, under the presidency of Mr. E. R. P. Moon, M.P. The gathering numbered over 200, and it is gratifying to announce that the society, in which telegraph men have always taken a great interest, is continuing its good work. A subscription of over £400 was announced at the dinner.

Kiew (Russia).—The City Electric Railroad Co. of Kiew are experimenting with two Pullman cars, built in Berlin, of the double-truck type, equipped with four 25 H.P. motors to each car. These cars, if successful, are to be substituted for the present cars, which are equipped with two 25 H.P. motors. The new cars are electrically lighted, and are fitted with electric brakes.

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Light Railways.—Application is being made by Messrs. F. B. Beauchamp and others for an order to construct the North Somerset Light Railway in Clutton, High Littleton, Timsbury, Camerton, Dunkerton, Wellow, Combe Hay, South Stoke, Hinton Charterhouse, Monkton Combe and Limpley Stoke.

Barking Council are applying for authority to construct light railways from the terminus of the Barking and Beckton Light Railways to junctions with the East Ham and Ilford Council's tramways, and various loop lines.

Messrs. T. H. Spry, W. H. Mewton and E. Andrews seek authority to construct the Padstow, Bedruthian and Mawgan light railway, 12 miles in length.

London United Tramways (Ltd.) are applying for an order authorising extensions of their light railways in Cranford, Bedfont, Harlington, Harmondsworth, Stanwell, Horton, Iver, Langley Marish, Stoke Pogeș, Slough, Farnham Royal, Burnham, Hitcham, Taplow and Maidenhead, &c.

Maidstone Corporation are applying for authority to construct two light railways in Maidstone and Barming.

The Crystal Palace Light Railways and Tramways Co. seek powers to construct a light electric railway in Camberwell, Lambeth, Lewisham, Penge and Croydon to standard gauge.

Messrs. J. Cumberland, J. Waugh and H. T. Green are seeking an order to construct a light railway in Leighton Buzzard, Eggington, Battlesden, Hockliffe, Chalgrave, Toddington, Harlingdon, Streatley, Barton-in-the-Clay, Higham Gobion, Shillingdon and Holwell, Pirton and Icklesford.

An inquiry has been held at Manchester into the application of the West Manchester Light Railway Co. to extend the time for the compulsory purchase of lands, &c., and for power to construct a short branch line connecting the present system with the Cheshire Lines Committee's main line. The commissioners decided to submit an order for the approval of the Board of Trade.

Lincoln.—The receipts of the electricity department for the past year amounted to £4,315. 13s. 7d., an increase of £80. 0s. 8d., and the working expenses were £2,440. 11s. 11d, a decrease of £81. 7s. 11d., which left a gross profit of £1,875. 1s. 5d. to meet interest and sinking fund. The local tramways company are to be required to sell their undertaking to the Corporation.

Liverpool.—The Council on Wednesday decided to confer the freedom of the City upon Sir William Forward, member of the Corporation and chairman of the Liverpool Overhead Railway Co., in recognition of eminent services rendered to the city.

Maritzburg Tramways.—A report on these lines was recently submitted to the City Council, and proposals put forward for the laying down of 6½ miles of single track. Cars of the single-deck pattern are recommended. The sliding-bow contact for the overhead wires is advised as having advantages over the trolley, and the engineers of the scheme have decided to adopt it. The *Natal Advertiser* severely criticises this plan, as the patents of the sliding bow are held in Germany, and its use will necessitate the placing of the contract with German firms. The trolley pole and wheel are employed in Durban.

Marylebone (London).—At last week's meeting of the Borough Council a sum of £6,000 was voted for counsel's fees, &c., in connection with the arbitration proceedings now pending between the Council and the Metropolitan Electric Supply Co. This amount comes out of capital account.

Subsequently Ald. Sir E. GALSWORTHY referred to the proceedings, and asked "whither was the Council drifting." He asked the chairman of the Lighting committee (Councillor Debenham) whether the definite claim of the company had been sent in, how long was the arbitration likely to last, what were the probable costs of the arbitration, and was the Council to be supplied with any information regarding the proceedings before their close?

Councillor E. DEBENHAM said the amount of the company's claim had been fairly accurately given in the Press (see *The Electrician*, May 16, p. 154). The sum represented between £2,500,000 and £3,000,000. It was difficult to say how long the arbitration proceedings would last. They had been adjourned for several weeks to enable the Council to prepare their answer to the company's case. Nor could he give the amount of the expenses likely to be incurred.

Sir E. GALSWORTHY asked if the committee, assuming the award to be given at anything like the amount of the company's claim, considered that the Council could carry the scheme through?

Councillor DEBENHAM said he would prefer not to further discuss the matter, and the subject dropped.

Motherwell.—The accounts of the first year's working of the electricity department show that the income was £3,036. 180,000 units have been supplied for public and private lighting at a cost of 1·44d. per unit. The charge for current for private lighting has been reduced from 5d. to 4d. per unit, and for power 1½d. for over 500 units, under that quantity 2d. per unit.

Municipal Telephony.—The negotiations between the Hull Telephone committee and the National Telephone Co. in regard to the acquisition of the Hull undertaking of the company have fallen through. At Saturday's meeting of the committee it was reported that the question of purchase was first discussed by the parties, and when it was found that no agreement as to price was possible, they discussed the alternative proposal of a reduction of the rate for unlimited service, subject to the extension of the company's licence. The Corporation's representatives urged a reduction to £7 for business premises and £6 for private houses, and the company offered £7 and £8 respectively. Subsequently the company decided that the reduction asked for by the Corporation could not be conceded. The committee have, in turn, unanimously resolved to decline the offer of the company. The company's bill in Parliament is to be opposed by Hull.

The Local Government Board have sanctioned a further loan of £15,000 for developing the Tunbridge Wells municipal telephone service.

Nottingham.—On Monday the Council agreed to apply for sanction to borrow £35,000 for extensions of the electricity undertaking referred to in our last issue.

Pontypridd.—The Rhondda and Pontypridd Councils have decided to acquire the British Electric Traction Co.'s lines between Pontypridd and Porth, and the company has been invited to submit terms.

Provisional Order Revocation.—The Board of Trade have revoked the Newhaven electric lighting order, 1900.

Redditch.—A proposal to supply a local manufacturing firm with energy for power at 1½d. per unit was somewhat heatedly discussed at the last meeting of the Council, on the ground that generation expenses exceed 2d. per unit, but as current would be supplied in the daytime and so would improve the day-load at the station, the councillors ultimately approved the proposal by seven votes to six.

Rochdale.—The Bury and Rochdale Corporations, the Heywood Town and the Tollington, Royton, Littleborough and Unsworth District Councils have decided to take joint action for the acquisition of the Bury, Heywood, Rochdale and Oldham steam tramway undertaking. Mr. James Moore, jun., has been appointed valuer. It is proposed to convert the entire system to electric traction.

Rotherham.—The salary of the borough electrical engineer (Mr. E. Cross) has been increased from £200 to £250 per annum.

St. Helens.—The net profit on the electricity works was £230, a reduction on last year, due to increase in capital charges, owing to the installation of additional plant, which had only been working three months of the year. On the recommendation of the Joint Tramways and Parliamentary committee, the Council have decided to enter into an agreement with the tramway company, conferring on them the right to use the tramways for carriage of goods on terms.

Salford.—The inquiry was opened by Judge Parry on Tuesday into various matters connected with the electricity supply undertaking of the Corporation, including (*a*) the building, &c., of the Walness-road works; (*b*) whether the works could have been enlarged so as to use the machinery at present contained therein sufficiently to supply electric current for the necessary lighting and to run the tramways at present and for the next five years; (*c*) the total power provided in the Walness works and the new works, and, if found to be in excess of the requirements, to go thoroughly into the matter and report to the Council as to who is responsible; (*d*) as to specifications, tenders or contracts in connection with the erection of Strawberry-road station; and (*e*) any other matters that should be inquired into. The inquiry was a public one, and Judge Parry stated that if any man bonâ fide made a statement that he believed to be true he could plead privilege if proceedings at law were brought against him, but if a statement was malicious there would be no privilege. He could not compel the attendance of witnesses.

The town clerk (Mr. L. C. Evans) appeared for the Corporation. Messrs. W. Hunt, F. W. Wheatcroft and C. L. Turner appeared on their own behalf. Various councillors and contractors were also represented, and Mr. W. Cobbett appeared for Messrs. Lacey, Clirehugh and Sillar.

The TOWN CLERK divided the subject of inquiry into the separate complaints of Mr. W. Hunt, Mr. F. W. Wheatcroft and Mr. C. L. Turner, and sketched the history of the electricity works at Walness-road and Strawberry-road.

Mr. HUNT stated that he did not make any charge of illegality or bad faith against Ald. Shaw or Ald. Holland.

Mr. WHARTON said Ald. Shaw's firm had sold a pump to a firm of contractors with whom his firm had dealt for many years, and these contractors afterwards supplied the Corporation with a cable. Their contract was considerably the lowest.

Judge PARRY said he did not think he need keep Mr. Shaw's counsel any longer. There was nothing in this matter to inquire into.

Mr. HOCKIN made a statement with regard to Mr. Holland, who had supplied bricks to a contractor with the Corporation. In consequence of what he read of a case in another corporation, Ald. Holland asked the opinion of the town clerk, who advised that while he (the alderman) had done nothing illegal, it would be well not to continue the practice. Ald. Holland had not done so since.

Mr. Hunt accepted the statement, and Judge Parry then relieved Ald. Holland and his legal representative from attendance.

Mr. WHEATCROFT then made a detailed statement in comparison of the electric power installed by the borough for lighting and tramway purposes with that of Hamburg. He selected Hamburg for comparison because the

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Corporation had sent two deputations there to gain information. While the requirements of Salford were not likely for many years to be more than one-third or one-fourth those of Hamburg, the Salford installation amounted to 10,750 H.P., and that of Hamburg to 8,400 H.P. Messrs. Lacey, Clirehugh and Sillar were recommended to consider and revise specifications for work for 50 guineas. This was the recommendation of a sub-committee, but ultimately the resolution of the general committee was that they should be employed at £1,500. The consulting engineers were afterwards placed on a commission basis, and in March, 1899, they made a recommendation as to the generating plant that would be required. The committee received their report with consternation, because they had been informed that the scheme of Messrs. Lacey, Clirehugh and Sillar would be more moderate in cost than the scheme previously drawn up by Mr. Turner, the electrical engineer to the Corporation at that time. They had a scheme practically the same size, but under their scheme the whole construction was to be rushed up and paid for within four years, whereas Mr. Turner's scheme was to erect the buildings as required. At Mr. Wheatcroft's request, the minutes were read relating to the provision of 16 Lancashire boilers. The longest period allowed for the delivery of those boilers was, he said, at first 14 months. On his initiative this was made 18 months, and the words were added "if required." At a later date, when he was not present, the committee rescinded the latter resolution and reverted to the original 14 months. Through the interference of certain parties in the latter part of 1898 the recommendations of the consulting engineers became "demoralised," and the official life of Mr. Turner was from this period not an enviable one. Mr. Turner informed him and the deputy-chairman and others that the representative of a certain firm had been to him and pressure had been put upon him to include certain specifications for boilers in his scheme. Mr. Turner did not comply, and from that moment trouble for Mr. Turner began. At a later date Mr. Turner was dismissed. Mr. Wheatcroft contended that on Dec. 7, 1898, a resolution was put on the agenda paper of the Council which had not been passed by the committee, to the effect that the Electric Light committee be authorised to arrange for the appointment of a consulting electrical engineer with reference to machinery and plant. The chairman had stated that he had been worried into putting this on the paper.

Mr. HAWORTH, who was then chairman of the committee, and was now present, declared the evidence to be fabricated.

The TOWN CLERK contended that the matter actually did appear on the minutes.

Judge PARRY said it was on the minutes in one form and not in another. He asked Mr. Wheatcroft whether he protested at the time about this matter, and he replied that he did so.

Asked what he suggested, Mr. Wheatcroft replied that his suggestion was that it was intended to appoint an engineer to upset the scheme of Mr. Turner. He thought the chairman in this matter had broken faith with the committee. He considered the consulting engineers were weak advisers. In a report to committee he thought undue preference was shown to a firm of boiler makers. The scheme of Mr. Turner was a progressive one, the premises and plant to be erected as occasion required.

Mr. DESQUESNES handed in a letter from Mr. W. Mather, in which he said that however satisfactory an electrical engineer the Corporation might have, having regard to the extreme importance of the matter, Salford was really departing from the practice of other municipal corporations in not seeking advice from well-known authorities, and his firm would not tender on a particular specification.

Mr. WHEATCROFT said that, so far as Sir Richard Mottram was concerned, his understanding of that gentleman's action was now modified. At the same time he thought Sir Richard ought not to have attended a meeting of the committee when they considered certain boilers. He did not think that Mr. Haworth should have asked Messrs. Galloway to tender.

Judge PARRY said he should have considered such a course irregular, but they would have Mr. Haworth's evidence.

Mr. WHEATCROFT said he had nothing to say against Messrs. Galloway as a firm, a statement in which Mr. Turner, who was questioned by Judge Parry, also concurred.

Judge PARRY said that such charges as were made appeared to be against Sir Richard Mottram personally, and he would give evidence.

Mr. C. L. TURNER then said he entered the service of the Corporation in Oct., 1894, and on completion of the Walness-road station became manager. In March, 1897, the Council elected an Electric Lighting committee, and he was appointed borough electrical engineer, continuing in that position till May, 1900. As to whether the Walness works could have been enlarged, he complained that he had not been supplied with certain information which he had asked for from the town clerk.

The TOWN CLERK read a letter from Messrs. Lacey, Clirehugh and Sillar, who had replied to his inquiries, and complained of vague and damaging charges, expressing their readiness to afford to Judge Parry any information on specific points which he might require.

Mr. TURNER said what he required was Corporation property.

Judge PARRY said he would consider the matter later.

Mr. TURNER went on to state that the Walness-road works could not be enlarged, and if they had been the cost in cables would have been £15,000 more. As to the power provided, and whether it was in excess, he considered the Corporation had now from three to four times more plant than was required. The estimated cost at Strawberry-road alone, including cables, was approximately £400,000. He did not say the amount of work put in for the tramways was so much in excess of the requirements as that for lighting, but the two ought to be separated. He considered that at least half the capital cost might have been left over for a future date.

Mr. COBBETT, answering Judge Parry, said the plant Mr. Turner desired installed would have been 11½ times too large.

The inquiry was adjourned till Thursday.

The Corporation have adopted an alternative system of charging for electric current—viz., a rental of 1s. per 8 c.p. lamp per quarter and a charge of 1½d. per unit. for current consumed.

Sheffield.—Mr. Robert Hammond has submitted his report to the Electric Light committee on the scheme and plans prepared by the electrical engineer and manager (Mr. S. E. Fedden) for the proposed new power station at Neepsend. The report states that the site selected admirably fulfils the conditions laid down by Mr. Fedden in his report—viz: (1) That no nuisance to surrounding property will result; (2) that there is a plentiful supply of water for condensing purposes; and (3) that if the Great Central Railway are willing to do so, a siding can be provided off their main line, over which it will be possible to conveniently deliver the coal. The site is 2 miles from the present generating works, and, being on the confines of the city, is 5 miles from the most distant part of the area of supply, and Mr. Hammond concurs with the conclusions of Mr. Fedden that such a site within the confines of the city, and with ample water and coal facilities, is preferable to one outside. The advantages offered by a site near to a colliery are outweighed by those arising from close proximity to the area of supply.

Shipley.—The Bradford-road route is to be lighted by arc lamps to be erected on the tramway pillars.

Sir John Cass Technical Institute.—We have received a brochure giving the history of the foundation of this institute, together with an account of its aims, organisation and equipment. The principal of the institute, which was formally opened yesterday (Thursday) by Lord Avebury, is Mr. Charles A. Kohn, M.Sc., Ph.D., F.I.C., who is also head of the department of chemistry and metallurgy. Mr. Richard S. Willows, D.S., B.A., is head of the department of physics and mathematics, and Mr. R. L. B. Rathbone is head of the arts and crafts department.

Stockton.—The Council have decided to revise their charges for electric energy for power, and in future the rates will be: Under 250 hours' maximum demand per quarter, 2½d. per unit; 500 hours, 2d. per unit; larger consumers, special terms. The charge for current for places of worship has been reduced to a flat rate of 4d. per unit.

Stretford.—Application is to be made for sanction to borrow moneys for electricity works. Efforts will be made to proceed at once with the necessary alterations to the tramway track to suit it for electric traction.

Sunderland.—The agreement relating to the appointment of the borough electrical engineer (Mr. J. F. C. Snell) was discussed by the Tramways committee last week. A joint recommendation from the Tramways and Electricity and Lighting committees that the terms of Mr. Snell's agreement, which will expire a little more than two years hence, should be varied, and that a new agreement be made with him providing for five years' service at £1,000 per annum, was confirmed, and the Council was advised to endorse the revised agreement.

Swansea.—The Corporation have offered to supply electric current for power to the Hafod Isha works at 1½d. per unit for a minimum of 100 000 units, and 1¼d. for 260,000 units per annum.

The c.s. "Grappler."—It is reported that Mr. C. B. Cruikshank whose term of service with the West India and Panama Telegraph Co. as electrician on board the ill-fated cable steamer "Grappler" had expired, has, at the request of the company, consented to return to the West Indies for a few months to carry out the repairs of the cables broken during the recent catastrophies at Martinique.

Theatre Lighting Rules.—Consulting engineers, installation contractors, and others are reminded that the new set of rules for the protection of theatres, &c., from fire, which have been for some time under consideration of a committee of the London County Council, have now been issued. These regulations affect the electric lighting and heating arrangements of theatres, houses, rooms and other places of public resort within the administrative county of London. The rules are in amplification of and substitution for those issued by the Council on July 30, 1901, and are the new rules referred to in "The Electrician" Electrical Trades' Directory and Handbook for 1902, page 233. They are much more voluminous than the Council's rules previously in force, which were practically the same as those originally issued in 1892.

Warsaw.—The Czenstochowa-Herby line of electric railway which is being constructed here, will shortly be completed, and traffic will commence in the early autumn of 1902.

Westminster.—The Watch committee recommend the Council to make official representation to the Board of Trade of the desirability of framing regulations to compel electricity supply undertakings to take such precautions as will prevent explosions in street boxes, electric lighting conduits, &c.

York.—The City Council have decided to obtain a report on the condition of the electricity supply undertaking from Mr. C. H. Wordingham at a fee of 100 guineas.

Marriage.—On April 27, at Johannesburg, Mr. John Roberts, borough electrical engineer, Durban, was married to Miss Kate Dagmar Blundell, daughter of Mr. H. C. Blundell, of Barnes, London.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Rotherham Corporation invite tenders for tramway and lighting feeders, mains and other cables, with road work, boilers and 320kw. steam dynamo. An advertisement contains further particulars. Specifications from the town clerk (Mr. H. Hampton Copnall), Town Hall, Rotherham, and specifications and drawings can be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster. Tenders to Mr. Copnall by noon June 17.

Stockton-on-Tees Corporation invite tenders for the supply, delivery and erection of a 350kw. steam generator, two Lancashire boilers, one switchboard panel and instruments, surface condenser and cooling plant, pipework and valves, extension feeders, economisers and feed pump. Specifications from the borough electrical engineer (Mr. J. J. Smith) and tenders to the town clerk (Mr. Arthur B Crosby) by noon, June 17. Further particulars are given in an advertisement.

Bristol Electrical committee invite tenders for feed and general pumps, water softener, tank, coke filters and pipework. An advertisement contains further particulars. Specifications from the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol, to whom tenders by noon June 20.

Ipswich Corporation invite tenders for engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains and road work, permanent way construction of tramways, and arc lamps. An advertisement contains further particulars. Specifications, &c., from the town clerk (Mr. Will Bantoft), and can be seen at (but not obtained from) the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster. Tenders to town clerk by noon July 5.

West Ham Borough Council require 50 double-deck electric tramcars, complete with electrical equipment. Specifications, &c, from the borough electrical engineer (Mr. James K. Bock). Tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E, by 4 p.m., July 8. Further particulars are given in an advertisement.

West Ham Corporation also invite tenders by June 10 for construction of about 8 miles of tramway permanent way, bonding, &c.

Walsall Corporation invite tenders for the supply and erection of a reversible booster and switches to work in series with a battery on a tramway circuit. Specifications from the borough electrical engineer (Mr. Alex. F. Wyllie). Tenders to the town clerk (Mr. John R. Cooper) by June 27. See advertisement.

Wellington (Salop) District Council are prepared to receive offers for a lease of their electricity supply powers. Further particulars from the surveyor (Mr. M. Morley), 45, Walker-street, Wellington, or from the consulting engineer (Mr. Thos. L. Miller), 7, Tower-buildings, N. Water-street, Liverpool, to whom tenders by June 25. See advertisement.

Messrs. Preece and Cardew are authorised by the *Shanghai* Municipal Commissioners to receive tenders for the supply f.o.b. of a 100kw. high-speed engine and alternator and exciter. Further particulars are given in an advertisement. Specifications, &c., from Messrs. Preece and Cardew, 8, Queen Anne's gate, Westminster, to whom tenders by noon June 17.

Worksop District Council invite tenders for low-tension cables and joint boxes. Specifications, &c, from the consulting engineer (Mr. A. B. Mountain), St. Andrew's road, Huddersfield. Tenders to clerk (Mr. Geo. H. Featherston), Town Hall, Worksop, by June 17. See advertisement.

Worksop District Council are also prepared to consider schemes for "free" or assisted wiring. Particulars, with form of proposed agreement, to clerk (Mr. Geo. H. Featherston) by June 10.

Manchester Tramways committee invite tenders for the supply of line materials for overhead equipment and trolley wire. Specifications from the general manager (Mr. J. M. McElroy), 55, Piccadilly, Manchester. Tenders (addressed to chairman) by 1 p.m., June 14.

Manchester Tramways committee also invite tenders for chilled cast-iron wheels and axles and lamp glasses for cars. Tenders by 1 p.m. June 14.

Manchester Electricity committee also invite tenders for cast-iron roughing, bends and capping. Tenders by noon June 9.

Little Woolton District Council invite tenders for supply, laying and jointing of cables, supply and fixing of junction boxes and lamp connections, and the supply of lamp fittings. Tenders to 5, Castle-street, Liverpool, by noon June 20.

Bermondsey (London) Council require main switches, cutouts, distributing boards, electrical fittings and shades, casing, conduits, &c. Tenders by 4 p.m. June 16.

Warrington Corporation invite tenders for tramcars, with motors and electrical equipment complete. Tenders to town clerk by noon June 18.

The *War Office* invite tenders for a self-propelled lorry. Specifications from Director of Army Contracts, War Office, London, S.W., to whom tenders by noon July 31.

The Craigola Merthyr Co., Cambrian-place, *Swansea*, invite tenders for six months' stores, including electric lamps, &c. Forms of tender up to 10th inst.

Stretford District Council invite tenders for steam-raising plant, generators and mains. Tenders by June 18.

Nuneaton Electricity committee invite tenders for a water-tube boiler and pipework. Tenders by June 18.

Bury (Lanca.) Tramways committee invite tenders by June 24 for tramway track material.

St. Anne's-on-Sea District Council invite tenders for fire alarms. Tenders by June 17.

Kirkcaldy Corporation invite tenders for wiring the central station. Tenders by 10 a.m. June 21.

East Indian Railway Co. (Nicholas-lane, London, E.C.), require tenders for electric pumping installation for Howrah-Lillooah water supply. Tenders by 1 p.m. 11th inst.

Tenders are invited until 17th inst. by the *Austrian* State Railway authorities, Cracow, for electric lighting plant at the railway works at Neu-Sandez.

Tenders for the establishment of electric tramways in *Valparaiso* (Chili) will be opened on Sept. 1. Particulars from the Chilian consulate, 10, Lime street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Liège Municipality for works in connection with their electric tramways:—

For doubling the track from Pont d'Avray to Place St. Lambert.

Dineur and Hertin (*accepted*)	£1,241
François Noel	1,764
Louis Brisbois	1,361
Nyssen and Dumonceau	1,357
Félix Mélotte	1,306

For overhead line work from Pont d'Avray to Place St. Lambert and Rue des Guillemine.

Union Electricitäts Gesellschaft (*accepted*)	£353
Cie Internationale d'Electricité	481
Félix Mélotte	396

Fulham (London) Borough Council have accepted the tender of Messrs. Dick, Kerr & Co. for the supply and erection of a 600kw. steam alternator, with Belliss engine, for £5,290. 4s., contract to be completed within six months. Should this condition be declined, the tender of the General Electric Co. (with Willans engine), at £4,125, will be accepted.

Newport (I. of W.) Council has accepted the tender of the Isle of Wight Electric Light and Power Co. for the supply of electric current to 30 public arc lamps at £14 each per annum for five years. The arcs are to be switched off at 11:30 p.m., when 50 c.p. incandescents will be employed until 1 a.m.

The Metropolitan and District Electric Traction Co. have placed the order for the storage battery for their electric traction scheme with the Electrical Power Storage Co. (Ltd.), 4, Great Winchester-street, London, E.C.

Hull Corporation received two tenders for the supply of 20,000 cast-iron holding-down plates for the tramways—from Wilson, Pease & Co. at £4 11s. 6d. per ton, and from J. Cowdy & Co. at £194. The chairman of the Tramways committee and the city engineer have been authorised to accept the most advantageous tender.

Devonport Corporation received 12 tenders for the construction of permanent way, road-bed, paving and bonding of electric tramways, and that of Griffiths & Co. has been accepted at £38,157. 7s. 1d. The amounts ranged from £35,127. 15s. 1d. to £46,146. 11s.

Messrs. Dunlop & Co. (Birmingham) have accepted the tender of Messrs. Willans and Robinson for two 250 H.P. engines for direct-coupling to dynamos for electric power.

Broughty Ferry Town Council have accepted the tender of Callender's Company for the supply and laying of cables, &c., and that of Messrs. Thomson, Son & Co. for steam piping.

Messrs. Fownes Bros. (Worcester) have placed an order with Messrs. Willans and Robinson for a standard compound engine for mill driving.

Bristol Electricity committee has accepted the tender of Messrs. Siemens Bros. & Co. for the supply of a turbo-alternator for the Temple Back electricity works.

The Chamber Colliery Co. (Hollinwood) have accepted the tender of Messrs. Willans and Robinson for a standard compound engine for direct-coupling to a dynamo for supplying power for electric coal cutters and other motors about the colliery.

The tender of Messrs. A. R. Bullivant & Sons has been accepted by the Manchester Corporation for the erection of the Hythe-road tramcar shed at £41,110.

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The tender of the National Electric Wiring Co. has been accepted for wiring and fitting the Swansea free library at £571.

Poplar (London) Guardians have accepted the tender of Messrs. A. H. Marshall & Co. for wiring and fitting the Union offices for the electric light at £289. 10s.

Aberdeen Corporation received 16 tenders for the supply and erection of a 20-ton electrical crane, and that of Messrs. James Carrick & Sons has been accepted.

Shipley District Council have placed an order with the British Westinghouse Co. for the supply of 30 Bremer arc lamps.

BUSINESS NOTICES.

The City Electrical Co., electrical engineers and contractors, have opened offices at 5, Tottenham-street, London, W.

Mr. James Gray, 19, Waterloo-street, Glasgow, has been appointed agent for the sale of the Union Electric Co.'s open and enclosed, direct and alternating current, flame and triplex arc lamps. The latest types of these lamps will be on view.

LIQUIDATIONS, &c.

Claims against the Gateshead Electric and Mechanical Supply Co. (Ltd.) must be sent by June 24 to Mr. W. T. Price, 21, Collingwood-street, Newcastle-on-Tyne.

Claims against Moon, Loughlin & Co. (Ltd.), electrical engineers, Luna Works, Harpurhey, Manchester, must be sent to Mr. E. Hall, 5, John Dalton-street, Manchester, by July 12.

A meeting of the Commercial Telegraph Construction Syndicate (Ltd.) will be held at 7, Angel-court, London, E.C., on July 15, to receive an account of the winding-up.

Claims against G. J. Lloyd (trading as G. J. Lloyd & Co.), electrical and mechanical engineer, formerly of Bristol (present address unknown), must be in by 16th inst. to Mr. W. F. Herbert, Brighton-chambers, St. Stephen's-avenue, Bristol.

At the Central Criminal Court, London, on Tuesday, an application was agreed to for the postponement to the first day of next sessions of the trial of Charles Bright and his co-defendants, charged with conspiracy to defraud creditors.

Winding-up Petition.—A petition for the winding-up of a company called the London and Provincial Electric Construction Co. (Ltd.) is to be heard in the High Court on 17th inst. by Mr. Justice Buckley.

Plant, &c., for Sale.—Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Leyton Electric Lighting committee, having adopted steam plant, wish to dispose of their gas-driven plant, including dynamos, gas engines, Dowson gas generators and accessories. Offers to the engineer and manager (Mr. F. Harman Lewis) by June 25. See advertisement.

A number of electric motors, a 100-ampere dynamo (110 volts), a 58-cell battery and two Crossley gas engines of 9 B H P. and 12 B H.P. are for sale. Offers to the Era Press, Leyton. See advertisement.

The Newcastle-upon-Tyne Electric Supply Co. having recently changed their system from alternating to continuous current, have for disposal a number of transformers by various makers from 1 H.P. to 6 H.P. capacity. Further particulars from the general manager, 50, New Bridge-street, Newcastle-upon-Tyne. See advertisement.

Ferranti Medium-speed Engines.—A list of Ferranti medium-speed engines is now ready, and can be obtained on application. These engines are made in standard sizes from 500 I.H.P. to 6,000 I.HP., and early delivery of standard sizes can be made. Several examples of these machines are illustrated, and a list of some electricity stations where Ferranti engines are installed is given.

Cooling Towers and Condensing Plant.—The Birmingham electricity supply station is being fitted by the Wheeler Condenser and Engineering Co. with cooling tower and condensing plant. The tower will deal with 90 gallons of water per hour. The same company have in hand for the East Ham electricity station a cooling tower for dealing with 45 gallons per hour, and, in addition, a condensing plant. Condensing plants are also on order for Sheffield, Stockport and Erith electricity works.

Starting and Regulating Switches.—A new line of starting and regulating switches is introduced by the International Electrical Engineering Co., Clun House, Surrey-street, London, W.C. These switches are made with a "no-voltage" release, both for light and heavy currents. In the latter case the contacts are of large area, and are renewable. Regulating switches are made with protective covers to prevent accidental shock, and when desired these switches can be enclosed in cast-iron cases for use in collieries or exposed positions. For switching off automatically in case of overload the switches are fitted with a relay to demagnetise the retaining coil. The switches are provided with a simple means for retaining the switch arm magnetically in the "full-on" position (for a starting switch), or on any desired contact in a regulating switch. This consists in winding the retaining coil upon an iron bobbin forming the bearing of the switch spindle, thus obtaining a closed magnetic current through the spindle and a part of the switch arm to the back flange of the bearing bobbin, the parts being made of soft iron. There is an ample number of contacts and the switch is not rated for greater horse-power at the higher voltages, because the current density at the contacts is reduced. Great care has been taken with the insulation of the apparatus. The connecting wires between the switch contacts and the resistances are held in definite positions by a clamp to ensure against accidental short circuits. This arrangement and the method by which the wires are connected, enables the switch to be readily separated from the resistance if desired. Every part of the apparatus can be readily taken to pieces for repair, renewal, inspection, or adjustment, and is easily replaced. The illustration shows (A) type of switch for currents over 50 amperes and (B) a minimum release switch.

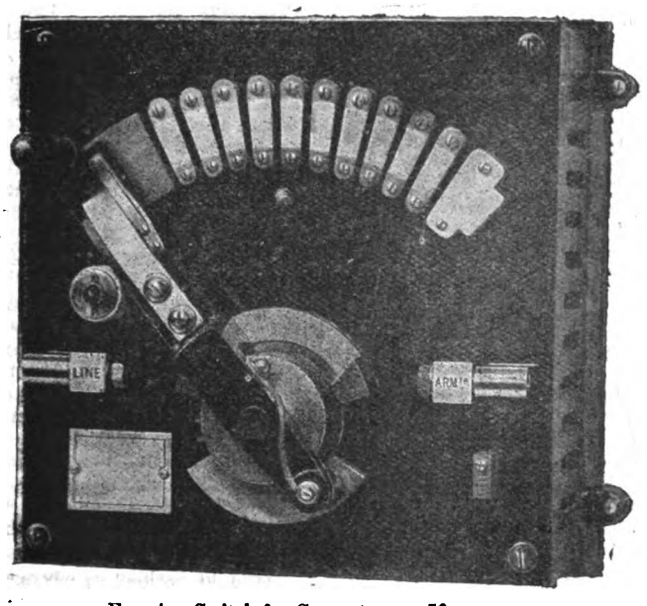

FIG. A.—Switch for Currents over 50 amperes.

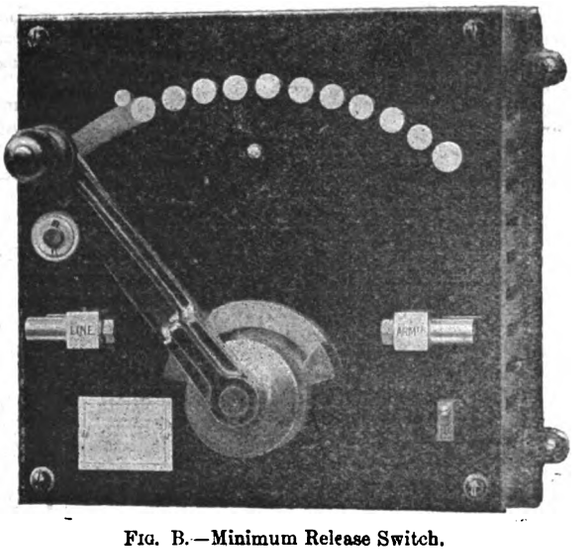

FIG. B.—Minimum Release Switch.

The former are provided with laminated copper contact brushes and an advance carbon brush, the latter to diminish sparking at the switch contacts. In (B) the switch arm does not touch the back flange of the bobbin except at the "full-on" position, a pole piece being supplied to the back flange at that point. The department of the company's works in which these switches are manufactured is in charge of Mr. Walter F. Jones, late of the Electrical Transmission Co., Hammersmith, London.

Luminous Electric Radiators, Hot Closets, &c.—We illustrate one of the numerous forms of luminous electric radiators, the design

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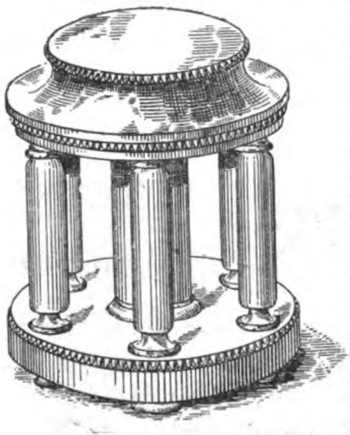
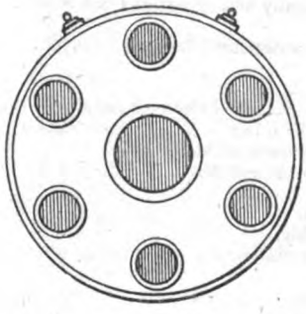
and construction of which have been patented by Messrs. Alex. Boyd & Son, warming and lighting engineers, 105, New Bond-street, London, W. This "Temple" form of radiator can be supplied in a variety of artistic designs, is very portable, and, in addition to giving a maximum of heat radiation, is well suited for lighting, and in this way may be made to serve for heating, lighting and decorative purposes. The demand for apparatus of this class is a rapidly growing one, and with the advent of bulk supply and the more economical generation of electric current, room will be found in mansions and the larger-sized houses for a quantity of this class of fixtures in many designs. A use to which Messrs. Boyd & Son find their patented apparatus at present applied is on board ship, where its extreme portability and general suitability for warming, lighting and decoration are found to be very acceptable. The apparatus can be either lightly or solidly constructed, and the amount of ornamentation which can be applied to the framework is, of course, practically unlimited. We have only particularised one form of electric heating apparatus. At their showrooms, the firm have a variety of designs on show, and there is every evidence of a large trade being done in these goods. A new list has just been issued showing the various ways in which luminous electricity can be employed for warming food, boiling water, &c., in addition to the warming of rooms.





Catalogues.—Installation firms are busy at this season in equipping offices, warehouses, &c., with electric fans. We have to notify that the Edison and Swan Company have just issued a good list of Ediswan "Paragon" fan motors for continuous-current and a separate sheet list of alternating-current fans. Copies of both can be obtained on application to the company's head offices, Queen-street, London, E.C., or to any of their numerous branches.

Sig. C. Olivetti, Ivrea (Italy), has now ready catalogues A, B, C and S, dealing in a comprehensive manner with a large number of electrical measuring instruments.

Messrs. Sanders, Rehders & Co., 108, Fenchurch-street, London, E.C., supply a patent automatic recorder for preventing waste of fuel in boiler furnaces, and an illustrated description of the apparatus is now published.

Messrs. John Fowler & Co. (Leeds), Ltd., have issued a prominent hanging-card description and illustration of Wilkinson's patent combined street transformer pillar and lamp standard, forming what is really a sub-station above ground level. The transformer chamber is constructed sufficiently large to take a 50kw. Fowler transformer, and is surrounded by a strong wrought-iron case. This case can be removed without interfering with the top cover and lamp standard. Ventilation is amply provided for. The base contains high and low-pressure switchboards, fitted with readily-accessible switch fuses and with a switch to control the lamp on the standard, which can be actuated by a key without unlocking the doors in the base. While the pillar is supplied in one size only, the transformers can be of various sizes, according to requirements.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from May 28 to June 4, with the ports of destination :—

Africa—Cape Town, £33; Durban, £801; East London, £441; Port Elizabeth, £429; Port Said, £37. *Argentina*—Buenos Ayres, £158 (telegraph material). *Australasia*—Adelaide, £495; Fremantle, £171; Lyttleton, £51; Melbourne, £110; Perth, £1,276; Sydney, £407; Wellington, £258. *Austria*—Trieste, £127. *Burma*—Rangoon, £245 (telegraph cable). *Ceylon*—Colombo, £23. *Channel Islands*, £235. *Colombia*—Santos, £138 (including £96 telegraph material). *Denmark*—Copenhagen, £63 (telegraph wire). *Greece*—Corfu, £47 (telegraph material). *Holland*—Amsterdam, £67; Rotterdam, £100. *India*—Bombay, £655 (including £550 telegraph instruments); Calcutta, £1,407 (including £800 telegraph cable); Madras, £50. *Japan*—Nagasaki, £636; Yokohama, £27. *Mexico*—Coatzacoalcos, £13; Salina Cruz, £41. *Russia*—Libau, £112; St. Petersburg, £1,019 (including £69 telegraph cable). *Siam*—Bangkok, £57. *Spain*—Barcelona, £91. Total, £9,843, against £141,166 for six days last year (May 30 to June 4)

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, of 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Where not otherwise stated, the application is made in London.

March 12, 1902.

6,093. J. E. Preston and S. S. Alcock. Apparatus for testing electrical circuits.
6,121. J. J. Rathbone. Arc lamps.
6,122. Otis Elevator Co. Electric switches for circuit closers and breakers. (Otis Elevator Co., U.S.)
6,143. British Thomson-Houston Co. and H. S. Meyer. Automatic regulation of voltage in alternating electric current systems.

March 13, 1902.

6,148. A. Eckstein and C. H. Archer. Manchester. Thermostatic cut out for electric heating circuits.
6,149. F. L. Wilder. Cheltenham. Transmitting motion and power by magnetic means.
6,155. E. M. Hollingsworth. St. Helens. Cleaning overhead conductors.
6,165. J. T. Cherry and E. H. Clive. Plymouth. Trolley head with wire-finding combination.
6,184. H. Hirst and W. Wood. Section insulators for trolley conductors.*
6,193. O. Cox. Measurement of high resistances.
6,209. S. H. Johnson. Arc lamps.*
6,229. K. H. Kochendörfer. Electric typewriters.*
6,233. S. Z. de Ferranti, C. C. Garrard and H. W. Clothier. Automatic electric circuit-breakers.

March 14, 1902.

6,264. J. Whitehead, E. Whitehead and H. J. Whitehead. Birmingham. Electric advertising devices.
6,295. G. A. Trube and W. Chapman. Brakes.
6,304. Accumulator Industries and J. J. H. Hunts. Accumulator plates.
6,306. W. P. Thompson. Electric alarm signals for railways. (P. Penza, Italy.)
6,328. W. M. Mordey and G. C. Fricker. Electricity meters.
6,331. M. Bayno. Electrical cooking apparatus.*
6,345. W. Taboulewitsch. Electric light signals.*
6,346. E. L. Joseph and G. Gardner. Electromagnetic circuit-breakers.*

March 15, 1902.

6,347. J. Swinburne. Electric railways.
6,376. W. Paterson. Arc lamps.
6,379. J. A. Rignon and E. Eisenmann. Continuous burning arc lamp with inclined carbons.*
6,393. J. E. Spagnoletti and J. Lawrence. Automatic battery regulating switch.
6,396. B. J. B. Mills. Magnetic contact box for electric tramways. (A. Diatto, Italy.)
6,406. F. B. O'Hanlon. Automatic regulators for constant-current dynamos.
6,430. E. H. Tyler. Overhead construction for electric railways.

March 17, 1902.

6,473. G. L. Hogan. Wireless telegraphy.
6,478. H. C. Porter. Storage batteries.*
6,481. H. Shoemaker. Wireless telegraph systems.*
6,484. H. T. Cedergren. Signalling devices for telephone systems. (Date applied for Oct. 21, 1901, date of application in Sweden).*
6,485. H. T. Cedergren. Telephone systems. (Date applied for Oct. 26, 1901, date of application in Sweden.)*

March 18, 1902.

6,558. A. Bourgeat. Paris. Telegraph poles.
6,607. H. Conradi and E. S. Conradi. Life-guard for vehicles.
6,629 R. Drügemüller. Liverpool. Trolleys or current collectors.
6,648. E. Lavens and E. J. Lavens. Signal telegraphs.*
6,652 and 6,653. E. N. Bray. Controlling electric circuits.
6,654. E. N. Bray. Switches.
6,666. J. H. St. H. Mawdsley. Dynamo-electric machinery.

March 19, 1902.

6,684. G. Hookham. Incandescent lamps.
6,686. R. J. Appleton and J. Oulton. Bradford. Switches for electric motors.
6,695. C. A. Palmer and E. Brice. Bristol. Frictionless trolley wheels.
6,699. M. Mercier. Manchester. Electrical signalling.
6,726 T. Wohlmuth. Decorative electric lamps.
6,733. W. D. Kilroy. Regulation of circuits in heating devices.
6,734. Hon. C. A. Parsons. Alternators.
6,760. W. Mc.Lellan. Fluid-tight joints.

March 20, 1902.

6,817. J. E. Kingsbury. Telephone sets. (Bell Telephone Mfg. Co., Belgium.)
6,818. J. E. Kingsbury. Flexible cords for telephone switchboards. (Western Electric Co., U.S.)
6,850. E. Schulz. Ceiling roses for electric lighting.
6,854. P. A. Newton. Electrical distribution. (Bliss Electric Car Lighting Co., U.S.)*
6,855. P. A. Newton. Brush mechanism. (Bliss Electric Car Lighting Co., U.S.)*

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6,880. G. C. Marks. Electrical heating devices. (G. L. Dengler, U.S.)
6,884. A. Graham. Telephonic apparatus.

March 21, 1902.

15,475A. P. M. Justice. Synchronising dynamo-electric machines. (Rowland Telegraphic Co., U.S.). (Date claimed July 30, 1901.)

March 31, 1902.

6,897. W. Pickering, S. A. Pickering, and J. Bromley. Manchester. Automatic life-guard and brake.
6,898. W. Pickering, S. A. Pickering, and J. Bromley. Manchester. Automatic safety device for trolley arms.
6,946. Callender's Cable and Construction Co. and H. Hastings. Covers for junction boxes.
6,947. Callender's Cable and Construction Co. and H. Hastings. Connections for electric cables.
6,948. Callender's Cable and Construction Co. and T. Petersen. Feeder pillars for supplying mains.

March 22, 1902.

7,003. N. Clemmenson, J. W. Butterworth and A. Morrison. Manchester. Incandescent lamps.
7,039. S. Z. de Ferranti. Electric fuses.
7,062. F. Häller and R. Noiset. Trolleys for electric vehicles.*
7,075. G. L. Hogan. Muliplex telephony, telegraphy and the transmission of electrical impulses and vibrations.
7,097. E. Schmidmer and G. E. Schmidmer. Microphones.
7,080. W. M. Thornton. Electromagnetic instrument.

March 24, 1902.

7,111. J. G. Roy. Glasgow. Double-pole electrical joint box.
7,121. J. Carr. Hull. Life-guard for electric or other cars.
7,125. P. K. Stern. New York. Electrical ozonising and circuit-breaking apparatus.
7,149. British Thomson-Houston Co. and F. Holden. Watt-hour meters.
7,150 British Thomson-Houston Co. Forming coils for electrical apparatus. (J. W. Lundakog, U.S.)*
7,151. British Thomson-Houston Co. Arc lamps. (W. C. Fish, U.S.)*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

1,122. Janney. Automatic telephone systems.
2,238. Baird. Toll apparatus for telephones. (Date applied for July 2, 1900.)
4,017. Vogelsang. Electrolytic bleaching of textile materials.
4,819. Weintz. Device for connecting trolley with trolley wire.
5,038. Mance and Nernst Electric Light. Incandescent electric lamps.
5,040. Garrard and Nernst Electric Light. Nernst lamps.
5,265. Webb, Lilley and Chapman. Recovery of precious metals by electrolysis.
5,421. Nodon. Converting alternating electric into direct current. (Date applied for August 17, 1900.)
5,460. Finlayson and Scott. Repayment electricity meters.
5,589. Muirhead. Electric telegraphy.
5,713. Lomax, Lomax and Tomlinson. Switches.
5,728. Mushet and Eggar. Electric switch operating apparatus for advertising or other electric lighting purposes.
5,766. Siemens Bros. & Co. (Siemens and Duke). Working and controlling of electrically-driven cars.
6,004. Beaumont and Still. Driving dynamos on vehicles from the axles thereof, and connecting such dynamos and batteries to lighting heating or other circuits on such vehicles.
6,041. W. J. Brown. Apparatus for taking up and paying out electrical conductors on lifts, arc lamps and other movable bodies.
6,161. Siemens Bros. & Co. and Lydall. Controlling single-phase alternate current motors.
6,352. Drake and Gorham. Accumulators.
6,353. Drake and Gorham. Electric rotary pumps.
6,358. Aldridge and Linley. Electric ignition.
6,460. Bartelmus. Electric signalling for railways.
6,723. Pescatore and Tudor Accumulator Co. Applying the active material to plates of secondary batteries.
6,862. Holden. Electric distribution system.
6,947. de Kandó. Suspension of conducting wires.
7,054. Storer. Electrical distribution. (Date applied for Sept. 6, 1900.)
7,676. Hancock and Walters. Guide for placing trolley wires.
7,868. Charlesworth. Safety devices for electric cars.
8,110A. Harrison. Electric couplings and switching apparatus. (Date claimed April 19, 1901.)
8,437. Claremont. Manufacture of vulcanised electric cables.
8,890. Heimebdinger. Printing electric telegraphs.
8,906. Maiche. Transmission of electric currents.
8,970. Woodward. Paste for use with lead plates of secondary batteries.
8,997. Gattie. Governing electric currents.
9,011. Sanders. Electrode position of metals for manufacture of compound wire bars.
9,023. Bristol. Testing secondary batteries.
9,187. Elieson and De Rorinsky. Accumulators.
9,188. Forbes. Induction coils.
9,193. Sir W. G. Armstrong, Withworth & Co. and Honner. Gear for electric switches of cranes, capstans and the like.
9,595. Austen. Securing telegraph, telephone or other wires.
9,611. Metcalfe. Trolley heads.
9,675. Jandus Arc Lamp and Electric Co. and Jones. Arc lamps.
9,745. Moy and Bastie. Circuit breakers.
9,801. Brown. Electric telegraphy.
9,829. British Thomson-Houston Co. and Wedmore. Automatic circuit breakers.
9,916. Flood and Honey. Collecting brushes and holders.
10,062. Eckstein and Pauter. Moving-coil electrical measuring instruments.
10,120. Muirhead. Electric telegraphy.
10,654. Weaver. Resistances for control of electric currents.
10,735. British Thomson-Houston Co. (Stewart). Electric circuit breakers.
10,756. Drake, Garrard, Ram and Nernst Electric Light. Magnet coils or solenoids.
10,758. Ram and Nernst Electric Light. Incandescent lamps in which the light-giving body is a conductor of the second class.
10,879. Dickson. Voltaic cells.
10,971. Lake (Tice). Controllers for electric railways.
11,007. Benson and Price. Combined electrical and mechanical motor.
11,120. Wyler. Shade-holders.
11,135. Johnson. Electric arc lamps.
12,186. Johnson (Chemische Fabrik Grieshermer Elektron). Electrolytic production of lead dioxide.
13,017. Hill. Recording apparatus for electrical measuring instruments.
15,804. Watkins, Bolster, Naylor, Davies, Coryelle and Berry. Telephone selecting devices.
16,955. Van Wagenen. Electrical intercommunication.
17,070. Reinmann. Incandescent electric lamps.
17,132. Quin. Insulators for electrically separating sections of overhead trolley line.
17,801. Shibley and Skirrow. Transmitting telegraph keys. (Date applied for Aug. 6, 1901.)
19,136. Vogt. Cover for electric cells.
21,602. Cerebotani and Moradelli. Polarised electromagnetic devices.
22,492. Thompson (Scott, Janney and Le Bar). Electric propulsion.
24,449. Everett. Dynamo electric generators and motors.
24,887. Burgess. Automatically and intermittently closing an electrical circuit on railways.
25,175. Struble. Electric signalling.
25,724. Hunt. Spiral sheave or trolley.
26,286. Frenay. Contact makers for electrically fired internal combustion engines.
26,702. Stover and Swren. Controlling devices for connecting storage batteries with a charging circuit.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH CORPORATION (LTD.)—Reg. May 31, capital £175,720 in 175,000 ordinary shares of £1 each and 28,800 deferred shares of 1s. each, to construct, equip, develop and maintain railways, tramways, electric and other public works, electric and general engineers, producers and suppliers of electricity, &c.

CHRISTIAN AND PHIPPS (LTD.)—Reg. May 28, capital £5,000 in £1 shares (3,500 preference, 1,000 founder and 500 ordinary), to acquire the business of Christian and Phipps, electricians, mechanical engineers, manufacturers of electrical apparatus and appliances, car and carriage makers, producers and suppliers of electricity, wire and cable makers, &c The subscribers are:—E. C. Gibbons, M.A., A.I.E.E., G. W. Green, C.E. H. Myram, electrical engineer, W. R. Estall, R. Poole, A.M.I.E.E., A. Patey and E. D. Poole. The first directors are J. S. Gibbons, J.P., A. C. Gibbons, R. Poole, G. W. Green and A. C. Poole.

THOMAS BOLTON & SONS (LTD.)—Reg. May 28, capital £300,000 in £1 shares, to acquire the business carried on by Thomas Bolton & Sons at Birmingham and elsewhere, and to carry on the business of copper smelters, manufacturers of metals, wire, tubes and sheets, alloys, metal rollers, engineers, workers in all metals, electricians, suppliers of electricity, &c. The first directors are F. S. Bolton, C. B. Toller, G. Rathbone, G. S. Robertson, T. O. Callender, I. M. Henderby and F. A. Bolton. Sir G. S. Robertson is "debenture director." Reg. office, Broad-street Metal Works, Broad-street, Birmingham.

GENERAL ELECTRIC TRAMWAYS CO. (LTD.)—The return to April 2 gives the capital as £50,000 in £1 shares, 18,500 of which have been taken up. £18,500 has been received. Mortgages and charges £15,000.

HARTLEPOOL ELECTRIC TRAMWAYS CO. (LTD.)—In the return to April 2 the capital is £100,000 in £10 shares (5,000 preference and 5,000 ordinary). 5,000 ordinary shares have been taken up, fully paid. Mortgages and charges nil.

MERTHYR ELECTRIC TRACTION AND LIGHTING CO. (LTD.)—The total capital to date is £86,850. The gross tramway receipts from April 6 (date of opening) to Dec. 31 were £9,587, and gross receipts from supply of electric current from July 22 amounted to £2,104, making, with sundry receipts, £11,772. After deducting expenses (£7,129) and £1,434 for interest there is a net profit of £3,208. The cumulative preference dividend to Dec. 31 absorbs £862, £1,000 is placed to reserve and depreciation, and dividend of 4s. per share on ordinary shares (equal to 5½ per cent. per annum), absorbs £1,200; £145 is carried forward. The number of private consumers connected to the mains represent the equivalent of 4,313 8 c.p. lamps, and this branch of the business makes satisfactory progress.

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CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 1/16d. per oz. (June 5). Consols (2¾ per cent.) 96⅜—96½ for money, 96 5/16—96 7/16 for account; 2½ per cent. 96¾—97¼ (June 5). Consols Pay Day July 2; Stocks and Shares Continuation Days, June 10 and 23; Ticket Days, June 11 and 24; Pay Days, June 12 and 25; Mining Share Carry-over Days, June 9 and 20.

WILLANS AND ROBINSON (LTD.)—With the rise in the price of Consols, and, in fact, of all gilt-edged securities, there is difficulty in finding investments returning anything like a safe 4 per cent. Investors in industrial securities will, therefore, turn with interest to the prospectus set out on another page of an issue of £250,000 4 per cent. first mortgage debenture stock in the well-known firm of Willans and Robinson (Ltd.), engine builders and boiler makers, Rugby, Warwickshire, and Queen's Ferry, Flintshire. Of this amount £105,000 has been allocated to the holders of the former first mortgage debenture stock, in redemption thereof, and £10,000 is reserved for future issue, leaving but £135,000, which is now offered for subscription at par. The authorised capital of the company is £750,000 in equal proportions of preference and ordinary shares of £5 each. Of this amount there has been issued £666,660. The debenture stock now issued is secured by a charge upon the undertaking and upon the property and assets of the company. The audited accounts to Dec. 31, which are sent out with the prospectus, show that the property and assets of the company on that date were £972,387, not including the amount paid for goodwill, which has all been written off. The company's indebtedness on the same date, including a debenture debt of £100,000, amounted to £133,508. The amount to be raised by the debenture stock now offered is required for completing the important works at Queen's Ferry and Rugby, for providing additional plant and machinery, and for further working capital. A report by Messrs. Cooper Brothers & Co., certifying the past profits of the undertaking from the year 1894, when the present company was formed, shows a steady increase from £15,130 in 1894 to £64,275 in 1901, not including the sum of £155,492 received as premiums on shares issued. The last issue of £5 ordinary shares in this company was made at £3 premium. The list of applications for this debenture issue will open on Monday, June 9, and will be closed on or before 4 p.m. on Wednesday, June 11.

ALLEN EVERITT & SONS (LTD.)—At the meeting on Saturday the chairman (Mr. C. C. Turnbull) said the condition of the copper trade had become a matter of notoriety owing to the exceedingly prominent part taken in it by Americans, and the extraordinary fluctuations in the price, which culminated last year in a drop of £20 to £25 a ton. They had to contend with very serious competition. The report disclosed a small profit, but if it had not been for excellent management it might have developed into an exceedingly large loss. During the past six years they had made a profit of £128,000, and had improved their financial position during that period by £76,000. There might be in time considerable competition arising from aluminium, and he thought the shareholders should bear in mind that transmission of electrical energy was not entirely confined to copper.

BELLISS AND MORCOM (LTD.)—The report for the year ended March 31 states that the profit, after making ample provision for depreciation, &c., and after payment of preference dividend, amounted to £32,853. An interim ordinary dividend at the rate of 5 per cent. has been paid, and a further dividend, making 12½ per cent. for the year, is now proposed. £10,000 is placed to reserve, and the balance carried forward.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)—Applications have been this week invited to an issue of 4,000 ordinary £5 shares of this company at 5s. premium and 50,000 4½ per cent. first mortgage debenture stock at 102. The list closed at 4 p.m. to-day (Friday).

BULUWAYO WATERWORKS CO. (LTD.)—At the meeting on Monday the chairman (Sir J. C. Willoughby) said that expenditure had been incurred during the year in extending the electric lighting mains and making additions to the plant and machinery, &c. His statement at the last meeting, that all extra electric light plant had arrived in Buluwayo, was not correct, as part of it was still at the coast, and was not allowed up country by the military authorities until near the end of last year. Consumers were being connected to the company's electric supply mains as fast as possible. With their electric light plant more than doubled, they could now generate considerably more than twice the number of units obtainable from the old plant. The 189,000 units generated in 1901 did not represent the full capacity of the old plant, and they could now produce somewhere about 500,000 units with the combined machinery. The profit and loss account showed a credit balance of £3,489. 17s. 6d. Including interest on loans, the profits for the year amounted to £4,862, compared with £4,560 in 1900, and £4,164 in 1899. In their electrical department fuel, which consisted entirely of wood, cost £2,704, or 3·46d. per unit of current generated.

COMMERCIAL CABLE CO.—A quarterly dividend of 1¾ per cent. on the capital stock has been declared, payable July 1, out of the net earnings of the company. The transfer books will be closed from 20th inst. to July 1 inclusive.

DIRECT SPANISH TELEGRAPH CO.—Mr. F. T. Preddle, who has been in the service of the Direct Spanish Telegraph Co. for the past 29 years, has been appointed by the directors secretary of the company.

EL JOAN CENTRAL DE ELECTRICIDAD DE LA CASTELLANA.—This is the style of a company formed in Madrid with a capital of £240,000 to utilise the water power of the river Jarama, 12 miles from Madrid, in the generation of electric energy.

MEXICO ELECTRIC TRAMWAYS (LTD.)—Out of a total credit to profit and loss of £16,662. 14s. 5d. the 6 per cent. preference dividend absorbs £12,357. 5s. 8d., the balance, together with that from last year (making £6,533. 2s. 11d.) is carried forward. During the past year 200,000 £1 6 per cent. cumulative preference shares were issued to enable construction work on the tramways to proceed. There are now remaining 112,987 shares unissued. The company at present works 107km. out of a total of 251km. of track by electricity. Nearly 27,000,000 passengers were carried during the year, the total receipts being £209,136. 12s. 5d. The process of the construction of the lines, is nearing completion, and all the more important sections are being worked by electricity.

MUNICIPAL ISSUE.—Burton-on-Trent Corporation invite applications for £247,579 3 per cent. stock, to provide funds for extensions of the electricity works, the construction of electric tramways, &c.

REUTER'S TELEGRAM CO. (LTD.)—The balance available for distribution for the year to Dec. 31 last is £5,047. 3s. 1d., including £178. 11s. from last account. An interim dividend of 2½ per cent. was paid in October, and the directors now divide 4s. per share (2½ per cent.), making 5 per cent., tax free, for the year. This will absorb £4,735. 12s., leaving £311. 11s. 1d. to be carried forward.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has ordered the further issue of 10,000 £5 fully-paid 6 per cent. cumulative preference shares of *Edmundson's Electricity Corporation (Ltd.)* to be quoted.

WESTERN TELEGRAPH CO. (LTD.)—An interim dividend is declared, payable June 24, of 3s. per share (at the rate of 6 per cent. per annum), tax free, for the quarter ended March 31. The transfer books will be closed from 17th to 23rd inst. inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	May 31	754	+ 36	52	36,875	+ 2,226
Ayr Corporation	„ 31	231	...	2	492	...
*Birmingham Tramways.	„ 31	5.017	- 630	21	98,371	+28,151
*Blackburn Corporation..	„ 30	841	- 5	22	14,644	+ 1,747
Blackpool Corporation...	„ 29	1,385	- 477	9	5,650	+ 317
Blackpool and Fleetwood	„ 31	671	-1,192	22	6,898	- 95
Bolton Corporation	June 1	1,819	- 32	9	14,080	+ 423
Bradford Corporation ...	„ 1	3,082	...	...	21,209	+14,366
Brighton Corporation ...	„ 1	764	...	27	16,243	...
Brisbane Tramways.....	Apl. 16	2,251	+ 318	16	37,149	+ 3,995
*Bristol Trams & Carriage	May 30	4,676	-1,921	21	88,746	+ 3,282
Burnley Corporation ...	„ 31	690	+ 172	‡9	6,086	+ 1,886
*Buenos Ayres & Belgrano	„ 4	3,022	+ 294	18	49,073	- 765
Calcutta Tramways Co...	„ 31	R20,027	+ R625	22	R483,643	+R43,758
*Cardiff Corporation	„ 31	1,368	...	...	...	...
Carlisle Tramways Co....	„ 31	172	- 44	†22	3,039	- 20
Central London Railway	„ 31	6,815	+ 447	22	147,483	+11,012
City & South London Ry.	June 1	2,952	+1,130	22	65,422	+21,988
Cork Elec. Tramways Co.	May 29	631	+ 46	§21	9,057	+ 257
Devonport & Dist. Trams	„ 23	469	...	20½	8,005	...
Dover Corporation	„ 31	246	- 43	9	1,801	- 150
Dublin & Lucan Railway	June 1	88	- 85	22	2,090	- 61
Dublin Southern Dist....	May 30	909	- 102	¶21	17,101	+ 4,148
Dublin United	„ 30	3,861	- 247	¶21	74,856	
Dudley—Stourbridge ...	„ 23	1,177	+ 517	20½	13,955	+ 2,614
*Dundee Corporation ...	...	...	...	...	...	...
East Ham Council	„ 31	479	...	49	18,013	...
Gateshead & Dist. Trams	„ 23	829	+ 412	20½	15,393	+ 735
Glasgow Corporation ...	„ 31	11,762	+ 380	52	612,794	+ 127,933
Greenock & Port Glasgow	„ 23	512	+ 295	20½	8,527	+ 4,830
Hartlepool Tramways ..	„ 23	366	+ 136	20½	4,255	+ 417
Hull Corporation	„ 31	1,703	+ 262	9	17,947	+ 49
Isle of Thanet Co.	„ 31	551	- 432	...	...	...
Kidderminster & Dist....	„ 23	214	+ 95	20½	2,147	+ 223
*Liverpool Corporation...	„ 24	10,032	+ 654	21	189,336	+15,371
Liverpool Overhead Rly.	June 1	1,481	— 598	‡22	31,368	— 3,087
Manchester Corporation	May 31	2,761	...	§51	108,020	...
Merthyr.....	„ 23	276	+ 38	20½	3,930	- 499
Middleton	„ 23	374	...	8½	2,485	...
Newcastle-on-Tyne Corp	„ 31	2,520	...	9	8,502	...
Oldham, Ashton & Hyde.	„ 23	607	+ 87	20½	9,842	+ 87
Perth (W.A.) Elec. Trams	„ 30	993	+ 221	†48	47,221	+15,120
Poole & Dist.....	„ 23	349	+ 85	20½	4,425	+ 76
Portsmouth Corporation	„ 31	1,646	+ 684	...	...	...
Potteries	„ 23	1,718	+ 278	20½	28,686	+ 1,333
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ...	June 1	3,865	- 725	22	82,723	+13,525
Southampton Corporat'n	May 29	902	+ 114	21	17,405	+ 3,097
Southport Tramways ...	„ 23	483	+ 319	20½	3,800	+ 1,215
*S. Staffordshire Trams...	„ 23	1 096	+ 328	20½	15,344	+ 914
Sunderland Corporation.	June 1	1,040	...	9	9,619	...
Swansea Trams.....	May 23	564	+ 139	20½	8,633	+ 892
Taunton Trams.....	„ 23	88	...	20½	1,166	...
Tynemouth & Dist.	„ 23	392	+ 155	20½	4,287	+ 358
Wigan Corporation	„ 29	245	+ 128	9	1,745	+ 996
Wolverhampton District	„ 23	301	+ 247	20½	2,922	+ 1,929

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, May 28.		Price Wednesday, June 4.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 4.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
£100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½	⅛	½	⅛		...	..	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103	104	100	104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11	12	11	12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103	106	103	106	6 5 2	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	8¾	9¼	8¾	9¼	4 6 6	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	March and September	...	...
20,000	5	3/6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8	9	8	9	3 6 8	...	...	...
10,000	5	3/4 13/16	Do (Nos. 20,001-30,000)	8	9	8	9	...	...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock xd	104	106	105	107	3 14 11	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	10	9	10	5 0 0	February and August	9½	9½
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	..	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	6¼	5½	6¾	3 18 3	...	...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 15 6	,, ,,	...	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5	5½	5	5½	3 12 9	...	106½	...
£180,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110	113	110	113	4 0 2	March	5 7/16	...
70,595	10	10/0	City of London Electric Lighting Ord.	8	9	8	9	5 5 7	June and December	11 ¾	11½
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12	13	11½	12½	4 13 0	February and August	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123	123	123	128	3 18 10	January and July	11 13/16	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 6 0	June and December	106	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	7½	8½	7½	8½	4 14 2	...	104	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12	13	12	13	4 12 4	...	8¾	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	108	111	108	111	4 2 6	March and September	...	...
12,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	6¾	6¾	6¾	6¾	3 12 0	...	110½	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10	11	10	11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½	6¾	6½	6¾	4 8 11	...	10¼	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	January and July	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104	107	104	107	3 14 11	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1½	1¾	1½	1¾	...	...	...	...
49,540	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	...	...
£150,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95	100	95	100	4 0 4	Mar., June, Sept., Dec.	96½	95
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16½	17½	16½	17½	3 14 4	April and October	17	16 15/16
£230,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111	115	111	115	3 18 2	June and December	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	98	101	93	101	3 10 4	...	...	...
10,552	10	6/0	Notting Hill Electric Ordinary	14	15	14	15	4 0 0	March	...	...
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	...	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	98	101	93	101	3 19 3	,,	...	...
300,000	1	...	Rand Electric	1 1/16	1 1/16	1 1/16	1 1/16	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	...	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 6 9	January and July	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	April and October	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	February and August	15 7/16	14 13/16
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98	101	98	101	3 9 6	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1¾	2¼	1¾	2¼	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	3	3½	3	3½	...	...	...	...
110,000	5	5/6	Westminster Electric Supply Ordinary	11	12	11	12	4 7 6	March and September	1 ⅛	11¼
28,141	5	...	Do. 5 per Cent. Cumulative Preference	3½	4	3½	4	...	...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4	4¼	4⅜	4⅝	4 11 5	April and October	4 5/16	4⅜
£230,000	Stock	6%	Do Permanent 6% Deb. Stock	127	132	127	132	4 12 7	...	...	...
20,000	10	...	Barcelona Tramways Ordinary	8	9	8½	9½	...	...	..	...
10,000	10	5/0	Do. 5% Cumulative Preference	8	9	8⅜	9⅜	5 5 3	...	9⅛	9
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½	14½	13½	14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3	3½	3¼	3⅝	...	...	3⅝	3½
75,000	5	2/6	Do. 5% Cum. Pref.	4½	5	4⅜	5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	104	107	104	107	4 4 1	...	106¾	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21	22	21	22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10	10½	10	10¼	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106	108	106	108	3 14 1	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7¼	7	7¼	2 13 4	...	7 5/16	7¼
20,000	10	5/0	Do. 5% Preference	9¾	10¼	9¾	10¼	4 17 6	May and November	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102¾	104¾	102¾	104¾	4 6 9	...	103½	...
100,000	10	6/0	British Electric Traction Ordinary	13¾	14¼	13¾	14¼	6 4 2	...	14¼	14⅛
100,000	10	6/0	Do. 6% Cum. Pref.	12¾	13	12¾	13	4 12 4	February and August	12⅝	12⅝
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	126	125¾
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅛	1⅜	1⅛	1⅜	...	...	1 1/16	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4¾	5¼	4¾	5¼	5 14 3	...	...	...
27,500	5	10/0	Do. "B"	4¾	5¼	4¾	5¼	5 14 3	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103	106	104	107	4 13 9	...	105½	105
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97	100	97	100	5 0 0	...	...	...
35,000	10	6/0	Calcutta Tramways (Nos. 1 to 34,440) ex rights	12½	13½	12½	13½	2 4 6	...	13 5/8	13
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	109	107	109	4 3 7	...	107*	...
£80,000	1	1/2⅞	Cape Electric Tramways Shares	2⅜	2⅝	2⅜	2⅝	3 16 2	...	2 3/16	...
£1,810,914	Stock	4%	Central London Ordinary Stock	103	106	104	107	3 15 1	June and December	106⅜	105½
£494,993	Stock	4%	Do. 4% Preferred Stock	103	106	103	106	3 15 11	...	1 5	...
£494,993	Stock	4%	Do. Deferred Stock	100	103	100	103	3 17 11	...	102	101½
£698,201	100	4%	Do. 4% Deb.	116	118	116	118	3 8 0	...	1 7½	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5	5½	5	5½	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	1 1/16	101
£1,350,000	Stock	2½%	City and South London Railway Con. Ordinary	71	74	71	74	2 14 1	February and August	74	71¾
37,500	10	1/0⅝	Do. Ordinary (Nos. 22,501 to 60,000)	...	...	...	...	...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	..	...	...	...	...	...	...	..
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	133	128	133	3 15 5	...	...	...
£200,000	Stock	5%	Do. (1896)	125	128	125	128	3 18 4	,, ,,	...	...
£150,000	Stock	...	Do. (1901)	120	124	121	125	...	...	124½	123½
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	113	117	115	118	3 9 7	May and November	118	117
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	12	13	11½	12½	3 16 11	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½	15½	14½	15½	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
33,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4	4½	4½	4⅝	6 6 4	...	4½	4⅜
£75,000	Stock	10/8	Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 15 2	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8	9	8	9	3 6 8	...	8⅝	...
20,000	10	8%	†Imperial Tramways Ordinary ex rights	27	28	23	24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	14	13½	14	4 5 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110	112	110	112	4 0 6	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½	5	4½	5	...	...	...	...
87,500	10	1%	Liverpool Overhead Railway Ordinary	4 13/16	4 15/16	4 13/16	4 15/16	3 0 0	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅝	11	10⅝	11	4 11 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98	99	98	99	4 0 10	January and July	...	...
51,501	10	..	London United Trams 5% Cum. Pref. (£10 paid)	10½	11	10¾	11¼	...	...	...	...
30,999	10	...	Do. (£5 paid)	5½	6	5½	6	...	...	...	...
£655,341	Stock	...	Do. 4% 1st Mortgage Debenture Stock	105	107	106	108	...	...	107	103
£169,659	Stock	...	Do. Prov. Certs. (£50 paid)	54	56	55	57	...	...	...	...
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	111	115	115	119	4 5 7	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	104	106	104	106	4 14 9	...	104½	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1932)	103	105	103	105	4 5 10	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3	4	7 10 0	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96	100	96	100	5 0 0	...	...	...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stck.	100	103	100	103	4 12 9	...	...	...
13,334	10	8/0	Potteries Electric Traction Ordinary	9½	10½	9½	10½	3 16 2	...	...	...
10,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	February and August	...	...
£320,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	107	110	107	110	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...	...	...	...	...	...
51,132	1	...	Do. 6% Preference (12/0 paid)	...	...	...	...	...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...	...	...	...	...	,, ,,	...	...
£500,000	Stock	...	Do. 4½ Debenture Stock (60% paid)	...	...	...	...	...	January and July	...	...
£340,000	Stock	2½	Westminster City Ordinary	93	95	92	95	3 3 5	June and December	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 28		Price Wednesday, June 4.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 4.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅛	4⅛	3⅛	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£788,840	Stock	12/6	Anglo-American	44	47	44	47	5 19 5	Feb., May, Aug., Nov.	...	...
£3,105,580	Stock	25/0	Do. Preferred	88	90	88	90	6 9 2	" "	89½	88
£3,105,580	Stock	2/0	Do. Deferred	7	7½	6⅞	7⅛	1 7 7	" "	...	...
$13,333,300	$100	$1⅔	Commercial Cable Capital Stock	159	160	160	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	93	96	94	96	4 3 4	" "	95½	94⅜
16,000	10	4/0	Cuba Submarine Ordinary	4⅜	5⅛	4⅜	5⅛	7 5 6	February and August	5⅛	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½	13⅜	12½	13⅜	7 8 2	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅛	3⅛	2⅛	3⅛	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8⅞	9⅛	8⅞	9⅛	5 5 3	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	98⅞	102⅞	98⅞	102⅞	4 8 3	January and July	...	...
60,710	20	3/0	Direct United States Cable	9⅛	10⅛	9⅛	10⅛	6 3 10	Jan., Apr., July, Oct.	10⅜	...
£101,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200) (red.)	1 7	127	120	130	5 7 8	Jan., Apr., July, Oct.	125½	150
£1,980,807	Stock	17/6	Do. 3½ per Cent. Preference Stock	86	89	86	89	3 19 5	" "	86½	...
1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	106	110	106	110	3 12 9	May and November	...	...
300,000	10	6/6	Eastern Extension	12⅛	13⅛	12⅛	13⅛	5 3 8	Jan., Apr., July, Oct.	13⅛	12⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	112	107	112	3 11 10	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 17 4	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	99⅞	102⅞	99⅞	102⅞	3 18 5	May and November	...	...
150,000	10	20 0	Great Northern of Copenhagen	26	28	25	27	5 11 1	January and July	28	...
£75,000	100	6½	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos	99	103	99	103	4 8 3	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	37	41	37	41	6 1 11	May and November	40	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 7	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3½	4⅛	3½	4⅛	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99	102	99	102	4 19 0	March and September	...	...
30,008	25		West Coast of America	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅛	⅜	⅛	⅜		May and November	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Pref. £6,0 on a/c of arrears	5½	5⅝	5½	5⅝	10 8 8	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅞	4⅛	3⅞	4⅛		" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	101	104	101	104	4 16 8	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	11⅛	12⅛	11⅛	12⅛	5 16 4	Mar., June, Oct., Dec.	12⅜	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1905)	102	105	102	105	4 15 3	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 18 5	...	...	...
			TELEPHONES.								
44,000	£5	5 0	Chili Telephone (fully paid)	3⅞	4	3⅞	4	6 5 0	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	½	½	½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	96⅜	96½
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	3⅛	3⅜	3⅛	3⅜	6 4 6	...	3 7/16	...
£1,966,667	Stock	4½%	Do. Deferred Stock	53	57	53	57	7 17 11	...	55	54
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	14	12	14	4 5 9	February and August	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	12	14	4 5 9	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5	5½	5	5½	4 16 2	" "	5	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	94	97	94	97	3 12 5	June and December	94	93½
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	103	107	103	107	3 15 8	...	105½	...
171,504	1	0/8⅓	Oriental	1 1/16	1 1/16	1 1/16	1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	4⅜	5	4⅜	5	7 0 0	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	5 0 0	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 8	June and December	...	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅝	¾	⅝	¾	5 14 3	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅜	½	⅜	½	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅝	⅝	⅝	⅝	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	8	9	7⅞	8½	5 17 8	July and February	...	...
70,000	5	3/0	Do. 6 per Cent. Preference	5½	5⅝	5½	5⅝	5 4 0	January and July	...	...
£250,000	Stock	50/3	Do. 4½% 1st Mort. Deb. Red.	101	104	101	104	4 6 6	...	103⅝	...
150,000	5	3/0	British Westinghouse 6% Preference	5⅝	6	5⅝	6	5 0 0	...	6 1/16	...
105,731	2	...	Brush Electrical Engineering	1⅜	1½	1⅜	1⅝	...	March	...	...
150,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	1⅝	2⅛	1⅝	2⅛	...	March and September	1⅞	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	101	104	4 6 7	March and September	10	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	95	100	95	100	4 10 0	January and July	95	...
80,000	5	5/0	Callender's Cable Construction Ord.	17	18	17	18	4 3 4	" "	17 1/8	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅜	6	5⅜	6	4 3 4	" "	6	5⅞
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111	115	111	115	3 18 4	November and May	...	...
450,000	1	0 9⅜	Castner-Kellner Alkali Co. (fully paid)	⅞	1⅛	1	1⅛	4 16 0	...	1⅛	1 1/16
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	90	95	90	95	4 16 0	...	93⅛	93
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	8 0 0	March	...	...
85,000	3	1/9⅜	Crompton and Co. (Nos. 1 to 54,000)	3	3⅛	3	3⅛	6 8 6	January and July	3⅛	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103⅝	108⅝	103⅞	108⅞	4 12 8	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜	⅝	⅜	⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	2	3	2	3	...	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	75	80	75	80	5 1 3	June and December	...	...
25,500	5	2/6	Edmundson's Electricity Corporation Ord.	6¼	6⅞	6¼	6⅞	5 3 3	Half-yearly	...	...
30,000	5	3/0	Do. 6% Cumulative Preference	5⅞	6⅛	5⅞	6⅛	4 16 0	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	108	111	4 2 0	...	...	...
112,100	2	1/2½	Electric Construction Co.	1¼	1⅜	1¼	1⅜	6 17 2	January and July	...	...
31,390	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅜	3	2⅜	3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97	101	97	101	3 19 3	January and July	...	...
122,785	1	...	Electro-lytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent Cumulative Preference	¾	1⅛	¾	1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	9⅜	10⅜	10	10⅛	4 15 3	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	93	101	93	101	3 19 3	...	...	...
35,000	5	10 0	Henley's Telegraph Works Ordinary	17	18	17⅛	17⅜	4 5 9	February and August	17⅛	16 3/16
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	6	5⅛	6	3 15 0	" "	6⅛	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	115	111	115	3 18 3	" "	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	21⅜	21⅜
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 5	March and September	101⅛	100⅛
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34	37	34	37	6 9 8	March and July	35½	35
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	106	3 15 5	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	10	11	9⅛	10⅛	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	6	5⅛	6	4 3 4	...	...	...
66,666	5	5/0	Willans and Robinson Ordinary		...		...	...	April and October	...	...
66,666	5	3/0	Do. 6 per Cent. Cumulative Pref.		...		...	...	" "	...	...
£40,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures.		...		...	...	May and November	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3 0	Electric and General Investment 6% Cum. Pref.	5⅛	5⅜	5⅛	5⅜	5 9 1	...	...	...
180,227	10	2/6	Globe Telegraph and Trust	8	9	8	9	5 16 8	Jan., Apr., July, Oct.	8 13/16	8⅝
180,042	10	3/0	Do. 6 per Cent. Preference	12½	13⅛	12½	13⅛	4 8 11	" "	13⅛	13 1/16
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
8,303	£100 Cert.	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

WE have received from a Member of the Institution of Electrical Engineers a copy of a circular which has been issued recently by the Secretary. After careful consideration, the Council have come to the conclusion that, in the interests of the Building Fund, as well as for other reasons, it is necessary that there should be an all-round increase in the subscriptions, except, we notice, for the student class. This opinion, we feel sure, will meet with the unqualified support of every member, associate-member and associate who has the welfare of the Institution at heart. Confronted by the statement "as to existing income and expenditure," with which Mr. MCMILLAN supplements his letter, no member could arrive at an opposite conclusion. The matter should be carried forward immediately with the hearty co-operation of every class of member.

ON the present arrangement, the lowest estimate of the cost of conducting the affairs of the Institution shows an average expenditure of nearly 30s. per member per annum, including students. Yet quite apart from the student class, there are no less than 940 members whose annual subscription does not exceed one guinea. The deficit from these has to be borne by the higher classes, or by members who have joined since the fees were raised. It will scarcely be credited, for example, that no less than 120 full members date their connection with the Institution so far back that, while the newer life pays £3.3s., these of the old stock only pay their comfortable £1 per annum. These things ought not so to be.

THE report of the directors of the British Electric Traction Co. indicates that important changes in the financial equilibrium of this leading traction concern have taken place recently. Perhaps the most notable among these changes has been the absorption of the Electrical Power Distribution Co., for the purpose of which absorption the nominal capital of the purchasing company has been increased by the creation of 100,000 ordinary shares of £10, and an equal number of preference shares also of £10 each. A curious feature of the share creation is that the directors have refrained from issuing any of the ordinary shares for public subscription on the ground that the present market value of this description of share—viz., £14—is below their real value. With reference to the above-noticed absorption of a friendly company, our readers will probably be able to judge therefrom, in conjunction with the combine with the Brush Company some time ago the trend of the general policy of the ever-active and alert British Electric Traction Co. In such hands the prospects of electric traction in the United Kingdom ought to be well assured.

IT is satisfactory to note the substantial drop in our export of British coal, and we shall be glad to find that the restrictions placed upon such exports are gradually telling. The drop in general exports may be a bad sign, especially where it occurs in machinery and other finished goods; but on no system of sound political economy can the exporting to rival industrial nations of coal—the national capital of the future—be justified. Prof. PERRY may be alarmed about the rate we are using up coal, and Lord KELVIN may be concerned lest there remain not enough oxygen to burn it with; but the practical way of conserving our national coal resources is not to allow, at any price, this fuel to go abroad for foreign commerce.

ONE of the rare cases in which the Board of Trade has granted an Electric Lighting Provisional Order to a company, notwithstanding the opposition of the local authority, has occurred at Pokesdown, a suburb of Bournemouth. Until recently this small district had its own Urban District Council, and refused its consent to all applications of the Bournemouth and Poole Electricity Supply Co. for a Provisional Order. The Company were anxious to obtain this Provisional Order, not so much for the value of the electric lighting which might be developed in Pokesdown itself, but

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chiefly owing to the fact of Pokesdown lying in the direct route for mains between the Company's station outside the western boundary of Bournemouth and the eastern part of their area (including the Borough and Rural District of Christchurch). This is the third application which the Company has made to the Board of Trade for the Pokesdown Provisional Order. In 1899 the application was refused because Pokesdown, while refusing its consent on account of the term of purchase, represented that it was considering the question of applying for a Provisional Order itself. In 1901 the Board of Trade again refused the Company's application because the question of including Pokesdown in the Borough of Bournemouth was under consideration, and now that Pokesdown has become absorbed into Bournemouth the Company is again asking for this Provisional Order. The Bournemouth Corporation is the objector this time, and wants Pokesdown for itself, possibly because it already has powers to supply public lighting and traction in Bournemouth, and would like to add to its load. As Pokesdown is surrounded on all sides by the Company's area, the Board of Trade has wisely decided to override the refusal of the Bournemouth Corporation and grant the Order.

It may be mentioned that, according to the Electric Lighting Act of 1888, the procedure is now as follows:—The Board of Trade has published a report on the matter giving its reasons, and this will be placed before Parliament; and, on the Provisional Order coming up for confirmation by Parliament, the local authority will have a *locus standi* to oppose. This privilege has been made use of on previous occasions, although the circumstances then have been different. Thus, in the case of the Freshwater and Totland (Isle of Wight) Provisional Orders, the local authority opposed the granting of the Order to the company unless the purchase period were reduced to 21 years; the Board of Trade granted an ordinary Provisional Order, with the 42-years' purchase clause notwithstanding, but the Committee of the House of Commons, before which the Bill came, altered the purchase period back to 21 years. A similar thing occurred in connection with the Gateshead Provisional Order of 1899. There are two notable cases in which the Board of Trade has granted and Parliament has confirmed company Provisional Orders in spite of the opposition of the local authority. One was the Guildford Order of 1894, when the local authority insisted on a 35-years' purchase clause, and the undertakers offered to accept it, if necessary, as a means of procuring the Corporation's consent, but the Board of Trade granted the full 42 years, notwithstanding the Corporation's objection. The second and more recent case was that of the Charing Cross and Strand Company's City Provisional Order, in connection with which the Corporation of London explained that, although it desired that the Charing Cross Co. should obtain its Order, it was reluctantly compelled to withhold its consent owing to an agreement—which might or might not be legally binding—with the predecessors of the City of London Electric Lighting Co.

Our amiable contemporary, the *Journal of Gas Lighting*, professes surprise at our having contradicted, last week, its sweeping statement that electric power "cannot beat horses on town tramways, from the point of view of remunerative working." It cites the municipal tramways of Liverpool and Birmingham in support of this assertion, and it is good enough to quote figures from *The Electrician* analyses of costs for these two tramway systems. Well and good; but we do not see what this has to do with the general question of electric power not being able to beat horses. Thank goodness electric traction does not depend on what they do down at Liverpool or Birmingham. If our contemporary is unable to find an electric tramway system that does not bear out our contention, let it interview the managing director or the chief engineer of the tramways at, say, Bristol. If this suffices not, we can supply it with a long list of towns where the replacement of horses by electric power has been an unqualified financial success. Let places like Liverpool and Birmingham take care of their own data.

We tender our sincere condolence to the directors of the General Electric Co. (1900) upon the calamity which befel them last Monday, through the destruction by fire of a portion of their premises in Queen Victoria-street, utilised as stores and offices. Lamentable as is the destruction of property by fire, the catastrophe is rendered infinitely more deplorable when there is loss of life; and our sympathy goes out to the staff and workpeople upon the tragic death of no less than ten of their young comrades.

The fire department of the London County Council cannot evade censure, on account of the utter inadequacy of their provision for escape from the upper windows of a building on fire. It is scarcely creditable that no available fire escape could reach within 6ft. of the unfortunate victims pent up on the top floors. Much loftier buildings are commonly reached by movable fire escapes in America, these being built on a more servicable plan than is customary in England, besides having a higher range of action. On the other hand, it is much to be regretted that so lofty and crowded a building—wherein at times highly inflammable materials were stored—was not equipped with fixed and permanent fire escapes.

American Pacific Cable.—The House of Representatives rejected on Wednesday, by 108 votes to 71, the bill for the laying of a Pacific cable by the Government.

Society of Arts.—The annual conversazione will be held on the 24th inst. in the Royal Botanic Society's Gardens Inner Circle, Regent's Park, from 8:30 to 12 p.m.

Royal Society.—The following Paper was down for reading yesterday:—Prof. E. Wilson, on "The Dissipation of Energy by Electric Currents Induced in an Iron Cylinder when Rotated in a Magnetic Field."

Obituary.—We regret to record the death, at Park House, Dumfries, on 9th inst., of Miss Agnes Anderson, sister of the late Sir James Anderson. The funeral takes place to-day, at St. Mary's Church, Dumfries.

Erratum.—In § 13 of Mr. Searle's article on "The Ballistic Measurement of Hysteresis" (*The Electrician*, p. 219, May 30, 1902) *for* "where n ranges from 1 to infinity" *read* "where n ranges from 0 to infinity."

Dutch-German Cable Enterprise.—The Second Chamber of the Dutch States-General have, it is announced, adopted the Convention between Holland and Germany for the establishment of a submarine cable service to the Dutch Indies.

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The German Electro-Chemical Society.—The title of the German Electro-Chemical Society has been changed to the German Bunsen Society of Applied Physical Chemistry (Deutsche Bunsen Gesellschaft für Angewandte Physikalische Chemie).

Deputation to the Board of Trade.—The secretary of the Institution of Electrical Engineers informs us that the deputation to the Board of Trade on the question of electrical legislation, which has already been twice postponed, will be received by Mr. Balfour on Wednesday next, the 18th inst., at 12 noon.

Manchester Section of the Institution of Electrical Engineers.—From the report of the committee of this section we learn that 12 ordinary meetings have been held during the session and that there was an average attendance of over 100 members and friends. The meetings of this section are now held in the new physical laboratory at Owens College.

Personal.—Mr. Arnold G. Hansard, who for many years has held various responsible posts with the Brush Electrical Engineering Co., including the direction of all their electrical designing (in succession to Mr. W. M. Mordey), and afterwards the direction of their traction contracts, has now left their service, and will in future engage in consulting work at 92, Victoria-street, Westminster.

South African Telegraphs.—The Eastern Telegraph Co. notified on 6th inst. that the shore end of the interrupted cable at Cape Town was temporarily restored on May 31st, since which date there had been no delay to Cape Town. The company were informed on June 5th that the land lines in Cape Colony had been restored to thorough working order, and as the cable-repairing steamer had then arrived at Cape Town the temporary repairs of the shore end of the cables were being made permanent.

Benevolent Fund of the Institution of Electrical Engineers.—Notice is given that an extraordinary general meeting of the contributors to the benevolent fund will be held at the offices of the Institution, 28, Victoria-street, Westminster, on Monday next, June 16th, at 5 p.m., for the purpose of confirming the resolution passed at the extraordinary general meeting of the contributors held on May 9th to alter, amend, and revoke the rules of the benevolent fund in the manner set forth in the notice convening the last-mentioned meeting.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Bolama	April 19, 1902 ...	—
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Puerto Plata—Fort de France	May 31, 1902 ...	—
Hong Kong—Manila	June 3, 1902 ...	June 10, 1902

Artificial Nitrogen Compounds.—The production of these compounds will shortly be carried out by electro-chemical means at Niagara Falls, where the Atmospheric Product Co. will erect a factory. An experimental plant has been in operation there for some time, and Lord Kelvin on his recent visit expressed great interest in it. Nitric oxide is formed by the process from the nitrogen and oxygen of the atmosphere, high potential electric sparks being employed for the purpose. Nitric acid or nitrates are obtained from this gas, by direct reaction on water or other substances.

The Edison Storage Battery.—According to information given to the New York correspondents of our daily contemporaries, Mr. Edison has considerably improved his storage battery. It is stated that, on a recent trial, an automobile, fitted with Edison cells and carrying two persons, ran 60 miles over rough roads with gradients of from 2 to 12 per cent. The same car, run until the cells were exhausted, covered 85 miles. At the completion of some long-distance trials it is announced that the manufacture of cells for automobile purposes will be commenced.

Wireless Telegraph Patents.—The German newspapers state that the application of the Allgemeine Elektricitäts Gesellschaft that the Braun wireless telegraph patent should be declared void has been refused with costs by the German Patent Office. This decision may be appealed against. It will be remembered that Messrs. Siemens and Halske are the owners of Prof. Braun's patent, and it has been contended that both the Slaby-Arco system of the Allgemeine Elektricitäts Gesellschaft, and the Marconi system as now employed, utilise methods disclosed in the Braun specification.

Electric Railway Accident.—The Metropolitan Elevated Railway of Chicago crosses the Chicago river by a bascule bridge, and on May 15th a train started to run on the bridge when it was being raised to allow a steamer to pass. The motorman evidently overran the signals, and could not stop his train until the first car had run partly on the rising leaf of the bridge. The car was derailed, and its rear truck jammed in the opening at the heel of the bridge, but no one was injured. The railway employs an automatic stop at some of its junctions for applying brakes to a train overrunning the "stop" signal, but at this particular bridge the appliance is not used.

American Association for the Advancement of Science.—The fifty-first annual meeting of this association will be held at Pittsburg, Pa., from June 28th to July 3rd, when the headquarters will be the Hotel Schenley, Pittsburg. In addition to the meetings of the society, there will be numerous excursions to the outlying country and also to works of interest in the neighbourhood, notably the Carnegie Steel Works, Westinghouse Electric, Machine and Air Brake Co.'s Works, Union Switch and Signal Co.'s Works, and the factory of the Nernst Lamp Co. These are of special interest to engineers, but the other sections of the association will find themselves equally well catered for.

Association of Technical Institutions.—The following resolutions in regard to the new regulations recently issued by the Board of Education have been unanimously adopted:—

(*a*) That this association welcomes the simplification in the regulations as to grants for day and evening schools which the Board of Education has made in the rules it has issued for the session 1902-3; and that it desires to tender its cordial thanks to the Board for these concessions.

(*b*) That this association notes with regret that the Board has not, as yet, promulgated any scheme of block grants applicable to the adult day classes in technical institutions; it respectfully urges the Board to give this matter its early and favourable consideration, and it desires to point out that the only grants at present available for aiding this—the most important—form of technical education, are the comparatively meagre ones mentioned in sec. X of the Board's regulations for secondary schools.

Carriages and the Telephone.—We quote the following from *The Times* of Friday last, in order to show how, by the use of the telephone, order can be made to replace chaos wherever a large number of private carriages have to be handled promptly:

Those guests attending their Majesties' Court who enter and leave the Palace by the grand hall are particularly requested to provide their servants with a card on which their names are distinctly written, so that the advantages of the telephonic arrangements for calling carriages on departure from the Palace may be fully obtained. The Lord Steward desires to impress upon all those attending the Court the absolute necessity of a footman being with every carriage. The footman, as soon as possible after the carriage has set down, should return to the Palace and wait at the place assigned, and pay particular attention to the telephone calls, so that on the name being given he may be able at once to proceed to find and bring up his carriage.

Multiplexing the Telegraphone.—Herr P. O. Pedersen, of Copenhagen, has recently been granted a patent for using the Poulsen telegraphone in such a way that a number of messages can be recorded on a single steel strip, and reproduced without interfering with one another. Two or more recording magnets are employed, and their connections are varied for each message with a corresponding variation in the combined action of the magnets on the recording strip. The combinations are affected by means of plugs, and it is possible to reverse the polarity of certain magnets in respect to their neighbours so that the original message will not be reproduced, as the magnetic condition of that portion of the strip will oppose that of the magnets themselves, and no current will be generated and consequently silence will result. It is unnecessary to use separate strips for each magnet, as a single strip will answer the purpose, it being only needed to arrange the magnets so that they act on different parts of the strip.

A New Form of Secondary Cell Electrode.—The *Centralblatt für Accumulatoren-und Elementenkunde* of June 1st gives some details of a new electrode, the invention of K. v. Stechow, of Berlin. It consists of a frame, within which strips of lead

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wound in spiral form are fixed, one end of these strips being free in order to allow for contraction and expansion. The spirals, after fixing, are subjected to pressure in order to close partially the space between the spiral windings, and to bring their ends within the borders of the frame. A granular mass soluble in water may be utilised with advantage in this operation, in order to prevent the spaces between successive windings of the spiral from being entirely closed up. The electrode, after dissolving out this inert material in water, is ready for the electrolytic bath. When properly constructed this form of electrode possesses great superficial area, with small transverse measurements—an advantage of considerable importance in the accumulator and other industries.

Wire Subways.—The growth of cities in America and the continual expansion of electric lighting and power schemes have necessitated the placing of conducting cables underground, though there are many places in which overhead wires are still permitted. In large cities, however, the simple conduit or armoured cable has been found quite inadequate to meet the continued demands, and steps are being considered for the construction of permanent underground subways. According to the *Electrical Review* of New York, there have been many plans brought forward for the introduction of these tunnels in that city, but they have not developed in any way. Even when the present rapid-transit subway was planned no very adequate provision was made for underground wires and pipes. In Chicago, however, a large subway is being built, with ramifications through the business districts, for the purpose of carrying cables for light and power.

British and American Coal Getting.—An interesting comparison was recently drawn between the methods of obtaining coal in these countries in an issue of the *Engineering Magazine*. The American conditions are favourable to the use of electricity, as the mines are at no great depth, and there is little or no fiery gas, consequently the use of machinery is much more extended. Again, the land above the mines is generally owned by the colliery proprietors, so that if subsidences occur they do not disturb anything on the surface. The number of coal-cutting machines employed is 3,907 for the year 1900. In Great Britain, however, the conditions seem to be reversed, there being deep mines and shafts containing fiery gas, and machinery is very little used, only 311 coal-cutting appliances being employed in the year 1900. The difficulties of haulage are largely increased in deep level mines, and there is much greater fear of employing electrical machinery by reason of the fiery gases. The article concluded with the assumption that the prevailing high prices of freight and railways in this country ultimately will seriously affect the coal trade to the advantage of American export.

Fatal Fire at the General Electric Co.'s Stores.—A fire of comparatively short duration, but attended with disastrous results, occurred in a building partly occupied by the General Electric Co., at 67, Queen Victoria-street, on Monday last, at about five o'clock in the evening. The particular part of the building in which the fire broke out was utilised as offices and stores on the sixth floor, where a large number of girls were employed and to which, unfortunately, the first escape which arrived did not reach. This being so, a number of the female employés jumped into the roadway, where a tarpaulin was held to break the fall, but all of them were more or less injured. So rapidly, however, did the fire spread that by the time a longer escape arrived it was impossible to enter the building, although one fireman bravely rescued two of the girls by being lowered from the roof by means of an electric wire, and being drawn up again by the same means. Eventually, when the fire had been sufficiently overcome to make a search, the bodies of eight girls and two other employés were discovered burnt to death, and in addition to these seven others are in hospital suffering chiefly from injuries received in their leap from the windows. The origin of the fire has not yet been ascertained, and in view of the unfortunate loss of life, said to be mainly due to the inadequacy of the life-saving apparatus at the disposal of the fire brigade, the London County Council is to discuss the matter fully at its next meeting. The inquest was opened yesterday, and, after identification of the bodies, adjourned to the 19th inst. at the Guildhall.

Report of the Board of Trade and Light Railway Commissioners.—This report, which was published last week, shows that during the year ended December 31, 1901, 45 orders were submitted to the Board of Trade by the Light Railway Commissioners for confirmation. The number actually confirmed before the end of the year was 27, as well as an additional 22 remaining over from 1900. Three of the outstanding 18 were rejected, and of the 15 then left, nine have been confirmed this year, the others being still under consideration. The proportion of electrical schemes confirmed is well up to the average. In the matter of loans we again note that financial support has not been given by the Treasury to any electrical scheme. In one case a free grant of £24,350 was made, and in another a similarly free grant of £22,000 is reported, with a loan of £6,000, free of interest in the latter case. Two further free grants of £2,500 and £7,000 had been conditionally agreed upon by the Treasury, the latter in respect of an order not yet confirmed, in addition to a loan of £3,500, without interest, and two others of £7,500 and £11,000 at 3 and 3¼ per cent. respectively, but none of these schemes were electrical. The fifth annual report of the Light Railway Commissioners, which is attached, states that, since the passing of the Light Railway Act in 1896, 379 applications for light railway orders have been received, of which 157 (including amending orders) have been passed and confirmed by the Board of Trade.

Mr. Swinburne on the Electrolysis of Gas Mains.—On Wednesday last Mr. Swinburne delivered a lecture before the Incorporated Gas Institute on the electrolysis of gas and water mains by the stray currents from electrical tramways. He traced the history of the legislation as to tramways and the telephone and gas and water industries. The present position is that tramways may use earthed returns, and are not liable for damages to gas and water companies if their pipes are corroded, provided proper precautions are taken by the tramway undertakers to prevent excessive leakage. The lecturer went on to explain how the stray currents arise, and how they enter and leave the pipes. Electrolytic corrosion only occurs where the electricity leaves the metal and goes into the damp earth. The methods of minimising leakage are: using rails of large cross section, efficient bonding, or electric welding, or cast-iron jointing; return feeders, return feeders with negative "boosters" or "suckers," and "helpers." The method of minimising the effects of stray currents is to connect the pipes by wires to the power-house, or to parts of the rails that are negative to them. One of the chief safeguards is that the tramways must themselves be the chief sufferers by electrolysis, as they have not only their own rails to consider, but they also use lead-covered cables which are very easily attacked, and destruction of these cables would be a very serious matter. The natural earth currents must have effects comparable with those of tramway leakage. Lead and iron service pipes in metallic contact with cast-iron mains are apt to be corroded without any extraneous currents. Finally, the lecturer held that the tramways do damage pipes, but he did not know how far the damage is really serious. Time will alone show whether the pipes will be seriously attacked when tramways are worked with the care usual in this country. If they are really injured, the companies should approach Parliament again later on. Electrolysis is a matter of degree and a matter of time.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, June 13th.

PHYSICAL SOCIETY.

3:30 p.m. Meeting at the National Physical Laboratory, Bushy House, Teddington. Station: Teddington, London and South-Western Railway. The laboratory will be open until 6 p.m. for inspection.

ROYAL INSTITUTION.

9 p.m. Extra Evening Discourse by Mr. G. Marconi. Subject: "The Progress of Electric Space Telegraphy."

TUESDAY, June 17th.

INSTITUTION OF JUNIOR ENGINEERS.

Visit to the Globe Rope Works, East Ferry-road, Millwall, E. Train leaves Fenchurch Street at 5:50 p.m.

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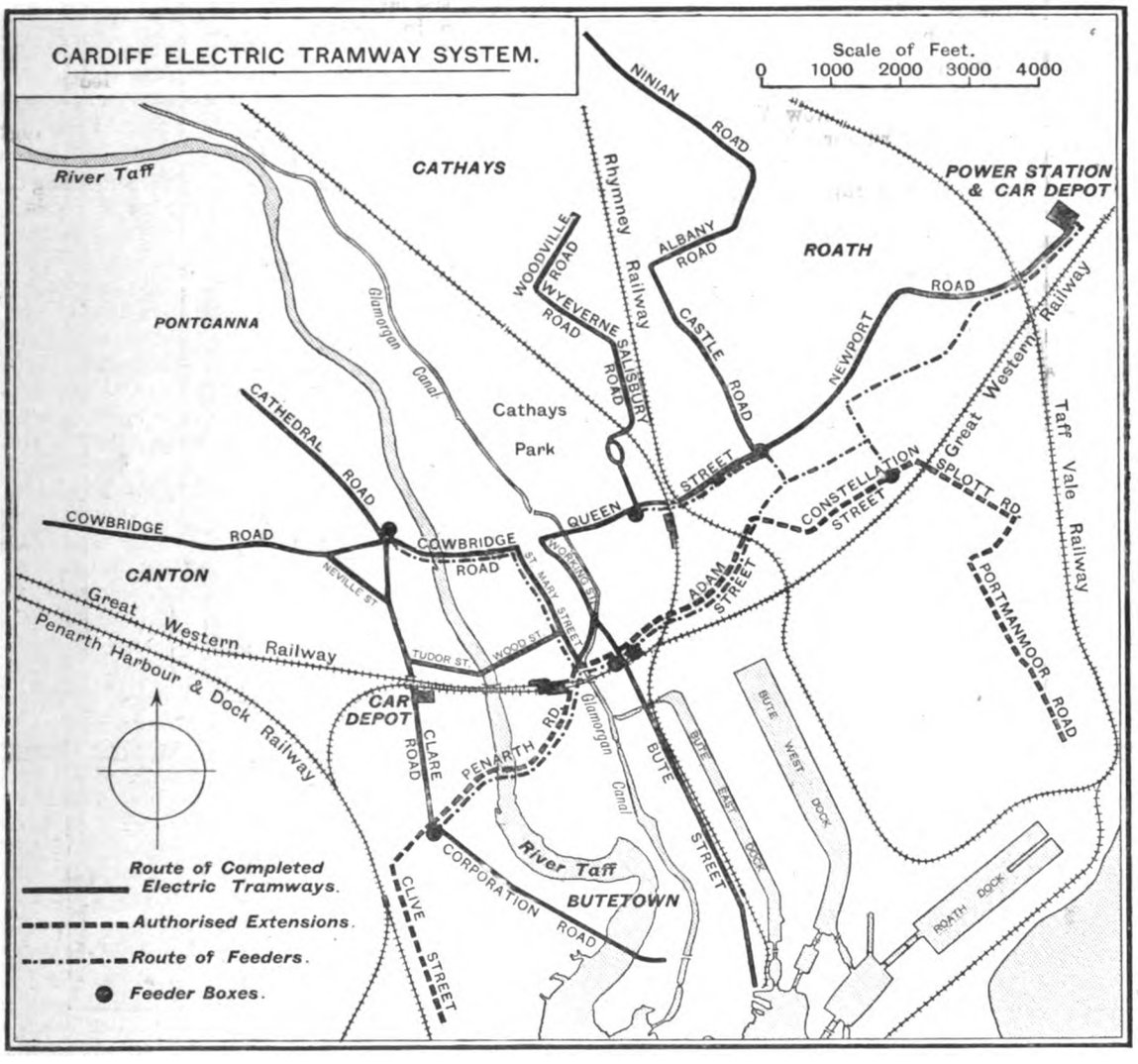
CARDIFF CORPORATION ELECTRIC TRAMWAYS.

Cardiff, the metropolis of the Principality of Wales, had a population at the last census of 164,315. The area of the municipal borough is 8,408 acres, or 13·13 sq. miles. During 1899 the chairman and deputy-chairman of the Tramways committee and the borough engineer, acting on instructions from the Council, visited all the important tramways systems in the kingdom, and presented a lengthy and detailed report thereon, with the result that the Council finally decided to adopt the overhead system of electrical traction. In June, 1900, Mr. Arthur Ellis was appointed electrical engineer to the tramways department, and took up his duties in September of the same year. In the month of December following he was appointed borough electrical engineer and manager of the electric lighting and tramways undertakings of the Corporation.



The power-station building is chiefly of red brick with stone copings. On entering the building a spacious hall and inquiry office is provided, on the right and left of which are the battery-room and stores-room, mess-room, repair shops and smiths' shop, workmen's lavatories, &c. Immediately over these rooms are the offices of the station staff, comprising in all five large rooms, complete with lavatories, &c. A bath-room is also provided for members of the staff. The staff offices are reached by means of a staircase leading from the main entrance hall as well as from the switchboard gallery in the engine-room. The engine-room and boiler-house are situated immediately behind the offices. The engine-room is a fine room, provided with excellent ventilation. It is 104ft. long, 60ft. wide and 56ft. high, and is lined throughout with cream-coloured glazed brick. At intervals along the side walls substantial piers, with semi-circular arches, are provided, upon which the rails for the crane are fixed. On one side of the engine-room is the boiler-house, of the same length as the engine-room, and 56ft. wide and 48ft. high. The walls of the boiler-house fronting the boilers are lined with cream-coloured glazed bricks. Immediately to the side of and adjoining the boiler-house is provided a building running the full length of the boiler-house, into which coal trucks are brought direct from the railway siding coupled up to the Taff Vale Railway. From this building the coal can be tipped either into the bunkers above the boilers or into the coal storage below the level of the siding. At one end of the boiler-house, and approached from the same and immediately beneath the repair shop and smithy, a large pump-room is provided, there being room for 12 feed-pumps of the Weir type. The roofs throughout are supported by mild steel principals and framing of neat design, composed of angles and flat tie-bars.

The buildings have been erected by Messrs. Symons & Co., of Cardiff, at a contract price of £16,100, the steel work being provided by Messrs. A. D. Dawney & Sons, of Cardiff. The chimney stack is situated at the front end of the building, and is 160ft. high. It is built of red brick and is octagonal in shape. The stack was erected by Messrs. Clark & Co., of Cardiff, at a cost of £1,568.

Mr. Ellis, in getting out the arrangement of these buildings, fixed their position in such a way as to leave room on the other side of the engine-room for an exact duplicate of the boiler-house and coal bunkers, so that when completed the engine-

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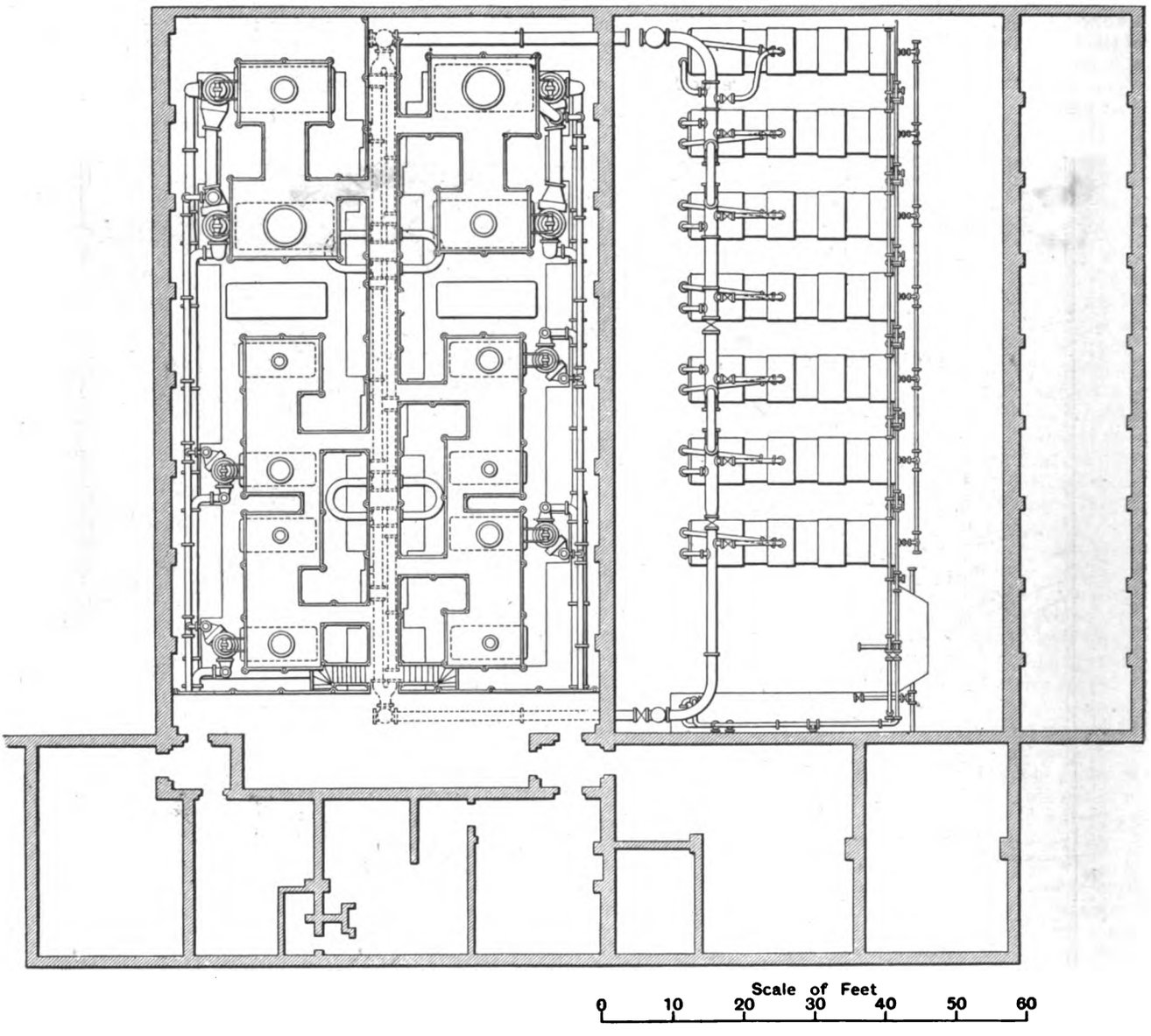
room will be between two boiler-houses. These extensions he anticipates will be required at an early date. The present buildings are all finished off with temporary brick ends. There is sufficient room on the present site to extend the buildings a further 800ft. with two chimney stacks at each end. At the end of the buildings and in front of the offices a large cooling pond is being provided for condensing purposes. The water in the pond is drawn from a fresh water brook running along one side of the main building and dividing the power-station site from that of the main car depôt. Mr. Ellis intends, when necessary, to erect cooling towers over the pond, which has been built with this end in view. The construction of the pond is very substantial, and has been constructed by the public works department under the direction and supervision of the borough engineer, who prepared the detailed drawings of the same to meet the requirements supplied to him by Mr. Ellis.



PLAN OF CARDIFF CORPORATION POWER STATION.

The tramways department are very fortunate in having the power-station on a site provided with a supply of water and a railway siding, and it is hoped that by this means the costs of generation of current will work out at a very low figure.

Plant.—The present power-station buildings will be fully occupied with plant during the present year. At the present time there are in the engine-room four engines, each of 500 H.P., and two more on order of 1,600 H.P. each. The engines have been and are being supplied by Messrs. John Musgrave & Sons. They are all of the inverted vertical cross-compound condensing type, of heavy design, and work under a steam pressure of 140lb. per square inch, at a speed of 100 revs. per min. Each engine is fitted with its own condenser driven by side levers from the crossheads. The air pumps of the smaller sets are 25in. diameter, 12in. stroke steel air pump, bricket rod and deep brickets, having a series of small valves and also delivery grid with valves. The condensers are of the injector type with suitable water regulators. The engines are entirely enclosed, and forced lubrication is used for all parts, the oil pumps being worked by eccentrics. The governors are of the quick-speed type driven by ropes from the crankshaft. Means are also provided so that the speed can be altered up or down by hand whilst the engines are running, the governing variation from no load to full load being 2½ per cent. The flywheels are 16ft. diameter, made in halves, having a weight of 14 tons in the rims alone, the total weight of each wheel being 85 tons. The larger engines have cylinders of 88in. and 58in. diameter respectively, with a stroke of 8ft. 6in. The four 500 H.P. engines cost £14,508, including spare parts and foundation plates, and the two 1,600 H.P. engines on order will cost £14,742. 17s.

The four generators at present installed were supplied by the British Westinghouse Electric and Manufacturing Co. They have each an output of 300kw., and are capable of withstanding overloads of 25 per cent. for two hours and

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50 per cent. for short periods without sparking and without moving the brushes. They are of the multipolar type and are mounted directly on to the shafts of the engines, between the high and low-pressure engines. The generators work as compound machines on tramway loads at a pressure of 500–550 volts, and as shunt machines on lighting loads at a pressure of 460–500 volts. The four generators cost £7,890. The two large generators on order are being supplied by Messrs. Dick, Kerr & Co., and have each a capacity of 900kw. They are being made to meet the same conditions as those already installed, and will be mounted on to the shafts of the engines in a similar manner. These two generators are being supplied at a cost of £5,560. There is also in the engine-room an 80kw. motor-generator, which works in conjunction with a battery of accumulators and serves several purposes, amongst which are the following :—

1. It receives current from the main battery 'bus bars at 500 volts, and gives out current at a pressure of 100—140 volts for charging the battery or supplying the works lighting independently (which can also be supplied direct from the battery when the motor generator is not working).

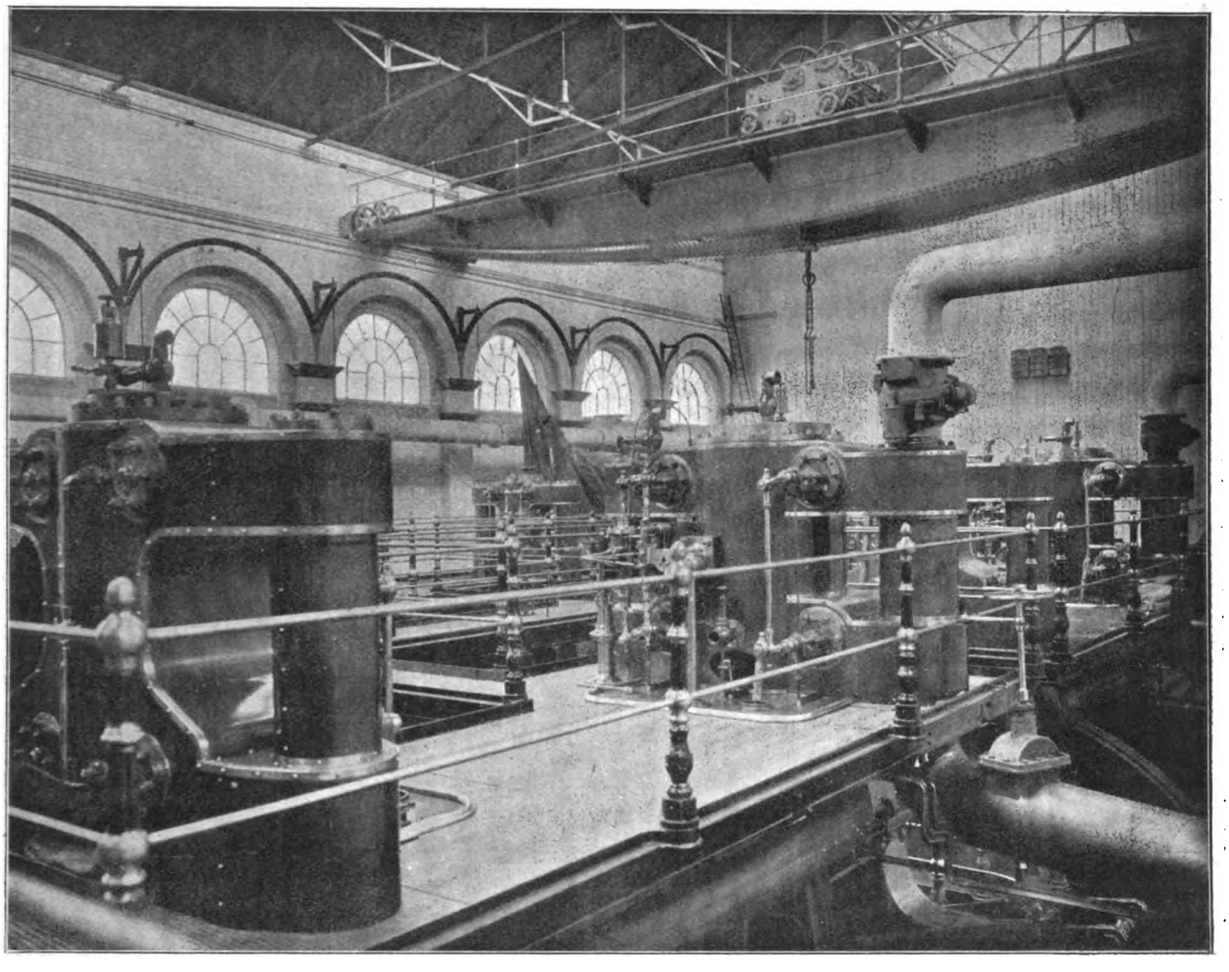
2. It can work in the reverse order and receive current direct from the battery at 100 volts, and give off current at a pressure of 500—550 volts. By this means it is possible to shunt cars, &c., in the depôts when the main plant is shut down, and to work the various motors in the power station in connection with the mechanical stokers, &c., when raising steam in the boilers previous to starting up the plant.

3. It is also used for running any specially early cars, or repair trolleys for night work on the overhead equipment.

The motor-generator was supplied by Messrs. D. Bruce Peebles & Co. It consists of two generators coupled together, with a flywheel between the machines, and mounted direct on to a common bed-plate. The low-tension machine has a double-wound armature, with a commutator at each end. The reason for the double-wound armature on this side of the machine is to get the maximum output out of the machine, and to run the set at constant speed.

A battery of accumulators has been supplied by the Tudor Accumulator Co., and consists of 56 cells with 81 plates in each. The cells themselves consist of lead-lined wooden boxes, supported on oil insulators. The capacity of the battery is: 2,100 ampere-hours when discharged at 210 amperes, 1,800 at 360, 1,620 at 540. The normal rate of charge is 300 amperes, and the maximum rate of charge 375 amperes. The duties of the battery, as previously mentioned, are the direct lighting of the power-station and car depôt and the supply of current to the motor generator.

In the engine-room there is a hand-driven 20-ton travelling crane, which can operate the whole length of the buildings. It is intended to eventually equip the crane electrically, and thus save time and labour. This crane was supplied by Messrs. Joseph Booth Bros.



View of Engines from Cylinder Level.

The main switchboard is built direct into the wall at one end of the engine-room, and stands back in a recess, taking up 42ft. of the total width of the room. Immediately in front of the board there is a clear space 10ft. in width. The gallery is carried through into the boiler-house and to the coal bunkers beyond, so that the engineer-in-charge can control the whole station with the smallest amount of trouble. The switchboard is of the standard Ferranti pattern, and consists of 10 feeder panels, each of 600 amperes capacity; 2 return feeder panels, each of 1,500 amperes capacity; 1 positive booster panel; 1 negative booster; 8 panels for motor generator and battery; 1 Board of Trade panel; 4 300kw. generator panels; 2 900kw. generator panels; 4 panels for controlling supply of current for private and public lighting and power purposes, each of these panels having a capacity of 1,000 amperes.

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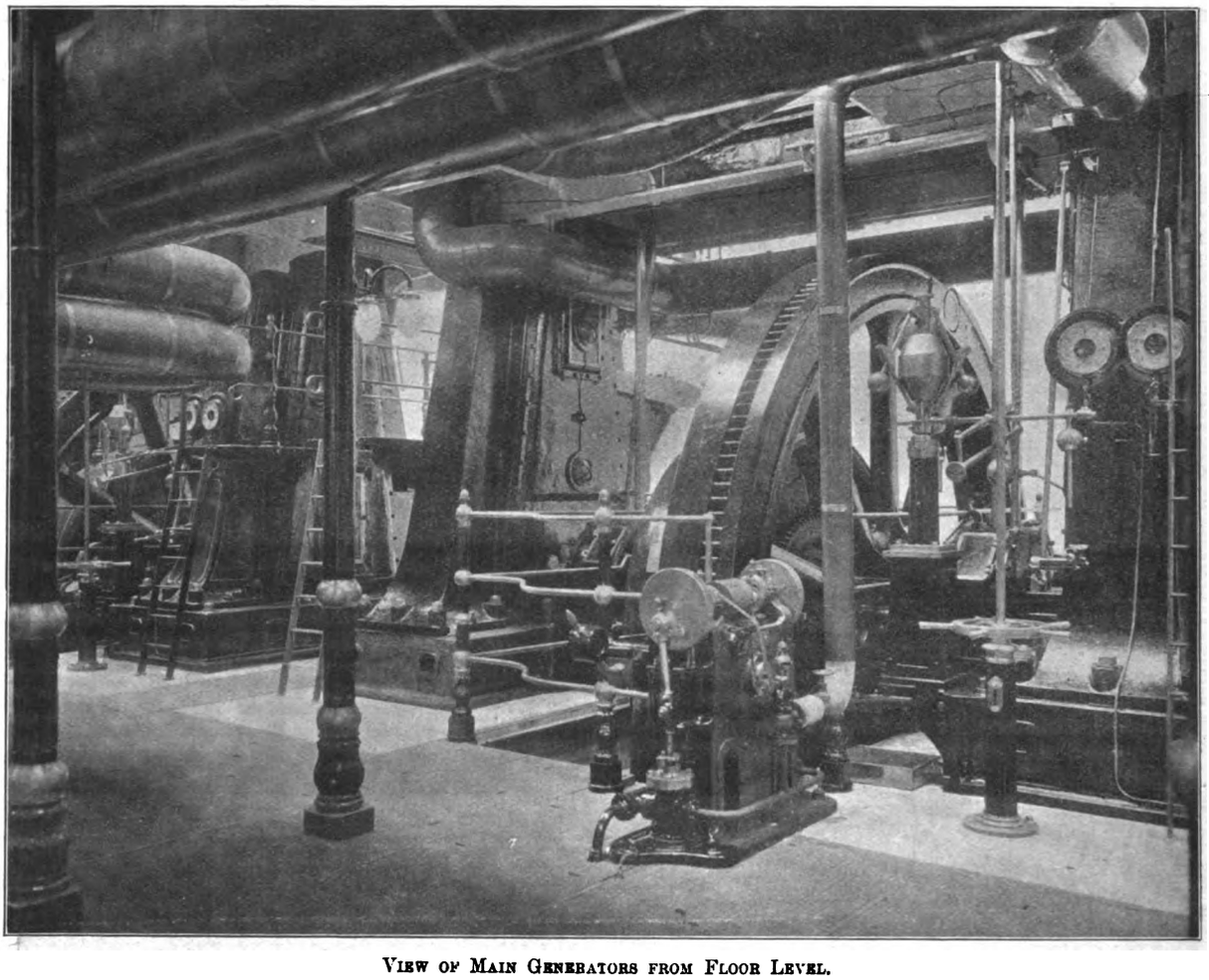
On the front of the board there is a table standing out from the board 2ft. 6in., upon which the field regulating and motor-starting switches are placed, the resistances being below the board. There are also four panels on the front of the table for controlling the works motors, battery and regulating cells, &c. There are two independent sets of main 'bus bars for controlling the traction and lighting loads. Each of the 'bus bars has a section of 6 sq. in. All the switches are designed for a current density of 60 amperes per square inch of contact area. Each panel is fitted with an automatic circuit breaker of the Ferranti pattern, and the various instruments are of the edgewise pattern. The recording instruments were supplied by Messrs. Elliott Bros. There are three Weston type illuminated dial voltmeters at each end of the board for lighting and traction purposes. There is also an independent switchboard for controlling the works lighting.



View of Main Generators from Floor Level.

In the boiler-house there are at present fixed four Lancashire boilers, 30ft. by 8ft., with provision for three more of similar size, which are now being delivered. These were supplied by Messrs. John Musgrave & Sons, and are made for a daily working pressure of 150lb. per square inch. Each boiler has two flues, with five cross tubes in each. The boiler fittings were supplied by Messrs. Hopkinsons, and are of their latest type. At the rear end of each boiler there is a superheater of the Musgrave type, so arranged that they can be easily moved for inspection, the steam in the meantime going direct to the main steam range. At one end of the boiler-house there is a Green's economiser, consisting of 288 pipes, built into a bye-pass from the main flue. The scrapers are driven electrically. The mechanical stokers, metal coal bunkers, ash conveyer and elevator are supplied by Messrs. T. and T. Vicars. The stokers are of the coking type, and hoppers are taken to each from the coal bunkers above. The ash conveyer is of the worm type, working in a trench in front of the boilers, and independent of the blow-off trench. There are at present two feed pumps fixed in the pump-room, and a third one on order. These were supplied by Messrs. G. and J. Weir, of Glasgow, and are of their vertical direct-acting type, capable of delivering each 6,000 gallons of water per hour against a pressure of 160lb. per square inch. The steam, exhaust, injection, and overflow pipes, and also the auxiliary and feed pipes, were supplied by the Sir Hiram Maxim Electrical and Engineering Co., who have also on order the pipe extensions for the two large engines and three boilers. This firm also supplied the central gangway and switchboard gallery in the engine-house. The steam pipes are made of the best wrought steel and other pipes of cast iron. The main steam pipes in the boiler-house are 18in. and 14in. diameter, and are coupled to each boiler by means of a 7in. branch, from which there is also a 7in. bye-pass to the superheaters. The main pipes are coupled up to suitable water separators at each end of the boiler-house. There is a large expansion bend in the centre of the range. The main range in the engine-room consists of two 14in. pipes supported by the central gangway. This range is coupled up through separators at either end to the boiler-house range by 14in. pipes. The separators are drained through Geipel steam traps, and delivered into the main drain pipe which runs back to the cooling pond. A duplicate system of 4in. auxiliary steam pipes is provided for the pumps, with separators and drains.

Adjoining the power-station and on a site of 2 acres, which is divided from the power-station by the Roath Brook, the main car depôt is at present being erected. This, when completed, will accommodate 100 cars. The main portion of the depôt consists of four bays, each 320ft. long, with three tracks in each, the total width being 136ft. At the side of the shed there are offices. At one end of the shed there will be an electrically-driven traverser operating the full width of

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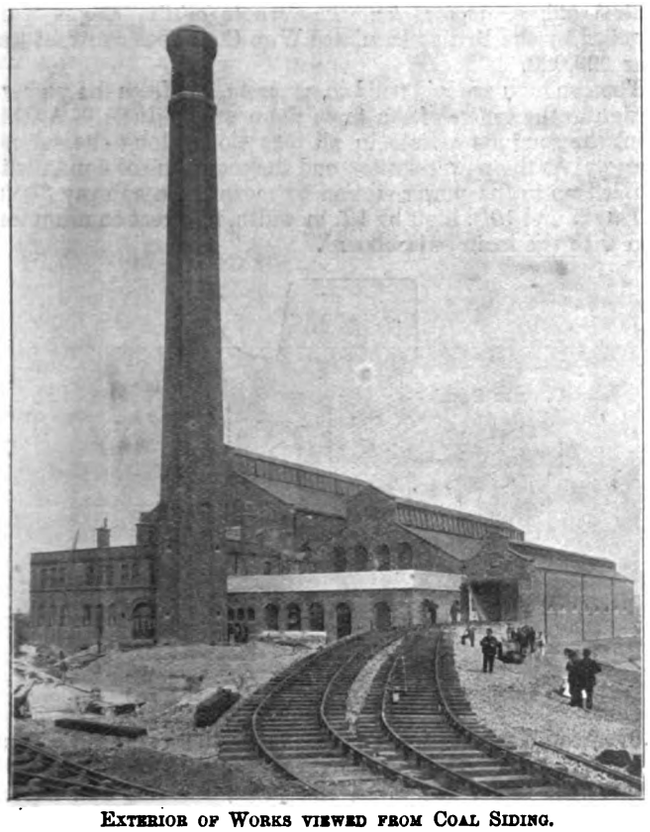
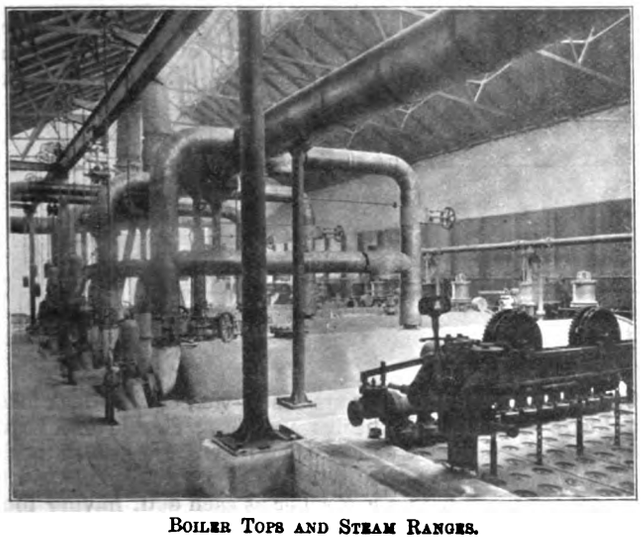
the shed for transferring cars either from one track to another or into the repair shops beyond. The traverser pit is 25ft. wide. The repair shops consist of a machine shop 120ft. by 66ft., painting shop 90ft. by 38ft., smithy 29ft. by 25ft. and carpenter's shop 29ft. by 25ft., together with mess-room for the men, oil stores, sand stores, &c. The foreman in charge of this part of the shed has an office between the paint shop



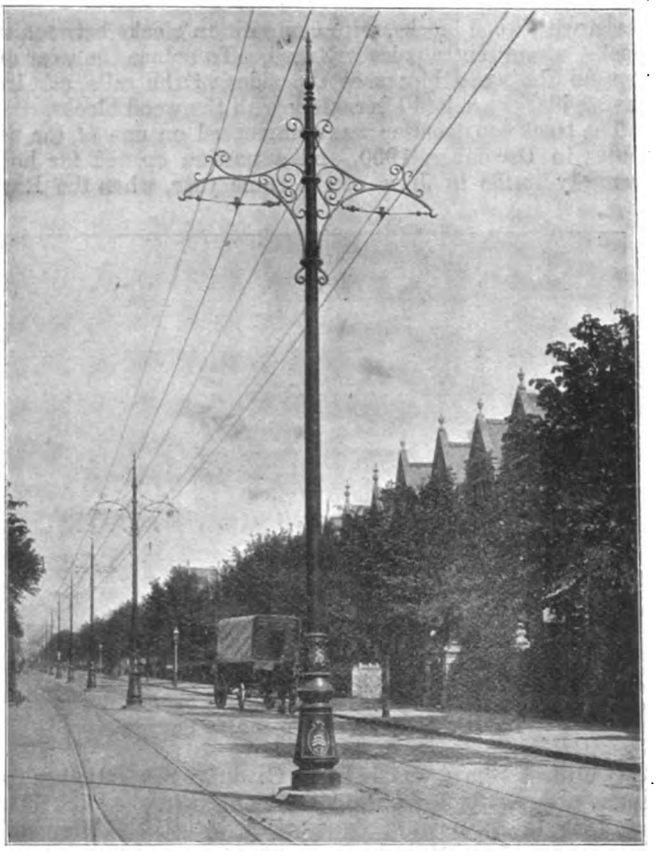
EXTERIOR OF WORKS VIEWED FROM COAL SIDING.

and the machine shop with glass windows on all four sides, so that he has a complete view of the whole building from his office. The contractors for this building are Messrs. D. W. Davies, whose tender for the work was £21,988. This firm also built the car depôt at present in use at the opposite end of the town, the second shed accommodating 32 cars.



BOILER TOPS AND STEAM RANGES.

Permanent Way.—Cardiff is an ideal town for tramways, being practically flat; there are only four gradients on the whole system, the worst of which is only 1 in 20. On the other hand, the tramways are handicapped to some extent by very low railway bridges, necessitating the reduction of headroom inside the cars, and on two routes the use of single-deck cars. Fortunately, on the main route to the docks, where most of the cars run to, it has been possible to lower the roadway 15in., giving sufficient headroom under the bridge on this route for the use of double-deck cars. The sharpest curve on the system is 40ft. radius.



CENTRE-POLE CONSTRUCTION.

Girder rails have been used, having a weight of 100lb. per yard. The rails are 6½in. in depth and a 7in. flange, the groove of the rails being 1½in. wide by 1¼in. deep. The rails are laid on a concrete bed 11in. deep, are 18in. wide, the depth of the concrete under the other portions of the track being 8in. The rail joints are made by fishplates weighing

MAIN SWITCHBOARDS.

64lb. per pair, with six 1in. bolts and patent lock nuts. The joints are further secured by sole plates 2ft. by 11in. and ½in. thick, secured by four single and two double clips by ⅝in. bolts and nuts. The tie-bars used were specially designed by Mr. Harpur, the borough engineer. The rails being 6½in. deep, and the paving blocks only 4in., enables the rails to be

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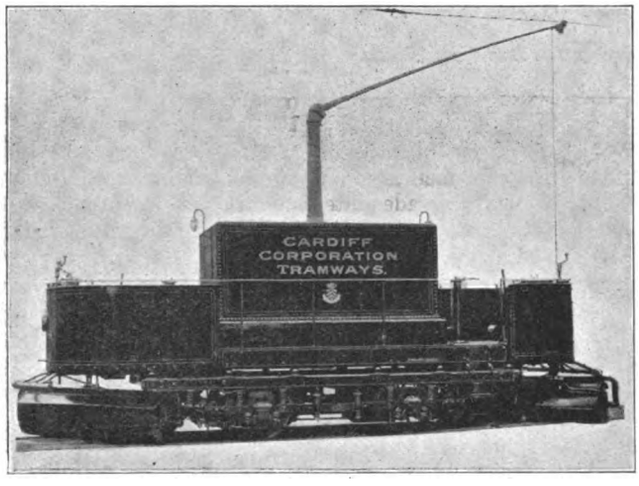
buried in concrete to a depth of 2¼in. The length of the rails is 45ft. The first lot of rails were supplied by Messrs. Dick, Kerr & Co., and the second by Messrs. Bolckow, Vaughan & Co. The points and crossings, drain rails and joint plates, have been supplied by Messrs. Askham Bros. and Wilson and by Messrs. Hadfield. The track is almost entirely paved with wood blocks, with composition blocks between the tracks, where centre poles are used. To reduce the wear and tear on the wood blocks at the sides of the rails, cast-iron paving blocks are laid alternately with the wood blocks.

The track construction was commenced on one of the new routes in December, 1900, and a portion opened for horse tramway traffic in June of the same year, when the Royal



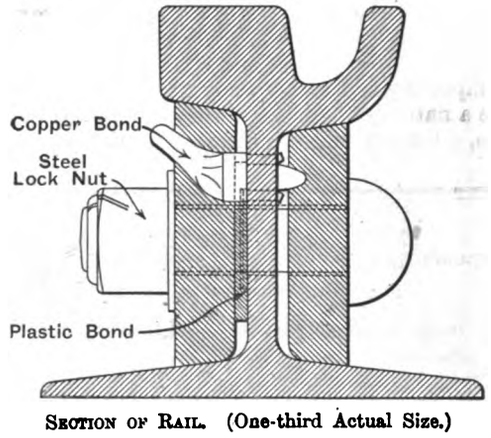
Trolley Water-cart and Street Sweeper.

Agricultural Show was held in Cardiff. Several other new routes were completed during the same year, the work being done for the tramways department by the public works department of the Corporation.

On December 12, 1901, after long and wearying negotiations with the Cardiff Tramways Co., terms were arranged whereby the company agreed to hand over their lines to the Corporation on December 31, 1901, the sum paid for the lines being £50,000. The Corporation also took over 52 cars and 342 horses, for which they paid £15,642. There still remains to be paid to the company the sum to be agreed upon for the purpose of three depôts.

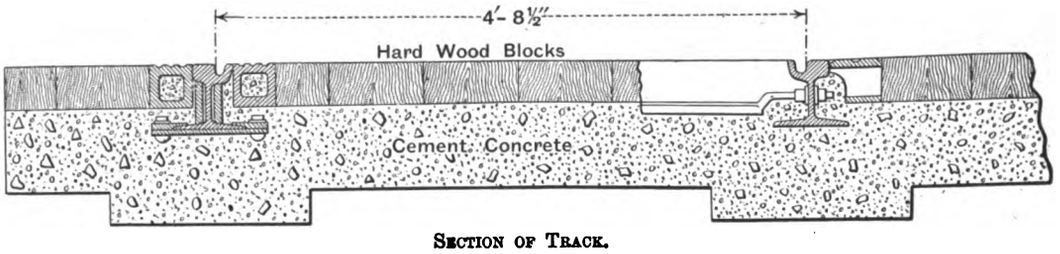
Cables.—The cables are single conductor plain lead-covered, drawn into Doulton's earthenware conduits. There are seven main feeding points on the system, the feeders varying in section from 0·6 sq. in. to 0·4 sq. in., there being five 0·6 sq. in., one 0·5 sq. in. and one 0·4 sq. in. feeders. These feeders run direct from the power-station to feeder pillars, and are not tapped between these points. The feeder pillars are of special design by Mr. Ellis, and contain one main feeder switch of 600 amperes capacity and four switches of 300 amperes each, a lightning arrester being provided in each pillar. From these pillars cables are taken to the section pillars from which each route is fed. The section pillars contain two main switches, for cutting the distributors into sections, and four line switches. There are two return points on the system from which insulated cables are taken back to the power-station, and from one of these three 0·8 sq. in. cables are taken and from the other two 0·6 sq. in. cables. These cables are coupled to the rails by means of special clamps and copper bonds. The distributors running along the several routes vary in size from 0·4 sq. in. down to 0·15 sq. in. Test cables, consisting of three-core cables, are taken to the various points of the system, one conductor being used for testing purposes and the other two for telephones. Special telephone pillars are fixed every half mile along each route and at different points in the centre of the town, and are in communication with the power-station, central offices, depôts, &c. The whole of the cables were supplied by the British Insulated Wire Co. whose contract was over £28,000.

The conduits are laid solid in concrete, and from the power-station to the centre of the town there are 30 ducts. At this point the conduits radiate in all directions along the several routes. At the power-station end the main line of conduits is coupled up to the power-station by means of a subway 300ft. in length and 10ft. high by 4ft. in width, in direct communication with the main switchboard.



Section of Rail. (One-third Actual Size.)

Overhead Equipment.—The whole of the overhead equipment has been carried out by the men of the tramways department under Mr. Ellis, the poles, brackets and bases, &c., being also designed by him. The equipment is solid and substantial, flexible suspension being used throughout. Centre poles are used chiefly, although side poles and brackets, arms and span-wire construction are used on some of the routes where the streets are narrow and not sufficiently wide for centre poles, although double track is laid. Specially heavy materials have been used, including 3/0 trolley wire supplied by Messrs. Back and Manson, the agents for Roebling & Sons. The hangers are made of best gunmetal, with ¾in. insulated bolts. None of the ears are less than 18in. long, and were specially designed to give strength. The ears vary in length up to 36in. The insulation is of Actna type, the line materials being supplied by Messrs. R. W. Blackwell & Co.



Section of Track.

Cars.—Three types of cars are used—viz., double-deck four-wheel cars with a fixed wheelbase of 6ft.; double-deck bogie cars, with maximum traction trucks and single-deck bogie cars with maximum traction trucks, the wheelbases being 4ft. The cars are fitted with a controller at each end, having four series notches and three parallel, also four notches for the electric brake. The electric braking is effected by connecting the motors, as series generators in parallel and in series with the same resistance as used ordinarily. Each car is fitted with an automatic circuit breaker, main motor switch and main fuse with magnetic blow out, lightning arrester and kicking coil. The trolley standards are of the enclosed spring type, a single spring under compression being used. The trolley standard is in one piece, made of malleable iron. A

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super-elevation stop is provided to limit the vertical motion of the trolley pole. Mr. Wood's trolley heads, made by the General Electric Co. are used.

The four-wheel trucks are the Brill No. 21 E type with 30in. wheels. The spring base measures 14ft. 6in. and the extreme length of top plate 15ft. 7in. The maximum traction trucks were supplied by Messrs. J. G. Brill & Co., and the wheel base is 4ft. and the driving wheels, 30in. with 20in. pony wheels, and with steel tyres and wrought-iron centres.

Each car is fitted with two series wound motors, each capable of a draw bay pull of 1,400lb., and, at this load, of propelling the car at a speed of 8 miles an hour at a pressure of 500 volts.

The cars have been supplied complete with equipments, &c., by Messrs. Dick, Kerr & Co. It is expected before the system is complete that there will be at least 150 cars required.

The general arrangement and plant, &c., at the power-station, together with the cables, overhead equipment and cars have all been carried out in accordance with the plans and specifications prepared by the borough electrical engineer and manager, Mr. Arthur Ellis, M.I.M.E., M.I.E.E., who, from the commencement has been very ably assisted by his chief assistant, Mr. C. E. Davies. It is expected that the system when complete will cost over half a million of money. The tramways were officially opened on May 1st, and since that time have been running smoothly and no accidents of any consequence have taken place. Since the opening the traffic on the electric cars has been enormous, and they have already become very popular in the district, the public realising the greater facilities offered to them for getting about.

In conclusion, we desire to express our thanks to Mr. Ellis for great assistance rendered by him in the preparation of this article.

CAMPS BAY, CAPE TOWN AND SEA POINT TRAMWAYS.

The Camps Bay and Cape Town tramways, as they exist to-day, are a natural extension of the previously existing Cape Town line, although the Camps Bay section is owned by a separate financial organisation. The construction of this tramway would have presented numerous difficulties under ordinary circumstances, but these were considerably enhanced during the progress of the Boer war. Not only did this prevent easy shipping facilities, but serious trouble arose from the difficulty of obtaining adequate labour; yet, in spite of these drawbacks, the tramway system, comprising 9 miles of difficult track work, has been completed without serious delay. The construction of the line has been carried out under special Act of Parliament, and a clear idea of the system will be obtained from the map in Fig. 1. Commencing at the Round

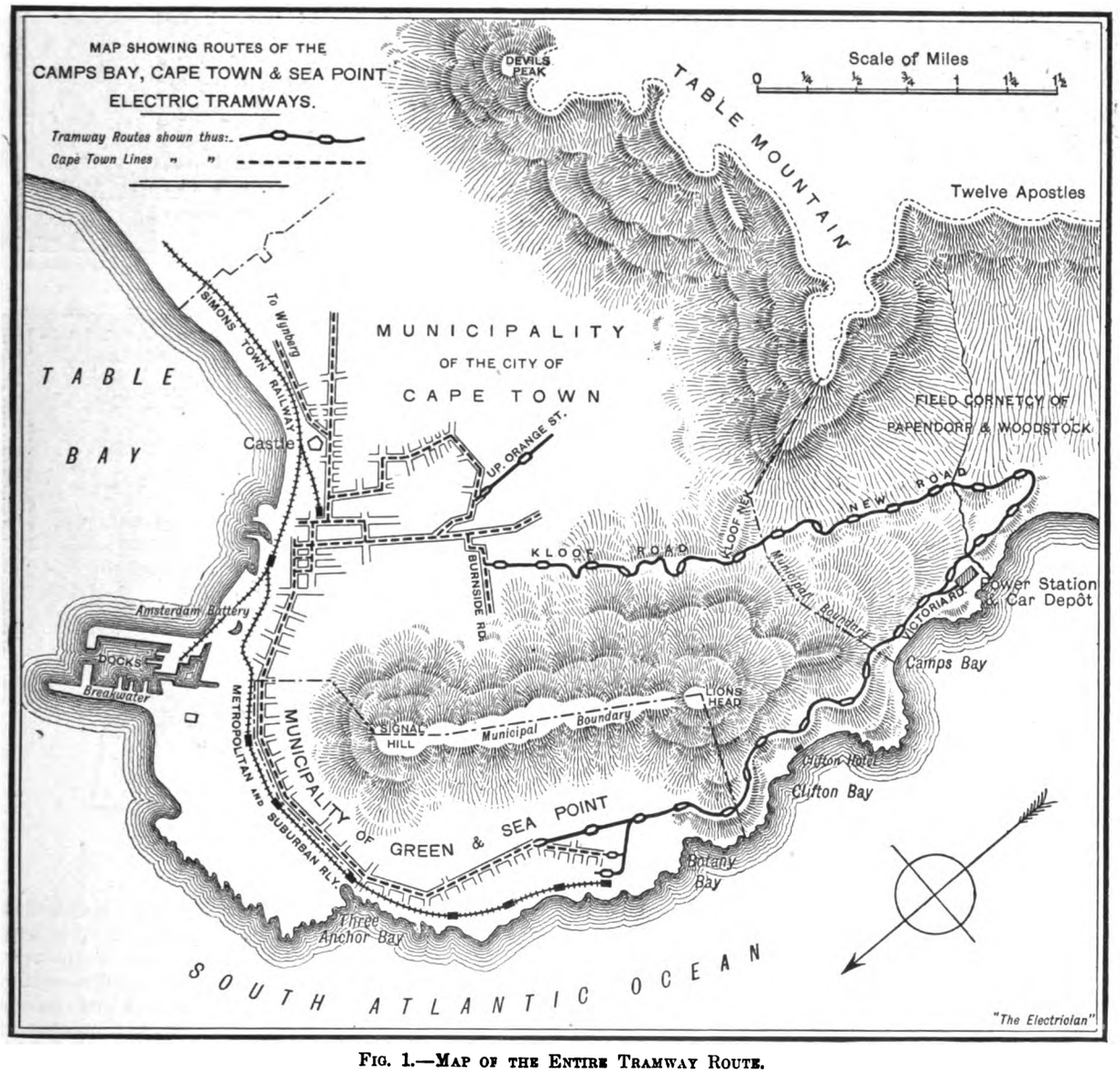

FIG. 1.—MAP OF THE ENTIRE TRAMWAY ROUTE.

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FIG. 2.—VIEW OF CAMPS BAY LINE.

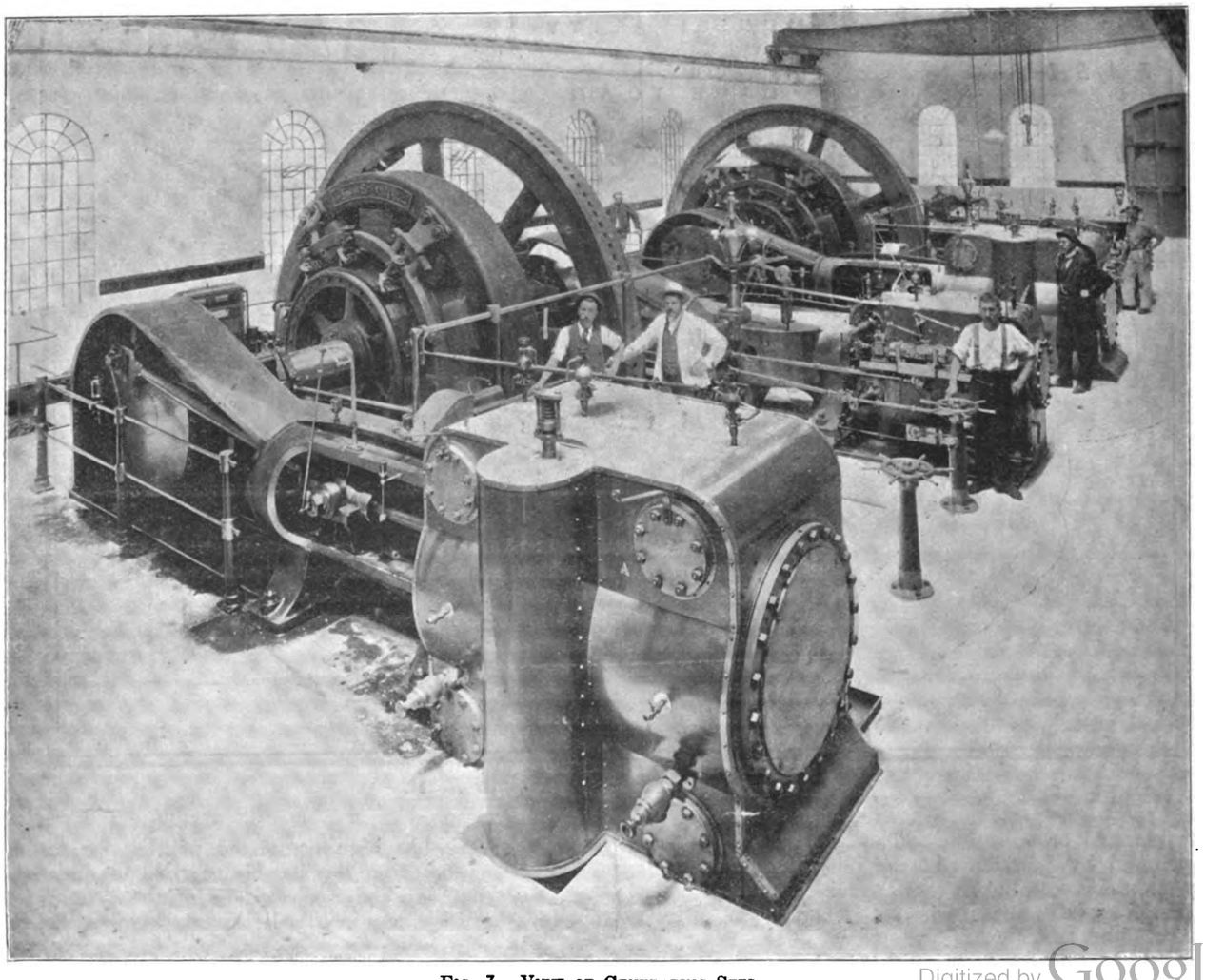

FIG. 3.—VIEW OF GENERATING SETS.

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Church, Sea Point, on the south-west of Cape Town, where connection is made with the Cape tramway, the line commences on an easy ascent, and has reached at the end of the first mile an altitude of nearly 300ft., grades of 1 in 12, or 8·33 per cent., having been encountered. Continuing southward, Upper Clifton is reached, and at this point a magnificent view is obtained of Camps Bay and the range of mountains—the Twelve Apostles. The line passes the old toll house, and at Camps Bay the track leaves the roadway and continues over land purchased by the company. A section showing the gradients is to be found in Fig. 5.

dry stone work laid in courses. In places these were of exceptional strength, measuring from 6ft. to 10ft. thick at the base, and from 20ft. to 25ft. in height, crossing the deep sluits of water courses on the estate. A view of a portion of the line is given in Fig. 2.

Permanent Way.—The gauge of the tramway is 4ft. 8½in., and is thus uniform with the Cape Town tramways, over which system running powers have been obtained.

Overhead Equipment.—The side-wire system has been adopted, the trolley wire, No. "0" B.W.G., being carried at a height of 18ft. 6in. above the rail level. Owing to the

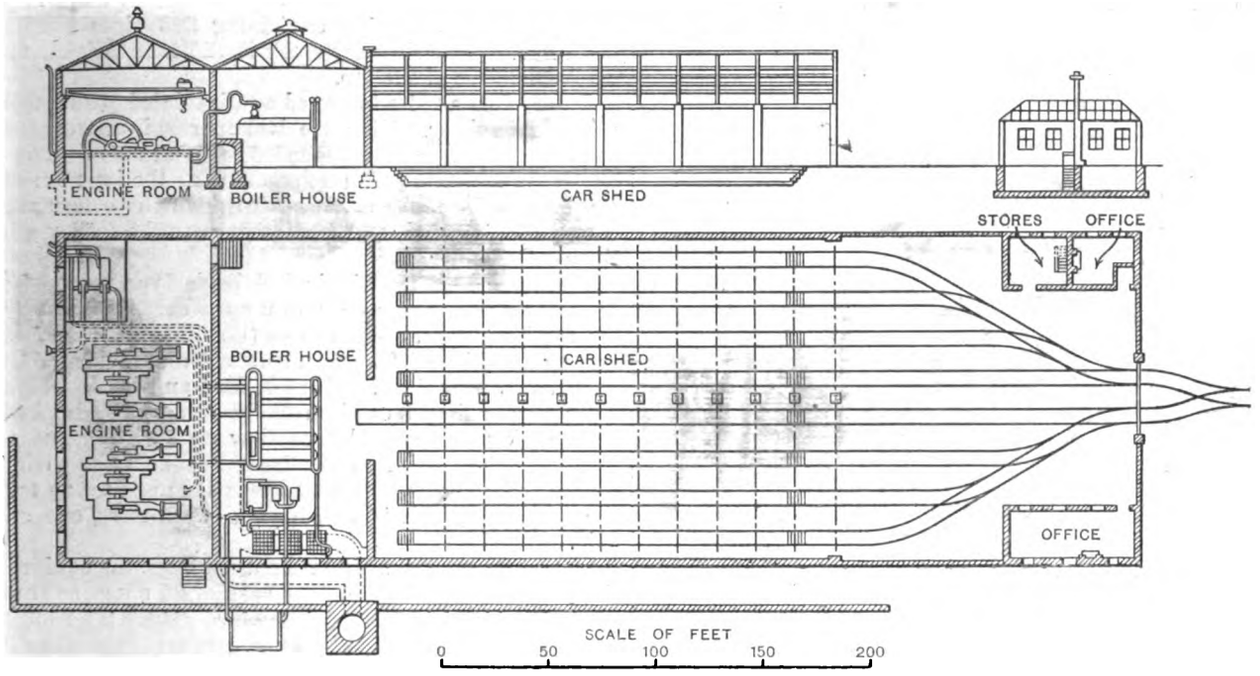

FIG. 4.—PLAN AND SECTIONAL ELEVATION OF POWER HOUSE.

After passing the power house the tramway is laid over the private estate of a local land company, and, following a new roadway which has recently been made for the purpose, the most southerly point of the tramway is reached at Oudekraal. Here the line diverges in a north-easterly direction, and, after encountering the heaviest grades of the system, the highest altitude is reached at Kloof Nek, at which point, some 800ft. above sea-level, there is obtained one of the finest views in the colony. The distance from the Round Church at Sea Point is, roughly, 7 miles.

The laying of the permanent way called for not only a considerable length of new roadway, but more than 75 per cent. of the existing roads had to be widened and graded. Though blasting operations on a large scale were necessary, they provided much excellent stone for concrete and road metalling, and the decomposed granite proved a suitable material for surfacing the roadways. Besides making provision for carrying off the heavy rains by means of capacious drains and culverts, massive retaining walls had to be constructed, consisting of

tortuous character of the route, it has been found necessary to run the trolley wire partly on one side of the road and partly on the other to allow of the poles being fixed in the most suitable positions.

Generating Station.—The generating station and car shed (Fig. 6) are situated at Camps Bay, almost at the southern extremity of the system. This site was the most suitable owing to the proximity of sea water for condensing purposes. A continuous supply of fresh water for boiler-feed purposes is also obtainable from a spring, a small stream flowing therefrom down Table mountain.

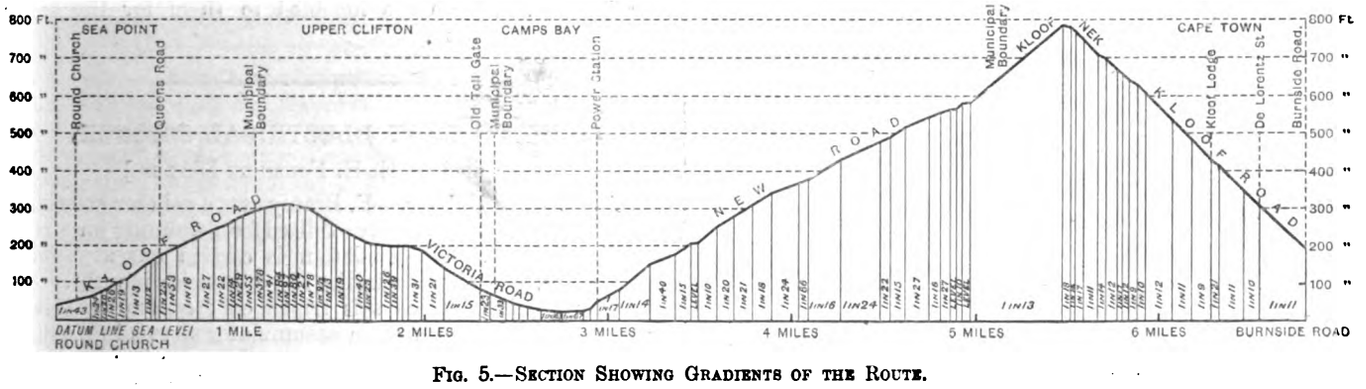

FIG. 5.—SECTION SHOWING GRADIENTS OF THE ROUTE.

The engine room is 94ft. by 42ft., and consists of two floors and a condenser pit. An overhead travelling crane, arranged for hand power and capable of lifting 10 tons, runs the whole length of the engine room and has a lift of 16ft. The boiler house is 94ft. long by 43ft. 5in. wide. The car shed, which is also part of the same buildings, is 186ft. long by 94ft. wide, with eight lines of track, four of which have pits running their entire length. A plan of the entire building is shown in Fig. 4.

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The generating plant (Fig. 8) consists of two direct-coupled 400kw. sets. The engines, constructed by Yates and Thom, are of the cross-compound type, fitted with Corliss automatic valve gear, developing 720 B.H.P. with a steam pressure of 150lb. at the cylinders when running at 90 revs. per min. The flywheels are 18ft. diameter, and weigh about 24 tons.

In the condenser pit are two surface condensers with combined air and circulating pumps. These are of the Admiralty type, and are specially devised for using sea water.

The generators were built at the works of the English Electric Manufacturing Co. (Ltd.), Preston, and are similar to those described in *The Electrician* of May 9, p. 98.

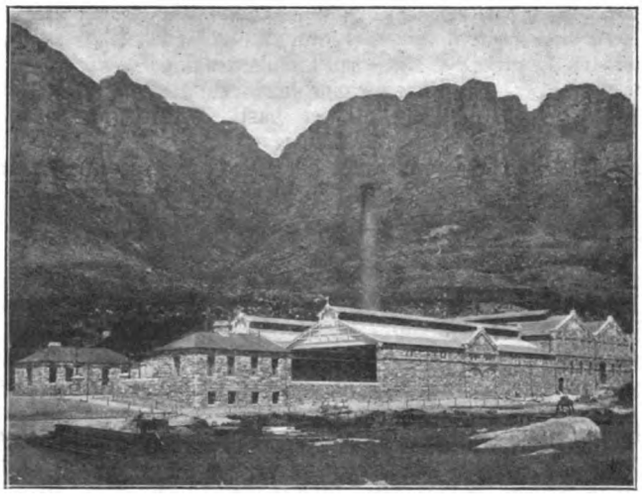

FIG. 6.—CAR SHED AND POWER HOUSE.

The output of each of the machines is 400kw. at 550 volts; they are compound wound, and are in accordance with the standard practice adopted at Preston.

The switchboard consists of nine panels, of which three are generator panels, three feeder panels, one station panel, one lighting panel and one leakage panel. Two of the generator panels only are in use, the other being a spare. Each is fitted with a positive and negative quick breaking switch, capable of carrying 1,000 amperes, a magnetic circuit breaker and an ammeter reading from zero to 1,200 amperes. Two of the

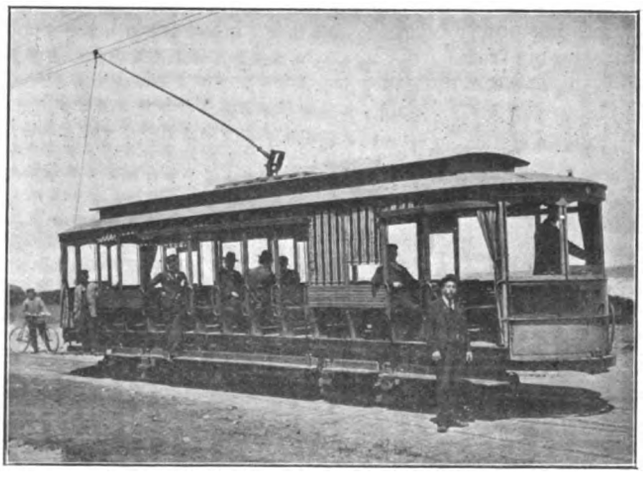

FIG. 7.—GRIDIRON OPEN CAR.

feeder panels are in use, the other being a spare. Each is fitted with an automatic circuit breaker similar to those used on the generator panels, an ammeter reading up to 500 amperes and a quick break switch for connecting feeder to 'bus bar. The station panel is provided with a main ammeter reading up to 3,000 amperes, on which the total output of the station is constantly shown, and a recording wattmeter. It is also fitted with a recording voltmeter, with a working pressure of 550 volts. The lighting panel is arranged for six 50-ampere double-pole circuit switches, with fuses and throw-over switches.

In the boiler-house are two water-tube boilers, each with a heating surface of 3,654 sq. ft., and capable of evaporating 12,000lb. of water per hour under normal conditions. Each boiler is fitted with a dead weight safety valve and a spring valve set to blow off at 160lb. pressure. Feed water is supplied by means of two compound non-condensing duplex pumps, working at a pressure of 160lb., and capable of delivering 24,000lb. of water per hour against a boiler pressure of 160lb. Before being pumped into the boilers the feed water is passed through a fuel economiser containing 288 pipes fixed in the main flue. The chimney stack is 125ft. in height, and 5ft. inside diameter at the top.

The feeders are lead-covered and insulated with paper and vulcanised rubber. They are laid in cast-iron troughs 18in. below the surface and surrounded with bitumen. The main cables are laid in ½-mile sections, and at the junction of each section a feeder pillar is placed in which the cables are connected to a 'bus bar, and from thence to the trolley wires in the usual manner.

The cars are of the single-deck bogie type, some of which are what are known as gridiron open cars, and some are of the combined type. The former (illustrated in Fig. 7) have a seating capacity of 65 passengers and the latter of 54. The length of car is 40ft., width 7ft. 6in., and inside height 8ft. They were shipped to Cape Town completely finished, the only work to be done before they could commence to run being to mount them on the trucks, connect the wiring and fix the trolley poles. The car bodies are mounted on trucks of the bogie type, each truck carrying two motors, one on each axle.

Departing somewhat from the usual lines, the equipment of the cars comprises four motors, each of 25 B.H.P., so that each car is capable of developing 100 B.H.P. There is no doubt that four motor equipments with long cars are imperative where grades are heavy, and in the case of Camps Bay the gradients are unusually severe. Three brakes have been fitted on these cars—viz., a hand brake with a brake block on each of the eight bogie wheels, an air brake acting in conjunction with the hand brake, and an auxiliary slipper brake. In addition to these it is also possible, by throwing over the reversing switch, to convert the motors into generators, thus enabling them to act as a powerful emergency brake. The cars are operated from either end by means of a special controller designed for four motor equipments. It may be observed that so popular has Camps Bay already become, that the company anticipate that the present equipment of cars will shortly be found too few to cope with the traffic.

Messrs. Dick, Kerr & Co. (Ltd.) have carried out this work to the specification of Messrs. Alfred Dickinson & Co., of Birmingham, and we are indebted to them for the above photos and particulars.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

A New Type of Coherer.—E. Branly uses a coherer consisting of a steel tripod with slightly oxidised feet, standing on a plate of polished steel. The oxidation is carried out at a fixed temperature, and remains in the same state for months. The receiving circuit contains this tripod coherer, and operates a Claude relay, which brings an accumulator circuit into action. The Morse connections are so arranged that, after the signal has been recorded, the recorder, in returning to its normal position, communicates a slight shock to the tripod, which decoheres it and makes it ready to receive the next signal. The tapping device used by Marconi is thus rendered superfluous. The feebleness of the shock required renders it possible to increase the speed of transmission. The coherer is shielded from the influence of the sparks of its own transmitter by the attraction of an auxiliary electromagnet, which serves to lift the tripod very slightly off the steel plate while signals are being sent out. The author claims that the new coherer is

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more regular in function than any filings coherer, and that it has the same sensitiveness as any other coherer used for Morse signalling.

[E. BRANLY, *Comptes Rendus*, May 26, 1902.]

Discharge between Flames.—J. Semenov makes a discharge pass between a gas jet and a metallic point, or between two gas jets. With two Bunsen flames 10cm. high, and an induction coil, discharges may be obtained which show a peculiar and characteristic behaviour. The spark proceeds from the orifice of the jet connected with the positive pole, follows the dark external layer of the flame, then leaves it, a little above the summit of the interior cone, and makes for the negative flame. It does not reach the latter, however, but stops about 1cm. in front of it. This difference is always well marked, whatever may be the sense of the primary current. The ordinary aspect of the spark is considerably altered within the flame. It is indicated by a brilliant point at the positive orifice, where the positive ions are projected, and a greater luminosity of the outer mantle of the flame. When the positive flame is very small, and the negative point is placed above it, the illumination of the mantle by the discharge is very well displayed. The flame appears much enlarged. When a platinum point is placed some distance off, the mantle is brightened when the platinum is made the anode, but not when it is the cathode. There is a transportation of matter from the positive to the negative pole.

[J. SEMENOV, *Comptes Rendus*, May 26, 1902.]

Temperature of the Arc.—C. Fery has made further experiments in radiation thermometry (see *The Electrician*, May 16th, p. 148). He determined the temperature of the arc by a new method, employing Wien's law giving the radiation in terms of any chosen wave-length, instead of the total radiation as in Stefan's law. Wien's formula is an exponential one of considerable complexity, but the author has compensated this complexity by a somewhat ingenious device. He reduces the standard radiation to equality with the radiation to be measured by interposing a very acute-angled prism of absorbing glass, and displacing it so as to interpose various thicknesses. It so happens that the absorption of the prism is also governed by an exponential formula of the Wien type, and the displacement is inversely proportional to the absolute temperature to be measured. The displacement actually required was 91mm. in red light and 49mm. in green light, giving 3,867deg. for the temperature of the arc in the first case and 3,897 in the second. This shows a considerable disagreement from the value obtained from Stefan's law, which was 3,490deg. The author has, therefore, sought for the cause of the discrepancy, and has found it in the fact that carbon does not behave as an absolutely black body at the temperature of the arc, which is 3,490deg.

[C. FERY, *Comptes Rendus*, May 26, 1902.]

Aluminium Rectifiers.—According to Graetz, an aluminium-alum-lead cell does not transmit a current at a voltage below 22 if the aluminium is the anode, evidently owing to the difficulty experienced by the light aluminium positive ions in forcing their way through the thin sheet of alumina. E. König has made a detailed study of the behaviour of some such rectifiers, and finds that Graetz's contention is not strictly correct. He puts it that an aluminium cell behaves like a condenser mounted in parallel with a high resistance and in series with a low resistance. Using four cells, arranged as indicated by Graetz, for the conversion of an alternate current into a pulsating continuous current, he found that the maximum efficiency increases up to a certain point (say an external resistance of ½ ohm) with increasing voltage. In the alternate-current circuit there is a phase difference between current and voltage which is greatest at zero load on the continuous-current circuit, and decreases when the load on the latter is increased. The author also observed that all cells after a while show a growth of cylindrical rods of alumina about 7mm. long and 1mm. thick after prolonged use, which limits their life.

[E. KÖNIG, *Electrotechn. Zeitschr.*, May 29, 1902.]

Absorption of Radiation by Metals.—E. Hagen and H. Rubens have begun a series of measurements of the absorptions shown by various metals with regard to ultra-violet, visible and infra-red rays, primarily with a view towards accumulating material for testing the electromagnetic theory of light. In this first set of observations, made at the Reichsanstalt, they examined layers of platinum, gold and silver deposited on glass by various methods. The deposition of silver and its chemical and optical estimation enabled them to test whether sheets deposited chemically and by the disintegration of a cathode had the same physical constitution. They found that they had, and that even transparent films of silver have the normal density. The curves of absorption given for the three metals extend over wave-lengths 200$\mu\mu$ to 1,400$\mu\mu$. In the ultra-violet, silver shows a strong absorption band, and gold a less marked one in the blue. The curve for platinum is nearly straight, the absorption decreasing slowly towards the red. In the infra-red, silver shows the highest absorption, gold the next, and platinum the least. This confirms Maxwell's postulate that for infinite wave-lengths the absorptions are proportional to the conductivities (free ions), but the material is as yet too limited for general conclusions.

[HAGEN and RUBENS, *Ann. der Physik.*, No. 6, 1902.]

The Ratio e/m.—The ratio of the charge of an electron in absolute electromagnetic units to its apparent mass in grammes has been put at about $1{\cdot}3 \times 10^7$ by Wiechert, 2×10^7 by Wien and $1{\cdot}77 \times 10^7$ by Kaufmann. This would mean that a single electron has an electrostatic charge of about five absolute electrostatic units, and would, at a distance of 1cm., repel another electron with a force of 25 dynes. The great importance of an accurate determination of the ratio e/m in cathode rays has led W. Seitz to make a comparison of the various methods hitherto used. He made three measurements of the quantity $mv^2/2e$ in the same tube by three different methods, these methods being that of Kaufmann and Simon of finding the potential, Wien and Lenard's electrostatic deflection method, and Thomson's method of simultaneously determining the energy and the charge of the particles. In addition, he determined the magnetic deflection. Of all the methods investigated, that of Kaufmann appeared to give the best and most consistent results. The magnetic deflection gave a value for $e/m \times 10^{-7}$ of 1·87, which agrees very well with Simon's value of 1·865. The bolometric method of determining energies is only suitable for high vacua and voltages of more than 8,500.

[W. SEITZ, *Ann. der Physik.*, No. 6, 1902.]

THE DISTRIBUTION OF MAGNETIC FLUX IN LARGE ELECTROMAGNETS.*

BY W. M. THORNTON, M.SC.

(*Concluded from page 231.*)

Table III. gives the results of Table I. in terms of flux, the armature flux being taken as 14×10^{-6} lines.

The original Paper includes a large number of records, for which curves and figures are given. In the above we have reproduced two of the observed curves only, and have included in Tables I. and III. only the figures which relate to these.

Table III.—*Flux Corresponding to the Curves of Table I. in Millions of Lines.*

Curve.	Fig. 2.	Fig. 3.	Curve.	Fig. 2.	Fig. 3.
I.	14	{15·3	VII.	16·42	...
II.	19·6	{19·6	IX.	16·25	...
III.	15·7	{14·65	XI.	6·94	...
IV.	...	{19·8	XII.	8·69	...
VI.	1·527	...	...	...	...

* Abstract of a Paper read before the Newcastle Local Section of the Institution of Electrical Engineers.

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At the close of a set of experiments the exploring coil was left connected to the recorder when the machine was at work lighting the building. It was noticed that the spot of light was in a constant state of oscillation, and that this was not mechanical vibration was shown by the effect ceasing when the galvanometer was disconnected. One concludes, therefore, that the magnetism of the machine is in a constant state of change within small limits (see *a* Fig. 5). On photographing the motion it was found that, in addition to the simple oscillation, there was a slower swing shown by drawing a mean line through the ripples at *b* and *c*, the time scale of the latter curve being one-sixth of *a*. The ripples are caused by the variation of speed of the Robey engine flywheel and armature during one stroke, the former working with a single cylinder at present, the speed being 74 revs. per min. The considerable fluctuations of curve *a* were caused by one of the valve trips being lifted so that the engine missed a portion of the stroke. The slow swing shows the hunting of the governor, and in curve *c* the combined period of the engine and of the flywheel and armature can be observed.

The Paper then gives an analysis of the curves, and a comparison with theory. The initial rate of change of permeability at "make" and "short circuit" is found, and its effect on the shape of the curves discussed. The initial throw is shown to be independent of the material of the core. In an appendix to this the reliability of the galvanometer as a recorder is examined, and curves obtained from which correcting factors may be calculated for a too heavily damped galvanometer. The amount of magnetic shunting to make the motion dead-beat is also discussed, and a new method of suspending moving coils to obtain the same effect. The appropriate size of copper former is given for a particular set of suspensions.

The Recording Ammeter or "Magnetic Flux Indicator."—Although in its final form the galvanometer proved very reliable and convenient, yet its bulk and delicacy rendered it awkward to carry about. It was felt that something of the nature of an engine indicator was wanted—powerful, free from friction, having small inertia of the moving parts, and yet sufficiently damped to make its readings dead-beat. With these objects in view, various modifications of ordinary

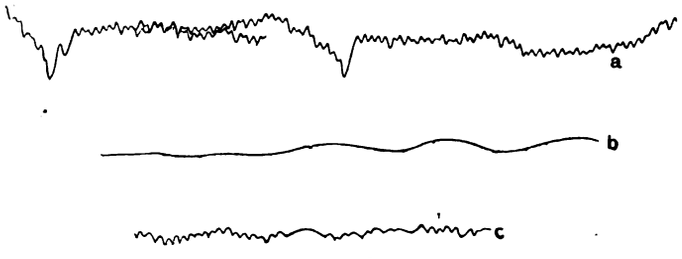

FIG. 5.

switchboard instruments were tried, but discarded because of the difficulty in obtaining records by means of a pen or pencil attached to the pointers, the leverage of the pencil friction being inevitably great compared with the radius of the pivoted coils, and the inertia of the coils greater than was desired when large currents were passed directly through them, instead of being shunted. In order that the instrument may be powerful, it is necessary to have a strong field, a large current-carrying capacity, and the length of coil in the field must be considerable. The resistance in the present instrument is 0·003 ohm, and the safe current 50 amperes. The coil moves in a circular cylindrical gap, 0·4cm. wide and 9cm. long, and to maintain a uniform strength of flux in the gap the magnetic circuit is made double, the radial field having everywhere the same direction in the gap, but the flux approaching from top and bottom the contracted section in the iron. The magnetism may be either permanent or separately excited. The coil is made of a strip of copper 0·75cm. wide at the narrowest part, 1·5cm. elsewhere, and 0·5mm. thick, formed into two turns insulated by silk tape and varnish. The current is led in at the top through the suspension of arc lamp flexible and out at the bottom in the same way. The elastic control is provided by two watch springs coiled inside light brass drums, and the spindles to which the springs are attached being fixed, the drum is free (as in an indicator) to rotate through an arc which depends upon the stroke of the coil and the radius of the drum. At rest the two springs are arranged to oppose one another, so that the suspensions are always in tension. The coil is made mechanically strong to resist deformation by a lapping of stout silk thread, and is tested to 10lb. pull. The position of the coil can be adjusted by means of rachet wheels and purls, so that the whole stroke may be taken in either direction, or, when at the centre, to respond to currents of changing sign. The strength of the pull F varies with the strength of field, B_g, of the current, *i* amperes, and with the length of winding on the coil *l* according to the relation

$$F=\frac{Bil}{10} \text{ dynes, or } \frac{Bil}{4{\cdot}46\times10^6} \text{ pounds,}$$

The measured pull was 2lb. when a current of 40 amperes was passed through the coil. The length of strip in the coil was 35·4cm. Thus the field in the gap with the instrument fully excited is 3,100 lines per square centimetre. This might with advantage be made very much stronger, but having been originally made with an 1½in. core, which was afterwards increased to 2in., there was not sufficient iron left in the shell to carry when saturated a greater flux.

The dimensions of the instrument depend entirely on the flux densities in the gap and iron. Thus, let *d* be the diameter of the inner iron cylinder, *b* the width of the gap, and *l* its half-length. Then through each half of the circuit the total flux must be $\pi(d+b)lB_g$. Either end of the core adjoining the covers must carry this also, and if B is the flux required to saturate the iron there, the total possible is $\pi/4d^2B$, if the core is solid, or less due to the area of the centre hole in the present form. Let this area be *a*. Then $(\pi/4d^2-a)B=\pi(d+b)lB_g$.

$$\pi/4d^2B-\pi ldB-(\pi blB_g+aB)=0,$$

whence *d* can be found for any values of B and B_g.

Neglecting the area *a* and the breadth of gap *b*,

$$\pi/4\,.\,d^2B=\pi ldB\,.$$

Thus,
$$d=4l.\frac{B_g}{B},$$

a first approximation to *d*.

If we want $B_g=7{,}000$, $B=16{,}000$. Then $d=1{\cdot}7l$.

In the present instrument $\frac{d}{l}=1{\cdot}7$, but the shell is of insufficient area to carry the flux, and the winding space is too small. From the shape of the magnetic circuit the reluctance may be readily calculated, and the winding space, instead of being 8 sq. cms. should have been 12; this is in consequence of the air-gap, originally made 0·3cm. wide, being bored out for greater clearance. The dead-weight of the moving parts, not including the wire on the drums, is 1·75oz, and in considering the motion the inetia of the drums must not be neglected.

In order to counteract the demagnetising effect of the coil current at one end of the circuit, and its distortion of the field from the other, the instrument was compound wound. Thin strips of copper were placed on top of the fine windings at both ends of the instrument and connected in series with the coil, only wound so that any change of flux was prevented, the same number of ampere-turns being given to each end as to the coil. Thus, with the exception of the stray local fields round each strip, the moving coil is free from self-induction, and the instrument can be used with alternating currents of moderate frequency provided the elastic control is stiffened and some method of optically multiplying the motion added, such as the following: A highly-polished stiff steel strip is bent twice at right angles and soldered to two steel pins at *a* and *b*; *a* is held by two end screws, and *b* is attached to the moving coil. A motion of a hundredth of an inch is sufficient to give an amplitude within the range of the breadth of the strip; thus an exceedingly stiff spring may be used, and the free period of the system made very high, 110 a second, with moving parts weighing 50 grammes.

An important feature of the design is the straight-line motion. In records this is frequently useful, and it facilitates the working out of the areas in the magnetising curves greatly. The only other straight-line motion instrument of any accuracy is the Hartmann and Braun modified Kohlrausch ammeter. In this, however, the spring is weak, relative to the weight of the moving parts. The damping in the first instrument is found to be enough without special provision by the back E.M.F. generated during the initial rush. If it were not, a copper ring former would be more than sufficient, except for very violent fluctuations in the coil current.

The permanent magnet form calls for no special remark, beyond noting that it also can be compound wound, and is much simpler than the separately excited to construct, probably the best method being to magnetise the sides to have consequent poles. With regard to putting the separately-excited form together, since, in order to get the supporting fins of the coil in, the centre core must be split, the diameter of the inside of the coil must be such that the two halves will slide into place. Again, since the return current passes under the entering in the slot, there is no tendency for the coil to rotate on its axis and so scrape against the sides of the slot. Rubber strips are placed at the ends of the slot to preserve the insulation or the fins from contact with the frame, though there is never any chance of a short circuit. If the instrument were wound to record high voltages, special insulation would have to be devised for the centre hole and slots.

The recording apparatus is an ordinary drum clock-driven, mounted close to the top of the instrument, the records being made with a pen attached to a loosely-jointed rod pivoted on the suspension, or to a cord, which draws the pen against an antagonistic spring. The drum of a phonograph has been found very useful for records of rapid changes, as in the changing over in a double-carbon arc lamp, or the induced voltage curves in testing transformers by the "make" "short-circuit" method. The experiment may, however, be conducted without any special self-recording apparatus if a dead-beat

galvanometer of any kind is available, such as the Kohlrausch moving-needle type, damped by currents induced by the motion of the needle in a copper block surrounding it. The curves given below (Fig. 6) were obtained with such an instrument by marking on a Wheatstone tape the times of transit of the spot of light across the tens of a millimetre scale. The readings were exact enough to show that the instrument was not dead beat enough, but on the return swing the record dipped below the true curve. The apparatus is easily erected, an ordinary electric bell being readily converted into a chronograph by means of a pen attachment, and a drum driven by clockwork or falling weight providing the time displacement.

The most accurate of all recording ammeters is the Duddell oscillograph, and records taken by it have been regarded as final. Its difficulty in use, apart from its delicacy, is that the resistance of the strips and fuses is high compared with the very low voltage dealt with. Ten or more turns around a large core give a throw of 5cm. or 6cm. only. In observing the slow rise of current in a large winding with the instrument shunted in the current, the record is perfect. The oscillograph used was of the low-frequency double-suspension type.

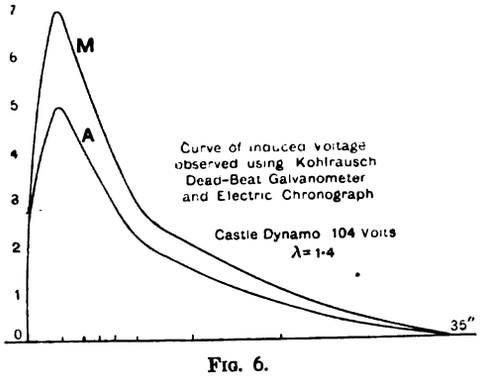

Fig. 6.

Further Tests on Large Machines.—The magnet cores of the 50kw. Castle dynamo were the largest of circular section available for test. It was, however, desired to examine machines of large size chiefly for the slipping of the molecules effect. By permission of the Newcastle Electric Supply Co., through their consulting engineer, Mr. C. H. Merz, tests were made on one of the 500kw. synchronous motor-generator sets in the Manors sub-station, the continuous side only being used. This consists of a six-pole machine by Brown-Boveri. It is designed to give 480 volts at 1,000 amperes, with a speed of 300 revs. per min. It was excited from the 'bus-bars at 480 volts, and the current was broken through a non-inductive resistance. The galvanometer being shunted across 0·01 ohm, with 600 ohms in series, the curve of rise and fall was obtained. This was repeated with 300 oms in, and II. recorded. A single turn of wire was then wound around the magnet at the centre of the winding, and with 500 ohms in series gave a third curve when the exciting current was

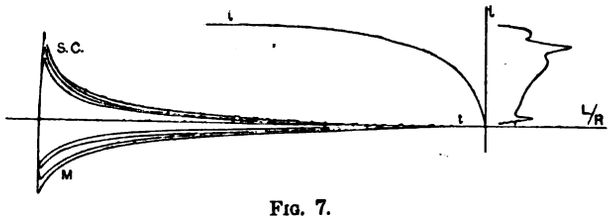

Fig. 7.

switched on. A and Y, referring to armature and yoke, had 300 ohms in series. The areas as recorded and as reduced to the same resistance are :—

Windings	B	.....	21 sq. in.	.....	34·25 sq. in.
Yoke	Y	.....	15	.....	15
Armature	A	.....	14·4	.....	14·4

Thus $\lambda = 1{\cdot}19$; $\left(= \frac{N_B}{2N_a}\right)$.

As would be expected, the yoke flux is slightly greater than the armature, their ratio being 1·035. The average time-constant found from the curve of rise is 10 seconds ; from B, 9·5 seconds ; γ, 10 seconds ; A, 9 seconds ; the method in the later cases being to find the time for the induced voltage to fall to $\frac{1}{e}$th of its maximum, since the flux follows the coil current closely after the first rush.

Mr. J. F. C. Snell kindly gave me leave and help to test two machines with large rectangular cores in the Sunderland Corporation Dunning-street station. The first taken—a Silvertown bipolar continuous-current generator for 250 volts 544 amperes at 400 revs. per min.—was excited from the 'bus bars, then at 226 volts, and the set of curves in Fig. 7 taken. Table IV. gives the values found from these.

Table IV.

Curve.	Make area in sq. in.	Resistance in galvanometer circuit.	Equivalent area.	λ.	N.	B per sq. in.
A	5·32	50 ohms	5·32	1	$32{\cdot}3\times10^6$	83,250
Y	2·95	200 ,,	6·1	1·145	37 ,,	87,250
B	3·86	200 ,,	6·85	1·29	41·6 ,,	98,000
P-F	4·92	50 ,,	4·92	0·925	29·8 ,,	37,250

The armature carries 232 conductors, of which 116 are at present in one winding, the two being in parallel. The magnets and yoke are of Sir Alfred Hickman's special magnetic steel forging. Each bobbin carries 5,512 turns, of resistance 79 ohms cold, the maximum exciting voltage for each being 250 volts. An application of the above data to find the permeability of the steel under working conditions is given in the original Paper, together with the results from the second machine tested. A Parker bipolar generator of similar pattern to the Silvertown was also tested. The same exciting voltage was used, and the curves of Fig. 8 recorded, from which Table V. is compiled.

Table V.

Curve.	Area. Sq. in.	Resistance.	Equivalent area.	λ.	N.	B per sq. in.
A	5·2	200 ohms	5·2	1	$30{\cdot}7\times10^6$	66,750
Y	6·52	200 ,,	6·52	1·255	$38{\cdot}6\times10^6$	95,000
B	4·35	400 ,,	6·86	1·32	$40{\cdot}5\times10^6$	100,000
P-F	4·73	200 ,,	4·73	0·91	$28{\cdot}0\times10^6$	39,700

This machine gives 250 volts 500 amperes at 360 revs. per min. There are 136 conductors on the armature, which, as the former machine, is double wound, to be converted to 500 volts when desired. The turns on each bobbin are 4,666, each coil having 43·5 ohms resistance cold.

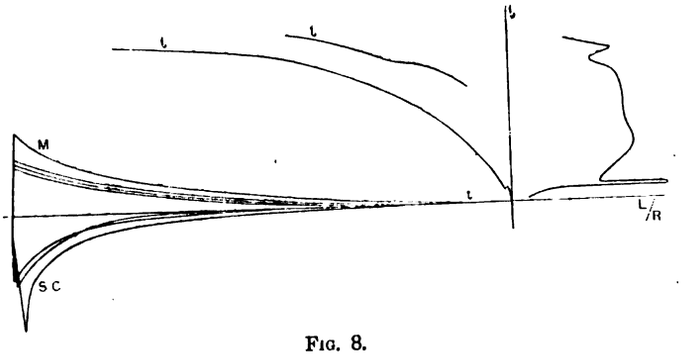

Fig. 8.

The curves of rise of current at make in both machines differ from the circular core case in being much flatter. Since a flattening of the curve corresponds to an increase of permeability, this shows that the average permeability of the machine as a whole is higher than in the Castle dynamo, probably because the reluctances of the air-gaps are so much less by reason of the large pole faces.

The remainder of the Paper contains a suggestion of a new method for determining the permeability of large iron cores, and is illustrated by experiments on three machines. Tests on transformers by the same method are also described. An investigation of the change of permeability with time shows slipping of the molecules at saturation, as indicated by Ewing's theory of magnetism, but not hitherto observed. Following this is an application of Heaviside's formulæ for the decay of induction in cores to the Holmes machine. The modification introduced by elliptical and rectangular cores is indicated. In the concluding portion of the Paper surface leakage formulæ generally used are experimentally examined for the case of the Holmes machine.

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ITALIAN OBJECT LESSONS IN ELECTRIC TRACTION.

The Paper on "Electrical Traction on Steam Railways in Italy," which Prof. CARUS-WILSON read before the Institution of Electrical Engineers on May 15th, differed in many important respects from the generality of Papers on electric traction read before engineering societies. Instead of directing attention mainly to engineering and electro-technical considerations, this Paper, from first to last, afforded a careful account of the financial aspects of the replacement of steam by electricity on railways, and a studious comparison between Italian and English conditions. There can be no doubt of the relative difficulty of the two tasks: for an expert engineer to draw up an account of the engineering features is an easy task, when compared with the numerous and intricate difficulties besetting the task of drawing financial deductions from Italian practice to British prospects. Prof. CARUS-WILSON has not shirked any of the difficulties that confronted him. If he has been unable to present a clear and convincing case to British railway men, it is simply owing to the inherent impossibility of arriving at an absolutely satisfactory basis for comparison and inference. Things are so different, in so many ways, as between the light railway systems of Lombardy and Piedmont, and the solidly-built standard railways of Great Britain. If nothing else causes irreconcilable disparity, the immense disproportion in the capital costs for any given length of line must be a warning against hasty generalisations.

Prof. CARUS-WILSON'S story is so clearly told in his Paper that it needs no lengthy repetition here. Briefly summarised, it amounts to this: Two Italian railway companies working some 80 per cent. of the railways in Italy have for some time studied the influence of electric traction on traffic returns and profits, with the result that they have perceived in it a means of combating the competition of a vigorous system of steam tramways. Electricity permits of the railways being run more on a tramway basis—*i.e.*, "a service of short trains running frequently at high speeds." From the balance-sheets of the steam and electric working, Prof. CARUS-WILSON infers that, in order that the electric service may be a paying one, there must be a considerable growth in the volume of traffic. Indeed, reasoning from these data, he concludes that the mainstay ensuring successful electric traction on British railways would be an increase in the volume of traffic, and not an actual decrease in the expenses:—

> It seems clear that, whether in England or in Italy, the full advantages of electrical traction cannot be obtained without an increase in the total running expenses, and this increase can only be met by a corresponding increase in the passenger traffic, so that the change from steam to electricity should not be made unless the increase in traffic may be reasonably expected at least to cover the increased cost of running and the interest on the capital expenditure.

The discussion on this valuable Paper turned largely on the financial inducements to British railway companies to convert

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their lines. Mr. STEEL, formerly general manager of the Great Northern Railway, denied in unqualified terms that there was any substantial inducement. Mr. SAYERS retorted that if such was to be the policy of railway companies, they would soon be left to their goods and mineral traffic. The President, Mr. W. LANGDON, an electrical engineer and railway expert whose opinion carries weight, could not accept the author's conclusions, on the ground of disparity between British and Italian conditions, and he doubted whether it would pay British railway companies to convert their lines. For ourselves, we think, as we have often stated in these columns, that the conversion of British steam railways will take place, not through any studious contemplation or forethought of railway authorities, but through the irresistible compulsion arising from the competition of rival electric lines. The case of the Inner Circle railway companies, driven by dire necessity through the competition of the Twopenny Tube, is an exact illustration of what we mean. Let Prof. CARUS-WILSON or any other traction expert approach any of our big railway companies with the most convincing data and the most unassailable arguments, and we doubt if a single steam locomotive would be thrown out of service in consequence. But let a parallel electric railway, built on the most modern principles for high-speed frequent service, threaten to draw off the bulk of the passenger traffic, and instantly the conversion of the steam lines to electricity will become the most pressing *question d'actualité*. Nor do we here conceive of a hypothetical case. It has occurred before—frequently in America, more than once in the United Kingdom. It will often be repeated in the near future. No object lesson from the distant plains of Lombardy can be half so convincing as the cannonading of electric traction at the very citadel of British steam practice.

SOME NOTES ON INDUCTION MOTORS.

BY H. S. MEYER.

The growing demand for alternating-current motors for all kinds of service induces the writer to call attention to a few points which are of the utmost importance when dealing with this question. The experience of a number of years has demonstrated that not only in large power distributing plants, such as, for instance, the Walker Wallsend, but also for isolated plants in factories, mills and collieries, the alternating-current motor has proved highly satisfactory. It is proposed in the following notes to deal more particularly with the asynchronous or induction motor, the synchronous motor being limited in its commercial usefulness to larger sizes and to special service conditions.

There are two essentially different forms of induction motors; first, the motor with a short-circuited rotor, or "squirrel cage" type, which is ideal in its simplicity but which requires a large current in starting at higher loads; second, the "rheostatic" motor, which consumes approximately the same amount of current when starting under full load as when running normally with the same load, but which requires a polar wound rotor with a variable resistance, either embodied in the rotor spider and revolving therewith, or connected by means of slip rings and brushes to the rotor windings. As to the choice of the two kinds of motors, I contend "there is no excuse for installing a motor of the rheostatic type where a simple squirrel-cage type can be used." On several occasions recently, an attempt has been made to limit the size in which the latter should be used; for instance, Mr. A. C. Eborall, in his Paper before the Institution of Electrical Engineers, states that "such motors which have to start against load should not be used in sizes above 5 B.H.P., and if not required to start against load up to 8 B.H.P." In an earlier Paper the same gentleman fixed the outside limit even at 5 B.P.H. Though such statements read very well in commercial bulletins of manufacturing concerns, giving their standard sizes and forms, one is rather surprised to find them unchallenged, when made before so representative a body as the Institution of Electrical Engineers. Any such attempt is as unwarranted as a law setting forth where to use motor generators instead of rotary converters. The service conditions alone decide which type should be chosen, and the incorrectness of the above statement is best shown by the many hundreds of successful installations using motors of the squirrel cage type in sizes up to several hundred H.P.

It is true such a motor does start with a large current, the exact amount depending upon the torque required, and upon the design of the motor; but against this we have to put the following advantages:—

1. The simplicity in its construction, the rotor winding consisting of straight copper bars passing through the iron core and jointed together at the ends by short circuiting rings.

2. Avoidance of all sliding contacts and complications caused by the introduction of resistance at starting.

3. Greater simplicity in operation. The starting consists in a simple movement of a switch, while with the rheostatic motor skill in starting is required, if the full benefit from this type is to be obtained.

4. Adaptability to any number of poles, and thereby, the possibility of using an efficient method of varying the speed by changing the number of poles in the stator only.

5. Considerably better constants. The power-factor is higher since the self-induction of the end connections is greatly reduced, and since the passage of the currents in the rotor bars is more favourable; also, the magnetising current is generally less due to the lower densities in the rotor iron.

The efficiency is better since the copper is more efficiently used, as no dead copper in the shape of end connections is present, and since the wind resistance is smaller and all losses caused by brush friction and contact resistance are avoided. Wherever the slip-rings are short-circuited and the brushes lifted off the rings after the motor is up to speed, a smaller difference in efficiency will exist, but the complications introduced by such devices will hardly recommend their use except in larger sizes.

To illustrate these points more fully, I give some data of a 7·5 H.P. three-phase motor at 220 volts, which was first tested with a squirrel-cage rotor, and secondly with a wound rotor, slip rings and outside resistance, using the same stator and the same bearings. Both rotors were of the standard type of a well-known make. No devices of the above-mentioned kind were used. The air-gap, according to most careful measurements was exactly the same in both cases.

—	Squirrel-cage rotor.	Polar wound rotor.	Remarks.
Core loss.....	250 watts	250 watts	Remained approx. same, differing only by the errors in readings.
Stator I^2R	320 watts	320 watts	...
Friction & windage	125 watts	270 watts	...
Rotor I^2R	310 watts	285 watts 215 watts	Tested. Calculated from resistance of windings, the difference being due to contact resistance.
Efficiency, full ...	84·9	83·2	...
Do. half ...	84·1	80·6	...
Power-factor, full.	89	88	Found by dividing watts by volt amperes.
Do. half	·77	75·6	...
Maximum output.	15·5 H.P.	14 H.P.	...
Starting torque ...	5·7mkg.	4·5mkg.	Torque corresponding to full load = 3·9mkg.
Starting current..	114 amp.	26 amp.	Full current = 19·9 amperes.
Rotor copper	6kg.	12·5kg.	...

From the above figures, which have been substantiated by a number of similar tests, I feel justified in saying that for motors which have to operate most of the time below their rated load—and such is the case with at least 50 out of a 100—an appreciable annual saving in cost of current can be effected by choosing the squirrel-cage type. Further, its greater mechanical reliability and the absence of sparking, which reduce the chances for accidents and breakdowns, and the less skilled attendance required, strongly recommend its use in all

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mines and mills where a delay in power, resulting from a failure of a motor, may have the most serious consequences. The only drawback against these advantages is the large starting current. We observe from the above table that the motor in question took a current equal to 5·7 times its normal full load value, exerting at the same time a torque = 1·46 times the full load running torque. For our further arguments, the motors should be divided according to their service conditions in: (1) Motors which have to start light or with a small load, say up to 30 per cent. of full load; (2) motors which have to start under full load; (3) motors which have to start under overloads. Certainly a fair percentage of all induction motors belong to the first group; for instance, all motor generators, motors driving fans or counter shafting and also a number of motors direct connected to presses, rollers and tools. To deal with such motors first, it will be seen that in the above example the starting torque of the squirrel cage motor could be greatly reduced without impairing in any way the duties such motor had to perform. To obtain this in such a manner that the starting current taken from the line is reduced in the same proportion, a compensator may be introduced, which acts as a transformer, reducing the potential at the terminals of the motor, and, consequently, diminishing the current taken by it. Fig. 1 shows the connections between a compensator and a three-phase motor. The three-phase compensator consists of three coils wound upon laminated iron cores. When the switch is in the starting position, the current from the line passes through the compensator, the windings of which are provided with a number of taps, so that various potentials may be

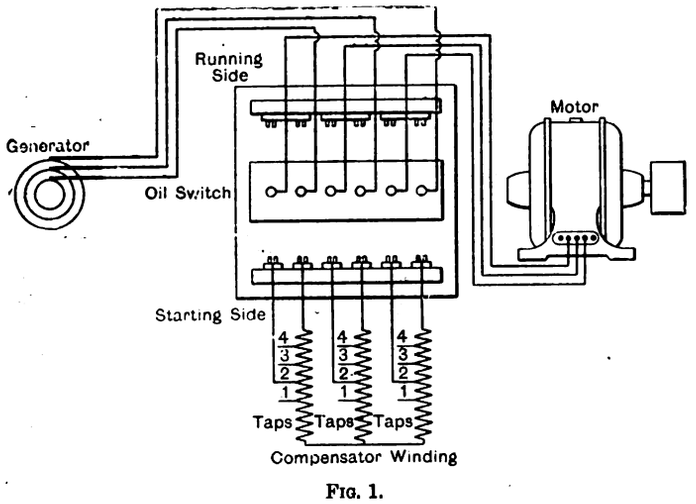

FIG. 1.

obtained. Only one coil being used for primary and secondary, the two currents will flow in opposition, and consequently the winding need to be designed only for the difference in currents. As, further, the iron and copper densities may be chosen considerably higher than in ordinary transformers, in view of the short time of use, the size and cost of such a compensator is greatly reduced. Fig. 2 represents diagrammatically the conditions when using a compensator for the above 7·5 H.P. squirrel-cage type motor, supposing it had to start with 30 per cent. of its full load torque. The torque being proportional to the square of the impressed voltage, we may reduce this to

$$\sqrt{\frac{1\cdot46}{0\cdot30}} = 2\cdot2 \text{ times, or to } \frac{220}{2\cdot2} = 100 \text{ volts.}$$

The starting current at 220 volts being 114 amperes we obtain a motor impedance $= \frac{220}{114} = 1\cdot95$ ohms. From this we find the motor starting current at 100 volts approximately = 50 amperes. In reality, it will probably be somewhat less, since the impedance at full voltage due to saturation in the iron is mostly somewhat smaller than at reduced voltages, and thereby causes an increased current to flow under such conditions.

While on the secondary side we have 100 volts and 50 amperes, we have on the primary side 220 volts and 23 amperes. Thus, only a current 15 per cent. larger than full load current is taken from the line. The winding of one part of the compensator has to carry 23 amperes, and the other 27 amperes, the currents flowing as indicated by the arrows in Fig. 2.

To express the general principles according to which such compensators are chosen, we may say that by reducing the voltage to a certain fraction 1/X, we reduce the current on the primary side and the starting torque as the square of this fraction or to $1/X^2$. When the motor has attained its speed, the starting switch is thrown into the running position, and the compensator windings are thereby entirely disconnected,

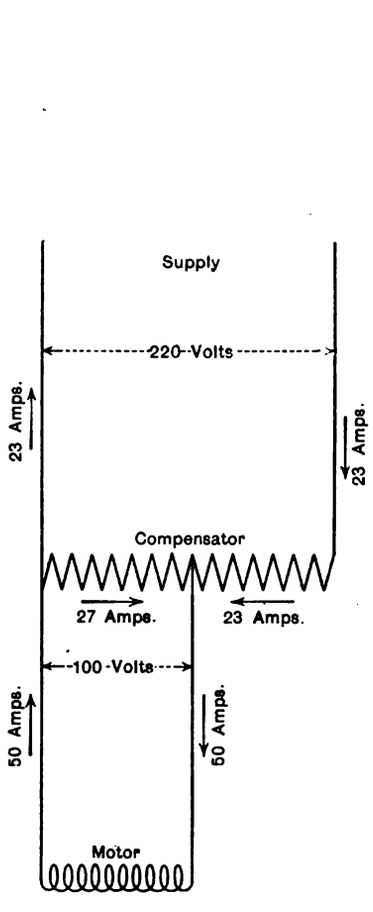

FIG. 2.

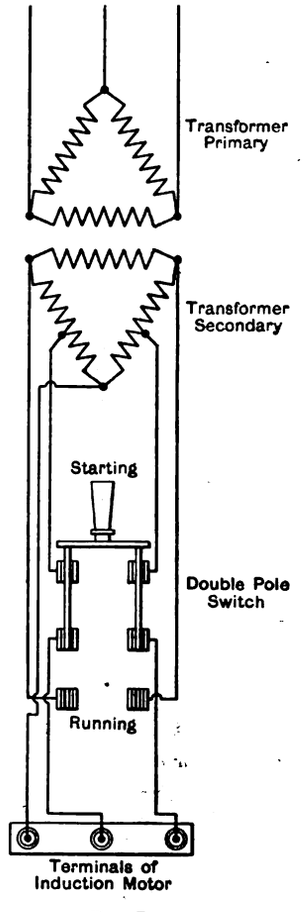

FIG. 3.

the motor taking current directly from the line at full potential. As to the cost of this apparatus, it may be said that a squirrel-cage type motor with a compensator may be obtained for approximately the same price as a rheostatic motor, including the resistance, in smaller sizes the latter arrangement being somewhat cheaper, in larger sizes the former. Wherever induction motors are supplied by means of step-down transformers, as, for instance, in high-voltage transmissions, where it is not advisable to wind motors, say, under 50 H.P., directly for voltages as high as 5,000 or 6,000, the starting taps may be conveniently provided right into the transformer secondary. Hereby, the cost of the squirrel-cage type will be reduced so as to become about 10 per cent. cheaper than a corresponding rheostatic motor. This method of starting has also been applied with success to rotary converters and synchronous motors which in the moment of starting are comparable with squirrel-cage induction motors. A double-throw switch as shown in Fig. 3 will start the induction motor or converter on reduced voltage so as to prevent the flowing of excessive currents in the line. The figure shows the advantage of the △ connection in such arrangements, which allows the starting by means of a V tapping at, say, half the voltage, thus requiring only a double-pole instead of a triple-pole switch.

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The only point left for discussion is the influence which the starting current of such motors has on the system. The cos ϕ of a rheostatic motor at starting will lie in average between 0·8 and 0·85,* while a corresponding motor of the squirrel cage type will mostly give figures as low as 0·15 to 0·20, or, in the first case, from 50 to 60 per cent., lagging current will be introduced against 94 to 97 per cent. in the latter, assuming that both types start with approximately the same total current, the torque, of course, being different.

The final decision whether a squirrel-cage motor can be used in any particular case will now depend upon the following conditions: (*a*) Size and quality of the generating plant, (*b*) character of the service, (*c*) character of the rest of the load. The generating plant should be large compared with the individual motors—at least from 10 to 12 times the kilowatt capacity which the largest motor has in H.P. The larger this ratio the less effect will be produced at starting. Further, the regulation of the generator should be good, say, between 5 and 7 per cent. at full non-inductive load where a lighting load is to be supplied from the same 'bus bars, and from 7 to 8 per cent. at full non-inductive load where power only is to be considered. In the first case, the lighting load itself will tend to improve the resulting power factor and thereby decrease the drop in volts produced at the moment of starting, which point mostly is overlooked. In the second case, a drop in voltage, even of 15 to 20 per cent., should have no serious consequences, as all modern induction motors are designed with a liberal margin in overload capacity, which will allow them to continue their operation even at such a reduced voltage. It should, however, be understood that the above only refers to motors which have to start as given under 1, and which are using a compensator or transformer at starting.

As to the character of the service, a good deal depends whether the motor has to be started frequently or whether the process of starting occurs only once or twice in a day, or can be so arranged that the main station is notified beforehand. In such a case even "comparatively" large sizes of squirrel-cage motors can be successfully operated, particularly if the starting happens at periods where there is very little lighting to be done; for instance, a big motor driving a factory which has to be started early in the morning and perhaps at noon. We also meet in mining work the case that one very large motor, of perhaps several hundred H.P., for operating the main exhaust fan is driven by its own generator. Here it will also be recommendable to choose a squirrel-cage type and start it together with its generator. As to point (*c*), it may be repeated that where the conditions are not too severe, even in a lighting system, the larger squirrel-cage motors may be used to advantage if installed with the necessary judgment. It would be impossible to give here any more definite rules, but in view of the great advantages which this type offers, it will pay well to carefully investigate each case.

Though the writer has defended at some length the squirrel-cage type, he is well aware of the advantages to be obtained from the rheostatic type, if motors, which are large in comparison with the output of the generating plant, are required to start under full load and even overloads. While the first condition offers no difficulties and can be obtained with all rheostatic motors, the second refers in particular to motors for intermittent service, as used in crane, hoist and elevator work. Here the maximum starting torque is mostly the deciding feature, and, since the working periods are mostly followed by periods of rest, we may rate such motors more liberally. For instance, by a somewhat modified design, giving a higher magnetising force, the above 7·5 H.P. motor with a polar-wound rotor will give a maximum starting torque of about 13mkg., or about 3·5 times its normal running value. The rating could be increased for intermittent service to 12 H.P. without exceeding the allowable temperatures. If speed control is required, a controller and a resistance of a larger current carrying capacity have to be used.

In connection with this kind of service, we may say a few words about slow-speed against moderate-speed motors which, however, do not apply to the ordinary conditions, where the higher-speed motor is always preferable as being cheaper, smaller and more efficient. All these advantages are lost by the large gearing required for crane, hoist and elevator work, and where it is, besides, very difficult to obtain a noiseless operation with high-speed gearing. The slow-speed motor also offers a smaller moment of inertia, which means a reduction in the time and power required for starting and stopping the motor.

Taking, again, for an example the above 7·5 H.P. motor, with four poles, at 1,500 revs. per min. against a 12-polar 7·5 H.P. at 500 revs. per min. we get :—

For the two motors.	Moderate speed.	Slow speed.
Weight of rotor	70kg.	130kg.
Diameter of rotor	24cm.	41cm.
Energy required for starting.....	2·28	1·0

The foregoing notes, I hope, will contribute to a general understanding of the problems connected with the installations of this type of motor, which has won such high favours in America and on the Continent, due to its simplicity and its reliability.

* Motors which have to start under heavy loads, as will be discussed further below, show figures for cos ϕ at starting as high as 0·9—0·95, their running value, however, being considerably lower.

ELECTRICITY WORKS ACCOUNTS.

Oxford Electric Co. (Ltd.).

This company's accounts for 1901 are most disappointing in the matter of costs. We had hoped that the improvement effected during 1900 in the repairs item was a step only in the reduction of the expenditure under this head to a reasonable amount. Unfortunately, not only have these expenses risen, but there is an increase also in the fuel item. It is necessary to state that nearly £500 was spent out of revenue in fitting two boilers with new fire boxes. The baneful influence of the two items above referred to is perceptible even in the total costs, notwithstanding that some reduction has taken place in the management charges. These latter also remain too high.

As the result of an increase in the average revenue received per unit, the working profit in proportion to the capital expenditure shows a rise from 4·82 to 5·15 per cent. £500 was placed aside to the renewal and reserve fund, and £2,051 paid in interest, leaving a net balance of £2,809.

It is more gratifying to find that with an increase of 21·3 per cent. in the lamp connections much better progress in the extension of business was made than in 1900, when the corresponding advance was only 12·9 per cent. Probably the diminution in the load factor was due to this greater increase.

The following table shows the progress in former years :—

Year.	Number of consumers.	Equiv. 8 c.p. lamp connections.	Output. Units sold.	Plant capacity. Kilowatts.
1893	...	7,670	103,895	240
1894	...	11,206	157,257	240
1895	225	15,003	207,633	340
1896	270	19,058	291,640	600
1897	340	21,364	343,567	630
1898	420	25,928	374,033	630
1899	500	29,538	426,720	630
1900	600	33,338	483,699	855
1901	573	40,458	569,561	825

Cambridge Electric Supply Co. (Ltd.).

A highly creditable reduction of the total costs is the chief and gratifying feature of the Cambridge accounts for 1901. The fuel costs were so diminished that the works costs are lower by 0·23d. per unit than they were in 1900.

The distribution of expenditure at this place is unexpected. At 2·58d. per unit the total costs are about 0·2d. under the average of stations of like size and load factor, and this position seems almost entirely due to the comparatively low fuel costs, for the other expenses are generally up to or above the average.

Owing to a diminution in sundry receipts rather than in the revenue from supply the total receipts per unit show a

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	OXFORD.		CAMBRIDGE.	
Undertaking Worked by	Oxford Electric Co. (Ltd.).		Cambridge Electric Supply Co. (Ltd.).	
Date of Commencement of Supply	June, 1892.		November, 1892.	
System of Supply	High-pressure continuous-current transform'rs		Alt.-current trans. sub-stations and house trans.	
Chief Engineer	F. H. Francis (*pro. tem.*).		H. B. Harvey.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	657,051	803,020	508,121	563,135
„ **SOLD (TOTAL)**	483,699	569,561	357,435	382,224
„ sold to consumers	437,408	523,138	344,790	380,689
„ sold for public lighting, &c.	46,291	46,423	1,535	1,535
„ sold for traction	nil	nil	nil	nil
„ used on works	173,352[a]	—	11,110[a]	7,815
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	21·3	21·7	15·6	10·2
Actual maximum supply demanded	468 kilowatts[b]	667 kilowatts	436 kilowatts	508 kilowatts
Load factor	11·8%	9·74%	9·36%	8·6%
Number of public lamps	32 arc, 40 glow	32 arc, 48 (16 c.p.) glow	1 arc	1 arc
Number of consumers	600	573	430	526
Connections to mains in 8-c.p. lamps at end of year	33,338	40,458	31,320	34,723
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	855	825	939	1,460
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£150,000 / £175	£150,000 / £182	— / —	— / —
Share	100,000 / 117	100,000 / 121	£100,000 / £106	£100,000 / £68·5
Loan (including Debenture charges)	— / —	50,000 / 60·6	— / —	— / —
RECEIVED (TOTAL)	100,500 / 118	110,370 / 134	62,025 / 66·0	71,792 / 49·1
Share	50,000 / 58·5	60,370 / 73·2	62,025 / 66·0	71,792 / 49·1
Loan (including Debenture charges)	50,500 / 59·1	50,000 / 60·6	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	39,630 / 48·0	37,975 / 40·4	28,208 / 19·3
Share (unissued)	50,000 / 58·5	39,630 / 48·0	5,770 / 6·14	5,770 / 3·95
Share (uncalled)	— / —	— / —	32,205 / 34·3	22,438 / 15·4
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	— / —
DEPRECIATION FUND	2,000 / 2·34	2,500 / 3·03	2,500 / 2·66	3,249 / 2·22
EXPENDED (TOTAL)	101,210 / 118	111,064 / 135	68,571 / 73·0	73,842 / 50·6
Lands and buildings	7,585 / 8·87	7,834 / 9·49	11,877 / 12·6	12,967 / 8·98
Plant	49,179[c] / 57·5	53,666 / 65·0	33,614 / 35·8	34,826 / 23·8
Mains	39,586 / 46·3	44,070 / 53·4	21,810 / 23·7	24,384 / 16·7
Miscellaneous	4,861 / 5·69	5,495 / 6·66	1,270 / 1·35	1,664 / 1·14
BALANCE OF CAPITAL ACCOUNT	−710[d] / −0·83	−694[d] / −0·84	−6,546[b] / −6·97	−2,050[b] / −1·40
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£10,788 / 5·350d.	£12,860 / 5·420d.	£9,814 / 6·590d.	£9,855 / 6·192d.
Revenue from supply	10,048 / 4·985d.	11,938 / 5·034d.	8,799 / 5·906d.	9,372 / 5·890d.
„ meters, &c.	220 / 0·109d.	257 / 0·108d.	391 / 0·263d.	373 / 0·234d.
„ public lighting	453 / 0·225d.	450 / 0·190d.	23 / 0·015d.	23 / 0·014d.
„ supply for traction	nil / —	nil / —	nil / —	nil / —
„ miscellaneous sources	67 / 0·033d.	214 / 0·090d.	601 / 0·404d.	87 / 0·055d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£6,047 / 3·000d.	£7,404 / 3·120d.	£4,087 / 2·745d.	£4,114 / 2·584d.
TOTAL WORKS COSTS	4,286 / 2·126d.	5,427 / 2·287d.	2,971 / 1·994d.	2,804 / 1·761d.
Generation of electricity	*3,730 / 1·851d.*	*4,870 / 2·053d.*	*2,888 / 1·939d.*	*2,684 / 1·686d.*
Fuel (including cartage, &c.)	1,531 / 0·760d.	2,130 / 0·898d.	1,509 / 1·014d.	1,226 / 0·770d.
Oil, waste, water, stores	126 / 0·063d.	161 / 0·068d.	240 / 0·161d.	196 / 0·123d.
Wages at station	946[e] / 0·469d.	1,045[i] / 0·441d.	799[e] / 0·536d.	864[i] / 0·543d.
Repairs and maintenance at station	1,127 / 0·559d.	1,534 / 0·647d.	340 / 0·228d.	393 / 0·250d.
Distribution of electricity	*556 / 0·276d.*	*557 / 0·235d.*	*83 / 0·056d.*	*120 / 0·075d.*
Wages, &c.	153 / 0·076d.	171 / 0·072d.	83[d] / 0·056d.	120[j] / 0·075d.
Repairs, renewals of mains, &c.	403 / 0·200d.	386 / 0·163d.	— / —	— / —
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,761 / 0·874d.	1,978 / 0·834d.	1,116 / 0·749d.	1,310 / 0·823d.
Net rents	*151 / 0·075d.*	*179 / 0·075d.*	*409 / 0·275d.*	*415 / 0·261d.*
Rates and taxes	*249 / 0·124d.*	*328 / 0·138d.*		
Management	*1,361 / 0·675d.*	*1,471 / 0·620d.*	*707 / 0·475d.*	*895 / 0·562d.*
Salaries	835[f] / 0·414d.	834[j] / 0·352d.	443[e] / 0·297d.	612[k] / 0·384d.
Stationery, &c.	89 / 0·044d.	82 / 0·035d.	152 / 0·102d.	180 / 0·113d.
Establishment charges	181 / 0·090d.	206 / 0·087d.		
Law charges &c.	256[g] / 0·127d.	349[k] / 0·147d.	112[f] / 0·075d.	103[l] / 0·065d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£4,741 / 4·82%	£5,457 / 5·15%	£5,727 / 8·97%	£5,741 / 8·06%
Sum carried to Depreciation Fund	250 / 0·254%	500 / 0·472%	750 / 1·57%	750 / 1·05%
Sum carried to Reserve Fund	79 / 0·081%	97 / 0·091%	— / —	— / —
Net interest on loans (incl. Debenture charges)	1,966 / 2·00%	2,051 / 1·93%	194 / 0·304%	340 / 0·478%
Net profit for the year	2,446 / 2·49%	2,809 / 2·65%	4,084[g] / 6·39%	4,679 / 6·57%
BALANCE FROM LAST ACCOUNT	74 / 0·075%	156 / 0·147%	211 / 0·330%	39 / 0·055%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	2,656[h] / 2·70%	2,965 / 2·80%	4,295[g] / 6·73%	4,718 / 6·63%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	5% / —	5% / —	7% / —	7% / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	56·0%	57·6%	41·7%	41·7%
Expenditure per mean kilowatt capacity	£8. 6s. 5d.	£8. 16s. 5d.	£5. 11s. 10d.	£3. 8s. 7d.
REVENUE PER MEAN KILOWATT CAPACITY	£14. 17s. 0d.	£15. 6s. 0d.	£13. 8s. 0d.	£8. 4s. 5d.
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	6s. 11d.	7s. 0d.	6s. 7d.	6s. 0d.
Price charged for lighting, per unit	6d.	6d.	7d. to 3½d.[h]	7d. with discounts
Price charged for power, per unit	4d.	4d.	3d.	3½d.
Price charged for public lighting	By contract.	By contract.	£23 per arc per ann.	3·60d. per unit
Receipts per unit for private supply	5·51d.	5·48d.	6·12d.	5·91d.
„ „ public lighting	2·35d.	2·33d.	3·60d.	3·60d.
„ „ traction	—	—	—	—

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drop of 0·4d. per unit. The return on the capital has thus suffered, but as there were no calls made on profits as in 1900 for preliminary expenses and the suspense account, it was found possible to divide 7 per cent. on the ordinary shares and carry forward about £119 to next year.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 1900
Ayr (Municipal)	Oct. 11, 1901	Kens'gton & Knightsbr'(Co.)	Apr. 11, 1902
Barnsley (Municipal)	Jan. 17, 1902	Kingston-upon-Hull (Mun.)	July 13, 1900
Bath (Municipal)	April 20, 1900	Kingston-on-Thames (Mun.)	July 20, 1900
Bedford (Municipal)	Aug. 3, 1900	Lancaster (Municipal)	Feb. 15, 1901
Belfast (Municipal)	Oct. 18, 1901	Leeds (Municipal)	Oct. 11, 1901
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 26, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal	Oct. 4, 1901	Leyton (Municipal)	Nov. 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Sept. 13, 1901
Bristol (Municipal)	Aug. 30, 1901	Morley (Municipal)	June 14, 1901
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	April 21, 1899	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	Aug. 9, 1901	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	April 12, 1901	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Nov. 29, 1901
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	April 12, 1901
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 16, 1901	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 23, 1900	Richmond (Company)	June 29, 1900
Croydon (Municipal)	Nov. 22, 1901	Salford (Municipal)	Jan. 24, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	Scarborough (Company)	Dec. 20, 1901
Derby (Municipal)	Jan. 26, 1900	St. Helens (Municipal)	Jan. 10, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dover (Company)	May 2, 1902	St. Pancras (Municipal)	July 5, 1901
Dundee (Municipal)	Dec. 6, 1901	Sheffield (Municipal)	Feb. 1, 1901
Eastbourne (Municipal)	Mar. 14, 1902	Shoreditch (Municipal)	Jan. 31, 1902
Edinburgh (Municipal)	Dec. 6, 1901	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Exeter (Municipal)	Aug. 5, 1898	South London (Company)	May 16, 1902
Folkestone (Company)	May 2, 1902	South Shields (Municipal)	Sept. 20, 1901
Glasgow (Municipal)	Sept. 27, 1901	Southampton (Municipal)	Feb. 8, 1901
Gloucester (Municipal)	Aug. 30, 1901	Southport (Municipal)	Jan. 17, 1902
Great Yarmouth (Mun.)	Dec. 13, 1901	Stafford (Municipal)	Aug. 16, 1901
Greenock (Municipal)	Aug. 30, 1901	Sunderland (Municipal)	Oct. 18, 1901
Guildford (Company)	Oct. 19, 1900	Taunton (Municipal)	June 16, 1899
Halifax (Municipal)	Dec. 27, 1901	Tunbridge Wells (Mun.)	Nov. 1, 1901
Hammersmith (Municipal)	Nov. 15, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hampstead (Municipal)	Nov. 22, 1901	Walsall (Municipal)	May 23, 1902
Hanley (Municipal)	Aug. 9, 1901	Wandsworth (Company)	May 9, 1902
Harrogate (Municipal)	Jan. 25, 1901	Westminster (Company)	April 4, 1902
Harrow (Company)	Dec. 21, 1900	Whitehaven (Municipal)	Feb. 8, 1901
Hast'gs & St. Leonards (Mun.)	July 12, 1901	Winchester (Company)	May 17, 1901
Hereford (Municipal)	Jan. 17, 1902	Windsor and Eton (Co.)	July 19, 1901
Hove (Company)	May 10, 1901	Woking (Company)	Dec. 22, 1899
Huddersfield (Municipal)	May 23, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Hull (Municipal)	Sept. 20, 1901	Woolwich (Company)	May 31, 1901
Isle of Wight Company)	Dec. 20, 1901	Worcester (Municipal)	April 18, 1902

REMARKS.

OXFORD.—*a* And in distribution. *b* Being 4,680 amperes at 100 volts. *c* £1,333 on public lamps, £2,965 on accumulators and £4,787 on meters. *d* Over-expended. *e* Proportion of engineers' salary £170. *f* Directors £415. *g* Insurance £150, carriage and cartage £48, auditing £32 and law £27. *h* £136 premiums on debenture stock. *i* Proportion of engineers' salaries £169. *j* Directors £115. *k* Insurance £171, law £90, auditing £32, carriage and cartage £57.

CAMBRIDGE.—*a* Sold to the company at 3¼d. per unit (being units used on works offices and workmen's houses). *b* Over-expended. *c* Includes proportion of engineer's and officers' salaries £104. *d* Includes proportion of officers' salaries £13. *e* Salaries of managing engineers, secretary, accountants' clerks, &c., £233 and directors £210. *f* Auditing £33, law £41 and insurance £38. *g* After deducting £250 to extinction of preliminary expenses and £449 to extinction of suspense account. *h* Maximum demand system (1-hour scale). *i* Proportion of engineers' and officers' salaries £131. *j* Proportion of officers' salaries £15. *k* Salaries of manager, engineer, secretary and accountants £292, directors £210. *l* Law £7, insurance £64, auditing £33.

ELECTRICAL TRACTION ON STEAM RAILWAYS IN ITALY.*

BY PROF. C. A. CARUS-WILSON, M.A.

(Concluded from page 273.)

Working Expenses and Receipts.

The working expenses of the Italian railways are given in Table II. These figures actually refer to the Adriatica Railway, but as the corresponding figures for the Mediterranean Railway are almost the same, they may be taken as representing the cost of running on either of the great systems. To afford a comparison, the figures for the cost of running an English railway are placed in the same table. A distinction has been made between those expenses which do and those which do not vary with the number of trains run. Thus, to the locomotive expenses comprising wages of driver, water, oil and repairs have been added the cost of conductors' wages and carriage repairs. All these expenses vary with the number of trains run, and are, therefore, dealt with apart from those, such as the maintenance of the line, which do not so vary.

Table II.—*Running Expenses per Passenger Train-mile.*

—	—	English.	Italian.
1	Coal	1·72d.	5·30d.
2	Wages of driver and stoker	3·81d.	3·18d.
3	Wages of conductor	1·52d.	2·08d.
4	Water, oil, &c.	0·77d.	0·60d.
5	Repairs, locomotives	2·39d.	3·52d.
6	Repairs, carriages	2·83d.	6·01d.
	Total	13·04d.	20·69d.

Note.—English items 2, 4, 5 and 6 from official returns for the Great Northern Railway for 1900.

Italian items 2, 3, 4, 5 and 6 from official returns of the Adriatica Company for 1899.

Item 3 under English costs, obtained by taking the wages of driver, fireman and conductor in the proportion of 42s., 22s. and 25s.

Table III.—*Giving the Receipts and Expenses per Mile.*

—	English.	Italian.
Fixed Expenses.		
Maintenance of the line	£535	£132
Traffic expenses	1,350	236
General expenses	537	53
Total	£2,422	£421
Running expenses	£1,750	£699
Receipts.		
Passenger traffic	£2,640	£640
Goods and miscellaneous	3,820	965
Total	£6,460	£1,605
Expenses in per cent. of receipts	65	70

Note.—The figures in this table are obtained from the same sources as those in Table II. "Per mile" means per mile of line regardless of the number of parallel tracks.

The coal consumption on an English railway is taken at 40lb. per train-mile, and the cost at 8s. per ton. The actual consumption of coal on the locomotive on the Italian railways is given in the official reports as 41lb. per train-mile. The statistics draw no distinction between the weight of an average goods train and that of an average passenger train, but the passenger train mileage is stated to be 68 per cent. of the whole train mileage. Taking the weight of coal per passenger train-mile to be 70 per cent. of that per goods train, the coal consumption per passenger train-mile would be 36lb., which brings the cost, at 27s. per ton—the price paid in 1899—to 5·3d. per train-mile.

In order to compare the running expenses with the fixed expenses, they have both been reduced to pounds per mile per annum, and placed in Table III., together with the receipts estimated in the same way. The running expenses of an Italian railway constitute a far larger proportion of the total expenses than is the case on an English railway, the percentages being 62 in the former case and 42 in the latter. The proportion of passenger to goods receipts is nearly the same, while the sum of all the expenses is 70 per cent. of the receipts in Italy and 65 per cent. in England. The receipts given for the Italian railways refer to the Adriatica system as a whole, and are greater than the receipts of the lines that are now being electrified. Thus the passenger receipts for the section Lecco–Colico are only £380 per mile per annum; for the section Sondrio–Chiavenna, £220; whereas for the section Milan–Varese–Arona–Laveno the passenger receipts are £600 per mile per annum. The most profitable section in the Mediterranean Company's system is the line from Milan to Genoa, which is six times as profitable as the average for the whole system; the most profitable on the Adriatica system is the line from Milan to Como—the continuation of the St. Gothard Railway—a line common to the two systems, and yielding to each railway three-and-a-half times the average receipts per mile on the Mediterranean.

The expenses of maintenance, traffic and central administration on an Italian railway amount to £421 per mile per annum—about one-sixth of what it is in England. Of the item for traffic expenses in Italy, £213 per mile is for station expenses, out of which, again, £170 per mile is for the personnel at the stations. The Adriatica Company is seeking to reduce this item by the adoption of the "economic" system of working the line referred to above.

Fares.

The fares charged on the various railway lines in Italy are given in Table IV. Column A gives the through express fares on the main lines, and column B the fares for the so-called omnibus trains which stop at all stations. Column C gives the reduced rates charged for omnibus trains on certain sections of the main lines—those, namely,

* Paper read before the Institution of Electrical Engineers, May 15th.

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where the competition with the tramways and economic lines is most keenly felt. Thus, on the lines Milan–Gallarate–Varese, where there is direct competition, reduced rates are charged. The rates in the economic lines are given in column E, while the tramway rates will be found in column F. The rates in column E cover both omnibus and express trains, whereas the "reduced" rates are exclusively for omnibus trains, so that the main lines do not offer such a good service for the same money as the economic lines, even at the reduced rates.

Table IV.—*Showing the Passenger Fares, in Pence per Mile, Charged on the Different Italian Lines.*

Lines	Main.				Economic.		Tram.
Power	Steam.		Electric.		Steam.		Steam.
Service	Exps.	Omnbs.	Exps.	Omnbs.	Exps.	Omnbs.	Omnbs.
Schedule speed (miles an hour)	25	16	45	25	25	16	9
Fares charged	Exps. A.	Ord. B.	Reded. C.	Ordny. D.	Ordny. E.		Ordny. F.
First class	2·1	1·9	1·5	0·9	1·5		0·9
Second class	1·4	1·3	1·0	—	1·0		0·7
Third class	1·0	0·8	0·5	0·5	0·6		—

The Train Service.

The service of steam trains that formerly ran on the Milan–Varese line is given in Table V., with the time occupied in covering the different sections. This may be compared with the new service of electric trains, particulars of which are also given in the table. Thus, on the line from Milan to Gallarate the schedule speed has been nearly doubled and the frequency increased 3·5-fold. On the line from Gallarate to Varese the speed has been increased 75 per cent. and the frequency about fourfold. The old trains, hauled by steam locomotives, have been replaced by trains of about half their weight, consisting of motor cars and trailers, the normal train consisting of one motor car and one trailer, weighing together 67 tons unloaded, and capable of carrying 165 passengers, or about one-half the accommodation of the steam-driven trains. The carrying capacity of this portion of the line, in passenger miles, has thus been increased 75 per cent. Between Gallarate and Arona and between Varese and Porto Ceresio the speeds have not been increased on account of the grades, which are as much as 2 per cent., and the trains will run with the motors in permanent series connection.

Table V.—*Giving the Steam and Electric Train Service on the Milan–Varese Railway.*

—	Miles.	Max. Grade.	Min. curve chains.	Trains each way per day.		Time in minutes.	
		%		Steam.	Elec.	Steam.	Elec.
Milan to Gallarate	25·0	0·6	40	10	35	60	34
Gallarate to Varese	11·7	1·0	25	7	27	28	18
Gallarate to Laveno	19·4	0·8	30	6	8	81	50
Gallarate to Arona	16·0	1·1	17·5	5	8	45	45
Varese to Porto Ceresio	8·8	2·0	15	5	6	28	28

The Cost of Working the Electric Service.

The cost of running the new electric service on the Milan–Varese line may be estimated approximately from the cost of working the old service, and is given in Table VI.

Coal.—The coal consumed per ton-mile in the steam generating plant, pending the completion of the hydraulic power-house, will probably be not much less than that used on a steam locomotive if the speed and rolling-stock is the same in both cases. Thus, as the weight of the electric trains is about half that of the old steam train, the coal used per train-mile will be halved. Possibly this assumption does not do justice to the economy of the electric system, but there is not sufficient data available to warrant a more favourable estimate being made. The speed is, however, nearly doubled, so that if the same rolling-stock were used the tractive resistance, and hence the coal consumption, would be increased. But the type of rolling-stock is being improved, and short two-axle carriages are being replaced by long coaches running on bogies, so that the tractive resistance at the higher speed should not exceed that at the lower speed by more than 25 per cent., bringing the coal consumption to 23lb. and the cost to 3·4d. per train-mile.

(*Note.*—The author learns from Signor Tremontani, the engineer of the Mediterranean Railway, that the coal consumption for a service of trains consisting of one motor-car and two trailers is 285lb. per train-mile. The weight of these trains is one-third greater than that estimated in the Paper, as it was found necessary to add a second trailer on account of the increase in the traffic. This increase in the weight of the train would have brought the author's figure for coal consumption up to 31lb. per train-mile; his estimate, therefore, appears to be about 10 per cent. too high. At the present time only 20 trains per day are running each way between Milan and Gallarate, and 17 between Gallarate and Varese.)

Wages.—The driver and fireman are replaced by one motorman at about half their combined wages, and, as the electric train is always ready to start up, a further saving of about 20 per cent. should be effected in comparison with a train hauled by a steam locomotive which has to spend a considerable time in the shed. These savings should reduce the item for locomotive wages to 40 per cent. of its former value—that is, to 1·27d. per train-mile. The item for conductors' wages will be reduced 20 per cent. owing to the saving of time mentioned above, and will be 1·67d. per train-mile. The wages at the generation station will amount to about £4,000 per annum: for a line 80 miles long, and with 28 trains per day each way, the cost would come to 0·58d. per train-mile. The wages at seven rotary sub-stations should not, together, exceed the wages at the generating station, making the cost for this item 0·58d. per train-mile.

Water, Oil, &c.—The cost of water, which is 25 per cent. of that for water and oil combined, will be saved, reducing this item to 0·45d.

Repairs.—The cost of repairs will be reduced. On the City and South London Railway, during 1901, the cost of locomotive and generating repairs per train-mile, including wages and materials, was 38 per cent. of the locomotive repairs on the Great Northern Railway. Taking 50 per cent. of the cost of steam locomotive repairs, the cost of repairs for electric motors and generating stations would amount to 1·76d. per train-mile. As the electric trains are one-half the length of the steam trains, the carriage repairs per train-mile will be halved; this item will thus be reduced to 3d. per train-mile. The total cost of running would thus be reduced from 21d. to 12d. per train-mile.

Table VI.—*Showing the Comparative Cost of Running an Electric and a Steam Line in Italy and in England in Pence per Train-mile.*

—	Italian.		English.	
Trains each way per day	Steam. 8	Elec. 28	Steam. 8	Elec. 28
Coal	5·30	3·40	1·72	1·07
Wages of driver and stoker	3·18	1·27	3·81	1·52
Wages of conductor	2·08	1·67	1·52	1·22
Wages at generating station	—	0·58	—	0·58
Wages at rotary sub-stations	—	0·58	—	0·58
Water, oil, &c.	0·60	0·45	0·77	0·58
Repairs, motors and generating station	3·52	1·76	2·39	1·20
Repairs, carriages	6·01	3·00	2·83	1·41
Total	20·69	12·71	13·04	8·16
Figure used in the Paper	21·00	13·00	13·00	8·00

Estimate of Traffic.

The passenger traffic required to pay the expenses of the new electric service can now be estimated. On the Milan–Gallarate–Varese line the service is being increased from eight to 28 trains per day, while the cost of running is reduced from 21d. to 12d. per train-mile. The cost per mile of line is thus increased from £510 to £1,110 per annum. To this must be added the interest on the capital expended in the electric installation. The total estimated cost is 10 million francs, or £5,000 per mile. At 3½ per cent. this would add £175 per mile to the increased cost of running, making the total increase £775 per mile per annum. See Table VII. The passenger receipts for this line, including the extensions to Arona and to Laveno, are £600 per mile per annum. Hence the passenger traffic must be

Table VII.—*Showing the Expenses in Pounds per Mile per Annum of Running a Steam Service of Eight Trains and an Electric Service of 28 Trains each way per day in Italy and in England.*

—	Italy.			England.	
Power used	Steam. Coal.	Electricity. Coal.	Electricity. Water.	Steam. Coal.	Elec. Coal.
Number of trains each way per day	8	28	28	8	28
Cost in pence per train-mile*	21	13	9·5	13	8
Running expenses	£510	£1,110	£810	£320	£680
Interest	—	175	175	—	280
Total	510	1,285	985	320	960
Increase	—	775	475	—	640
Per cent. increase in traffic required to pay expenses	—	129	80	—	61

* With rotary sub-stations.

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increased by 129 per cent. to pay the interest and the increased cost of running. With transformer sub-stations the running expenses are decreased 5 per cent., and the increase of traffic must then be 114 per cent. On the completion of the hydraulic power station coal will no longer be used, and this item in the cost of running will be saved. The cost per train-mile will then be reduced to 9·31d., or, say, to 9·5d., making the total increase in expenses £475 per mile per annum, and the increase in the passenger traffic required to meet this increase 80 per cent., as compared with 129 per cent. for a steam plant. With transformer sub-stations the increase need only be 72 per cent. The value of water-power may, therefore, be represented by a reduction of 20 per cent. in the passenger traffic required to pay expenses.

On the Lecco line the service of steam trains was formerly about half as frequent as on the Varese line. The proportional increase in the number of electric train-miles will be about the same, so that the increase in the cost of running per mile of line, with transformer sub-stations, will be £150 per annum with water power. The capital expenditure has been about eight million francs, or £5,000 per mile, involving an interest charge of £175 per annum, which, together with the increase in the running expenses, brings the total increase to £325 per annum. The passenger receipts are here much less than on the Varese line, being £380 per mile per annum for the section Lecco–Colico, £220 for the section Colico–Sondrio–Chiavenna, and £330 per mile for the whole line. Thus an increase of £325 per annum will require an increase in the passenger traffic receipts of 128 per cent. The conditions of working an electric service on this line are, therefore, not quite so favourable as on the Varese line.

Reduction of Fares.

The extent to which a combination of reduced fares and increased travelling facilities augment traffic has long been made a subject of careful consideration by the Italian railway companies. For some time past the Adriatica Company has been investigating this question experimentally on the line connecting Bologna with St. Felice, referred to above. The experiment was made with cars driven by electric accumulators. The speed and the frequency of the trains were both doubled, and the fares reduced to 40 per cent. of their original amount. The result has been that the passenger traffic has increased five-fold, and the receipts have been doubled. The fares on the new electric trains are given in Table IV., and are good for all trains, whether express or omnibus. On the Milan–Varese line the reduced rates, as given in column C, have been available on omnibus trains only, express fares being charged on all express trains, about 20 per cent. of the total passenger receipts on this line being at the express rate, and 90 per cent. of the receipts from third-class passengers. If this proportion is maintained under the new conditions, the falling off in the receipts due to the reduction in the fares would be about 20 per cent., if there were no increase in the traffic. It has already been shown that to pay the expenses of the new service at the old rates the traffic must be increased 80 per cent. if water power is used, so that with the new rates the traffic must be rather more than doubled. With the new electric service on the Milan–Varese line the minimum fare is still about the same as before—namely, a halfpenny per mile—but whereas formerly this rate only entitled a passenger to travel on an omnibus train, it now entitles him to travel by any of the express trains, the speed of these trains being twice what it was before, and the service three or four times as frequent, so that for those who formerly patronised the express trains the fares have been halved and the speed doubled. The speed of the omnibus trains is also doubled, but owing to the number of stops the saving in time is not more than 30 per cent. The new service has been inaugurated by the railway company in confident expectation that the improved service will increase the amount of traffic to such an extent that the receipts, even at the lower rates, will more than pay the expenses.

Comparison of the Conditions of Running an Electric Service in England and in Italy.

It may be useful to compare the figures obtained above for the conversion of a steam to an electrically-driven railway in Italy with those that would be obtained under similar conditions in England. If the reduction in the weight of the train and the increase in the service are in the same proportion in the two cases, the proportionate reduction in the running expenses will also be the same. With this assumption the cost will be reduced from 13d. to 8d. per train-mile; the different items are given in Table VI. With a similar increase in the train service—namely, from eight to 28 trains each way per day—the working expenses would be £680 per mile per annum, as compared with £320 with the former steam service, or an increase of £360 per mile. The electric installation would probably be more costly than that for the Italian lines, and might come to £8,000 per mile, on which the interest at 3½ per cent. would amount to £280 per mile per annum. The total increase in the expenses would thus be £640 per mile per annum.

The passenger receipts for 1900 for the Great Northern Railway, to take a definite case, averaged 43d. per train-mile, at which figure the receipts on a line running eight trains each way per day would amount to £1,050 per mile per annum; the average for the whole of the Great Northern Railway being £2,460. Hence, to make up for the increased cost of the electric service the passenger traffic on such a line would have to increase 61 per cent. if the fares were unaltered. With halfpenny fares the traffic would have to be trebled.

It seems clear that, whether in England or in Italy, the full advantages of electrical traction cannot be obtained without an increase in the total running expenses, and this increase can only be met by a corresponding increase in the passenger traffic, so that the change from steam to electricity should not be made unless the increase in traffic may be reasonably expected at least to cover the increased cost of running and the interest on the capital expenditure.

Most railway managers would probably admit that the use of electricity on existing railways is worthy of consideration, and some will even go so far as to say, "If you can show that we should reduce our expenses by adopting electricity we would do so." It is not, however, by reducing expenses that electricity is going to help the railways, but in enabling them to offer greatly increased travelling facilities to the public at a figure impossible with steam traction, and thus to meet the growing competition of the tramways.

In answer to the question as to why the Italian railway companies are adopting electrical traction, it is often urged that they are doing so because of the saving effected by the use of water power in place of coal. This is, however, very far from being the case, since even with water power the expenses cannot be met unless the traffic increases. The use of water power simply reduces the increase required to pay, the reduction in the case of the Italian lines being 20 per cent. The prospects of success in England with cheap coal are more favourable than they are in Italy with water power, as is shown by the fact that the increase in the traffic required to pay expenses is less in England than in Italy.

The figures given above do not take any account of the relative possibilities of travel development in the two countries. Milan has a population of 471,000, about equal to that of Birmingham, but the towns along the line now being electrified are all quite small, Gallarate having a population of 8,000, Varese of 6,000, and Arona of 4,000, the largest being Busto Arsizio with 13,000. Taking the different lines radiating from Birmingham, by way of comparison, we find that the united populations of the two largest towns on each line within a radius of 45 miles amount to 39, 41, 63, 86, 101, 109, 121, and 185 thousand. With these figures before one, it is difficult to avoid the conclusion that the possible increase in travel is far greater in England than in Italy, and that if there is a field of usefulness for electrical traction on Italian steam railways, there is a still greater field of usefulness on the railways of our own country.

I wish to express my thanks to the officials of the Strade Ferrate del Mediterraneo, and of the Strade Ferrate Meridionali, and in particular to Signor Ing. Victor Tremontani, Signor Ing. Pietro Lanino, and Signor Ing. Leone Olper for their kind assistance in furnishing me with data and information. I am also indebted to Signor Tremontani for the views and plans in Figs. 3, 5 and 6, and to Messrs. Ganz & Co. for the view in Fig. 2. In preparing the maps and profiles the following have been consulted:—The map of Italian railways published by the Instituto Geograpico Militare, and the official train sheets of the Adriatica Railway Co.

DISCUSSION.

The PRESIDENT said this Paper had come at a most opportune moment, having regard to the proposed visit of the members to Italy next year. He had read it with great interest, and considered that the author had done the railway companies of this country a great service in dealing with the question, as he had, from the commercial point of view. It was simply the commercial aspect that would affect the railways of England. Railways were commercial institutions, their object being, of course, to earn fair dividends for their shareholders; and if it could be shown that by the introduction of electricity an advantage was to be gained in the economising of expenses or by an increase in receipts, then railway companies would be equally anxious, with electrical engineers, to adopt electric traction; but he was afraid that many, in reading this Paper, might feel inclined to doubt whether such would be the case. Prof. Carus-Wilson came to the conclusion that railway companies had to look not so much to economies as to increase of passengers, and this he very much questioned with respect to British railways. He was not in harmony with the author in his deductions, because it appeared to him that there was not a fair comparison between the railways described in Italy and those in Great Britain. British railways were much more costly, and, further, the present traffic necessitated a much larger number of trains even with steam working. However, he was glad that the Italian Administration were dealing with the question, not in the same sense as it had often been suggested it should be dealt with by the British authorities—viz., by an enormous increase in speed. They were taking fair speeds and not extravagant ones, which meant the employment of much higher power. He felt quite sure that if increased facilities meant increased traffic on such lines as had been mentioned in the Paper, similarly increased facilities on British railways would be attended with far better results.

Mr. CHARLES STEEL, late general manager to the Great Northern Railway, said he felt bound to endorse the remarks of the president. The conditions of railway working in Italy and the character of the traffic, were widely different from what they were in this country. If the introduction of electric traction upon existing railways was to depend upon a

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large increase of traffic, this could only be accomplished where there was a huge population to work upon. But taking two points on the Italian lines, say Milan and one of the country places, there was a large oscillating traffic, and it did not follow that because there was a frequent service between these two places that there would necessarily be an increase in the traffic. When people travelled they usually had an object in view, and people would not travel between Milan and the country places simply because there was a frequent service if they did not wish to go for any other purpose. Taking the case of London, he said this was altogether different, but even in respect of London traffic he must point out a fallacy which existed in the author's Table VII., and he would be very glad if Prof. Wilson would remove the impression which this table had created upon his mind. The expenses of running eight trains were shown as compared with running 28 trains—3½ times as many. The figure for the eight trains was £320 in the case of steam and £960 with electricity for 28 trains. But whilst with the shorter trains there were the same number of vehicles as with the longer and less frequent trains, the expenses were three times as large. Therefore, the expenses were being increased enormously and the traffic was not. This brought him back to the point as to the kind of traffic which must be considered in dealing with this question. In the case of suburban traffic this was heaviest in the morning and evening, but during the daytime there were comparatively few people travelling, and therefore these trains would be running at a loss without an increase of traffic, and further than this, trains of two vehicles were not adapted for dealing with London suburban traffic. Then there was another difficulty to which the author had called attention in respect of the introduction of electric traction into this country. It was impossible to run trains at short intervals over already crowded lines. Taking the case of the Great Northern Railway, he could not run a five-minute service over the main lines. What would become of the ordinary traffic of the day? This was one of the great difficulties with which the existing railway companies of this country had to contend, and with which they would continue to have to contend. We could not reduce the fixed expenses as was possible in Italy. They had had a specimen of a so-called railway station out there, but the Board of Trade which existed here, and would continue to exist, would not allow such a station to be used. The block system of signalling would have to be continued, and whenever they came to deal with electric traction upon existing lines there would also have to be considered in connection with it what effect it would have upon the block system. His own opinion was that so far as the main railways of this country were concerned, there was not much hope of electrification, and certainly not in the suburbs of London. Electrical railways must be railways for passenger traffic only. If it was impossible to introduce electricity on steam railways, what was the alternative? Additional lines must be provided, but the cost of the necessary lands in the vicinity of London was simply prohibitive. He was sure of this—*i.e.*, that railway chairmen and directors would be very slow to introduce any system which would increase the working expenses, and which left the question of the increase of traffic as a problem to be solved in the future; and he was afraid that this was the position which Prof. Wilson had put before them in connection with the introduction of electricity. His own view was that the great question of overcrowding was to be solved by electrical locomotion, but he did not think the existing railways were to be the means by which this great problem was to be solved. At the same time, he must express the hope that electric railways would continue to develop, and that the condition of the working classes and overcrowding would be solved by this means in the not far distant future.

Mr. H. M. SAYERS thought the last speaker had given one of the reasons why England was behind Italy in electrifying its main railways. Excepting for a pious hope expressed in his last few words, Mr. Steel's interesting speech had been a series of *non possumus*. Prof. Wilson had earned the gratitude of all engineers, and especially electrical engineers, by taking a live sample and discussing it in this very careful way. Commercial elements were the first to be considered. We had been treated during the last few months to a very interesting series of Papers showing how various electrical engineers would electrify railways if they had a chance, and it was very interesting to note that so many people were willing to try their hands at the problem; but before they could get that chance they would have to show that it would pay, and they had a very hard problem in the way of conviction before them. At the same time he would like to point out that we had some examples nearer home than Italy, which showed that increased facilities *did* increase taffic. Within the last five years a good many tramways had been converted to electric traction, and in many instances the systems had been enlarged from a mere few miles to tramways running well outside the limits of the particular towns, linking up large towns with small ones. One example of such a system with which he was acquainted in its palmiest days of steam working carried about 1,600,000 passengers. But in the first year of electrical working over a very slightly increased length of line it carried 6,000,000 passengers. What was the difference in the character of the service? Exactly the difference which Prof. Wilson had shown was the difference between the character of the steam and electric services on Italian lines—viz., more frequent trains, greater speed and lower fares. It was a very curious thing that tramway statistics showed that the earning capacity of any car with a carrying capacity of from 28 to 63 passengers was almost a fixed figure—viz., from 8d. to 1s. a mile, and this meant, of course, that as many cars as possible should be run. This was where electricity would help the main steam lines. What was the trouble with English main lines? The enormous capital expense that had been incurred in the construction. They worked at somewhere between 50 and 65 per cent. of their earnings. Of the balance, he supposed that four-fifths went to debenture interest; at any rate, the balance which was left for ordinary shareholders was somewhere in the neighbourhood of 45 per cent. It was perfectly certain that a quite small increase in the traffic, even if it were accompanied by an increase in working expenses, would increase the dividend, besides paying the cost of the electrification capital. Last year he had occasion to consider the case where two large towns in this country were connected by competing lines, and it was a revelation to him to find what a small passenger revenue these lines had. It had also been found that if one of these lines was electrified and used for passenger traffic it would be capable of carrying four times as many passengers as the other one and leave this latter open for goods traffic, and also leave a very good dividend on the cost of construction. Mr. Steel had remarked that people travelled for a purpose. They did, but there was some proportion between the purpose which would make a man travel and the trouble and cost in time which it took to travel. He himself would travel a good deal more if railway travelling were more expeditious and it were not such an infernal nuisance to get from Mr. Steel's main line on to the Lancashire and Yorkshire, for instance. It was because the time tables were designed with utter disregard to the meeting of trains on different lines, and because the services on many cross country lines gave intervals of from 2½ to 5 hours between trains. When it came to travelling for pleasure, people choose the lines and places to which they could get cheaply and quickly and without changing or waiting about. If one could go to a London terminus and be sure of being taken to any town by a particular railway without waiting more than 20 minutes or half an hour, a great many more people would travel both for pleasure and business purposes.

Mr. W. R. COOPER, criticising Table VI., thought it was a little misleading to the uninitiated, because it looked as if it were simply a comparison between steam and electric traction on equal terms. It was all right when one came to analyse the figures, but people did not do that, unfortunately, and were inclined to take matters as they looked on the face. As to drivers and stokers, we would not be allowed to drive a locomotive in this country with one man, and therefore we could not hope for the economy in this item. The author took 3½ per cent. for his interest, which was a low figure. In the final section of the Paper, in which the conclusions of the author were given, there were some misleading statements also. The conclusions of the author really amounted to saying that there must be an increase in traffic, no matter what the traffic was, for electric traction to pay, and this conclusion was arrived at by assuming an increase in the number of trains run. Of course, this assumption must necessarily also lead to an assumption of increased traffic in order to make the railway pay. As to the competition of tramways, he presumed that the author was dealing with main lines, and in this country these lines would not be affected by tramways in the same way that they were in Italy. Anyone who had travelled on the main lines in Italy would notice that they were quite different to our own. The trains were run at a very slow speed, they stopped at every station for about five minutes, and one need never be troubled about a train being late. In fact, it could not be unless it stopped altogether. In this country, however, it was possible for trains to be late. Therefore, he did not think a comparison could be made between the two countries. In England, of course, there were slow trains which might be run faster, but the expresses could not run much faster, and what was wanted was a true comparison between electric traction and steam traction with the speeds at present employed. It was really not a question of increasing the traffic. This came in in connection with suburban lines, and not main lines. There would not be many people travelling from London to Manchester or Liverpool for pleasure, and if the service was accelerated by half an hour or so it would not make many more people go. In the consideration of main line problems, authors seemed generally to limit themselves to passenger traffic, but he thought it would be well to take in account goods and mineral traffic as well. On a main line the passenger traffic was probably only about one-third of the total traffic on the line, and it was run much more economically than the other classes of traffic. With the other classes there were the difficulties of shunting and sidings to be got over, and this was a matter which he was not at all sure had not been rather exaggerated. But it was worth while thinking over from the electrical point of view, because steam locomotives were run under very bad conditions for shunting purposes. In a Paper read by Mr. S. Johnson before the Institution of Mechanical Engineers in 1898, that gentleman pointed out that the shunting of passenger trains amounted to 13 per cent. of the train-mileage actually run on the lines, whereas the shunting of the goods and mineral trains amounted to 38·7 per cent., and on that account the coal consumed by passenger trains per train-mile was 36lb., and by mineral trains 62lb. Going further, and investigating what this amounted to in I.H.P. per hour on the locomotive, it would be found that it was still greater, because, although the trains were heavier than the passenger trains, they ran at a very much slower speed. Therefore, it would be well for authors to take into account goods and mineral traffic, as well as passenger traffic.

Mr. ARNOLD LUPTON said he was in agreement with Mr. Steel, but he did not know of any engineer who had really grappled with all the problems that had to be considered in dealing with this main line traffic on such a line as the Great Northern Railway working under electrical conditions. On the suburban lines where the trains were running under comparable conditions to the Italian lines the same class of circumstances arose, and, naturally, involved the same treatment. By reducing the length of the trains and increasing the number, the traffic would be greatly increased. There was not the slightest doubt that in country districts in England it was owing to the small number of trains that the people did not travel. In some country places it was a whole day's work to go 20 miles and back again. And here it was he thought that Mr Steel was right—viz., that one of these days there would be separate electric railways. Referring to Table VI., which gave a comparison of English steam and electric railways, according to the author's calculation, he took it that there would be a vast deal more horse-power developed at the generating station than there would be in the corresponding steam locomotives, and that the extra cost of this was met by the more economical engine and the cheaper kind of fuel used at the generating station. Probably, also, the economy

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of fuel in favour of electricity would be greater than the author calculated, because he was dealing with trains of half the length, and this would only give half the cost of fuel per train mile. There was, further, the probability that gas engines would be used for generating electricity, which would bring down the amount of fuel to ¾lb. of slack per I.H.P. at the generating station. Then, again, with regard to the item of water, oil, &c., he hardly thought this would be 0·58d. if it was 0·77d, in trains twice as long. But there was an additional item which the author had not added, but which he perhaps had in his mind. In comparing the cost of steam and electric railways in England and Italy a considerable item for the interest on the electrification had been added. But as the author was speaking of existing railways there would also be the interest on the cost of the steam lines as well. It was only when new lines were constructed that this could be omitted.

Major-Gen. C. E. WEBBER suggested that the discussion of this Paper should be adjourned until the commencement of next session, as it was of such importance that full justice could not be done to it at one meeting.

The PRESIDENT thought it would be unfair to Prof. Carus-Wilson if his Paper was carried over in the ordinary sense until next session, because the author would naturally like to have the Paper printed, and the members would no doubt also prefer to have the observations of the speakers put into print. But he would try and meet the suggestion this way—the author would be called upon to reply to the discussion so far, and then to supplement this reply by some further information which no doubt he would be able to compile between now and November, which would be read at the first meeting after the inaugural address next session.

Prof. CARUS-WILSON said he left himself entirely in the hands of the Institution. Replying to the discussion, he said this had emphasised what he had felt in other discussions on this subject. An author tried to take up a certain line and used certain terms, but, with the very best feelings and intentions, speakers found a difficulty in entering into the author's position and understanding what his intentions were; and they naturally worked along a different line and made criticisms which were perfectly just and true, but which did not always affect the real question which it was intended to bring forward. The most striking instance of this was as to what they all meant by main lines. In several remarks that evening this question had come up again and again, but nothing was further from his intention than that the main lines of this country should be electrified forthwith. The railways in Italy were defined by the number of trains per day which he had dealt with, and he did not think anyone could say that a service of eight trains per day was a main line service. To begin with, he thought he could at once offer a reply to the criticisms of the president, when he stated that he did not think the general trend of the statements in the Paper offered a fair comparison between the state of affairs in Italy and those in Great Britain. What they had to do was to compare line with line, and to take a line such as was now being electrified in Italy and compare with a line carrying the same amount of traffic in England. If that were done they would have the very fairest basis of comparison possible. It was a very difficult thing to gauge the character of the traffic which might be expected on a line, and when the president had remarked that we, in England, had very much more traffic to deal with than was the case on the Italian lines, he presumed he had in his mind a comparison of one of our main lines with such a one as that running from Milan to Varese. But a very large proportion of the mileage of our lines were lines comparable with that from Milan to Varese. An immense proportion of the mileage of our lines consisted of lines upon which there were not more than eight trains per day, and the comparison was not, perhaps, such an unfair one. The remarks of Mr. Steel, of course, came with very great weight from one who had for so long carried on the very responsible work of manager to one of our greatest railways. Mr. Steel put the difference between his view and the view expressed in the Paper in the clearest possible way, which greatly emphasised the position he himself took up. The introduction of electricity upon suburban lines, which were at all comparable with those now being done in Italy depended entirely upon an increase of traffic. What he firmly believed was that it was only by looking forward to the increased facilities for developing traffic that electricity would ever be introduced upon lines such as these. He never for a moment suggested the introduction of a five-minute service on a main line. In fact, throughout the Paper there was no mention of anything like a five-minute service. 35 trains a day was not a five-minute service; and considering that there were a number of lines in this country upon which there was only one train every two hours, it was here that the advantages of electricity would come in. Mr. Cooper had said that it was not fair to consider simply a case in which the train service was increased, as, if the train service was increased, so was the cost of working, and it was not fair to confine oneself to that, but cases should be taken where the train service was not increased, and the motive power simply being made electricity and not steam. In this Mr. Cooper had struck a fundamental point of difference of the way of looking at the whole question. The great advantage of the introduction of electricity was that it enabled an increase in the frequency and speed of the service, and it was only, in his opinion, when one could do this that it was worth while to introduce electricity. But simply to introduce electricity for steam on such lines as those in Italy did not seem to him to offer any advantage. Mr. Lupton thought he had made the cost of fuel too high. He hoped he had. This was a criticism which he might be proud of, because he had endeavoured to be conservative in the statements he had made. As to the question of whether the cost of electrifying a line would be different if it were made *de novo* he had not gone into this. He had simply taken the cost of electrifying an existing steam line. He would commend to the members a portion of the Paper which he had not dealt with at any length—viz., that on the very last page of all, and this was necessary in some respects after the criticisms which had been made. He had endeavoured to find out what was the real possibility of an increase of traffic on this Varese line, and when the population along these lines was taken into account and compared with the populations on our own lines he did not think there could be any doubt that the possibility of increased traffic was far greater here than in Italy. Further, the railway companies of Italy had not approached this question in a policy of blind faith. According to the way Mr. Steel looked at the matter, this was the manner in which railway managers in this country were being asked to approach the question. Nothing would be more fatuous. In Italy the railway companies for years past had been carefully studying the connection which existed between increased facilities and increased traffic, and in this lay the whole secret of what they were doing now. They were electrifying the lines as the outcome of this consideration, and not simply as a physical experiment, and this was what the managers of our great railways should do. He did not suggest that they should forthwith equip their lines, but they should lose no time in taking steps to inform themselves on this very vital question. As far as he could see at the present moment, very little was known in England outside experience such as that of people like Mr. Sayers, but if more were known English railway managers would come to the same conclusion as the Italian managers, and be very much more hopeful as to the travelling potentialities of the British public.

The PRESIDENT having proposed a vote of thanks to the author, which was heartily given, the discussion concluded.

CORRESPONDENCE.

COMPENSATORS FOR WEAKENED MAGNETS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice on page 223 of your last issue a description of compensating instruments for the weakening of permanent magnets, and would take this opportunity of pointing out that this is not by any means a new idea, as a patent was taken out for this by Mr. Soames about eight years ago, and a number of these instruments have since been made by Nalder Bros. & Co., succeeded by Nalder Bros. and Thompson (Ltd.), in which the control was magnetic and the instrument was so arranged that the reading was independent of any weakening of the magnet.—Yours, &c., A. FREDK. HARRIS.

London, June 5.

G. E. C. FIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The General Electric Co. (1900), Ltd. wish to express their unqualified regret at the terrible results which attended the fire at their premises on Monday, the 9th inst., and to state that they are taking steps to give this sentiment practical shape.

They would also like to take this opportunity to convey to their friends and customers their thanks for the many expressions of sympathy received in letters, telegrams, and personal inquiries, and to inform them that the part of their premises which was involved is small. Business will be carried on exactly as before, and it is hoped that if at first one or two delays may have occurred the firm will receive indulgence on this account.

Hoping you will give this letter publicity.—Yours, &c.,

THE GENERAL ELECTRIC CO. (1900), LTD.
(M. Bing, Managing Director).

London, E.C., June 11.

PARLIAMENTARY INTELLIGENCE.

LONDON UNITED TRAMWAYS BILL.

On the Committee of the House of Commons which has this bill under consideration resuming last Monday, June 9, Mr. W. S. BOND, Chairman of the Electric Lighting, Parliamentary and Finance committee of the Wimbledon Council, was examined. He said that the Council in 1901 themselves promoted a tramway bill, but it was dropped. Communications were subsequently opened with the London United Company, and then the Council was almost immediately approached by the British Electric Traction Co. As soon, however, as that company saw the requirements of the Council they retired, and an agreement was then come to with the present promoters, which he considered to be satisfactory in the interests of the ratepayers. An overwhelming majority of the population in Wimbledon, both as regards population and rateable value, were in favour of the tramways. The street improvements and widenings which the company proposed to make in connection with the tramways would be a distinct advantage.

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The CHAIRMAN: Were these improvements precisely the same as you asked of the British Electric Traction Co.?—Precisely.

Mr. COWARD, K.C., said the widenings and improvements to be made by the company in Wimbledon were estimated to cost £165,000.

Further examined, Witness said that since the deposit of the present bill the railway company had extended the favour of third class season tickets for Wimbledon and Raynes Park, for which the residents had been asking for years.

Mr. BALFOUR BROWNE, K.C., in reply to the Chairman, said the London United Company were quite prepared, if the London County Council would allow them, to lay the small link of line necessary to connect the proposed line, No. 13, from Wimbledon along Haydon's-road to the London county boundary, with the authorised tramway just inside the boundary. He had no doubt that connection would be made, and in that case there would be a through route from Malden via Wimbledon to Clapham Junction.

The CHAIRMAN suggested that there should be a conference between the representatives of the promoters and the London County Council in regard to the construction of this link, which would be some 300yds. in length, and counsel undertook to take steps with that object.

Mr. G. H. Woodlands, chairman of the Wimbledon Urban District Council, and Mr. George Mason, a member of the same body, gave evidence generally supporting that of the last witness.

On Tuesday Mr. F. S. MALLETT, member for the Trinity Ward of the Wimbledon Urban District Council, gave further evidence in support of the Wimbledon lines.

Mr. MOON, K.C., for the London County Council, then referred to the suggestion made on the previous day as to the construction of a short spur needed to connect tramway No. 13 with the authorised line from Lower Tooting through Wandsworth to Clapham Junction. Mr. J. W. Benn, the chairman of the Tramways committee of the London County Council, had authorised him to say that if the Committee thought there was any necessity to make the connection he was prepared to recommend the County Council to make the connection themselves. They would resist most strenuously any proposition of the London United Company to come into the County of London.

The CHAIRMAN said the Committee would take counsel's guarded statement as an intimation that the Council would make the spur if it would pay them.

Mr. FITZGERALD, K.C., for the promoters, said the company knew the line would pay, and they were willing to make it.

A number of other witnesses from Wimbledon and New Malden then gave evidence in favour of the tramways proposed.

On Thursday (yesterday) further evidence was called in favour of the Wimbledon group of lines. After the examination of one of the witnesses,

Mr. PAGE, K.C., for the London and South Western Railway Co., said he should not cross-examine the witness, as their case would be that at present there was an efficient service.

The CHAIRMAN: Yes. I expect your case will be one of argument more than evidence.

Witnesses from Merton, and the clerk of the Croydon Rural District Council (which embraces Mitcham and Merton), also testified to the benefit which the lines would be to residents in their districts.

Local evidence in favour of the Hammersmith lines was then taken.

Mr. CLIFTON ROBINSON, re-called by the Chairman, said the existing line between Kew and Richmond and the new line from Richmond to Hammersmith would be quite unconnected physically with the rest of the company's system. That would not cause greater expense in working. Though physically disconnected at Kew and Hammersmith Broadway, the whole of the cables would be laid underground, and connected electrically. There would be no necessity for a generating station on the Surrey side of the river, the station at Chiswick being sufficiently large to generate all the current that would be required. The company had power to put cables under the river, and that would obviate the necessity of having physical connection with the tramways. Last year the company proposed to have a physical connection at Hammersmith Broadway in order to get the cars backwards and forwards. There was strong opposition to that by the local authority and the London County Council, because of the congestion of the traffic at that spot, and consequently the proposal was abandoned, and was not suggested this year. There would be a dead end to the tramway at Kew Bridge, and another within 300yds. of the company's terminus at Hammersmith.

Mr. COLLINS, the representative of Hammersmith on the London County Council, said that the Richmond and Hammersmith line would be of great assistance in relieving the congestion of population in Hammersmith, and would also help the London County Council to deal with the housing problem. The tramway would much appreciate the property in Bridge-road.

Cross-examined by Mr. PAGE, for the London and South-Western Railway: There were four trains per hour between Richmond and Hammersmith over the London and South-Western Railway.

Mr. G. HOBSON, examined by Mr. BALFOUR BROWNE, said he had 30 years' experience of bridge designing. He had examined the drawings from which the bridge was constructed in 1894 by the late Sir J. Bazalgette and also the structure. The width of the roadway was 27ft. except at the towers. The footway was outside the chains. If two cars were passing, 5ft. clear would be left on either side. The foundations, chains, towers, vertical rods and girders were sound and capable of carrying ordinary roadway traffic, as well as exceptionally heavy vehicles up to 15 tons in weight. If the bridge were covered by a crowd of people none of its parts would be overstrained. Such a load would mean a weight of about 800 tons on the central span of 400ft., the side spans being 145ft. each, and that would not strain the chains to one-fourth of their breaking point. 10 per cent. of the chains used in the construction of the bridge were tested to destruction. He should not think of approaching breaking point, the usual margin of safety being one-fourth. The breaking point of the chains used was 28 tons to the square inch. The weight of a tramcar fully loaded was 13 tons, which would be distributed over four pairs of wheels on a wheel base of 15ft. 2in. The weight of the car would be distributed over three or four cross girders of the bridge floor, which were 8ft. apart, and each of which would safely bear 25 tons.

Is there any portion of the bridge that will require alteration to suit it to the purposes of a tramway?—Yes, the wooden deck floor would have to be made suitable. That is composed of wooden baulks 10in. deep and covered with wood pavement 5in. deep. Even that alteration might not be necessary.

Do you know of any suspension bridge over which trams run at the present time?—No, I do not.

Cross-examined by Mr. MOON for the London County Council: Asked what was the meaning of the notice on the bridge saying that vehicles of more than 15 tons weight must not use the bridge, he said he did not think its deck would bear that weight. Oscillation was inherent in the design of a suspension bridge. Oscillation, within certain limits, had to do with the safety of the bridge, but he should not like to define the limit. A car weighing 13 tons, travelling at 10 miles an hour over the bridge, would cause some oscillation if the brake were put on. He had made no calculations as to the amount of oscillation which would be caused by two cars passing over the bridge if the waves of oscillation should happen to coincide.

By the CHAIRMAN: By bracing, the vibration could be diminished That would be rather costly, but he could not give an estimate of the expense it would involve. To widen the bridge would alter the structure entirely; but it could be strengthened without altering its character.

Mr. E. C. RAWLING, chairman of the Parliamentary committee of the Hammersmith Borough Council and other witnesses having given evidence in favour of the Hammersmith and Richmond line, the Committee adjourned.

NATIONAL TELEPHONE CO. (HULL) BILL.

On Tuesday this bill, which seeks to make further provision with respect to the Kingston-upon-Hull undertaking of the National Telephone Co., came before a Committee of the House of Lords presided over by Lord Hawkesbury.

Mr. BALFOUR BROWNE, K.C., for the company, said that before the passing of the Telephone Act of 1899, an agreement existed between the Company and the Corporation as to the laying of cables in the streets on the strength of which the Company had spent £103,000. After the Telephone Act became law the Corporation gave the Company notice terminating the wayleave, which, he contended, was an endeavour to secure a monopoly by an evasion, whereas it was clearly the object of Parliament to allow competition.

Mr. LITTLER, K.C., for the Corporation, said the two parties had entered into an agreement terminable by six months' notice on the part of the Corporation. This agreement was binding, and it was not for Parliament to interfere with the termination of it.

The Committee, after consultation, upheld this view, and the bill was accordingly rejected.

OTHER ELECTRICAL BILLS.

The Birkenhead Corporation Bill came before the Chairman of Committees of the House of Lords on Tuesday as an unopposed measure, and was ordered to be reported, with amendments, for third reading. The bill, which has already passed the House of Commons, seeks, among other things, further powers in respect of electricity supply.

The Exeter and District Tramways Bill, which was similarly ordered to be reported for third reading, contains a proviso that animal power may be utilised instead of electricity. This, also, has passed the House of Commons.

The Gloucestershire Electric Power Bill came before the Chairman of Committees of the House of Lords as an unopposed measure last week, and was duly ordered for third reading, it having passed through the House of Commons.

The Manchester Corporation (Improvements) Bill, which was considered and passed by a Select Committee of the House of Commons last week contains a section relative to the improvement of the electricity works, principally as regards railway sidings, bridges and subways in connection with the Stuart-street works.

The Newport Corporation Bill, which has already passed through the House of Commons (see *The Electrician*, Vol. XLVIII., p. 789), came before a House of Lords Committee on Tuesday. As was the case when the bill was before the other House, the Great Western Railway Company are opposing the tramways portion in respect of the trams passing over the railway lines on a level crossing, and propose the erection of a bridge. The Committee has not yet come to a decision.

The Bradford Corporation Bill seeks *inter alia* authority to construct additional tramways. Before a House of Commons Committee on Tuesday, it was stated that this section was unopposed.

The following bills have been read since our last issue:—

House of Lords, Friday, June 6—Garston and District Tramways and Electric Supply (Transfer), North Metropolitan Tramways and York Corporation, second time. Middlesex County Council Tramways, third time.

Monday, June 9—Central London Railway, Bristol Corporation and Wigan Corporation, second time.

Tuesday, June 10—North Metropolitan Electric Power, second time. North Staffordshire Tramways, Rossendale Valley Tramways, and Gloucestershire Electric Power, third time.

House of Commons, Friday, June 6—City and Brixton Railway, third time.

Monday, June 9—London County Council (Subways and Tramways), London County Council (Tramways and Improvements) and London, Tilbury and Southend Railway, third time.

Tuesday, June 10—Liverpool Corporation, third time.

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PATENT OFFICE FEES.

In the House of Commons on Tuesday, Mr. GERALD BALFOUR, replying to a question by Sir J. Leng, said that no reduction in patent fees was at present contemplated. The increase of staff, which would become necessary if the Patent Bill now before Parliament was passed, would greatly reduce the present surplus, but the work done would be of material benefit to the inventor.

LEGAL INTELLIGENCE.

G. H. Chard & Co. v. Manzel.

This action commenced before Mr. Hemming, K.C., official referee, on Friday last and continued on Monday, Tuesday and Wednesday this week. The claim was for £371. 11s. 10d. for electric and gas work carried out by plaintiffs to the order of defendant, proprietor of Gambrinus Restaurant, Rupert-street, London, W. Mr. P. T. Blackwell appeared for plaintiffs and Mr. J. R. Randolph and Mr. C. W. Tilley for defendant. Plaintiffs' case was that defendant instructed them in 1901 to proceed with the refitting of his premises for electric and gas lighting. No formal contract was entered into and no price fixed. Defendant at first said he would have combined electric and gas fittings, but, after brackets, wiring, gas barrels and conduits were fixed, altered his mind and decided he would have ceiling lights only. It subsequently transpired that defendant was applying for a music licence, which would necessitate two separate sources of light, and defendant again altered his instructions. The London County Council would not pass the combined fittings, and required the gas and electric light fittings to be separate, which rendered necessary further alterations. Two sums of £30 each had been received. Defendant denied liability, and contended that Messrs. Strode & Co. did the greater part of the electrical work, and that he (defendant) instructed plaintiffs to finish the work, which consisted of extending the connections, fixing up brackets and making a safety circuit in accordance with the regulations of the London County Council. He maintained that the price charged by plaintiffs was exorbitant, and that charges were made for goods which were never supplied. He complained also of the unreasonable time taken on the work. Plaintiffs had not even yet finished the work, and another firm had been called in to do so.

A counter-claim for about £600 was filed for pecuniary loss alleged to have been suffered owing to the postponement of the granting of the music licence, due to the unsatisfactory fittings supplied by plaintiffs, and the delay.

Mr. John Hewitt and Mr. L. G. Tate, consulting engineers, gave evidence that plaintiffs' charges were reasonable.

Mr. F. C. STUBBS, London County Council's assistant engineer, who first tested the installation, stated that he found the current too low on one circuit. He did not ultimately pass the installation.

After evidence for the defence had been furnished, judgment was given for plaintiffs for £258, with costs of the claim and counter-claim.

Satchwell v. Dunlap.

Mr. Justice Bigham, in the Commercial Court, on Wednesday, heard an action brought by Mr. F. J. Satchwell, M.I.E.E., against Mr. F. W. Dunlap also an electrical engineer, on a guarantee given by defendant that on the successful flotation of a certain company plaintiff should be entitled to remuneration for services he had performed.

Mr. BIRON said plaintiff was asked to make certain experiments as to a patent of defendant's. The invention was ingenious, and consisted of a spiral coil of glass wire wound round an electric globe, giving it a lens-like quality. Plaintiff found it could not be done in the way suggested by defendant because, to put the coil on as a whole it would have to be heated to such an extent that it would infallibly crack the glass. He, however, thought of a scheme by which it could be put on in sections and the difficulty avoided. He made certain tests which were so satisfactory that plaintiff approached him in October, 1896, with regard to a contract to be made between him and Mr. G. W. Smiley, to whom defendant and a Mr. Quaine were anxious to sell the patent with a view to offering it to a company. By the contract Mr. Smiley agreed, in consideration of the services rendered and to be rendered by plaintiff, to pay him £100 in the event of the sale of the patent to a limited company. Mr. Smiley, who subsequently died, obtained from defendant a guarantee, on which the present action was brought. The only defence was a suggestion that Mr. Satchwell did not, in fact, do the work. The patent was sold to the Spiral Globe Co. in 1899.

Mr. SATCHWELL said he had studied electric lighting appliances, and had considerable knowledge of glass and glass-blowing. He had been under-manager of the Sunbeam Company, which made glass globes, and in 1896 was manager to Mackie and Mackie, electric lamp manufacturers. The idea of the defendant's patent was to improve the power of the electric globe by putting a spiral coil round it. He made very satisfactory photometric tests both before and after the agreement, and afterwards assisted in the actual manufacture of the globes.

For the defence it was urged that no services were rendered after the signing of the guarantee. Plaintiff had attempted to make some of these globes, but the attempts were not satisfactory. The coils were too far apart and could not be wound without breaking, and in joining there were lumps, so that it was possible to see through them to the light inside. He, in fact, introduced defendant to a man named Müller, who made them in a satisfactory way and was paid from £75 to £100. The globes were not wanted in large quantities, but merely for purposes of demonstration. The patent was sold for about £2,000 in cash and £5,000 in shares. The Spiral Globe Co., whose nominal capital was £150,000, was now in liquidation.

His LORDSHIP thought plaintiff had done something, and suggested that there should be judgment for the plaintiff for £50 without costs, to be increased to £100 if not paid within a month.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Indian telegraph department invite applications for five appointments as assistant superintendents in the telegraph department of the Government of India. Commencing salary Rs. 4,200 a year. Further particulars of the secretary, judicial and public department, India Office, Whitehall, London, S.W., to whom applications by June 30. Some further particulars will be found in an advertisement.

A demonstrator in electrical engineering is required for University College, Nottingham. Applications to secretary (Mr. Philip H. Stevenson) by June 30. See advertisement.

A teacher of electric lighting and power transmission is required at the Acton and Chiswick Polytechnic, Bedford Park, London, W. Particulars are set out in an advertisement. Applications to Mr. W. H. Barker, B.Sc., by June 19.

An instructor in electric lighting and wiring, &c., is required by the Harrow District Technical Education committee. Application forms, &c., can be obtained of Mr. A. Fillmore, secretary, High-street, Harrow. See advertisement.

The Council of University College, Bristol, require a demonstrator in engineering, with workshop experience and training, &c. Salary, £120 per annum. Applications by July 4 to Mr. James Rafter, registrar and secretary. See advertisement.

The Electricity committee of Blackburn Corporation require a station superintendent for the electricity works. Commencing salary, £175 per annum. Applications (addressed chairman), Town Hall, Blackburn, by noon June 19. Mr. A. S. Giles is borough electrical engineer. See advertisement.

A shift engineer is required for Blackpool Corporation electricity works. Salary £125 per annum. Applications to Mr. Charles Furness, borough electrical and tramways engineer, Electricity Works, West Caroline-street, Blackpool, by 23rd inst. See advertisment.

An assistant engineer is required by the guardians of St. Mary, Islington (London), for their infirmary at Highgate Hill, N. See advertisement.

The position of principal of the Wandsworth Technical Institute is vacant. Applications to honorary secretary, 4, Galveston-road, Putney, London, S.W., by June 30.

An assistant master in engineering and mathematics is wanted for Birmingham Municipal Technical School. Salary £125. Applications by June 30.

A demonstrator in engineering is wanted for University College, Bristol. Salary £120. Applications by July 4.

An instrument maker is required for the Royal Technical Institute, Salford. Forms of application from the secretary up to June 23.

Broughty Ferry Council have appointed Mr. James Turnbull, of Willesden, as electrical engineer, under Mr. Forbes Waddell, manager of the Council's electricity department, at a salary of £156 per annum. Mr. Turnbull commences his duties in August.

Portsmouth Tramways committee on Wednesday appointed Mr. J. G. Lironi tramway electrical engineer at £200 per annum.

Aberdeen.—Col. Von Donop has made a Board of Trade inspection of the circular Queen's Cross, Bayview and Bridge of Dee and Bridge of Don electric tramway routes. The experimental surface-contact line on the sea-beach route was also inspected.

Alnwick.—Electricity supply may be commenced in Coronation week.

Aston.—Mr. E. A. Sandford Fawcett held an inquiry on Friday into the Council's application for sanction to borrow £52,436 for electricity supply. The clerk (Mr. J. Ansell) said numerous applications for current were in hand. The works were to be constructed with sufficient capacity both for lighting and for power and traction. The local tramways were to be acquired and converted to electric traction. There was no opposition.

Belfast.—The Council have agreed to supply current for power at Messrs. Harland and Wolff's Alexandra Dock Works on an undertaking by the company to consume current equal to 20 per cent. of the outlay for mains.

Berwick.—The Council are urging Edmundson's Electricity Corporation (Ltd.), who hold a provisional order for the district, to proceed to carry out its provisions.

Bexhill.—Messrs. Preece and Cardew have resigned their position as consulting engineers to the District Council, and Mr. Robert

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Hammond has been appointed to report upon the present position and future requirements of the electric lighting works.

The report on the second year's working of the electricity department to March 31 last shows the total revenue to have been £4,814. 6s. 10d.; expenditure, £2,736. 14s. 7d.; gross profit £2,077. 12s. 2d. Interest and sinking fund required £1,654 19s. 10d., leaving a net profit of £422. 12s. 4d. At the annual meeting on Monday the electrical engineer (Mr. W. T. Le Feuvre) was complimented upon the satisfactory result of the year's working.

Blackburn.—After a lengthy discussion, on Thursday last the Council decided to accept the tender of Messrs. Dick, Kerr & Co. for the supply of steam dynamos with Willans engines. Some considerable local feeling has been imported into the discussion of the question whether the engines of Messrs. Willans and Robinson or those of Messrs. Belliss and Morcom should be selected. The matter was ultimately referred to Prof. Kennedy, who recommended that Willans engines be adopted at Blackburn, and this recommendation was ultimately approved by 23 to 21. The amount of the tender is £18,127.

Blackpool.—The accounts of the electricity department for the past year show receipts from private lighting, £15,748; public lighting, £5,946; tramways, £6,123; sundries, £94—total, £27,911. Working expenses, &c., amounted to £17,200, leaving gross profit £9,192. 2,262,516 units were generated, compared with 1,760,459 in the previous year. 930 customers are connected, 90 miles of mains are laid and in use, and 260 arcs and 290 incandescents are in use for public lighting. Capital outlay was £25,939, bringing the total to £167,493, and sinking funds to £14,925. Six months' notice of termination of the Corporation's agreement with the Electric Free Wiring Syndicate is to be given.

Discussing, at Tuesday's meeting of the Council, the question as to whether a representative of the Corporation should attend the forthcoming Convention of the Incorporated Municipal Electrical Association, Ald. Grime stated that, by his attending last year's Convention, Blackpool had been saved £500 in coal! As no proposal was before the Council that a representative should be selected, the matter was referred back to the Electricity committee for reconsideration.

Blaydon.—The Council has accepted the offer of the owners of the Priestman Collieries to supply current for public lighting. The charges are to be £90 per annum for 15 lamps at Rowlands Gill and £60 for nine lamps at Barlow on a five years' agreement.

Bradford.—The Four Lane Ends–Allerton section of the electric tramways was opened on Friday. The Otley-road route is under conversion and the service of electric cars upon a portion of this route (from Otley-road to Peel Park) was commenced on Tuesday. The only remaining line to be converted is the Bankfoot and Shelf, now worked by steam.

Brighton.—Mr. H. Percy Boulnois, M.I.C.E., held an inquiry on Monday into the Corporation's application for sanction to a loan of £5,500 for electricity supply. Mr. Talbot (deputy town clerk) said it was proposed to instal a 325kw. storage battery, which would practically double the power of the existing battery installation, to meet the increasing demand for energy for working the tramways. The resident electrical engineer (Mr. John Christie) stated that no new buildings would be required. There was no opposition.

Broughty Ferry.—The Council have obtained sanction for borrowing £15,000 for electricity works.

Bury.—The gross profit on the Council's electricity undertaking for the past year was £2,356, against £1,774 in the previous year. Interest and sinking fund amounted to £2,515, against £1,932, leaving a deficiency of £158. This compares with a loss of £657 in 1901, and a profit is anticipated next year. The consumers connected are 305, equivalent to 24,668 8 c.p. lamps. This is an increase of 51 consumers for the year. The number of units supplied was 62,090, against 24,471. The Council are reducing the charge for current for private use to 4½d. per unit, and meter rents are also reduced.

Cardiff.—Mr. Arthur Ellis reports that the revenue of the electricity supply department for the year ended March was £15,515, against £11,153 in the previous year. Working expenses were £8,255, and after providing for interest, sinking fund, &c., there was a net surplus of £1,106. The number of lamps connected was 51,800, an increase of 14,300, and the units exceeded 1,000,000, compared with 688,000. The total revenue worked out at the low figure of 3·85d. per unit for private supply. Cardiff is now fifth on the list of stations as regards percentage of units sold to units generated. Authority has been given by the Council for certain extensions of the high and low-pressure mains.

The mayor formally inaugurated the Bute Docks section of the electric tramways yesterday.

Carnforth.—The Carnforth Hæmatite Iron Co. are putting down plant for electric driving at their works. The Willans standard compound engine has been selected, direct coupled to a Mather and Platt dynamo.

City and Guilds of London Institute.—Particulars are given in an advertisement of the courses of instruction, &c., at this institute for the Session 1902-3.

Colchester.—Lieut.-Col. A. C. Smith, R.E., held an inquiry on Thursday last into the application of the Corporation to borrow a further £8,500 for extension of electricity buildings, purchase of additional plant and mains, &c. The town clerk (Mr. H. C Wanklyn) said the demand for current had increased so rapidly that during last winter all available boiler power had to be used continuously. The inspector complimented the Corporation officials upon the completeness of the information prepared for the inquiry.

At last week's Council meeting the Electric Light and Power committee reported that a complaint of vibration had been lodged by the officials of the St. John's-green Baptist Church. The electrical engineer (Mr. A. R. Sillar) and the borough surveyor (Mr. H. Goodyear) are preparing a report and estimate as to the probable cost of introducing electric tramways into the town, the relative merits of several Continental systems, and as to the suggested erection of a refuse destructor in connection with the tramways.

Coronation Illuminations.—Maidstone Council will supply current on June 26, 27 and 28 at 2½d. per unit.

Colchester Corporation will supply current at 3d. per unit on 26th and 27th inst.

The Southampton Council have agreed to supply current to an equivalent of over 3,000 8 c.p. lamps for Coronation illuminations.

Bury Corporation will supply current for Coronation illuminations at cost (1d. per equivalent 8 c.p. lamp) from 8:30 to 12 p.m on June 26 and 27.

The Isle of Wight Electric Light and Power Co. have obtained a contract from Ventnor Council to fix, and light on the night of the 26th, the device "Edward VII." in 50ft. letters on the southern slopes of St. Boniface Down.

Coventry.—The Council seek powers to borrow £22,480 for the electricity department. £2,000 is required for electric motors for letting on hire, and the balance for plant of increased capacity to replace existing machinery at the station. The accounts of the department show an increase of net profit on the past year's working of £450. There was no opposition.

Customs Tariff Changes.—A duty of 1k 50ö. is now placed upon electric incandescent lamps imported into Norway, and 7½d. per lb. is the duty charged upon similar goods by the Russian customs authorities.

The Fiji Customs Commissioners notify that insulated wire used in connection with electrical machinery is classed under the heading of "electrical machinery" when imported into Fiji, and is admitted into the colony free.

Dawlish.—The proposal that Messrs. Crompton & Co. should erect and equip electricity works and provide a complete installation at their own cost and risk, allowing the District Council the option of purchase at stated periods, is being considered by a committee.

Doncaster.—The electric tramways were opened on Monday last, and after 2 o'clock in the afternoon, with only four cars running, 10,553 passengers were carried.

Dundee.—The Fairmuir section of the electric tramways was inspected on Wednesday.

Electric Power Plant in Works.—The Electric Construction Co. has recently completed an important electric power plant installation at the Horseley Co.'s works, Tipton, Staffs. The greater portion of the motors are some considerable distance from the power-house, and a 500-volt system is employed. The generating plant consists of an E.C.C. standard compound-wound 105 H.P. dynamo, driven by a Stockport gas engine. The motors installed are employed in driving line shafting in the fitting shops, hydraulic pumps, large shears, plate planing machines, &c. There are also a number of jib cranes, formerly steam driven, being equipped for electric driving.

Electricity in Coal Mining.—Electric coal cutters are to be adopted shortly in the Coal Creek Mine, Gippsland, Australia. The introduction of electric haulage is also contemplated.

Electricity in Colliery Working.—The British Westinghouse Company are supplying to the Bolsover Colliery Co., Chesterfield, a complete polyphase electric power installation for hauling and pumping in the colliery works.

Failsworth.—The Council are asking the Manchester Corporation on what terms a supply of electric energy can be made to the Failsworth district.

Frome.—The Council will probably shortly apply for sanction to borrow £16,400 for the establishment of electricity works. Mr. F. H. Medhurst is to be engaged as consulting engineer.

Glasgow.—The Corporation are taking over, at a cost of about £1,000, the Clydebank Tramways order, which the Clydebank Town Council obtained in 1901.

Figures prepared by the city electrical engineer (Mr. W. A. Chamen) put the approximate revenue of the electricity supply works for the financial year just closed at £104,000, against £79,449, and the units sold as 9,200,000, against 6,813,000 in the preceding year. The cost for fuel was £13,550, compared with £19,667.

Gutta-percha and Indiarubber.—According to a report which has reached Berlin, the South Sea Colonies gutta-percha and india-

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rubber expedition in German New Guinea (from Stephansort to the Bismarck Mountains) has resulted in the discovery of both gutta-percha and indiarubber of best quality in large quantities in the district.

Hamilton.—Edmundson's Electricity Corporation (who have acquired the Hamilton provisional order) have secured a site at Almada Hall for electricity works at a cost of £1,300.

Hereford.—The Electric Lighting committee's report states that the revenue for the year ended March was £2,124, and was, after providing for working expenses, taxes, &c. (£1,123), and interest on the debt (£593), sufficient to contribute £408 towards repayment of capital, leaving a deficit of £392. In the previous year the revenue provided £700 towards repayment of capital, leaving only £85 deficit. This difference is accounted for by a special honorarium of £105 to the surveyor (Mr. J. Parker) charged to revenue, £129 allowed in discounts, consequent upon reduction of period of maximum demand from two hours to one, and the provision out of revenue of condensing apparatus, tools, &c. The report was approved.

Ilford.—A Local Government Board inquiry was held here last week, by Col. W. Langton Coke, M.Inst.C.E., into the application of the Council to borrow, amongst other sums, £30,800 for electric lighting. The clerk (Mr. J. W. Benton) said the money was required to meet over-expenditure and cost of additions to the electrical plant and mains. The Council's consulting engineer (Mr. W. C. C. Hawtayne) gave technical details.

Kingston-on-Thames.—The Corporation are obtaining independent expert advice (at a fee not exceeding £100) as to the condition and prospects of the electricity supply undertaking.

Land Line Telegraphs in South Africa.—The Civil Administration will take over the telegraphs and telephones of the Orange River and Transvaal Colonies from July 1.

Light Railways.—The Southend (and District), Bradwell-on-Sea and Colchester Light Railway scheme is to be granted, except as regards as the line originally projected from Southend to Shoeburyness. This portion had previously been withdrawn owing to opposition of the Southend Corporation and the Great Eastern and London, Tilbury and Southend Railway Companies.

London County Council.—At Tuesday's meeting—the first after the Whitsuntide recess—it was agreed to loan Hammersmith £21,600, Stepney £95,642, and Stoke Newington £3,000 for electricity supply.

The purchase by the Council of the undertakings of the Woolwich and South-East London Tramway Co., the South London Tramways Co. and the London, Deptford and Greenwich Tramways Co. was approved.

Parliamentary sanction is to be applied for this session to enable the site of Pimlico Gasworks, which has been acquired, to be used for a generating station for the Council tramways in the western half of the County of London. The estimated net cost of the complete site is £120,000.

Lorenco Marques.—Electric hoists for the handling of merchandise are to be erected here, and arrangements are being made for a considerable extension of wharfarge and other facilities for handling goods for despatch over railway to the Transvaal.

Lynn.—The accounts of the electric lighting department for the year to March last show the total works costs £2,088, lamps, attendance and renewals £248, interest £1,119, sinking fund £1,310, total £4,765. The revenue from private consumers was £1,837, public lighting £1,664, street lamp attendance and renewals £248, meter rents £99 and profits on fittings £124, total £3,972, leaving a deficit of £793 compared with £1,068 in the previous year. Capital expenditure amounts to £44,460, and is £4,980 in excess of the authorised borrowing powers. 286,679 units were sold, against 245,009 in the previous year.

At Wednesday's meeting of the Council Mr. BROWN moved the appointment of a sub-committee to go into the accounts. He complained of the reduction in the price of current to private consumers and to the low charge for public lighting.

Mr. W. S. DEXTER, a member of the Electricity committee, said the price of current was reduced to get more customers and the number of consumers had as a consequence increased by 100 per cent.

Mr. FLOYD (chairman of the committee), pointed out that they had paid £1,469 off capital account out of income.

The resolution to appoint a sub-committee was carried.

Maidstone.—Ratepayers will oppose the application of the Council for a loan for the construction of a light electric railway from Maidstone to Barming.

Middlesbrough.—The borough electrical engineer (Mr. H. M. Taylor) has recommended that the electric lighting be extended, which has been approved.

Mr. Robert Hammond, consulting engineer to the Corporation, has reminded the Electric Lighting committee that sanction has been obtained to a loan for £1,350 to provide 40 arc lamps, and that mains have been made. Mr. Hammond points out that the Local Government Board objects to applications being made for moneys which it is not intended to spend. Furthermore, the nightly and continuous load on the works when these 40 additional arcs were employed would assist in reducing the cost of generation.

Municipal Loans.—Huddersfield Corporation this week invited applications to an issue of stock sufficient to realise £500,000, chiefly on electricity supply account.

The Borough of Durban (Natal) has this week issued a loan for £300,000 4 per cent. stock for the purpose of extending the electric tramways, the electric lighting of Durban and other public works. Already on a portion of the Durban tramways electric traction has been adopted with satisfactory results, and the town and a large portion of the suburbs are provided with electricity supply for lighting and power. This undertaking is well supported by a population numbering 57,000. It is officially announced that the issue has been subscribed about six times over.

Municipal Telephony.—Glasgow Corporation telephone department has opened a branch exchange for the Clydebank district.

Bournemouth Corporation have appointed a committee to consider the question of establishing a municipal telephone system.

Newport, I.W.—The Council have accepted the offer of the Isle of Wight Electric Light and Power Co. to light certain thoroughfares up to 11:30 p.m. with 30 1,000 c.p. arc lamps, and from 11:30 p.m. to 1 a.m. with 50 c.p. incandescents, at a charge of £14 per lamp per annum on a contract for five years.

Northampton.—It is announced that the negotiations between the Corporation and the Northampton Electric Light and Power Co. as to the purchase of the company's undertaking by the local authority are quite at an end. An offer made by the company, at the instance of the Tramways committee, to supply current at 1⅛d. per unit having been rejected, the directors have decided to proceed with the development of the company's undertaking irrespective of any question of purchase by the Corporation.

Peru.—In an interesting report on the trade and general condition of Peru for 1901, Mr. Consul-General St. John sets out his views upon the applications of electricity in this practically undeveloped country as follows:—

The use of electricity for purposes of illumination is increasing rapidly in Peru. The town of Lima is now entirely lighted by electricity. This illuminant is also extensively used in private houses in Lima, and supplied by three companies. The town of Arequipa is also lighted to a considerable extent by electricity, and companies are being formed for lighting Callao and Chiclayo in the same manner. The electrical plant chiefly comes from the United States. Notwithstanding the initial advantages possessed by the United States in the matter of electrical plant, it would seem that this is a branch of industry which fully deserves close attention on the part of British manufacturers, as the demand for electrical plant throughout South America, where there is so much water power, must eventually become enormous. British machinery of this class is barely mentioned in this country. German dynamos and motors have been tried, but, although well finished, they are looked upon as being too complicated.

It is also highly probable that a demand for power transmission lines for various purposes must arise sooner or later, as the natural configuration of the ground in this country can be turned to account for the development of immense power at comparatively little cost.

Telephonic networks exist in the departments of Lima, Piura, La Libertad, Arequipa and Ica. The total length of lines is probably over 3,000 miles. Moreover, a number of applications for further authorisations to put up new installations have been made lately. Most of the telephonic appliances now come from Sweden. Only very small orders have been placed in the United Kingdom, on the ground that the instruments and appliances made by British manufacturers are quite unsuitable for use in this country. Inasmuch as the demand for telephonic apparatus must, in the near future, become very large in South America, this branch of industry may be deserving more attention than it appears to receive at present in the United Kingdom.

All Peruvian towns, including Lima, require to be drained properly and to acquire furnaces for the destruction of refuse. This remark applies also to nearly all Central and South American towns. British manufacturers of refuse destructors might periodically send a short prospectus to all South American municipalities of any importance in which the advantages of the system should be explained, but, of course, in the language of the country. Another essential point is to furnish estimates of installations according to size, otherwise it will be thought that the cost of these installations is so high as to preclude all possibility of acquiring them. Time should also, in some cases, be given for payment.

An electric lighting company has been formed at Trujillo. Power is to be obtained from a waterfall on the river Moche, near Poroto, about 21 miles from Trujillo. The waterfall is about 180ft., and is calculated to generate 200kw. of electric energy. Tri-phase transmission is to be adopted. The installation should be complete by December, and will create a demand for electric appliances.

During 1901 the Trujillo Telephone Co. extended their connections to Oiuzco, Huamachuco and Cajabamba, in all about 300 miles. Great difficulty was experienced at first on account of the electric storms which arise in those mountainous districts, but the difficulties have been overcome and communication is both safe and constant. What was at first regarded with terror is now in continual demand.

Poole.—Bournemouth and Poole Electricity Supply Co. offer to supply the Council's public lamps with current at 2½d. per unit net, or to supply current to arc lamps, inclusive of cleaning, carbons, &c., lighted from dusk to midnight, at £15. 5s. per lamp per annum, or for 25 c.p. incandescents at £2. 7s. 6d. per lamp per annum. If the incandescents are lighted throughout the night the charge to be

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£3 12s.; 32 c.p. incandescents, lighted from dusk to midnight, £2. 16s. 6d., or lighted all night, £4. 7s. 6d. per lamp per annum.

Portsmouth.—The gross receipts of the Corporation tramways for the past year were £50,664, out of which the electric cars earned £21,857. The gross profit of the complete (electric and horse) system was £20,792. After deducting interest and sinking fund charges there was a loss on the undertaking of £5,184.

Presentations.—Mr. R. W. Francis, motor inspector of the Brighton Corporation tramways, was on Monday the recipient of a number of valuable presents on the occasion of his recent marriage. Mr. Francis came from Sheffield to Brighton in November last, and has carried out his duties with conspicuous success.

Mr. E. Dewar, assistant engineer at the High Wycombe electricity works, was presented last week by the staff and employés of the company with a gold chain on the occasion of his departure from the town.

Mr. C. M. Johnston, borough electrical engineer, Shrewsbury, on the occasion of his recent marriage received from the chairman and members of the Lighting committee a marble clock and pair of bronzes, and from the staff a barometer.

Mr. P. J. S. Tiddeman, the retiring resident electrical engineer at St. Anne's-on-Sea, who has been appointed to a similar position at Stoke-on-Trent, has been presented with an oak and silver tray by the St. Anne's electricity works staff.

Mr. W. H. Ridpath, outside engineer of the Lowestoft electricity department, has been presented by the staff with a double set of carvers as a wedding present. The presentation was made by the resident engineer (Mr. G. A. Bruce).

Rhyl.—The 140ft. "Eiffel" Tower to be erected here is to be surmounted by a 20,000 c.p. electric searchlight.

Richmond.—The Richmond Electric Light Co. has given notice of intention to change the pressure of electric supply from 110 to 220 volts to new consumers.

Rotherham.—In recommending for acceptance the tenders for tramway contracts set out on another page, the Tramways committee reported that the only portion of the material or rolling stock not manufactured in this country would be the trucks. The wheels would be supplied by Messrs. John Baker & Co., and the crossings by Hadfield's Steel Foundry Co.

Salford.—The inquiry before Judge Parry, reported in our last issue, was resumed on Friday last (not Thursday as we stated in error last week):—

Mr. C. L. TURNER continued his evidence as to the tenders for engines and boilers. He considered undue influence had been exercised in favour of the acceptance of certain tenders. He, however, admitted that, while he thought a report which was produced was intended by Mr. Clirehugh to help Galloways to obtain an order, he knew Mr. Clirehugh advised the committee to adopt engines of another type, and that, in fact, Galloways did not ultimately get the contract. He had been told by Mr. Clirehugh that Messrs. Galloways must have the job, and had ceased his criticisms, after being informed that "if he did not it would be the worse for him."

Mr. WILLIAM HUNT, elective auditor for the borough, said Messrs. Lacey and Clirehugh approved of Mr. Turner's plans and specifications at about £80,000. The present work would cost approximately £400,000, the result being that there were 12 boilers and 6 engines lying idle, and likely to be for some time to come. He considered that for this state of affairs there were only responsible the consulting engineers and the Electric Light committee, but the Council could not be held entirely free from blame. The consulting engineers were paid a commission on capital expenditure, and the more they spent the more they received. The responsibility rested with the professional advisers of the Electric Light committee. He protested against what had been done with respect to boilers, and said that to place in the hands of Sir Richard Mottram the responsibility of conferring with the consulting engineers as to the type of boiler to be adopted was unjust to other firms afterwards invited to tender. He further complained of what he regarded as a breach of contract by Messrs. W. H. Bailey & Co. The legal representative of that firm had given a formal denial of the charges. He thought this extraordinary, as that gentleman did not know what the charges were. He did not say the committee were endeavouring to unduly shield any firm of contractors, but that they had not exercised a due regard to the interests of the ratepayers. With regard to the works he considered it would have been possible to avoid the closing of Walness-road works and to have supplied all the requirements of electric traction from the other station.

Mr. S. V. CLIREHUGH then gave evidence as to the employment of his firm as consulting engineers. In their first report they suggested that less money should be spent than was proposed in putting down the electrical plant. He denied that they were at any time prepared to carry out the scheme on Mr. Turner's specifications. There was no truth in the statement that he altered the report at Sir Richard Mottram's instigation. Sir Richard had opposed the appointment of witness as consulting engineer. It was untrue that Sir Richard had influenced him in his recommendations. He had never been approached directly or indirectly on behalf of Sir Richard Mottram with a view of improperly influencing him on behalf of Mr. Haworth. It was entirely owing to information he had received that he had altered his report, and after a visit to Messrs. Galloways.

Sir RICHARD MOTTRAM said he took an interest in the matter of the electricity undertaking owing to a letter he received from Mr. William Mather. As an engineer himself, however, he thought it was better for him not to interfere. His action in the matter throughout had been in the interest of the ratepayers. He denied that he had advised in committee as to the acceptance of any tenders. He had spoken in favour of a particular type of engine. He did not attend meetings afterwards when tenders were accepted.

Mr. A. HAWORTH said he was appointed chairman of the Electricity committee of Salford Corporation when that committee was formed. He denied that he had told Mr. Turner there was a conspiracy to upset his specifications. He had no interest in any tender.

At this stage Judge PARRY said, with regard to Mr. Turner's dismissal, his view was that the subject did not come within the terms of the present inquiry.

Mr. WHEATCROFT then gave evidence as to the cable contract with Messrs. W. T. Glover & Co. This, he said, was not the lowest contract, and he contended that the report made by Messrs. Lacey, Clirehugh and Sillar distinctly favoured Messrs. W. T. Glover & Co., as against the lowest tender, that of the British Insulated Wire Co. He thought, however, so far as Messrs. Glover were concerned, that the contract was obtained honestly. Mr. Wheatcroft further urged that the consulting engineers had permitted Messrs. Glover to put down brick instead of stone troughs in the laying of the cables.

Judge PARRY asked why this charge had not been put into Mr. Wheatcroft's particulars.

Mr. WHEATCROFT said he wanted first to be quite sure, and he had not had the road taken up to satisfy himself on this matter till several days after the particulars were sent in.

Mr. TURNER also contended that the report of the consulting engineers was unequal and unfair to the other tenderers for the cables and mains. The contractors in this case did not carry out the work according to specification.

Judge PARRY: Do you suggest that Messrs. Lacey, Clirehugh and Sillar and Messrs. W. T. Glover & Co. committed fraud?—No.

Judge PARRY said he could not accept statements which merely suggested error. No doubt mistakes had been made.

COUNSEL for Messrs. Glover (Mr. Hawkins) said the cost of the troughs put in was almost identical with that of stone troughing.

Mr. A. E. TANNER, managing engineer for Messrs. W. T. Glover & Co., who carried out the work under the contract, said he advised the change as to the troughing to Mr. Clirehugh. The brick troughing adopted was superior to the stoneware troughing specified. He did not consider stoneware better than brickware underground.

Mr. W. HUNT, elective auditor, supported his complaint that Messrs. Galloway did not deliver the boilers to contract time. He contended that Galloways had departed from the specifications in regard to the mouthpieces and fittings of the boilers, and that the latter parts had been condemned by the Steam Users' Association on account of the material used in them.

Mr. GALLOWAY admitted the ground of the complaint as to the mouthpieces.

Judge PARRY held that if there was an deviation from the specification the Electricity committee's attention ought to have been called to it. There was, however, no suggestion of bad faith or of injury to the ratepayers.

Councillor JACKSON said Galloway's tender was £320 higher than another tender received, but it was accepted. He did not approve of the invitations to certain members of the Electricity committee to a luncheon at Messrs. Galloway's. He received an invitation but did not go. When the luncheon was mentioned in committee Sir Richard Mottram said Messrs. Galloway would not tender for the boilers.

In closing the inquiry, Judge PARRY said that, so far as Messrs. Wheatcroft and Hunt were concerned, it seemed to him that in bringing forward these matters they had done so in the public interest and not to serve their own ends. He left Mr. Turner out of this reference as his portion of the case might not be finished, and he did not wish to criticise. Having said this he had been considering whether, as his report would take some time, it was not due to the other parties that he should make a statement. On one point he had made up his mind, and it was only fair to the parties to state, with regard to Messrs. Lacey, Clirehugh and Sillar, that, though he did not think direct charges of fraud were made against them, there were certainly suggestions of fraud and ill-doing made which, hanging over them, must be damaging. He had yet to go into much detail, and might have to say whether or not they had been guilty of irregularities. He had, however, come to the absolute conclusion that nothing like fraud, ill-doing, or undue influence was made out against them. The same remark applied to Sir Richard Mottram. He saw no ill-doing. He might have to report that Sir Richard was indiscreet, but between doing ill and making a mistake or an error of judgment there was enormous difference. With regard to ex-Councillor Haworth and others, he found no evidence on which they were rightly to be charged with fraud, or ill-doing, or wickedness, or cheating of any kind. He would issue his report in due course.

Sevenoaks.—The Council are seeking information from the Kent Electrical Power Distribution Co. as to their intentions with regard to the company's electric lighting provisional order for the district, which expires in July.

Sheffield.—The report and accounts of the electric department for the year to March last have been presented by Mr. S. E. Fedden, the general manager and engineer, and shows that the capital expenditure to that date was £538,502, including £105,486 for the year under review.

The total income for the year was £39,831, cost of generation, management, &c., £13,586 and interest and sinking fund charges £20,641, leaving a surplus of £5,604, and bringing the total surplus to £11,898. This represents a profit for the year of 4·93 per cent. 447 new customers were added and 403 connected. 38 motors (total 53 H.P.) have also been connected to the mains. 2,487,584 units of current were generated during the year. Of this number, 2,407,584 units were sold. The total number

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of 8 c.p. lamps connected, which was in April, 1900, 100,000, had increased to 165,000 in March, 1902. The factory and wiring and fittings departments have made steady progress, orders received by the latter numbering 3,592, representing an additional 20,000 8 c.p. lamps, against 2,700 in the previous year. This department in the change over to 200 volts has overhauled all badly-wired installations, and has put them in safe condition for receiving the higher pressure. Many consumers have complimented the department on the manner in which this work has been carried out.

Mr. Fedden sets out particulars of the considerable extensions to the plant at the generating station which have been made during the year, including two 550kw. E.C.C. alternators, coupled to McLaren triple expansion engines; one 300kw. Parsons steam turbine; two Brown marine-type boilers, with Ellis and Eaves induced-draft and Bennis stokers; a cooling tower, capable of treating 180,000 gallons of water per hour. The cooling fans and pump are driven by Westinghouse two-phase motors. Two 60in. fans have also been erected in the station, and are driven electrically. The litigation between the Brush Company and the Corporation with regard to the 600kw. "Universal" set has been arranged, and terms for the reconstruction of the plant have been agreed upon. The overhauling of the mains has been very thoroughly carried out, and Mr. Fedden reports a marked improvement in their condition. The alterations in this department have reduced the number of extinctions for the 12 months to March, 1902, to 31, compared with 106 for the previous 12 months, notwithstanding that many miles of additional mains have been laid and connected. Eight sub-stations have been completed during the year, and the ninth is under construction. A jointers' school, which has been formed by Mr. Fedden to meet the difficulty of obtaining competent jointers for this department, has met with every success. The manufacture of transformers by the factory established by Mr. Fedden has also proved successful.

South Africa.—The *British and South African Export Gazette* announces that plans and specifications for the lighting of Ladysmith by electricity are being prepared. A site has already been selected for the generating station.

Durban municipal tramways were recently inaugurated. The total expenditure on the lines will, it is estimated be about £350,000. The complete network will be 25 miles in length. There are 40 well appointed, double-deck, 50-passenger cars at present on the system. The lines are only partly opened.

The authorities at Pretoria are considering an important scheme of electric lighting and power transmission, and the adoption of electric traction for the tramways of the city.

Mr. P. Hird, of Durban, has secured the adoption of a scheme submitted to the Town Council for a 10 years' concession for lighting Newcastle (Natal) by electricity. After the 10 years' period the Council have the right to either continue the term of the concession or to take over the installation at a valuation.

The value of electrical fittings imported into Natal for the first quarter of 1902 was £12,000, compared with £7,000 for the same period in 1901.

Southport.—The Electricity committee report that the surplus shown by the electricity undertaking accounts for the past year is £1,682, or £68 short of the amount promised in relief of rates. The report of the Electric Tramways committee shows that the receipts for the past year were £16,019, leaving a debit balance of £41, compared with a net profit of £81 for nine months of the previous year. The number of passengers carried was 3,317,963.

Stafford.—The resignation of the chief electrical engineer (Mr. J. H. Clothier) has been accepted by the Council, and an honorarium of £50 has been granted to him. As announced in our issue of May 30, Mr. Clothier has been appointed to St. Anne's-on-Sea.

Thirsk.—The Parish Council have decided that if the Northern Counties Electricity Supply Co. erect works at Thirsk or Sowerby, "the Council will adopt electric lighting for their street lamps for one year at a price not exceeding the price at present paid for gas."

Truro.—It is suggested that Messrs. Crompton & Co. should be permitted to establish and work electricity works at their own cost and risk, the Corporation to have the option of purchase at stated periods.

Tunbridge Wells.—The accounts of the electricity department for the past year show an income of £11,000, or nearly £2,000 more than for the previous year. The gross profit was £3,941, an increase of £1,600. £7,000 has been paid off capital, and 3d. in the £ applied to relief of rates. The surplus stands at £1,985. The units generated were 800,160 against 702,574. The number of lamps connected is 43,370 against 35,260.

The Lighting committee recommend the Council to apply for a further loan of £10,000 for electricity supply.

Wakefield.—The city electrical engineer (Mr. R. Blackmore) recommends the Corporation to expend about £15,000 in increasing the capacity of the electricity works and a sub-committee has the matter under consideration. The Council have agreed to supply electric energy to the Seamless Steel Boat Co. for five years at 1d. per unit.

Whitby.—It has been decided to replace the gas lamps on the West Pier by electric incandescent lamps at an estimated cost of £183.

Wolverhampton.—What is described as the deadlock between the British Electric Traction Co. and the Wolverhampton Corporation was discussed at the meeting of the latter body on Monday, when Ald. Craddock, acting chairman of the Tramways committee, made a lengthy statement upon the subject. He said the overtures of the committee had failed to effect an arrangement, and he described the action of the British Electric Traction Co. as causing unnecessary delay in the settlement of the question. The committee were prepared to meet the company half way in their contentions, or, failing this, the committee would build another line to complete the connection between the municipal and the company's tramways. The subject is to be discussed at an early meeting of the Council.

Col. Yorke's report on the Corporation tramways, after making some restrictions as to speed, states that the experience of the Lorain system on the section opened for traffic has so far been encouraging. The Board of Trade will be recommended to certify the lines dealt with in the present report as fit for traffic for 12 months.

Workhouse Lighting.—Swindon Guardians have received a report from Mr. T. Pearce, electrical engineer, Manchester, estimating the cost of substituting an independent electric lighting installation at the workhouse to replace the existing gas lighting at £2,000 and about £300 annual upkeep. This represents an actual saving of from £100 to £150 a year, and it has been decided to effect the change.

York.—The City Council are engaging Mr. C. H. Wordingham as consulting engineer to report upon the electricity undertaking at a fee of £109.

The Corporation will exercise their right to purchase the undertaking of the City of York Tramways Co., and the latter have therefore abandoned their proposal to convert the line to electric traction.

Marriage.—The wedding took place on Thursday last of Mr. Charles Morison Johnston, M.I.E.E., borough electrical engineer, Shrewsbury, with Miss Hilda Margaret Robinson, of Lancaster.

Mr. F. T. Callis, a member of the Sheffield Corporation electricity works staff, was married on June 6 to Miss Lucy Eleanor Swindell, of Sheffield.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week*]

SPECIAL NOTICE.

CORONATION WEEK.—The issue of "The Electrician" for June 27 will go to press on Tuesday evening, June 24, and communications for the Editorial and Publishing Departments should reach the Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London, as early as possible on Tuesday.

TENDERS INVITED.

Teddington Urban District Council invite offers from persons and companies willing to take over the Teddington provisional order, 1901, and to submit a scheme for the electric lighting of the district. An advertisement contains some further particulars, and tenders have to be sent to the clerk to the Council, Mr. G. H. Salmons, Elmfield House, Teddington, S.W., by July 12.

Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board require tenders for three 500kw. steam-driven, direct-coupled, three-phase alternator sets; three 50kw. ditto continuous-current exciters, &c.; and permanent way (including copper bonding and conduits for cables). Specifications, &c., from the clerk (Mr. Frank Schofield), Town Hall, Stalybridge, to whom tenders by July 7. An advertisement gives further particulars.

West Ham Borough Council require 50 double-deck electric tramcars, complete with electrical equipment. Specifications, &c., from the borough electrical engineer (Mr. James K. Bock). Tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E., by 4 p.m., July 8. Further particulars are given in an advertisement.

Lowestoft Corporation invite tenders for rails, fish-plates and bolts and permanent way construction for their electric tramways. Specification, &c., from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C. Plans can also be seen and information obtained from Mr. Walter Baer, 47, Victoria-street, Westminster, London, S.W. Tenders to town clerk (Mr. R. Beattie Nicholson) by 5 p.m. July 12. An advertisement gives additional particulars.

Blackpool Corporation invite tenders for the supply and delivery of carbons for the year to March 31, 1903. Specifications, &c., from the borough electrical and tramways engineer (Mr. Charles Furness) Electricity Works, Blackpool. See advertisement.

Messrs. Preece and Cardew, by authority of the Municipal Council of *Sydney* (*N.S.W.*), invite tenders, on the Council's behalf, for the supply, delivery, laying and erection of a complete system of high

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and low-pressure cables, and of arc lamps for street lighting. Specification, &c., can be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, London, S.W., to whom tenders must be sent before noon July 23. An advertisement gives some further particulars.

Messrs. Preece and Cardew are authorised by the *Shanghai* Municipal Commissioners to receive tenders until noon June 17 for the supply f.o.b. of a 100kw. high-speed engine and alternator and exciter.

Sunderland Corporation tramway department require tenders for the supply of permanent way and overhead equipment and cables. Specifications, &c., from the borough electrical and tramways engineer (Mr. John F. C. Snell), Town Hall, Sunderland. Tenders (addressed chairman, Tramways committee), to the town clerk (Mr. F. M. Bowey) by July 9. See also advertisement.

Romford Urban District Council are open to receive offers for the construction and maintenance of electricity supply works for the district. General description of the scheme and form of offer from the clerk to the Council (Mr. Charles T. King), Council Offices, Romford, to whom offers by noon of June 30. An advertisement gives additional particulars.

Stockton-on-Tees Corporation invite tenders for the supply and erection of a 350kw. steam generator, two Lancashire boilers, one switchboard panel and instruments, surface condenser and cooling plant, pipework and valves, extension feeders, economisers and feed pump. Tenders to town clerk by noon, June 17.

Little Woolton District Council invite tenders for supply, laying and jointing of cables, supply and fixing of junction boxes and lamp connections, and the supply of lamp fittings. Tenders to 5, Castle-street, Liverpool, by noon June 20.

Ipswich Corporation invite tenders for engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains and road work, permanent way construction of tramways, and arc lamps. Tenders to town clerk by noon July 5.

Bristol Electrical committee invite tenders for feed and general pumps, water softener, tank coke filters and pipework. Tenders to city electrical engineer by noon June 20.

Rotherham Corporation invite tenders for tramway and lighting feeders, mains and other cables, with road work, boilers and 320kw. steam dynamo. Tenders to town clerk by noon June 17.

Walsall Corporation invite tenders for supply of reversible booster and switches to work in series with battery on tramway circuit. Tenders to town clerk by June 27.

Wellington (Salop) District Council invite offers for a lease of their electricity supply powers. Offers to Mr. Thos. L. Miller, 7, Tower-buildings, N. Water-street, Liverpool, by June 25.

Newcastle-on-Tyne Guardians invite tenders for lighting three relief offices in the town. Tenders by noon July 11 to the clerk (Mr. J. W. Gibson), 127, Pilgrim-street, Newcastle-on-Tyne.

Warrington Corporation invite tenders for tramcars, with motors and electrical equipment complete. Tenders to town clerk by noon June 18.

Stretford District Council invite tenders for steam-raising plant, generators and mains. Tenders by June 18.

Nuneaton Electricity committee invite tenders for a water-tube boiler and pipework. Tenders by June 18.

Bury (Lanca.) Tramways committee invite tenders by June 24 for tramway track material.

St. Anne's-on-Sea District Council invite tenders for fire alarms. Tenders by June 17.

Kirkcaldy Corporation invite tenders for wiring the central station. Tenders by 10 a.m. June 21.

Worksop District Council invite tenders for low-tension cables and joint boxes. Tenders to clerk by June 17.

Bradford Corporation invite tenders for the extension of the engine house at the new Valley-road electricity works. Tenders by 19th inst.

Salford Corporation invite tenders for supply of tram rails and paving materials. Tenders by 9 a.m. 17th inst.

Tenders are invited by Messrs. Watson, Son and Ellison, King-street, Wakefield, for the electric lighting of *Wakefield* Technical and Art Schools.

The Telegraph Department of the *Australian Commonwealth* invites tenders for the supply of 17 miles of telephone cable and five metallic circuit 100-line telephone switchboards. The cables are to be supplied to specifications Nos. 6 and 7, and the switchboards to No. 8. These specifications can only be seen and tender forms obtained at the General Post Offices at Sydney, Melbourne, Brisbane, Adelaide, Perth and Hobart. Tenders have to be in by noon July 28.

Tenders will be received up to 11 a.m. of 20th inst. for the supply of electric lanterns and lamps for use on *Italian Warships*, the articles to be delivered at the Royal arsenals at Spezia, Naples, Venice, and Taranto. Copy of specification, with translation, can be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

TENDERS RECEIVED AND ACCEPTED.

Tynemouth Corporation have received the following tenders for the supply of a condenser and air pumps :—

A. Koppel	£1,469 5	Wheeler Condenser Co	£1,045 0
Babcock and Wilcox	1,453 13	Shields Engineering Co.	1,043 0
Belliss and Morcom	1,408 0	Cole, Marchent & Morley	911 0
Davey, Paxman & Co.	1,397 0	Mirrless, Watson & Co.	842 0
W. H. Allen, Son & Co.	1,173 0	I. Storey & Sons	823 0
Worthington Pumping Engine Co.	1,072 0	Pulsometer Co.	800 0
Klein Engineering Co.	1,067 0	Wallsend Slipway and Engineering Co.	825 0

The tenders varied in details, which partly accounts for the variation in price.

The following tenders have been accepted by Grimsby Corporation electricity department :—

Johnson and Phillips' Cable Works (cables)	£229 4 4
Mackenzie Bros. (arc lamp posts)	176 15 0
Gilbert Arc Lamp Co. (arc lamps)	141 11 6
Doulton & Co. (stoneware pipes)	54 19 0

Fulham (London) Board of Guardians have received the following tenders for pipework in connection with electric lighting works :—

Rosser and Russell	£1,643 4	D. Stewart & Co.	1,541 10
Sir Hiram Maxim Co.	1,589 4	Babcock and Wilcox	1,413 3
Ditto	1,439 4	Aiton & Co.	1,330 13

Hunslet Guardians have received the following tenders for provision of two electric ward lifts for their Rothwell Haigh Infirmary :—

Wilson Hartnell & Co. (*accepted*)	£440	R. Waygood & Co.	£595
A. and P. Steven	810	Safety Lift and Elevator Co.	535
Edwards and Armstrong	788	Holt and Willetts	530
F. H. Bagge & Co.	690	W. J. Fryer & Co.	489
H. J. Boothroyd, Hyslop & Co.	690	P. Dewhirst	445
A. Smith and Stevens	616	Lahmeyer Electrical Co.	405
J. G. Child & Co.	610	J. Hitchen & Son	371

The London County Council have received the following tenders for the wiring and supply of electric fittings at Euston-road fire station :—

D. Assersohn (*accepted*)	£268 10	W. Mossop & Co.	£357 0
Wakelin & Co.	597 0	Jackson Bros.	352 0
A. Goldsmith & Co.	400 0	Lawrence & Co.	323 0
C. Cooper & Co.	376 0		

Southampton Corporation Electricity committee have accepted the tender of Messrs. Butler & Co. for the supply of an 18in. shaping machine at £142, less 2½ per cent.

Burton-on-Trent Corporation have accepted the tender of the British Thomson-Houston Co. for the supply of generators and switchboard for the tramway power station at £4,099.

Rotherham Corporation have accepted the tender of Messrs. Dick, Kerr & Co. for rolling stock for the tramways at £8,711, and the tenders of Messrs. Macartney, McElroy & Co. for overhead construction (£7,102) and permanent way (£55,419).

Colchester Town Council have accepted the tender of the Oak Building Co., Cambridge, for building extensions at the electricity works for £2,242.

Maidstone Corporation have accepted the tender of the British Thomson-Houston Co. for the supply of 100 electricity meters at 33⅓ per cent. off list price.

The South Wales Electrical Power Distribution Co. have accepted the tender of Messrs. Willans and Robinson for three 3,000 H.P. engines and several of smaller size for their Pontypridd station. These engines are to be direct coupled to alternators.

The Alliance Electrical Co. have secured the contract for the electric lighting of the Burgh Hall, Dundee. This tender was the lowest submitted.

Wallasey Tramways committee has accepted the tender of Messrs. Dick, Kerr & Co., for five cars at £571 each and a combined track sweeper, water car and detachable snow sweeper at £660.

The tender of the General Electric Co. for the supply of three high-pressure steam alternators at £24,000 has been accepted by Liverpool Corporation.

Southend Corporation have accepted Messrs. Crompton & Co.'s tender for the supply of motor generator, balancer, two boosters and booster switches at £1,995.

Browett Lindley & Co., are supplying two 1,000kw. steam alternators (consisting of three-crank, triple expansion engines and Ferranti alternators) to the Bournemouth and Poole Electricity Supply Co.

Bradford Corporation have accepted the tender of Ferranti Limited for two switchboards at £670, that of the Keighley Electrical Engineering Co. for two 20 H P. motors for £198, that of E. Green & Son for economiser and dampers at £1,648, and that of Cole, Marchent and Morley for spare parts for engines at £364. 10s.

The tender of Messrs. Willans and Robinson has been accepted by Liverpool Corporation Electricity department for three 1,500 H.P. engines for direct coupling to Siemens dynamos. The British

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Thomson-Houston Co. have also placed an order for three 1,500 H.P. Willans engines for coupling direct to three-phase alternators for Liverpool Corporation.

Broughty Ferry Town Council have accepted the following tenders for their electricity department:—

Callender's Co., cables	£4,964	8	7
Ditto middle wire distributor	555	15	9
Thomson, Son & Co., steam pipes and auxiliary gear	750	0	0

Oldham Electricity committee have accepted the tender of Messrs. Babcock and Wilcox for the supply of exhaust piping at the Greenhill electricity works.

BUSINESS NOTICES.

The Direct United States Cable Co. have removed their New York office from 40, Broadway, to 60, New-street.

The address of the Barcelona agency of the Anglo-American Telegraph Company is now 56, Paseo de Gracia.

The partnership existing between Mr. J. F. Wake and William Carr (trading as Wake and Carr), engineers, machinery merchants, &c., Darlington, has been dissolved. Owing to pressure of other business Mr. Wake retires. Mr. Thomas Carr will join Mr. William Carr, and will continue the business under the style of Carr Bros.

Messrs. C. J. Cooper, S. W. Cooper and J. E. Wilkins (trading as Cecil Cooper & Co.), electrical engineers, 14, Gloucester-road, London, S.W., have dissolved partnership. Debts by Messrs. C. J. and S. W. Cooper, who continue.

LIQUIDATIONS, &c.

The discharge in bankruptcy of J. G. M. Hilton, electrician, Trafalgar Works, Bow Common-lane, London, E., is suspended for two years.

Claims against H. D. McIntyre (trading as the Glanamman Colliery Co.), colliery owner and electrical engineer, 15, Werter-road, Putney, Surrey, and Glanamman, Carmarthenshire, must be in by 25th inst. to Mr. Davies, 58, Wind-street, Swansea.

A meeting of the Electrical Transmission Co. (Ltd.) will be held on July 15 at 7, East India-avenue, London, E.C., to receive an account of the winding-up.

Plant, &c., for Sale.—Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Leyton Electric Lighting committee have for disposal their gas-driven plant, including dynamos, gas engines, Dowson gas generators and accessories. Offers to engineer and manager (Mr. F. Harman Lewis) by June 25.

There is advertised for sale on another page an E.P.S. battery in good condition, under maintenance, to be sold complete or in sections by Messrs. Owen Lucas & Co., 39, Victoria-street, London, S.W.

A number of electric motors, a 100-ampere dynamo (110 volts), a 58-cell battery and two Crossley gas engines of 9 B H P. and 12 B H.P. are for sale. Offers to the Era Press, Leyton. See advertisement.

The Newcastle-upon-Tyne Electric Supply Co. having recently changed their system from alternating to continuous current, have for disposal a number of transformers by various makers from 1 H P. to 6 H.P. capacity. Further particulars from the general manager, 50, New Bridge-street, Newcastle-upon-Tyne. See advertisement.

There is advertised for disposal elsewhere an E.P.S. battery of 55 cells, K type, a Siemens dynamo, a 10 H P. Crossley gas engine, a switchboard, &c., which can be seen in working order at Gate Lodge, Gallowhill, Paisley, N.B.

A 20 B H.P. gas engine, dynamo, switchboard, belting, &c., nearly new, is advertised for sale by the secretary, Northgate Mansions (Ltd.), Gloucester.

Mr. James E. Ward, C.A., receiver and manager of the British Electrical Mfg. Co. (Ltd.), advertises for disposal the goodwill of the business, machinery, plant and fittings, and a number of patents owned by the company. The works are situate at Putney Bridge Station, London, S.W., and the whole is for sale as a going concern. An advertisement gives some further particulars.

Messrs. White Bros. & Co., High-street, Stratford, London, E., advertise for sale electric lighting plant, including Ruston, Proctor engine and Crompton dynamo.

Accumulators.—Mr. E. G. Bek, 30, Frederick-street, Birmingham, has for disposal some new processes for accumulator construction. See advertisement.

Plant Wanted.—A second-hand compound-wound dynamo for battery charging is required by an advertiser.

A Lamp for Festooning.—Mr. W. Barker, of 1, Derby-street, Preston, has sent us a sample lamp specially adapted for festooning purposes which may prove of some utility for Coronation illuminations. The lamp is an ordinary one with bayonet socket, but soldered to the two bottom contacts are small brass slotted terminals, so arranged that they can be connected directly on to the wires without cutting the latter. A wooden bridge-piece prevents short-circuit between the terminals. The bridge-piece is merely held by a wire passed round the pins of the socket, so that it is easily removable. It is stated that the lamps can subsequently be converted into ordinary lamps. To do this, however, it would be necessary, besides taking off the bridge-piece, to remove the additional terminals, which are securely soldered to the bottom contact plates.

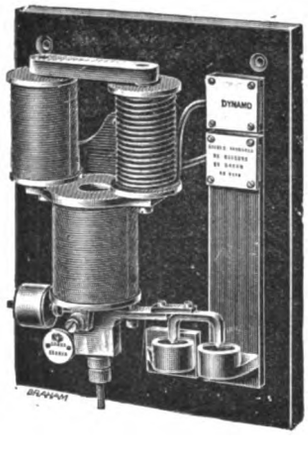
E.P.S. Moting Cells.—The Electrical Power Storage Co., 4, Great Winchester-street, London, E.C., will supply post free particulars relating to their latest type of moting cell of 19 plates. This is a considerable advance on the same company's 15-plate cell.

Photo Papers.—Messrs. Bemrose & Sons (Ltd.), of Derby, London and Leeds, are supplying the "Perfection" brand of photo papers for all processes, black, blue and brown.

"Great Britain: Her Finance and Commerce."—This is the title of what is described as a *Morning Post* souvenir edition. Some months ago large advertising firms were approached by an American named Parker, who, under cover of the authority of the *Morning Post*, obtained large sums of money from trading firms for advertisement announcements in a book with the above title. After an injunction had been obtained against Parker, he and some of his assistants suddenly left the country. The proprietor of the *Morning Post*, recognising that many firms had parted with their money in the belief that they were dealing with that journal, determined to produce the volume at his own cost, and this has now been issued. It is a handsome volume, and contains a mass of information of interest to commercial firms.

"Kelly's Building Trades' Directory."—The 1902 issue of "Kelly's Guide and Directory to the Building Trades" marks the 9th edition of a very useful work of reference, which has been published at intervals since 1870. In the Preface a brief review is given of the state of the building trades since the last issue of the work, and the principal architectural features of the chief buildings in course of construction in the metropolis. A copious index, both of towns and places in the kingdom and to the building and its allied trades enables the mass of information given to be readily referred to. Preliminary to the directory proper a list of county and borough surveyors is provided, and the directory which follows occupies no less than 2,510 pages of names and addresses of firms and persons in the various branches of the building industries. The price of the work is 30s., the publishers are Kelly's Directories, Ltd., 182–184, High Holborn, London, W.C.

Catalogues.—A new price list of ammeters, voltmeters, circuit-breakers and automatic switches manufactured by Messrs. Nalder Bros. and Thompson, 34, Queen-street, London, E.C., is just published, and deals with electromagnetic ammeters and voltmeters and electrostatic voltmeters. The list forms section 1 of this firm's new catalogue. Section 2 (moving coil, ammeters and voltmeters), section 3 (recording instruments), and section 4 (automatic switches and circuit-breakers) will follow in due course. We illustrate the N.C.S. automatic charging switch, which is purely automatic in its action, and is used for closing the charging circuit of the cells on to the machine. When the volts of the latter rise some five or six above that of the battery the switch automatically closes the circuit, and the main charging current, then flowing through the coil on the top right-hand side, holds the dippers down. When the current falls, owing to drop of volts in the machine or other cause, the dippers leave the mercury cups by the action of gravity. There is no spark at breaking, as the current at the time is practically zero. There is no permanent magnet in the switch, the whole action being electromagnetic. These switches are made for any voltage up to 500.



The Improved Electric Glow Lamp Co. have ready a well-illustrated catalogue of direct and alternating-current desk and ceiling ventilating fans for a large variety of uses. Of these fans prompt delivery can be made. The same company have also ready a comprehensive list of electrical accessories.

The Sandycroft Foundry Co., Chester, have a new catalogue ready of continuous-current dynamos and meters manufactured at the company's works.

Pamphlet No. 125, issued by the British Thomson-Houston Co., treats of the G. E. 67 traction motor, a complete machine, and the individual parts thereof, being described and illustrated.

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Catalogue.—Messrs. O. Berend & Co. are issuing a new edition of their "S" catalogue, dealing with switches, cutouts, motor switches, switchboards, and various accessories. They draw our attention particularly to one of their standard patterns of photometer constructed in accordance with the rules for photometry finally approved by the German Electrical Association in 1898, and published in *The Electrician*, Vol. XLI., p. 426. The photometer, a general view of which is given in Fig. 1, is fitted with a Lummer-Brodhun telescopic screen, whose construction is shown is shown in Fig. 2; and the diagrammatic arrangement of the photometer is according to Fig. 3. At p^1 and p^2, accurately ground reflecting prisms are placed, and L and B are also glass prisms on which the light falls from both the standard lamp and lamp under test. The screen S, viewed through the telescope T, shows a white spot in a dark ring

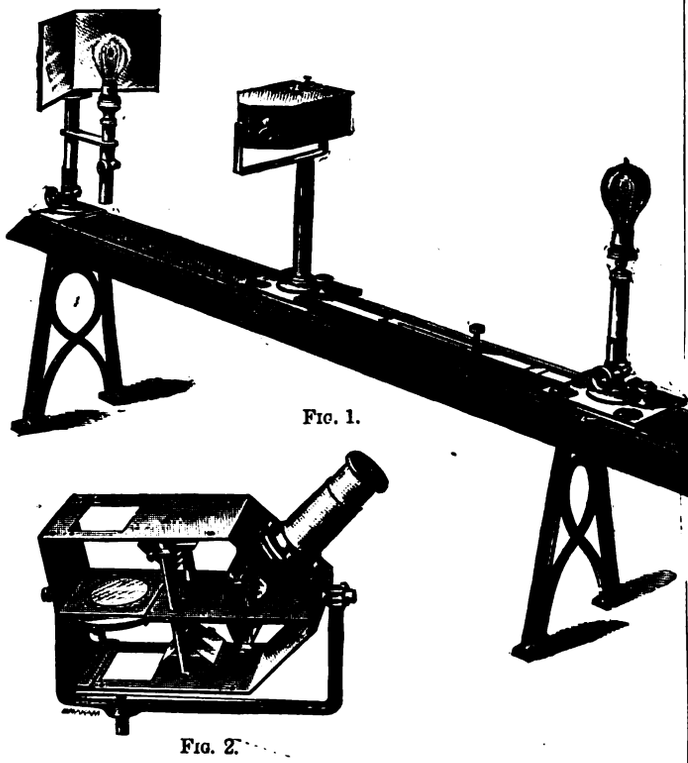

FIG. 1.

FIG. 2.

(A, Fig. 3) when the incandescent lamp gives the stronger light, and a dark spot in the centre (B) when the standard lamp is more powerful. When the photometer is adjusted to balance, the field is uniformly illuminated (C). In the pattern shown in Fig. 1, the bench is 8ft. 3in. long, and is made of angle iron and furnished with three scales on ebonised wood—centimetres, candles (2½, 5, 8, 10, 16, 25,

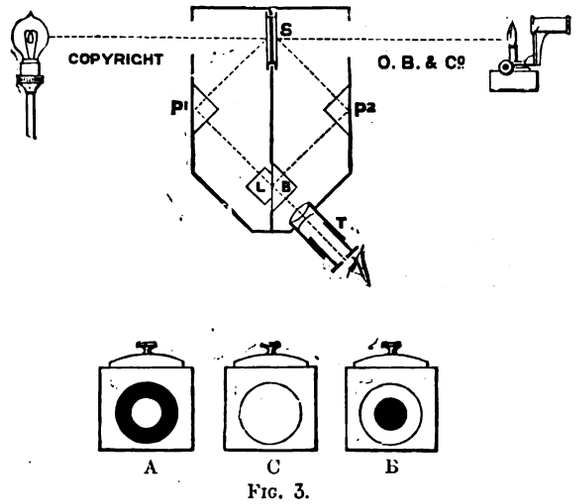

FIG. 3.

and 32 c.p.) and an extension scale to 100 c.p. Standardised electric lamps are usually employed for the test, and these can be standardised on the bench itself by comparison with a Hefner lamp or standard candle.

Imports of Electrical Goods.—The value of the electrical goods imported into this country during May was £53,361, against £90,281 in May, 1901, and £78,350 in May, 1900. The total value for the five months ended May 31 was £283,702, compared with £498,599 and £334,082 in the corresponding periods of 1901 and 1900 respectively.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 5 to June 10, with the ports of destination:—

Africa—Cape Town, £1,357; Durban, £378 (including £36 telegraph poles); East London, £178; Port Elizabeth, £1,777. *Argentina*—Buenos Ayres, £179 (telegraph material). *Australasia*—Auckland, £621; Brisbane, £53; Fremantle, £143; Melbourne, £1,510 (including £1,345 telegraph wire); Perth, £42; Sydney, £600; Wellington, £102. *Canada*—Halifax, £221. *Canary Islands*—Teneriffe, £60. *Ceylon*—Colombo, £306 (including £76 telegraph material). *Channel Islands*, £1,225. *Chili*—Boca, £82 (telegraph poles). *China*—Shanghai, £10,432 (including £9,950 telegraph cable) and 77 tons old cable strippings. *Germany*—Hamburg, £110. *Gibraltar*—£16 (telegraph material). *Holland*—Amsterdam, £130. *Hong Kong*—£67. *India*—Bombay, £122; Calcutta, £519; Madras, £80. *Russia*—St. Petersburg, £79 (telegraph material). *Siam*—Bangkok, £77. *Spain*—Bilbao, £57 (telegraph apparatus). *Sweden*—Gothenburg, £81 (telephone cable); Malmo, £178 (telegraph cable); Stockholm, £282. *Zanzibar*—£78 (including £54 telegraph material). Total (for six days) £20,142 against £18,267 for seven days last year (June 5 to 11).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

March 24, 1902.

7,152. BRITISH THOMSON-HOUSTON Co. Electrical steering gear. (M. W. Day, U.S.)*
7,169. C. A. ALLISON. Battery. (W. C. Banks, U.S.)*
7,188. C. ILGNER. Controlling electrically-driven reversible roller mills.
7,195. C. OLIVER. Arc lamps, especially "projector" type.

March 25, 1902.

7,201. MAPPIN AND WEBB and W. E. SAUNDERS. Electrically-lighted portable timepieces.
7,203. J. MCKERNAN. Bolton. Electromagnetic point-turning arrangement for tramway crossings.
7,207. W. J. STEWART. Glasgow. Working of tramway or railway points.
7,215. G. C. HURRELL. Insulating and protecting underground cables.
7,216. G. C. HURRELL. Conduits for electrical conductors.
7,257. SHERARD COWPER-COLES and COWPER-COLES INVENTIONS DEVELOPMENT Co. Leading-in wires for incandescent lamps, vacuum tubes and the like.
7,258. A. A. BENCE. Lamp holders.
7,260. H. J. LEEVES-JOHNSON. Incandescent lamps and connections.

March 26, 1902.

7,314. J. W. HABUSSLER. Manchester. Armatures for electric motors.*
7,321. G. HOOKHAM. Incandescent lamps.
7,322. A. ECKSTEIN and A. BROOKER. Manchester. Apparatus for testing telephone, telegraph and like lines.
7,323 and 7,324. SCOTTISH WIRELESS ELECTRIC SYNDICATE and W. JAMIESON. Glasgow. Etheric telegraphy
7,348. G. B. SMITH and E. W. SMITH. Coin-freed meters.
7,351. W. J. CARTER. Kingston-on-Thames. Time-switches.
7,361. SIEMENS BROS. & Co. Connecting continuous-current motors to supply network on starting. (Siemens and Halske A.G., Germany.)*
7,362. SIEMENS BROS. & Co. and L. M. G. FERREIRA. Electrical locking gear for railway signals.
7,363. SIEMENS BROS. & Co. Electrical resistance and application to switch. (Siemens and Halske A.G., Germany.)
7,370. J. H. WEST. Electric cables.
7,380. F. PROCTOR. Arc lamps.
7,383. P. HÖGNER. Arc lamps.*
7,385. C. O. BASTIAN. Electricity meters.

March 27, 1902.

7,401. H. HIRST and H. BEVIS. Switches.
7,405. J. PLACE & SONS and W. H. PLACE. Conduits.
7,420. G. SPERRYN and W. H. WOOD. Birmingham. Switches.
7,447. OTIS ELEVATOR Co. Transmission of power. (Otis Elevator Co., U.S.)*
7,475. G. HOOKHAM. Incandescent lamps.
7,477. J. A. TIMMIS. Conveying railways, pipes and electric leads through towns.
7,478. P. DELAFON. Galvanic batteries.
7,484. G. J. HICKS. Transmitting electrical impulses and signals.
7,487. BRITISH THOMSON-HOUSTON Co. and H. S. MEYER. Electric railways.

March 29, 1902.

7,510. T. E. PRICE and T. PRICE. Birmingham. Electric swing top.

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7,528. J. Tomlinson, H. Lomax and R. Lomax. Manchester. Switches.
7,536. A. E. Thomas and J. Buckley. Birmingham. Electric revolving brush.
7,537. R. S. Burn. Stockton-on-Tees. Safety guard for tramcars.
7,585. J. F. Wakelin. Utilising filaments of higher resistance when cold for electric lighting.
7,5€0. W. P. Thompson. Liverpool. Electric head wheels. (La Cie. des Mines de Bruay, France.)
7,592. P. F. V. Pedersen and J. Timm. Telegraph transmitters.

April 1, 1892.

7,631. J. Atkinson Marple. Continuous-current dynamos, motors, and converters.
7,634. E. Soutter and W. Soutter & Sons. Birmingham. Globes and shades.
7,642. W. Kirk. Leeds. Brushes for commutators.
7,651. J. E. Doughty. Electric flashlight for signalling, attachable to kites or balloons.
7,661. A. G. Betts. Electrolytic refining of lead and lead alloys.*
7,665. Siemens Bros. & Co., and J. G. Wilson. Dynamo-electric machines and motors.
7,670. R. Wichand. Means for generating electricity.*
7,684. A. J. Bonnella, D. H. Bonnella & Son, E. E. R. Bryant, C. H. Bryant, and E. W. Bryant. London. Arc light mechanism for rapid exposure photography.
7,689. J. B. Struble. Electric signalling.*

April 2, 1902.

7,702. H. T. Dawson and H. A. Dawson. Coventry. Electrical ignition apparatus.
7,718. A. Zellweger. Manchester. Electric punka-motors.
7,736. R. H. Read. Extinguishing electric arcs. (Date applied for April 3, 1901, date of application in Japan.)*
7,760. R. E. Raven. Automatic system of preventing accidents by short-circuiting or breakage of trolley wires.
7,773. A. Nodon and J. Pietrre. Oxidation by electric currents.
7,782. O. Könitzer. Electrically-operated locks.
7,783. O. Könitzer. Short circuiters for high-tension electric cables or wires.

April 3, 1902.

7,792. L. Lutz. Manchester. Electric cooking and heating apparatus.
7,800. E. S. Toomer. Sandwich. Construction of machinery without cranks in obtaining rotary motion.
7,809. H. S. Scott, H. F. Tyzack and T. J. Wright. Gateshead-on-Tyne. Arc lamp.*
7,834. A. Romaine and J. D'Aygunesvives. Liverpool. Supports for incandescent lamps.
7,838. J. A. Wright and W. Fletcher O'Neill. Switches.
7,847. E. Matthys. Electric traction for vehicles.
7,851. H. H. Lake. Electrical sterilising and preserving apparatus. (L. D. Giroux and L. E. Seddon, U.S.)*
7,858. M. Krouchkoll. Electric-vacuum discharge tubes.*
7,860. New Polyphon Supply Co. and R. Schmidt. Coin-controlled machines for giving electric shocks.
7,864. H. Korteu. Secondary batteries.

April 4, 1902.

7,866. V. W. Sworn, Southampton. Self-acting safety trolley arm rope guide.
7,921. A. Nodon. Electrolytic condensers.
7,922. J. Renous and A. C. L. Turpain. Distribution of electrical energy.
7,923. E. Goldberg. Electrolytically coating iron with zinc.
7,938. A. D. Shuter. Splicing electric cables.

April 5, 1902.

7,952. H. Oppenheimer. Flexible cords. (A.G. Mix and Genest., Germany.)
7,954. J. W. Ewart. Electric water heaters.
7,955. S. Evershed. Electrical measuring instruments.
7,957. Electric and Ordnance Accessories Co. and R. Frederick Hall. Birmingham. Switches.
7,958. J. T. Pearson. Burnley. Overhead tramway wires.
7,989. Veritys Limited and W. Pipkin. Distribution boards.
7,996. P. Jensen. Metallic deposit by electrolysis. (Dr. G. Langbein & Co., Germany.)*
8,014. G. Schauli and D. Loewenstein. Galvanic dry cell.
8,020. A. Neelemans. Controlling railway points and signals operated by electricity.*
8,021. British Thomson-Houston Co. and H. S. Meyer. Distributing systems employing rotary converters.

April 7, 1902.

8,032. A. L. Reinmann. Liverpool. Incandescent lamps.
8,060. J. C. Gill. Connector for joining electric cables.
8,065. B. L. Langmann. Sidcup. Door switch for electric light.
8,066. A. J. Boult. Block-signal systems for railways. (A. C. Miller, H. V. Millar, J. D. Price, G. Failing and W. H. Council, U.S.)*
8,103. M. Schneider. Electrodes for storage batteries.
8,112. Hon. R. T. D. Brougham. Electrical indicating and controlling mechanism.
8,121. M. Büttner. Electric lighting of vehicles.

April 8, 1902.

8,126. C. H. Pearson. Manchester. Service box and cable connection
8,136. G. Hill. Manchester. Fittings for trolley wires.
8,172. H. Manders and A. W. Sharman. Production of electrical oscillations of requisite amplitude and frequency.
8,178. J. D. F. Andrews and Electrical Productions. Switching apparatus for electric circuits.
8,181. W. Spielter and F. Dunker. Controlling polyphase and alternating current motors.
8,188. P. Coote. Controlling of electromotors.
8,189. G. P. McDonnell. Circuit-regulating devices.*
8,190. Otis Elevator Co. Controlling electric motors. (Otis Elevator Co., U.S.)*
8,202. J. M. Davidson. Röntgen-ray apparatus and interrupters therefor.
8,217. O. T. Griffiths and T. H. Kerr. Liverpool. Safety cutouts for trolley lines.

April 9, 1902.

8,281. Telegraph Manufacturing Co. and W. Bartlett. Spring jacks for telegraph and telephone circuits.
8,288. E. Stassano. Electrical smelting and refining and furnaces therefor.*
8,308. R. Otto. Electric light cure arc lamps.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can be obtained at the uniform price of 8d. each.

1902.

118. D'Andrimont. Anodes for electrolytic operations.
360. Wetmore. Contact devices for electric railways.
609. Hall. Electrical switches and cutouts.
999. De Pass (Cheatham Electric Switching Device Co.). Electrically-controlled railway switches.
1,344. Higginson. Electric switch.
1,496. Berry, Simon and Skinner. Electric switches.
1,675. Boult (Martin). Sparking plugs for motors.
2,159. Shawfield and Wetmore. Electric fuses.
2,774. Hall. Electrical switches.
3,154. Frank. Sockets for uniting two telegraph wires.
3,416. Jones and Jones, Jun. Switches for electric light circuits and the like.
3,490. Siemens Bros. & Co. (Siemens and Halske A.G.). Lightning dischargers.
3,491. Siemens Bros. & Co. (Siemens and Halske A.G.). Brush holder.
3,608. Siemens Bros. & Co. (Siemens and Halske A.G.). Manufacture of stands for telegraph and telephone cables.
3,610. Behr. Electric vehicles for single rail railways.
3,657. Cummings. Insulated electrical conductors.
3,894. Brown. Glowlamps for occasional illuminations.
3,953. Lake (Aktiesel-kabet "Progress"). Telegraphic and telephonic apparatus.
4,521. Apple. Storage batteries.
4,754. Lundell. Field magnets for dynamos or motors.
4,755. McOuat. Electric lamps.

NEW COMPANIES, STATUTORY RETURNS, &c.

ART FITTINGS (LIMITED.)—Reg. June 2, capital £10,000 in £1 shares, to trade as manufacturers of and dealers in fittings for electric and other illuminants, electric heating and cooking apparatus, batteries, lamps, electrical apparatus and machinery, art metal work, &c. The subscribers are A. C. Read, secretary, R. Dand, secretary, F. Jarrett, T. B. C. Nuttall, elec. eng., A. Payne, elec. eng., C. S. J. Freeman, elec. eng., and H. E. Benwell, elec. eng. Reg. office: 66, Victoria-street, S.W.

CLUBBE AND SOUTHEY (LTD.)—Reg. June 4, capital £2,000 in £1 shares, to acquire patents and rights relating to devices for measuring liquids, to acquire from A. W. Southey certain existing inventions, and to carry on the business of electricians, electrical and mechanical engineers, manufacturers of electrical vehicles and carriages and electrical apparatus, suppliers of power, traction, light and heat, &c. Reg. office: 13, Elm-street, Gray's Inn-road, London, W.C.

FOOTE AND MILNE (LTD.)—Reg. June 3, capital £15,000 in £1 shares (5,000 pref.), to carry on business as electrical, mechanical, hydraulic and general engineers, contractors, metal workers, tool makers, metallurgists, &c., and to take over the business carried on by H. Foote, L. Milne and E. J. Owen at 66, Victoria-street, S.W. The subscribers are L. Milne, elec. eng., H. Foote, elec. eng., E. J. Owen, elec. eng., P. Dove, elec. eng., C. R. Gadsden, R. Hern and P. F. Abbott. The first directors are H. Foote, L. Milne and E. J. Owen. Remuneration: H. Foote and L. Milne £364 each per annum, E. J. Owen £243 per annum.

C. E. AND H. M. PEEL (LTD.)—Reg. June 3, capital £20,000 in £1 shares to carry on business as metal merchants, electrical and mechanical engineers, &c., at Swansea and elsewhere, and the business of iron and steel manufacturers, metal workers, tin, terne and black plate manufacturers, tram and waggon builders, &c., and of an electric traction and lighting company. C. E. Peel and H. M. Peel are permanent and governing directors. Reg. office: Quay Parade, Swansea.

PEKING AND NORTH CHINA ELECTRICAL CORPORATION (LTD.)—Reg. June 2, capital £100,000 in £1 shares, to acquire the business of the Siemens and Halske Actien Gesellschaft, Mandl & Co., and the Chinesiche Electricitäts Gesellschaft G.m.b.H., or one of them; to carry on the business of electrical engineers, makers of electrical plant, contractors, &c., in Peking or elsewhere in China, and to adopt an agreement with the Syndicat du Yunnan (Ltd.). The first directors are A. Adam, Sir H. C. J. Bunbury, P. A. Loeder and A. W. West. Reg. office: Salisbury House, London, E.C.

ACCUMULATOR SYNDICATE (LTD.)—The return to Dec. 31 gives the capital as £30,000 in £1 shares, all taken up. £1 per share has been called up on 5,000. 25,000 shares are considered as fully paid. Mortgages and charges, £375.

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CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24½d. per oz. (June 12). Consols (2¾ per cent.) 96⅛—96⅜ for money, 96⅞—97 for account; 2½ per cent. 96¾—97¼ (June 12). Consols Pay Day July 2; Stocks and Shares Continuation Days, June 23 and July 10; Ticket Days, June 24 and July 11; Pay Day, June 25; Mining Share Carry-over Days, June 20 and July 8.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—At a meeting of this company on Monday, Mr. H. Fielden Jackson, who presided, said the past year had been one of continued prosperity; they had increased their subscribers by 70, bringing the number to 2,534. The revenue was £20,619, an increase of £1,410 on the previous year, while their expenses had decreased by £280. The contract with the Electric Tramway Co. of Lisbon had been completed, and £6,000 compensation had been paid to them by that company. It was proposed to carry this sum to reserve, bringing it up to £38,000. The contract with the Portuguese Government for a renewal of their concession to 1937 has been ratified by the Portuguese Parliament, and the work of reconstructing the Lisbon and Oporto lines was commenced. The net profit of the year to Dec. 31 last was £10,928. Out of this it was proposed to pay 3 per cent. dividend, place £2,500 to reserve and carry forward £6,928.

BLACKPOOL AND GARSTANG LIGHT RAILWAY CO.—The list of applications closed yesterday in an issue of 18,000 ordinary £10 shares in this company at par. The company's line, when constructed, will be about 14 miles in length.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)—The debenture stock register will be closed from 16th to 30th inst. inclusive, preparatory to the payment of interest due July 1.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The report of the directors for the year to March 31 gives the profits (including £21,457. 5s. 7d. brought forward) at £224,727. 5s. 5d. Premiums, amounting to £121,184. 11s. 6d., on shares, &c., are not included, and are carried direct to reserve. After deducting expenses, interest, &c., there is a net profit of £158,307. 7s. 8d. Goodwill account is to be reduced by £1,500, £2,500 is applied in reduction of licences and testing of new systems, and £510. 14s. in reduction of furniture account. Dividend on the 6 per cent. preference shares requires £54,847. 4s. 9d., and a dividend at the rate of 12 per cent. per annum on the ordinary shares for the half-year ended March 31, 1902 (making 9 per cent. for the year), £71,511. 1s. 11d., leaving £27,438. 7s. to be carried forward.

BRITISH WESTINGHOUSE COMPANY AND THE LORAIN STEEL CO.—It is announced that arrangements have been made for the British Westinghouse Company to acquire the electric motor and equipment manufacturing business of the Lorain Steel Co. The rumours afloat concerning the arrangement between the companies do not definitely state whether the Westinghouse Company are taking over the Lorain system of surface-contact electric traction.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The report of the directors for the year to March 31 shows a credit balance of £8,765. 13s. 8d. Preference dividend and an interim dividend at the rate of 6 per cent. per annum on the ordinary stock have absorbed £5,400, and out of the balance it is proposed to pay a dividend on the ordinary shares at the rate of 10 per cent. per annum, less tax, for the last half of the year, making 8 per cent. for the year.

CITY OF BIRMINGHAM TRAMWAYS CO.—It is announced that Mr. James Ross, of Montreal, chairman of this company, has disposed of his holding of ordinary shares to the British Electric Traction Co. for 37s. 6d. each. It is understood that a similar offer is being made to other shareholders in the company.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and stockholders' register of the £400,000 5 per cent. debenture stock and the £300,000 4½ per cent. second debenture stock will be closed from 16th to 30th inst. inclusive.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)—The register of debenture stock holders will be closed from 16th to 30th inst. inclusive, preparatory to the payment of interest due July 1.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—The following dividends have been declared for the year to May 31:—Ordinary shares: A dividend of 3s. per share (making 5s. for the year), a bonus of 2s. per share, and 1s. per share out of the ordinary shares reserve fund, bringing the total distribution on the ordinary shares to 8s., or 40 per cent. for the year (less tax). Founders' shares: A dividend for the year of £50 per share and £10 per share from the founders' shares reserve fund, making £60 for the year (less tax).

FERRANTI LIMITED.—The transfer books of the 5 per cent. mortgage stock of this company will be closed from June 16 to 30 inclusive, preparatory to the payment of interest on the stock for the half-year ending June 30.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The directors' report for the year 1901 states that the negotiations for the amalgamation of the company with Messrs. Callenders' Cable and Construction Co. (Ltd.) are still proceeding, and the directors are therefore unable to submit the terms to the shareholders. The directors consider that the payment of the final dividend should not be longer deferred. There has been a net profit for the year of £64,447. 19s. 9d. Deductions for directors' and auditors' fees, interest, income tax, depreciation, leave, with £24,210. 16s. brought forward, £81,660. 9s. 3d. £1,000 is transferred to debenture redemption sinking fund and £11,000 to reserve, and the directors recommend a dividend on the ordinary shares at the rate of 20 per cent. per annum (less tax, and including the interim dividends of 5 per cent. paid Sept. 1 and 10 per cent. paid March 1). This leaves £26,785. 9s. 3d. to be carried forward.

MEXICO ELECTRIC TRAMWAYS (LTD.)—Col. Sir C. Euan-Smith, who presided at the meeting on Wednesday, said the past year had been one of somewhat abnormal depression, but the outlook was now of a most encouraging nature. The re-construction of the whole line was nearing completion, and when once all the important lines were worked by electricity they had good reason to anticipate that they would be on the high road to success.

MIDDLETON ELECTRIC TRACTION CO. (LTD.)—Subscriptions to an issue at par of £50,000 4 per cent. first mortgage debenture stock and 10,000 5 per cent. cumulative preference shares of £5 each have been invited this week.

PERTH (W.A.) ELECTRIC TRAMWAYS (LTD.)—The directors' report for the period of 18 months from July 1, 1900, to Dec. 31, 1901, states that 7 miles of tramways have been in operation for three months, 10½ miles for 3¾ months, and 13 miles for 11¼ months. The total gross revenue from this mileage during the 18 months amounted to £60,268. £102,109. 15s. 5d. has been spent on the construction of further sections, and additional plant and cars. Since the date of the accounts additional routes have been completed, making the total mileage now in operation 16½ miles. There is, after payment of interest and preference dividend, and allowing for a debit from last year, a credit balance forward of £1,125.

STOCK EXCHANGE NOTICES.—The London Stock Exchange Committee has ordered the further issue of 50,000 6 per cent. fully-paid £5 preference shares (Nos. 150,001 to 200,000) of the *British Westinghouse Electric and Mfg. Co. (Ltd.)*, and the further issue of £102,377 4 per cent. mortgage debenture stock of the *Eastern Telegraph Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	...	...	...	...	...	...
Ayr Corporation	June 7	301	...	3	793	...
*Birmingham Tramways.	„ 7	5,287	+ 663	22	103,658	+28,814
*Blackburn Corporation..	„ 6	1,029	+ 355	23	15,674	+ 2,097
Blackpool Corporation...	„ 5	660	- 962	10	6,311	- 644
Blackpool and Fleetwood	„ 7	476	- 402	23	7,374	- 497
Bolton Corporation	„ 8	1,623	- 79	10	15,703	+ 344
Bradford Corporation ...	„ 1	2,937	+1,505	9	28,215	+19,010
Brighton Corporation ...	„ 8	827	...	28	17,071	...
Brisbane Tramways.....	Apl. 23	2,255	+ 431	17	39,404	+ 4,426
*Bristol Trams & Carriage	June 6	4,678	+ 272	22	93,424	+ 3,554
Burnley Corporation ...	„ 7	822	+ 373	‡10	6,908	+ 2,259
*Buenos Ayres & Belgrano	May 11	2,449	- 218	19	51,522	- 984
Calcutta Tramways Co...	June 7	R21 556	+R1,063	23	R505,'99	+R44,821
*Cardiff Corporation	„ 7	1,416	...	...	...	...
Carlisle Tramways Co....	„ 7	185	...	†23	3,225	- 20
Central London Railway	„ 7	7,336	+1,272	23	154,819	+12,284
City & South London Ry.	„ 8	3,074	+1,145	23	68,496	+23,133
Cork Elec. Tramways Co.	„ 5	556	+ 11	§22	9,613	+ 268
Devonport & Dist. Trams	May 30	545	...	21½	8,550	...
Doncaster Corporation...	June 7	162	...	1	162	...
Dover Corporation	„ 7	259	+ 33	10	2,060	- 112
Dublin & Lucan Railway	„ 8	119	- 5	23	2,209	+ 65
Dublin Southern Dist....	„ 6	815	- 13	¶23	17,916	+ 3,814
Dublin United	„ 6	3,640	- 180	¶22	78,496	
Dudley—Stourbridge ...	May 30	715	- 522	21½	14,671	+ 2,091
*Dundee Corporation ...	...	...	...	...	...	...
East Ham Council	June 7	451	...	50	18,464	...
Gateshead & Dist. Trams	May 30	737	+ 241	21½	14,130	+ 977
Glasgow Corporation	June 7	12,182	+ 584	1	12,182	+ 584
Greenock & Port Glasgow	May 30	525	+ 310	21½	9,052	+ 5,140
Hartlepool Tramways ..	„ 30	276	- 52	21½	4,531	+ 365
Hull Corporation	June 7	1,765	+ 108	10	16,713	+ 158
Isle of Thanet Co.	...	...	...	...	...	...
Kidderminster & Dist....	May 30	122	- 187	21½	2,269	+ 41
Leeds Corporation	June 7	5,904	+1,569	10	52,593	+ 7,950
*Liverpool Corporation...	May 31	9,706	- 453	22	199,042	-14,918
Liverpool Overhead Rly.	June 8	1,506	- 145	‡23	32,874	- 3,232
Manchester Corporation	„ 7	5,181	..	§52	113,201	...
Merthyr.....	May 30	213	- 159	21½	4,194	- 657
Middleton	„ 30	470	...	9½	2,956	...
Newcastle-on-Tyne Corp	June 7	2,665	...	10	11,167	...
Oldham, Ashton & Hyde.	May 30	634	+ 23	21½	10,476	+ 109
Perth (W.A.) Elec. Trams	June 6	1,053	+ 168	‡49	48,289	+15,288
Poole & Dist.....	„ 30	259	- 151	21½	4,684	- 75
Portsmouth Corporation	...	...	...	...	...	...
Potteries	„ 30	1,439	- 301	21½	30,125	+ 1,032
Salford Corporation ...	June 9	2,403	+ 484	10	24,472	...
*Sheffield Corporation ...	„ 8	4,237	+ 582	23	86,960	+14,107
Southampton Corporat'n	„ 5	1,022	+ 205	22	18,427	+ 3,302
Southport Tramways ...	May 30	366	- 2	21½	4,166	+ 1,213
*S. Staffordshire Trams...	„ 30	814	- 505	21½	16,153	+ 409
Sunderland Corporation.	June 8	1,140	...	10	10,759	...
Swansea Trams.....	May 30	477	- 155	21½	9,110	+ 759
Taunton Trams.....	„ 30	62	...	21½	1,228	...
Tynemouth & Dist.	„ 30	262	- 107	21½	4,549	+ 251
Wigan Corporation	June 5	262	...	10	2,007	...
Wolverhampton District	„ 30	147	+ 44	21½	3,069	+ 1,973

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, June 4.		Price Wednesday, June 11.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 11.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	El'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Crd. (fully pd.)	½	¼	½	¼			..	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)..	100	104	100	104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11	12	11	12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103	106	103	106	6 5 2	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	8¼	9¼	8¾	9½	4 6 6	...	..	...
20,000	5	3/6	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	March and September	9⅛	...
2 ,000	5	3 6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8	9	8½	9½	3 3 2	...	...	...
10,000	5	3/4½	Do (Nos. 20,001-30,000)	8	9	8½	9¼		...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	107	105	107	3 14 11	...	105¾	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	10	9	10	5 0 0	February and August	9⅜	9½
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	..	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	5¾	5½	5¾	3 18 3	" "	5½	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 15 6	...	106¼	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5	5½	5	5½	3 12 9	March	...	...
£180,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110	113	110	113	4 0 2	June and December...	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8	9	8	9	5 5 7	February and August	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	11½	12½	11½	12½	4 16 0	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123	128	123	123	3 18 10	June and December ...	...	...
£300,000	Stock	4½%	Do, 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 6 0	...	103½	...
40,000	10	6/0	County of London and Brush Prov. Ordinary	7½	8½	7⅜	8⅛	4 14 2	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12	13	12	13	4 12 4	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	108	111	108	111	4 2 6	...	...	...
10,000	5	4,6	Folkestone Electricity Supply Co. Ordinary	6¾	6¼	6¾	6¼	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10	11	10	11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6¼	6¾	6¼	6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 18 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104	107	104	107	3 14 11	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1½	1⅝	1½	1⅝	...	...	...	...
25,840	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	...	...
£260,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95	100	95	100	4 0 4	Mar., June, Sept., Dec.	96½	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16½	17½	16⅜	17⅛	3 14 4	April and October	18 1/16	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111	115	111	115	3 18 2	June and December ...	...	...
£260,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	93	101	98	101	3 10 4	...	100½	98¾
10,552	10	6/0	Notting Hill Electric Ordinary	14	15	14	15	4 0 0	March	...	...
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	"	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	93	101	99	102	3 18 10		...	...
300,000	1	...	Rand Electric	15/16	1 1/16	15/16	1 1/16	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 6 9	April and October	...	...
40,000	5	9.6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	15 15/16	16⅛
20,000	5	3/6	Do. 7 per Cent. Preference	8⅜	9⅛	8⅜	9⅛	3 13 8	" "	9 1/16	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98	101	98	101	3 9 6	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1¾	2¼	1¾	2¼	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	3	3½	3	3½	...	...	...	...
110,000	6	5 6	Westminster Electric Supply Ordinary	11	12	11	12	4 7 6	March and September	1⅛	11½
28,141	5	...	Do. 5 per Cent. Cumulative Preference	3½	4	3½	4	...	...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4⅛	4⅜	4¼	4½	4 8 11	April and October	4 1/16	...
£220,000	Stock	6%	Do. Permanent 6% Deb. Stock	127	132	127	132	4 12 7	...	...	...
20,000	10	...	Barcelona Tramways Ordinary	8½	9½	8½	9½	...	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	9	9⅛	9	9⅛	5 5 3	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½	14½	13½	14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3½	4	3⅜	4	...	...	3⅜	3⅝
75,000	5	2/6	Do. 5% Cum. Pref.	4½	5	4⅜	5	5 0 0	...	4⅜	4 1/16
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	104	107	104	107	4 4 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21	22	21	22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106	08	106	108	3 14 1	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7½	7	7⅜	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9⅜	10⅛	9⅜	10⅛	4 17 6	May and November ...	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102⅞	104⅞	102⅝	104⅞	4 6 9	...	...	...
100,000	10	6/0	British Electric Traction Ordinary	13½	14½	13⅜	14⅜	6 4 2	...	14⅜	13¾
100,000	10	6/0	Do. 6% Cum. Pref.	12⅜	13	12⅜	13	4 12 4	February and August	12⅝	12 9/16
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	126	...
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅜	1⅝	1⅜	1⅝	...	...	1⅞	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅜	5⅛	4⅜	5⅛	5 14 3	...	5 3/16	5⅛
27,500	5	10/0	Do. "B"	4⅜	5⅛	4⅜	5⅛	5 14 3	...	...	...
£120,000	Stock	5%	Do. 5 per Cent. Debentures	104	107	104	107	4 13 9	...	101½	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97	100	97	100	5 0 0	...	...	...
25,000	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	12½	13½	13⅜	14⅛	2 1 5	...	13 1/16	13⅜
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	109	108	110	4 3 1	...	...	...
180,000	1	1/2½	Cape Electric Tramways Shares	2⅜	2⅝	2⅜	2⅝	3 16 2	...	2½	...
£1,810,014	Stock	4%	Central London Ordinary Stock	104	107	103	106	3 15 1	June and December...	106¼	105
£494,003	Stock	4%	Do. 4% Preferred Stock	103	106	104	107	3 15 11	...	1.6½	104
£491,993	Stock	4%	Do. Deferred Stock	100	103	100	103	3 17 11	...	101	...
£258,201	100	4%	Do. 4% Deb.	116	118	116	119	3 8 0	...	1 18/32	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5	5½	5	5⅛	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	2½%	City and South London Railway Con. Ordinary	71	74	71	74	2 14 1	February and August	72½	71½
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	...	...	...	...	...	" "	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	...	...	...	...	...	...	..	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	133	128	133	3 15 5	" "	...	...
£200,000	Stock	5%	Do. (1896)	125	128	123	129	3 18 7	...	...	...
£150,000	Stock	...	Do. (1901)	121	125	121	125	...	...	...	...
£446,463	Stock	5%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November ...	116	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅞	12⅜	11⅞	12⅛	3 16 11	...	...	...
52,887	10	6/0	Do. 6 per Cent. Preference	14½	15½	14½	15⅜	3 17 5	...	...	...
£ 00,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4¼	4⅜	4¼	4⅜	6 6 4	...	...	...
£75,000	Stock	40/8	Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 15 2	...	...	...
78,000	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8	9	8	9	3 6 8	...	...	...
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	14	13½	14	4 5 8	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	10	112	10	112	4 0 6	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½	5	4½	5	...	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4 13/16	4 15/16	4 13/16	4 15/16	3 0 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅜	11	10⅜	11	4 11 1	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98	99	98	99	4 0 10	January and July	...	...
[51,501	10	..	London United Trams 5% Cum. Pref. (£10 paid)	1 ¾	11¼	10¾	11½	...	...	10 15/16	...
50,999	10	...	Do. (£5 paid)	5½	6	5½	6	...	...	...	...
£655,341	Stock	...	Do. 4% 1st Mortgage Debenture Stock	106	108	106	108	...	...	107⅛	107⅜
£169,659	Stock	...	Do. Prov. Certs. (£50 paid)	55	57	55	57	...	...	...	...
$5,5[illegible],000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	115	119	115	119	4 5 7	...	...	...
£50,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	104	106	104	106	4 14 9	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	103	105	104	106	4 6 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	—
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3	4	7 10 0	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96	100	96	100	5 0 0	...	...	...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stck.	1 0	103	100	103	4 12 9	...	102	...
13,334	10	8/0	Potteries Electric Traction Ordinary	9½	10½	9½	10⅜	3 16 2	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	107	110	107	110	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...	...	...	...	...	...
51,132	1	...	Do, 6% Preference (12/0 paid)	...	...	...	...	...	April and October	...	...
10,000	1	...	Do. 6% Preference (fully paid)	...	...	...	...	...	"	...	...
[illegible]0	Stock	...	Do. 4½% Debenture Stock (60% paid)	...	...	...	...	...	January and July	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Shares.	Last Dividend.	Name.	Previous Week's Price, June 4,		Price Wednesday, June 11.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 11.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.).....	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph.....	3⅛	4⅛	3⅛	4⅛	...	June and December ..	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£778,840	Stock	12/6	Anglo-American	44	47	44	47	5 19 5	Feb., May, Aug., Nov.	46	45
£3,105,580	Stock	25/0	Do. Preferred.....	88	90	87	89	6 9 11	" "	88⅛	88⅛
£3,105,580	Stock	2/0	Do. Deferred	6⅞	7⅛	6⅞	7⅛	1 7 7	" "	7⅛	6⅞
$13,333,300	$100	$1⅔	Commercial Cable Capital Stock.....	160	170	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	94	96	95	97	3 2 10	" "	97	96⅛
16,000	10	4/0	Cuba Submarine Ordinary	4⅛	5⅛	4⅛	5⅛	7 5 6	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½	13½	12½	13½	7 8 2	" "	13	12½
13,000	5	2/0	Direct Spanish Ordinary	2⅛	3⅛	2⅛	3⅛	5 14 4	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8⅛	9⅛	8⅛	9⅛	5 5 3	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	98%	102%	98%	102%	4 8 3	January and July	...	...
60,710	20	3/0	Direct United States Cable	9½	10⅛	9⅛	10⅛	6 3 10	Jan., Apr., July, Oct.	9⅛	...
£101,300	100	4½%	Direct West India Cable 4½% Eg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December ...	...	...
£4,000,000	Stock	25/0	Eastern Ordinary ....[to 1,200) (red.) ..	120	130	120	130	5 7 8	Jan., Apr., July, Oct.	126	123
£1,930,807	Stock	17/6	Do. 3% per Cent. Preference Stock	86	89	87	89	3 19 5	" "	88⅜	87⅛
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	106	110	107	111	3 12 2	May and November ...	109⅛	...
300,000	10	6/6	Eastern Extension	12⅛	13⅛	12	13	5 7 8	Jan., Apr., July, Oct.	13	12⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	112	108	113	3 11 4	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 17 4	February and August		...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	99%	102%	99%	102%	3 18 5	May and November ...	101⅜	...
150,000	10	20/0	Great Northern of Copenhagen	25	27	25	27	5 11 1	January and July	26⅛	...
£75,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos	99	103	99	103	4 8 3	June and December ...	...	...
17,000	25	37/6	Indo-European.....[1 to 1,200) (red.	37	41	37	41	6 1 11	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ..	100	104	100	104	5 15 4	March and September	.	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 7	June and December...	...	...
15,609	10	...	*West African Telegraph Shares	3½	4⅛	3⅜	4⅛	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99	102	99	102	4 19 0	March and September	...	...
30,008	2½	...	West Coast of America.....	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99	102	99	102	3 18 5	January and July	101⅜	101
88,321	10	...	West India and Panama	⅜	⅝	⅜	⅝	...	May and November ...	...	...
34,563	10	£/0	Do. 6 per Cent. 1st Pref.	5⅛	5⅝	5⅛	5⅝	10 8 8	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅜	4⅜	3⅜	4⅜	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	101	104	101	104	4 16 8	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazil'n Submarine).....	11⅜	12⅝	11⅛	12⅛	5 16 4	Mar., June, Oct., Dec.	12⅛	11⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 3	June and December...	..	..
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 18 5	...	...	...
			TELEPHONES.								
44,000	£5	5 0	Chili Telephone (fully paid)	3⅛	4	3⅛	4	6 5 0	August	3⅞	3⅞
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October.....	..	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	½	½	½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	..	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	97⅜	...
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	3⅛	3⅜	3⅛	3⅜	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	53	57	53	57	7 17 11	...	54½	...
15,000	£6	6/0	Do. 6 per Cent. Cumulative 1st Preference..	12	14	12	14	4 5 9	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12	14	12	14	4 5 9	" "		...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ..	5	5½	4⅞	5⅜	4 17 6	" "	5⅛	5
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	94	97	94	97	3 12 5	June and December ...	...	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	103	107	103	107	3 15 8	...	103	105
171,504	1	0/8½	Oriental	1 7/16	1 9/16	1 15/16	1 17/16	5 12 11	April and October.....	...	...
58,000	5	2/6	United River Plate	4½	5	4⅝	5⅛	6 13 4	July	5	...
40,000	5	2/6	Do. 5% Cumulative Pref.....	4⅝	5	4⅝	5	5 0 0	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.).....	103	106	103	106	4 14 8	June and December ...	...	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.....	⅝	¾	⅝	¾	5 14 3	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛	¼	⅛	¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅝	¾	⅝	¾	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary.....	7⅛	8½	7⅛	8½	5 17 8	July and February ...	...	...
70,000	5	3/0	Do. 6 per Cent. Preference	5½	5⅝	5⅝	6	5 0 0	January and July	...	...
£250,000	Stock	50/3	Do. 4½% 1st Mort. Deb. Red.	101	104	101	104	4 6 6	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference.....	5⅝	6	5⅝	6	5 0 0	...	6	5⅝
105,731	2	...	Brush Electrical Engineering	1⅛	1⅜	1⅛	1⅜	...	March	...	...
150,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	1⅛	2⅛	1⅛	2⅛	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock.....	101	104	101	104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	95	100	95	100	4 10 0	January and July	...	...
£0,000	5	5/0	Callender's Cable Construction Ord.	17	18	17	18	4 3 4	" "	17⅛	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference.....	5⅛	6	5⅜	6⅛	4 0 0	" "	6⅛	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb.(red.).....	111	115	111	115	3 18 4	November and May ...	...	...
450,000	1	0/3½	Gastner-Kellner Alkali Co. (fully paid).....	1	1⅛	1	1⅛	4 16 0	...	1⅛	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	90	95	90	95	4 16 0	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	8 0 0	March	...	...
85,000	3	1/9½	Crompton and Co. (Nos. 1 to 54,000)	3	3⅛	3	3⅛	6 8 6	January and July	3⅛	3 1/16
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb.(red.) ..	103%	108%	103%	108%	4 12 8	" "	109	101½
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid) ..	⅛	⅜	⅛	⅜	...	February and August	...	...
17,139	5	...	Do. (£5 paid).....	2	3	1½	2½	..	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.) ...	75	80	75	80	5 1 3	June and December...	75	...
25,500	5	2/6	Edmundson's Electricity Corporation Ord.	6½	6¾	6½	6¾	5 3 3	Half-yearly	...	...
30,000	5	3/0	Do. 6% Cumulative Preference	5⅞	6¼	5⅞	6¼	4 16 0	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	108	111	108	111	4 2 0	...	...	...
112,100	2	1/2½	Electric Construction Co.	1½	1⅝	1½	1⅝	6 17 2	January and July	...	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅜	3	2⅜	3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97	101	99	102	3 18 11	January and July	...	...
122,685	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	10	10⅛	10	10⅛	4 15 3	...	10⅜	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98	101	98	101	3 19 3	...	...	...
35,000	5	10/0	Henley's Telegraph Works Ordinary	14⅛	17⅛	16⅛	17⅛	4 5 9	February and August	17	...
35,000	5	2/8	Do. 4% per Cent. Preference	5⅛	6	5⅛	6	3 15 0	" "	...	...
£42,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) ..	111	115	111	115	3 18 3	" "	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	" "	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34	37	24	37	6 9 8	March and July	33⅜	35½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	106	3 15 5	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	9½	10½	9⅜	10⅛	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛	6	5⅛	6	4 3 4	...	...	...
66,666	5	5/0	Willans and Robinson Ordinary		...		...	...	April and October	...	...
66,666	5	3/0	Do. 6 per Cent. Cumulative Pref.....		...		...	...	" " "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures..		...		...	...	May and November ...	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3 0	Electric and General Investment 6% Cum. Pref. ..	5½	5⅝	5⅛	5⅝	5 9 1	...	5½	...
180,727	10	2/6	Globe Telegraph and Trust	8	9	8	9	5 16 8	Jan., Apr., July, Oct.	8⅞	8½
180,042	10	3/0	Do. 6 per Cent. Preference.....	12½	13⅛	12½	13⅛	4 8 11	" " "	13⅜	12⅜
11,839	8	4 0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	7	...
8,303	£100 Cert.	0%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

A FULL report of the speeches made on the occasion of the Institution of Electrical Engineers' deputation to Mr. GERALD BALFOUR will be found in another column of this issue. It is too early to forecast what the ultimate result of the deputation will be, as the President of the Board of Trade has, up to the present, merely followed the ordinary course of listening patiently and with intelligent interest to the case put forward by the deputation, and promising that the matter shall have consideration. It has been elicited, however, that a traction Bill has been drafted on the lines of the report of the recent departmental committee on light railway legislation, that another Bill has been drafted to carry out the recommendations of Lord CROSS' "Joint Committee on the Law Relating to Electrical Energy Generating Stations," published in 1898 (*The Electrician*, Vol. XLI., p. 218), and further, that there is little chance of either of these Bills being carried through this session. In addition to this, the Institution is invited to submit for the consideration of the Board of Trade any alterations it deems necessary in the existing Board of Trade regulations, but no definite indication has been given as to how the wider and more important question of general electrical legislation will be dealt with, and whether there will be practical consideration of an alteration of the present relations between local authorities and the promoters of new electrical undertakings.

THE opening of a new electricity works at Haggerston by the Shoreditch Borough Council on Monday provided a curious variety entertainment for those who took either an active or a passive part. A noisy brass band and a garish display of bunting and lamps were the first things to greet the visitors. Soon after the formalities and speechifying had commenced, the proceedings degenerated into something like a pothouse political wrangle. Someone alluded to dust destructors, and instantly contentious partisans and rivals caught fire. Passing over these local characteristics, however, we are glad to be able to congratulate the consulting engineers, Messrs. KINCAID, WALLER and MANVILLE, the resident engineer, Mr. C. NEWTON RUSSELL, and the numerous contractors, on the successful completion of an important addition to the electricity works of the metropolis. It argues well for the popularity of electric light among the masses, no less than among their richer neighbours, that electricity supply is extending so rapidly "down East."

WE all have heard the story of the Irish counsel who offered to produce "fifty witnesses who would swear that they did not see the prisoner commit the crime." Our contemporary, the *Journal of Gas Lighting*, having put forward two witnesses —the cities of Liverpool and Birmingham—whose official statements show that they cannot make electricity beat horse traction, now thinks that these two veracious but altogether irrelevant witnesses have floored the multitude who are prepared to prove that electric traction can and does beat horses. Bristol is objected to, by our contemporary, as an example of successful conversion, on the ground that it is hilly. Horses, it tacitly admits, are useless on hills. Then, let our contemporary go to Dublin, which is flat enough. There the trolley has triumphed as completely over the horse as it has done at Bristol. Beaten on the main question of the financial superiority of electric power, our contemporary shifts its ground and retorts that the advantages of electricity are not due to the electricity at all, but are "by reason of increase of traffic." This is decidedly metaphysical. We imagine that if tramway owners see that electricity spells more traffic, they are not likely to trouble their heads what it is in this mysterious electricity that produces so excellent a result.

SINCE MOISSAN published his classical researches on carbon and exhibited to the members of the French Academie des Sciences minute diamonds which had been obtained by rapid cooling of a highly-heated mass of cast iron, little has been

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effected in this field of research. The *Zeitschrift für Elektrochemie* of May 8th contains details of experimental work relating to the fusion of carbon, carried out in recent years by Dr. A. Ludwig, which will serve to re-awaken interest in the subject of artificial diamonds. Having referred to the fact that under ordinary conditions of heating, carbon, like arsenic and phosphorus, volatilises without passing into the liquid condition, Dr. Ludwig gives details of his own work, and shows that by the use of a pressure of 1,500 atmospheres it was possible to obtain carbon in a non-conducting state, clearly indicating its passage into the transparent liquid condition. The carbon passed rapidly, however, from this state into that of graphite, and experiments proved that this last allotropic form of carbon can be formed either with or without the intervention of the liquid state. Attempts to form diamonds by rapid cooling of the liquid carbon, while still under pressure, were not very successful; but Dr. Ludwig believes that he has solved the problem of the natural formation of diamonds, and that, by following the lines which he has indicated, later workers may be successful in producing this form of carbon in the laboratory.

So seldom is any radical departure made in the arc and carbon arrangements of arc lamps, that a design in which the two carbons and the arc are not, as usual, co-axial is most interesting. It is obvious that any disposition of the arc carbons which permits of a free and uninterrupted downward radiation of light from the crater and the negative carbon end is an ideal one, and so often has this been recognised by inventors that it is only necessary to turn over the files of patents for arc lamps to find what repeated efforts have been made to produce a practically satisfactory lamp of this type. What is the inherent difficulty? A good many difficulties not encountered in the ordinary form occur with such arcs, but we believe the chief problem arises from the long and curved arc column which is involved even with carbons of small diameter. The instability and unsteadiness of such arcs are greatly increased by the strong convection currents of air which, of course, act transversly to the arc column.

The latest attempt to solve this attractive problem has resulted in the "Bremer" lamp. The general principle of this lamp is described in the Paper by Herr Siegmund Saubermann, an abstract of which appears on another page of this issue. A modified form was described by us on March 21st. In the Paper referred to, a virtue evidently has been made of what is really a necessity. By impregnating the positive carbons with certain salts, a "carbon" electrode is obtained, probably approximating to the constitution of the cores in ordinary cored carbons. The use of these prepared carbons renders possible the production of a relatively stable long arc, and what is also important, in view of the practical design of the lamp, an arc at a much lower temperature than usual. Much is made of the advantages, and even the superior efficiency, of the resulting light radiation emitted from this arc. A great deal depends on particular requirements as to what extent these claims are true in practice. The *colour* of the light is about midway between that of an unmantled gas flame and that of an ordinary arc, while the arc column itself appears to be an important source of light. This extension of the volume of the radiating source, involving a lower temperature, is opposed to the principles of efficiency of light radiation, and therefore it seems to us that the practicability of the favourable disposition of the carbons has been dearly bought by a sacrifice of the prime conditions for initial efficiency. The drawings accompanying the Paper are obviously diagrammatic rather than representative of the actual design; but it is evident that since the carbons depend on their own weight to feed, it is necessary to keep the tubes or slides moderately clean—a difficult task, considering that they are practically open to the gases at their lower ends. Nothing seems to be provided to obviate the possible unequal feeding down of the two carbons.

Reduction in Telegraph Rates.—The Western Telegraph Co. announce the following reduction in tariffs from July 1st:—Lagos, from 6s. 5d. to 6s. 3d. per word; Brass, 6s. 7d. to 6s. 3d.; Bonny, 6s. 10d. to 6s. 3d.; Lagos Government stations, 6s. 7d. to 6s. 5d.; and Cameroons, 7s. to 6s. 5d.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Bolama	April 19, 1902
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Puerto Plata—Fort de France	May 31, 1902
Jeddah—Suakim	June 18, 1902

Marylebone Arbitration.—The arbitration proceedings to settle the amount to be awarded to the Marylebone Electric Supply Co. by the Marylebone Borough Council in connection with the transfer of the company's Marylebone undertaking to the Council were resumed at the Surveyors' Institute, Westminster, yesterday (Thursday). The examination of Mr. R. R. Todd, engineer-in-chief to the company, was resumed, followed by that of Col. R. E. B. Crompton. The proceedings were adjourned to to-day (Friday).

Physical Society.—A meeting of the Physical Society will be held to-day (Friday) in the rooms of the Chemical Society, Burlington House, Piccadilly, at 5 p.m. The following is the agenda:—(1) "Exhibition of a Three-circle Goniometer," by G. F. Herbert Smith. (2) "The Heat Absorbed when a Liquid is brought into Contact with a Finely-divided Solid," by C. J. Parks. (3) "On the Electrical Resonance of Metal Particles for Light Waves" (second communication), by Prof. R. W. Wood. (4) "On a Remarkable Case of Uneven Distribution of Light in a Diffraction-grating Spectrum," by Prof. R. W. Wood. (5) "Exhibition of a Simple Form of Apparatus for Measuring the Mechanical Equivalent of Heat," by Prof. H. L. Callendar.

Lighting Miners' Safety Lamps by Electricity.—Mr. E. Brown read a Paper on "An Apparatus for Lighting Miners' Safety or other Enclosed Lamps by Electricity" at a recent meeting of the Midland Institute of Mining Engineers. A metallic conductor was fixed in the glass surrounding the wick of the lamp, which was lighted by placing it on a stand having a battery and induction coil inside it. Contact plates were arranged on the top of the stand, and by pressing down the lamp the primary circuit of the coil was closed, causing a spark to pass between the conductor in the glass and the wick tube, this being sufficient to light the wick. It was possible by this arrangement to light an ordinary safety lamp without passing a conductor through the bottom. The apparatus was on view at the meeting.

The Use of Superheated Steam.—The applications of superheated steam were dealt with in a recent article contributed to *Electricity* of New York, by W. H. Wakeman, and some of the difficulties in the use of packings were pointed out. Soft packings have been found of very little use, as the great heat

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melts a portion of the packing, and the remainder will speedily blow out. Metallic packing only should be used in the piston-rod stuffing boxes of engines driving generators required for continuous service. Fibrous packing is of little value for withstanding the steam for a reasonable time, especially with sliding or rotating valve stems. Globe, gate and angle valve stems should be packed with asbestos wicking, coated with graphite mixed with cylinder oil, the author's experience having found this superior to anything else.

Central London Railway.—The Central London Railway Co. have just closed a contract with the British Thomson-Houston Co., of Rugby, covering 64 motor-car equipments and 160 trail car equipments. The equipment for each motor car is to consist of two B.T.H. 125 H.P. traction motors, one motor truck of the swinging bolster type with 33in. wheels, one motor-driven air-compressor with a capacity of 35 cubic ft. of free air per minute; an automatic governor, arranged to cut in the compressor at 80lb. air pressure in the main reservoir, and to cut it out at 90lb. pressure; and one British Thomson-Houston master train control equipment for the motors. Each trail car equipment consists of the control circuit cable and wiring material for the controller train line required for this system. Each train will consist of two motor cars and five trailer cars, the motor cars being at each end.

Cable Steamer "Colonia."—A party of gentlemen connected with submarine telegraphy visited the Telegraph Construction and Maintenance Co.'s works at Greenwich on 13th inst. to witness the manufacture of the Pacific cable, and were afterwards entertained at lunch on board the cable ship "Colonia." Amongst those present were Sir John Wolfe-Barry, Sir John Denison-Pender, Marquess of Tweeddale, Sir Albert J. Leppoc Cappel, F. A. Johnston, Hon. Arthur Brodrick, Sir Henry C. Fischer, Dr. Goodsall, John Coppen, Sir Henry C. Mance, Sir James Pender, Messrs. G. Draper, F. E. Hesse, A. R. Hardie, W. Judd, G. C. Jack, T. A. Bullock, W. R. Lyne, S. Collett, J. Cambrook, H. E. Plank, J. T. Crowe, T. Richardson, D. Gair, G. R. Neilson, J. G. McMillan, F. C. C. Nielsen, W. Shuter, P. V. Luke, Colin F. Campbell, F. R. Lucas, Willoughby Smith, E. Dickens, J. G. Griffiths, Capts. Pattison, Greey, Cato and Woodcock. The "Colonia" is taking on board cable for, and will shortly proceed to lay, the Vancouver–Fanning island section.

Lead Poisoning Regulations in Germany.—According to the *Elektrochemische Zeitschrift* for May, the Minister of the Interior has ordered the following regulations to be enforced in all factories and working places within the borders of the kingdom of Saxony:—

1. No work connected with the manufacture of lead or its compounds shall be permitted in ordinary living or sleeping rooms.
2. The rooms or work places must be kept as clean as possible, and must be well ventilated. The floors must be washed daily, or swept after sprinkling with water.
3. Washing places must be provided for the workers, in addition to suitable accommodation for storing and changing their ordinary clothing.
4. Special clothing must be provided and worn by the workers during working hours.
5. Tobacco smoking and chewing must not be permitted during working hours.
6. Food and drink must not be stored or partaken of in the working rooms.
7. Meals must be eaten in a separate room, completely separated from those in which manufacture is carried on. Before eating, the workers must change their clothes, wash their faces and hands with hot water and soap, and rinse out their mouths with clean water. These precautions are also to be carried out when leaving the factory at night.
8. A periodic medical examination of the workers is also to be carried out, and those found to be suffering from lead poisoning, or from any disease predisposing thereto, are to be excluded from the factory until restored to health.

The special dangers of the work must also be explained to all applicants before permitting them to start work in the factory.

It is customary to regard our own country as being far ahead of any other in sanitary regulations framed to protect the workers, but we think that even English manufacturers would consider the above regulations somewhat burdensome and vexatious.

Compensated Alternators.—M. Boucherot read a Paper on this subject before the Société Internationale des Electriciens on June 4th. The compensation of synchronous alternators by Boucherot's method is effected by a special exciter, the fixed part of which is similar to the stator of an induction motor, the revolving part being similar to a multipolar armature of a continuous-current dynamo. Theory shows that the exciting current I necessary to maintain a constant pressure is $I = \sqrt{(A + BI_1 \sin \phi)^2 + (BI_1 \cos \phi)^2}$, if the armature resistance be considered as negligible, and M. Boucherot points out that such a current can be obtained from a series transformer. Further explanation of the theory of the subject will be found in our description of the machine at the Paris Exhibition (*The Electrician*, Vol. XLV., p. 886). The compounding effect is theoretically perfect, but in practice it is impaired by the leakage effect. For a high-leakage machine (92 polar, for instance) with a non-inductive load the compensation was perfect, but with inductive load there was an over-compounding effect. Ordinary machines show no practical difference, however; fluctuations of load and speed, of course, result in perturbations, but these can be allowed for just as the effects of hysteresis and heating. This automatic compounding offers an instantaneous compensation much better than the hand rheostat regulation, which is never simultaneous with the variation it is intended to compensate. The exciters used by M. Boucherot are designed for a comparatively low number of brushes, eight, for instance, for 20 or 30-pole alternators. An advantage claimed by M. Boucherot for the compensated alternator is that it can be given a higher inductance and a smaller flywheel than other machines of equal output, and is, therefore, less expensive to build. In the case of paralleled alternators, the compounding transformers are grouped in parallel, so that they compound as a whole with reference to the network. Among the compensated alternators in operation in France, M. Boucherot showed photographs of 20, aggregating about 3,000kw. These included a 2,600 volt, 42 cycle, 800 H.P. machine, and some of 300kw., 200 kw., 100kw., and less.

Tests of Graphite and Platinum Anodes for Electrolytic Cells.—A recent issue of the *Zeitschrift für Elektrochemie* contains details of experiments carried out by Foerster and Denso with graphite and platinum anodes in various electrolytes. The graphite anodes were supplied by the Acheson Graphite Co., of Niagara Falls. The tests made with this material were on the same lines as those made by Sproesser, referred to in these columns on January 31, 1902. The specific gravity of the Acheson graphite was 2·14, and the ash contents only 0·83 per cent. Tested in an 8 per cent. sodium hydrate solution at 20°C., the oxidation at the anode amounted to only 2 per cent., as compared with 50–78 per cent. when ordinary carbon was employed in such a solution. With an electrolyte of sodium chloride, containing some chromate, at 60°C., the figures were 7·4 and 12·41 per cent. respectively. With a 20 per cent. solution of sulphuric acid at 18°C., the Acheson graphite was, however, no more resistant than ordinary carbon. Upon these results the author bases the statement, that the higher the hydroxyl concentration of the electrolyte, and the lower the potential at which the oxygen ions are discharged at the surface of the anode, the greater is the superiority of the artificial graphite over the ordinary varieties of carbon. The experiments with platinum anodes were made with alloys of platinum and iridium (7·6 to 15 per cent. of Ir) supplied by Heraeus, of Hanau, in thin foil of only 0·007mm. thickness. Potassium chloride, sodium chloride and hydrochloric acid solutions were used as electrolytes in these experiments, with temperatures varying from 20°C. to 80°C. The experiments showed that a slight loss in weight which occurred in some cases quickly fell to nil on continued electrolysis, and was, therefore, to be ascribed to surface inequalities or impurities of the foil, probably introduced by the rolling operation. The fact that this loss is not a continuous one, coupled with the fact that the Hanau firm can now supply platinum electrodes with a superficial area of 2 sq. metres, weighing only 2 grammes as regards the platinum, is held by the authors to prove that platinum is likely to compete in the future with carbon and graphite as anode material for alkali cells. All the experiments were carried out in the chemical laboratory of the technical Hochschule at Dresden.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Ionisation by Ultra-Violet Light.—The conductivity produced in gases by the aid of ultra-violet light has been examined by J. S. Townsend with a view to the discovery of definite relations between the E.M.F., the pressure, and the distance between the electrodes. He finds that the total number of ions n reaching the positive plate from a negative zinc plate at a distance d is given by the formula

$$n = n_0 \epsilon^{ad},$$

when n_0 is the number of ions set free from the zinc plate, and a the number of ions generated by a zinc electron by collision with the gaseous molecules encountered along a path 1cm. in length. The number of ions generated increases with the E.M.F., and there is a certain maximum of a for any given pressure, this maximum representing the point at which every collision results in ionisation. The results also show that the ions given out by the zinc plate under the influence of ultra-violet light are identical with those produced in a gas under the influence of Röntgen rays. When the E.M.F. is small and the pressure great, the ions quickly acquire the properties of masses which are large compared with molecules; but as the force increases these masses are broken up and the negative ions become isolated electrons. Thus the apparent masses of the ions depend upon the ratio of the electric force to the pressure.

[J. S. Townsend, *Phil. Mag.*, June, 1902.]

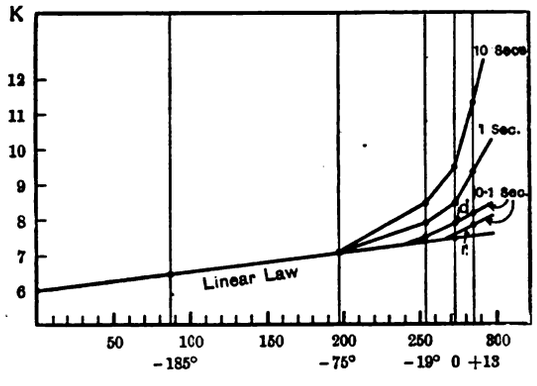
Mechanism of Electric Conduction.—Under the title "The Change of the Electrical Resistance of Metals when Placed in a Magnetic Field," J. Patterson describes some interesting and important experiments made to determine the effect of a magnetic field upon the paths of the electrons which convey the current through a wire. According to J. J. Thompson, an electron or "electric corpuscle" moves in a cycloid in a magnetic field at right angles to its original path, and in a spiral in a field parallel to its path. Both modifications of the straight path should lead to a retardation of the progress of the particle; in other words, to an increase of "resistance." Such an increase has already been observed and measured in the case of bismuth, but the author examined the non-magnetic metals and drew some new conclusions from the results. He obtained an increase of about 0·21 per cent. in cadmium, 0·06 per cent. in zinc, 0·03 per cent. in gold, 0·004 per cent. in platinum, 0·02 per cent. in tin, 0·02 per cent. in silver and carbon, the field being transverse. Slightly lesser values were obtained with a longitudinal field. The mean velocity of the electrons acquired under a unit field would be of the order 10^{-6} cm/sec., their mean free path of the order 10^{-6} cm., while their numbers per cubic centimetre of metal would range from $1{\cdot}08 \times 10^{19}$ in the case of carbon, and $4{\cdot}3 \times 10^{20}$ in the case of mercury, to $8{\cdot}6 \times 10^{22}$ in the case of copper. Their pressure would range from 21 atmospheres (mercury) to 1,840 atmospheres (silver).

[R. Patterson, *Phil. Mag.*, June, 1902.]

Polarisation Capacity of Palladium.—Besides the maximum value, the so-called initial value of electrolytic polarisation is of special interest, since the E.M.F. of polarisation is proportional to the quantity of electricity which has passed through it, as long as that quantity is small. In other words, the initial polarisation takes place as in a condenser. M. Wien divides liquid cells into three groups, according to their polarisation capacities. The first group is represented by platinum electrodes in dilute sulphuric acid. These have small polarisation capacity and small phase difference, practically independent of the frequency of the current. The second group has the so-called unpolarisable electrodes, with a large polarisation capacity decreasing at higher frequencies, and a phase difference of about $\pi/4$. The third group consists of cells with platinised platinum electrodes, which show high phase-differences and polarisation capacities. The author tests Warburg's theory of these cells, with especial reference to the part played by occlusion of gases. He used palladium electrodes on account of their great occlusion of hydrogen, but found that they behaved practically like platimum. Even when coated with palladium black, they only behaved as if their surface had been somewhat increased.

[M. Wien, *Ann. der Physik.*, No. 6, 1902.]

Specific Inductive Capacities at Low Temperature—J. Curie and P. Compan have determined the dielectric constants of various glasses, mica, ebonite, and quartz at 15deg., −19deg., −75deg., and the temperature of liquid air (−185deg.) The final results are given for a microscope cover glass of crown glass, but the behaviour of all the other substances is quite similar. It appears that the specific inductive capacity is a linear function of the absolute temperature. This is strictly true at temperatures below −75deg., but at higher temperatures it is only true for instantaneous charges, whereas a charge lasting for one second and even more for 10 seconds entirely alters the character of the curve. In the diagram given herewith



d indicates that the temperature is proceeding downwards, and r that it is proceeding upwards. The difference in the corresponding curves shows that there is some hysteresis. Below 75deg., however, glass behaves as a perfect dielectric, and its specific inductive capacity at the absolute zero of temperature is probably about 6.

[Curie and Compan, *Comptes Rendus*, June 2, 1902.]

Canal Ray Ions.—Some important advances in our knowledge of canal rays and the charges and masses transported by them have been made by W. Wien. He first of all showed that however high the vacuum a positive or negative discharge can always be obtained from an electrode kept at a white heat. A glowing carbon filament will discharge negative electrons when charged to −800 volts and positive ions (canal rays) when charged to +8,000 volts. A platinum wire will go on discharging in a similar manner until its whole substance is worn away. In determining the heating effect of the canal rays and the charges transported by them, the author obtained values for e/m which are very much lower than those for negative electrons (cathode rays). This is not surprising, since we know that positive electrons are invariably associated with atoms of matter when discharged from solids. But the author finds, in addition, that the ratio e/m varies within wide limits—say, 3,500 and 40,000 absolute electromagnetic units per gramme, as against the 10 million found in the case of negative electrons. The value for hydrogen ions in electrolysis is about 10,000, and the author draws attention to the possibility of the hydrogen ion being identical with the canal ray ion. He is, however, not quite certain of it yet, as he has failed to discover a characteristic variation of e/m for the canal rays with the atomic weight of the gas.

[W. Wien, *Ann. der Physik.*, No. 6, 1902.]

Erratum.—On p. 303 of the last issue, in the "Contemporary Electrical Science" note on the ratio e/m, the second sentence should read: "Taking the effective mass of the electron as of the order 10^{-27} gramme, this would mean that one electron has a charge of about 2×10^{-20} electromagnetic or 6×10^{-10} electrostatic units, and would repel another (negative) electron at a distance of $1\mu\mu$ with a force of 36 microdynes."

E. E. F.

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THE NEW ELECTRICITY WORKS AT HAGGERSTON.

The first electric power station of the Shoreditch Borough Council when opened by Lord Kelvin in June, 1897, contained three generators, each of 165kw., and three with an output of 70kw. each. From the moment that the service was inaugurated the demand has steadily increased, and though for some time past the original generators have been supplemented by others of the largest size that could be got into the remaining space in the original engine-room, it soon became necessary for the Council to consider the advisability of erecting a new power-station on a larger scale than the former one. A suitable site having been found on the banks of the Regent's Canal, the Borough Council instructed their consulting electrical engineers, Messrs. Kincaid, Waller and Manville, to prepare a comprehensive scheme for the erection of a station which should provide for the future needs of the district. The scheme proposed by them was adopted by the Council, and the works, of which the following is a description, have been completed under the supervision of Messrs. Kincaid, Waller and Manville and Mr. C. Newton Russell, the able and energetic borough electrical engineer.

The design of the new power-station is on a large scale, although only two units of generating plant have at present been installed. The engine-house and boiler-house are capable of extension as may be necessary. The accompanying plan and elevations show the general arrangement of the works.

Buildings.—The generating station occupies a site of about 19,800 sq. ft. at the corner of Whiston-street and Bath-place, Haggerston, with frontages to the Regent's Canal and the Haggerston basin, enabling coal to be delivered by barge and providing a supply of condensing water. The main buildings consist of a boiler-house, 68ft. by 62ft., with pump room adjoining, and engine-house 78ft. 6in. by 59ft. 6in., with basement, into which the condensing water and other pipes are taken. A subway, leading from this basement to a chamber under the pavement in Whiston-street, is provided for the feeder cables leaving the station. A transformer-room, containing the continuous-current transformers for supplying the network in the neighbourhood of the generating station, together with workshop and stores, adjoins the engine-room. The switchboard gallery extends the whole length of the engine-house, at a height of 11ft. above the floor level. Chambers are provided below the gallery for the reception of the shunt-regulating and other resistances, and for the accommodation of the cables proceeding to the machines and circuits. A room for the engineer-in-charge, at the same level, leads direct on to the gallery. A handsome room, with ante-room, having separate approach, is provided for the members of the committee, and accommodation for a resident mechanical engineer has been provided in a small house at the corner of the site. There are also separate rooms for the men employed in the engine-house and boiler-house respectively, each having the necessary lavatory accommodation.

Boiler Plant.—The boiler plant consists of four water-tube boilers of Messrs. Babcock and Wilcox's marine type, with solid-drawn steel tubes. Each boiler has a heating surface of 2,720 sq. ft., and is fitted with an economiser containing 350 sq. ft. of heating surface, making a total heating surface in the four boilers of 10,880 sq. ft., and in the four economisers of 1,400 sq.ft. It will be noticed that the floor space occupied by these boilers is very much less than with boilers of the "land" type. Three of the boilers are hand fired, having an ordinary grate area of 73½ sq. ft. each. The remaining boiler is fitted with a double 4ft. patent chain-grate stoker, made by Messrs. Babcock and Wilcox. The grate area of this boiler is 68 sq. ft., the total grate area in the four boilers being, therefore, 288½ sq. ft. These four boilers, combined with the economisers, produce about 50,000lb. of steam per hour, and are arranged along one side of the boiler-house, the space on the opposite side of the boiler-house being available for the accommodation of additional boilers whenever they are required.

The products of combustion are conveyed from the boiler to the chimney through flues constructed of steel, placed overhead. The flues are lagged outside by magnesia, which is held in position by means of external plates. A chamber has been provided at the base of the chimney shaft, to which the main flue is connected; it is so arranged that induced draught apparatus can be added subsequently.

The boilers are supplied with coal from an overhead coal store, having a total capacity of 750 tons, erected on steel stanchions above the stoking floor in the centre of the boiler-house. Pockets with sloping sides are provided in the bottom of these bunkers to facilitate the discharge of the coal to the boilers. The openings at the bottom of the pockets beneath the coal bunkers are provided with regulating valves, one being placed opposite the centre of each boiler, which enables the flow of the coal to be controlled. The coal is delivered, by means of these valves, into a hopper having a weighing apparatus, so as to correctly register the amount of coal delivered to the boilers. For the present, the coal for the boilers which have not been fitted with mechanical stokers will be delivered on the floor in front of the boilers, as the fireman require it. In the case of the boiler fitted with a mechanical stoker, the coal will be delivered directly into the hopper in connection with the stoker. A special feature about the boiler-house is the arrangement by which the coal is lifted from barges on the canal alongside the generating station, conveyed to the bunkers and afterwards to the boilers. The coal is lifted from barges by means of a hinged grab or shovel of ¼-ton capacity, which is suspended from a boom of parabolic form, extending over the canal. This apparatus is situated at the top of a tower constructed of steelwork, placed near the edge of the canal at the end of the boiler-house. The parabolic form of the boom enables the load to be lifted vertically until it reaches its extreme elevation, when an inward movement takes place, at the end of which the coal is dumped into a hopper and delivered, through a regulating duplex valve, into an automatic waggon; as soon as this is filled it is released, and runs over the top of the bunkers, dumping the coal at any point where it is required. The hoist is driven by means of two electric motors of the enclosed type, supplied by the Westinghouse Company, the speed being regulated by a series-parallel controller.

The peculiar feature of the automatic railway consists in the storage of energy by the loaded car in descending an inclined track, the energy being utilised to return the empty car to the place whence it started, after the load has been discharged. By the time the loaded car has reached the end of its journey it has raised a counter-weight a certain height by means of a cable, which the car picks up while running down the track. The weight rises only a limited distance, but when the car has dumped its load of coal, which weighs from 20 to 25cwt., the weight falls, and in so doing pushes the car a certain distance back up the track, the momentum thus gained being sufficient to carry the car over the remaining space. Only one man is needed to operate the railway. He starts the car when it is filled, but does not accompany it. The car runs with great rapidity, making the trip of 100ft., dumping its load, and returning, in about 30 seconds. The coal-handling apparatus was supplied by Messrs. Babcock and Wilcox, and is of the Hunt Conveyor Co.'s special design.

The feed pumps are three in number, two of them being capable of delivering 2,500 gallons per hour to the boilers, and the third 5,000 gallons per hour. They are of Messrs. G. and J. Weir & Co.'s make, and deliver to the boilers through the feed mains, which are in duplicate, each main being provided with a separate filter and water meter. The suction pipes to the feed pumps are also in duplicate, one pipe being connected to the overhead feed storage tank, and the other to the hot well. The feed-water storage tank is constructed of cast-iron plates, and is capable of holding 12,000 gallons of water. This tank is divided into two sections, to enable either section to be cleaned without interfering with the continuity of the supply of water to the pumps. The

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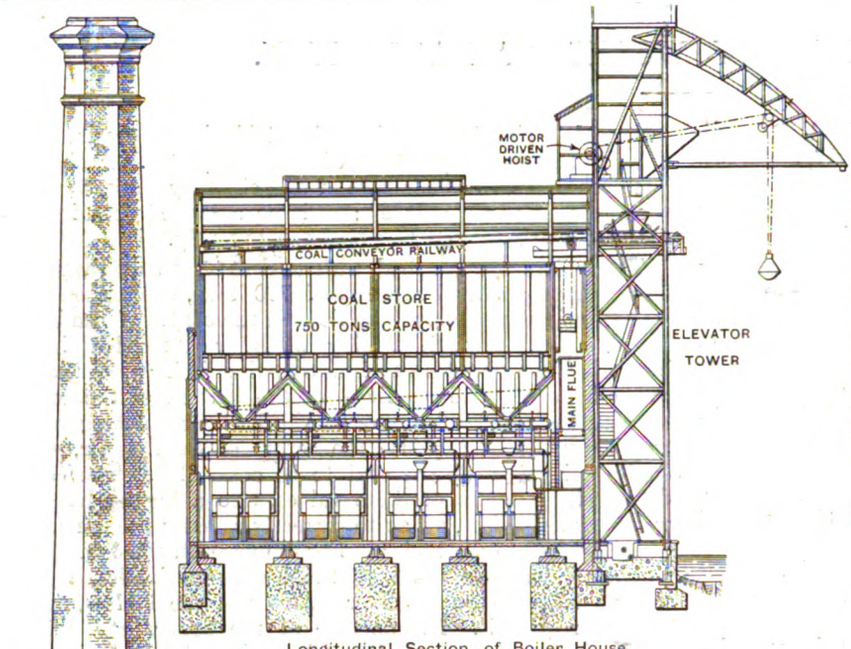
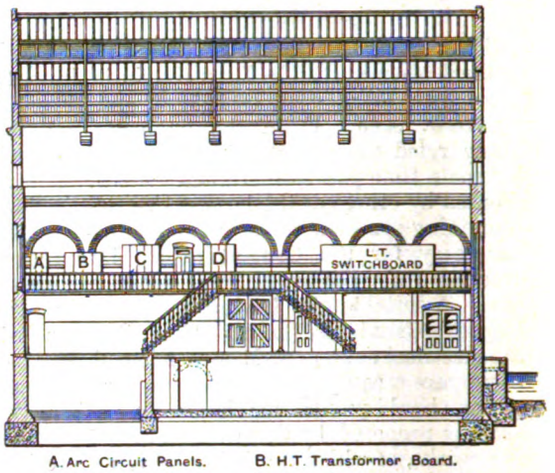
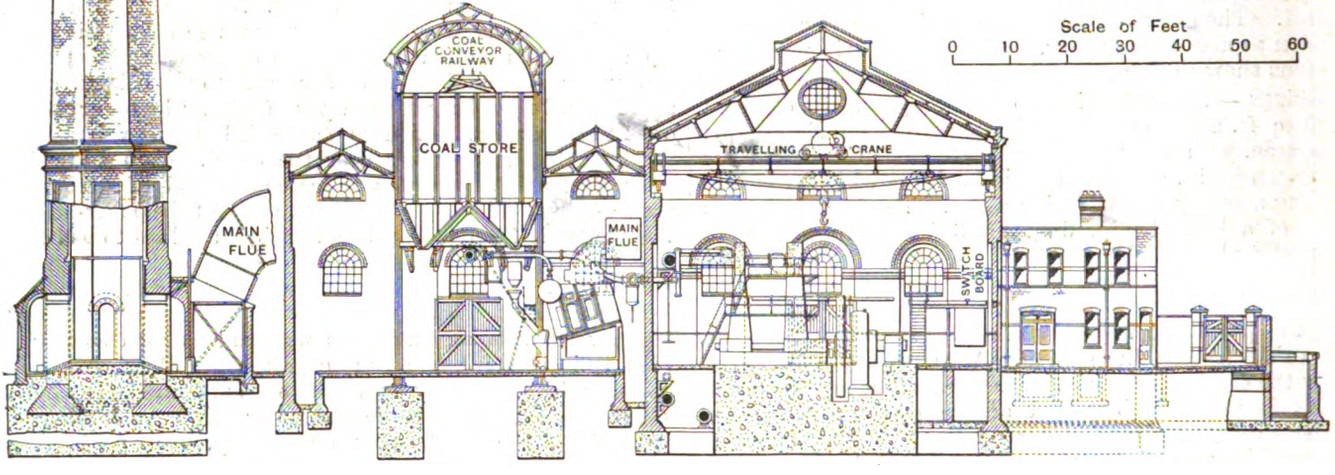


Longitudinal Section of Boiler House

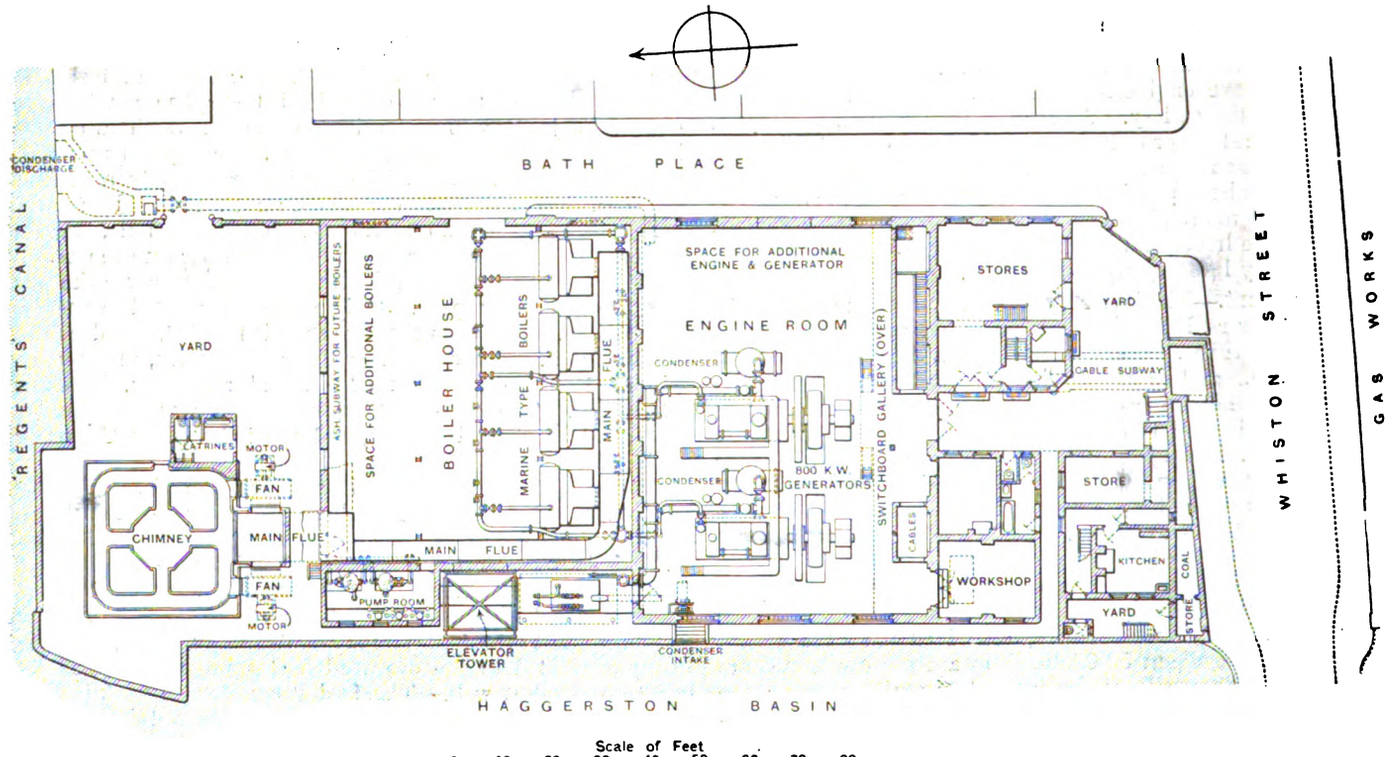


A. Arc Circuit Panels. B. H.T. Transformer Board.
C. H. T. Dynamo Board. D. Trunk Feeder Panels.

Longitudinal Section of Engine Room.



Cross Section of Boiler House and Engine Room.



Scale of Feet
0 10 20 30 40 50 60 70 80

General Plan of Works.

HAGGERSTON ELECTRICITY WORKS OF THE SHOREDITCH BOROUGH COUNCIL.

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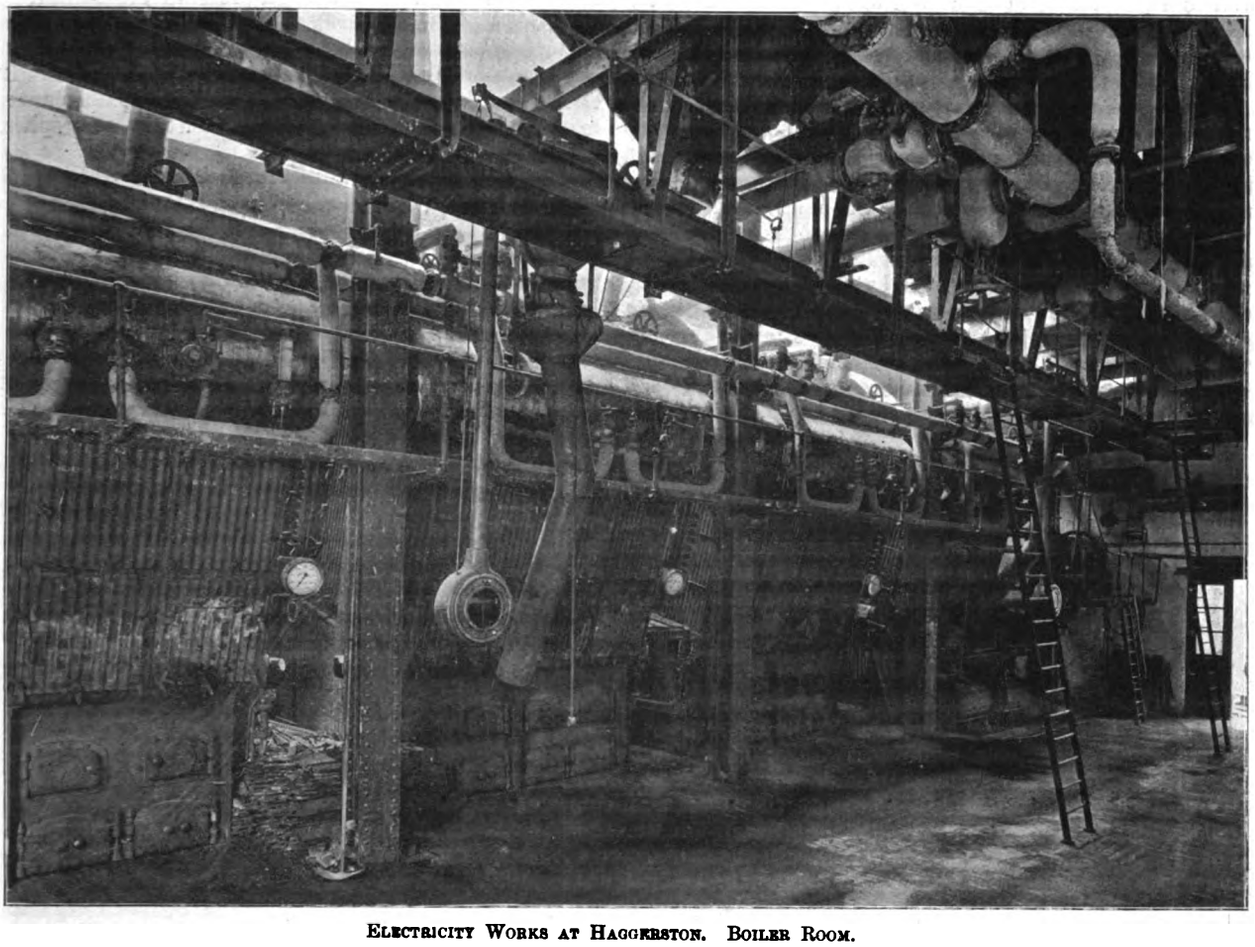
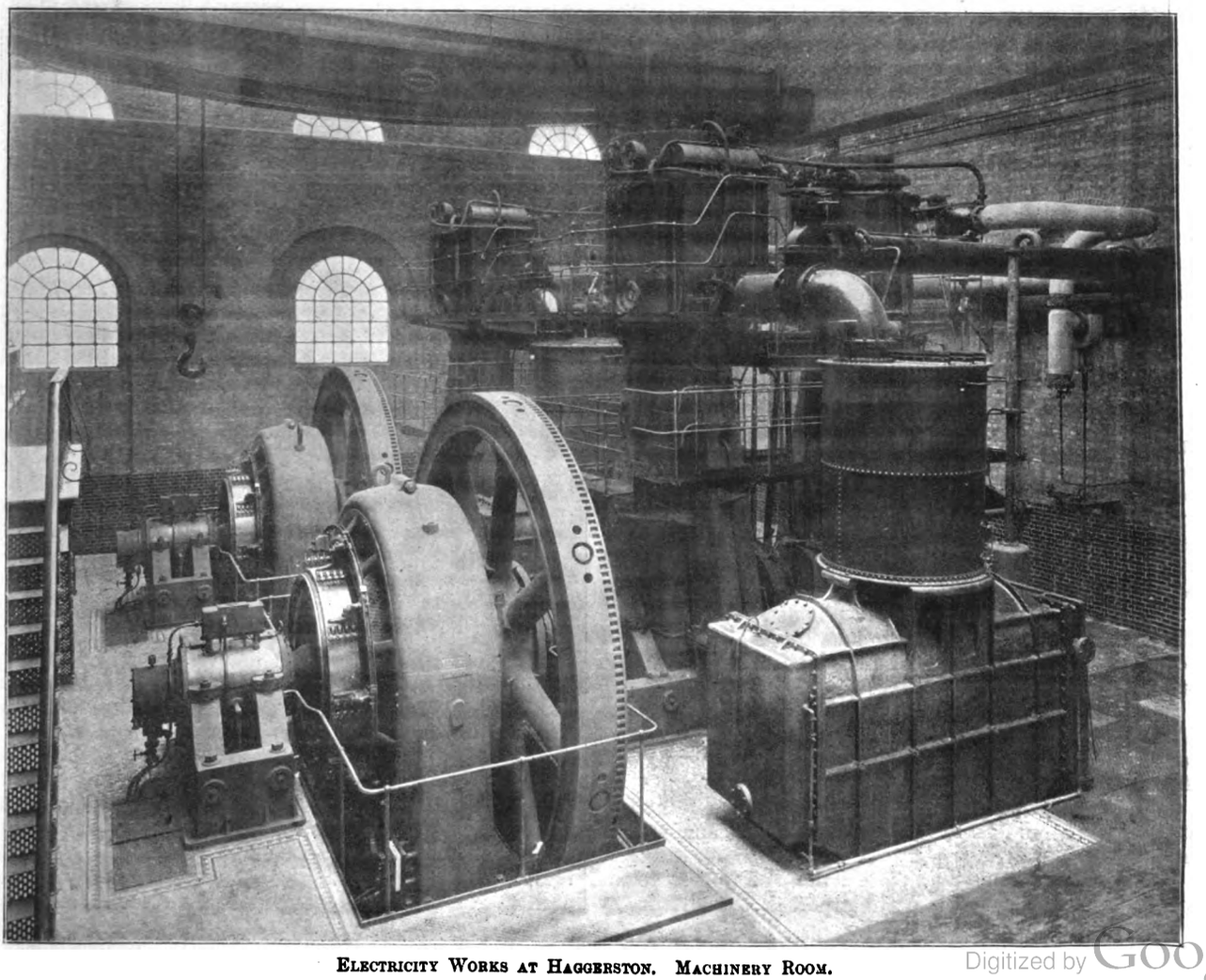


ELECTRICITY WORKS AT HAGGERSTON. BOILER ROOM.



ELECTRICITY WORKS AT HAGGERSTON. MACHINERY ROOM.

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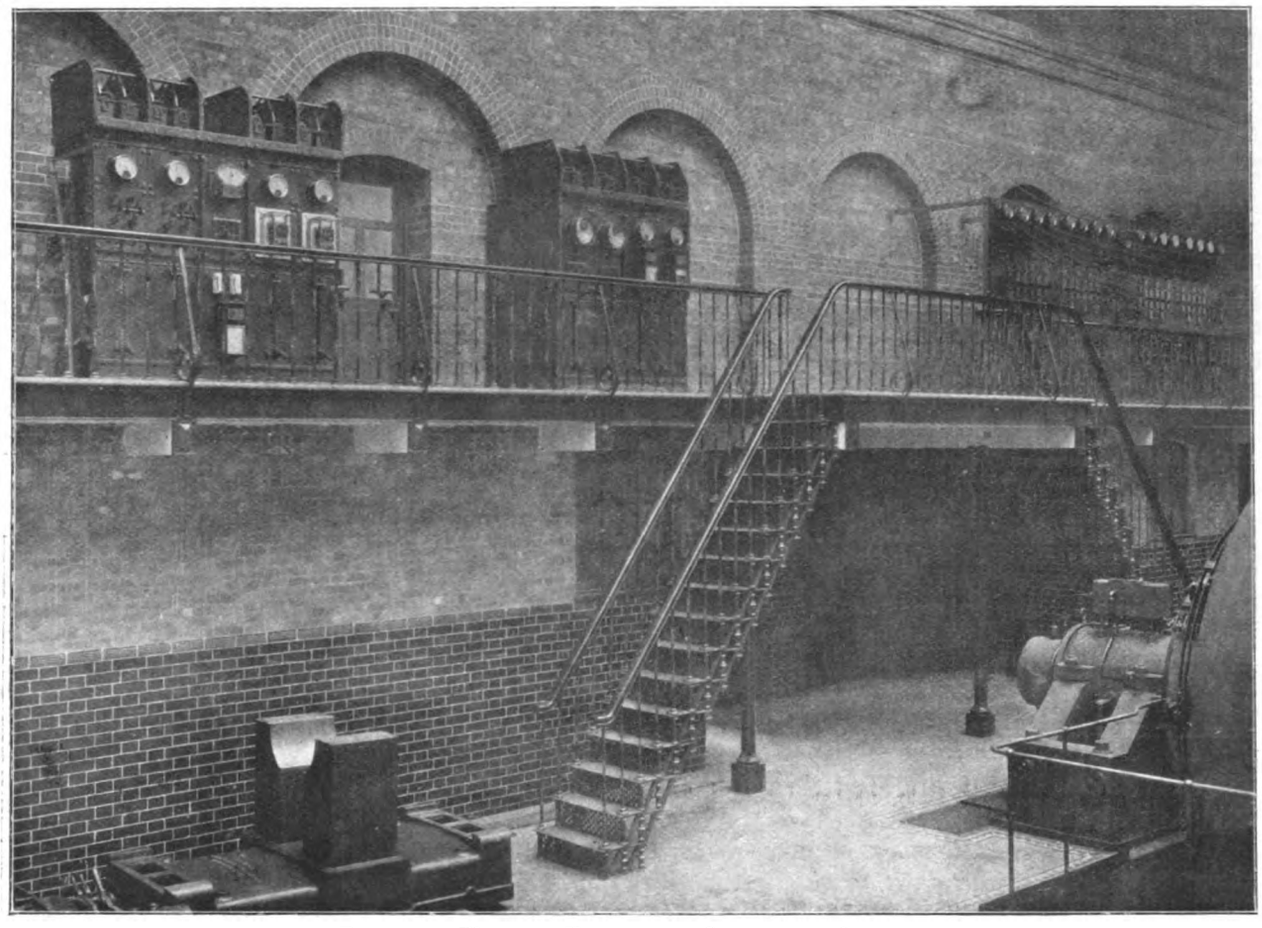
hot well consists of a galvanised iron tank, having a capacity of 1,500 gallons. A special feature in connection with the hot well is that it is placed upon a weighbridge, so as to provide a ready means of measuring the water discharged from the air pump when carrying out tests on the plant.

The main steam pipe is arranged in the form of a ring placed in the boiler-house; the main pipe is 10in. in bore, and is constructed of mild steel, with the flanges shrunk on and riveted. Jointing is avoided as much as possible, and with this in view the branch connections are made by means of flanged outlets of mild steel, riveted on to the main pipes. The ring is divided up into sections by means of stop valves, so as to limit the effect of any failure to the particular section of the ring affected. All the valves are of the straight-through pattern, with cast-steel bodies. The steam and feed piping, feed pumps, storage tank, &c., have been supplied by Messrs. Aiton & Co.

means of levers from the high-pressure cross-head. The air pumps are of the Edwards single-acting type, the circulating water pumps being of the double-acting type. The circulating water is taken from the basin in connection with the Regent's Canal, and is returned through pipes down Bath-place into the main canal. An alternative exhaust to atmosphere with automatic release is provided.

The engines were manufactured by the Wallsend Slipway and Engineering Co., who also supplied the generators, together with the exhaust and water pipes in connection with the engines and condensers. The generators are of the multipolar type, made by the Westinghouse Company. The rated load of each of the machines is 730 amperes at 1,100 volts. The machines, however, are designed to carry an overload of 50 per cent. above this rating for two hours if necessary. The armature and commutator are built upon a ventilating cast-iron sleeve, forced on the engine shaft under pressure.



ELECTRICITY WORKS AT HAGGERSTON. SWITCHBOARD GALLERY.

Engine Plant.—The engine plant consists of two vertical low-speed Corliss compound steam engines, each direct-coupled to a continuous-current generator of 800kw. capacity. Each engine is provided with its own condensing plant, consisting of a surface condenser, with air and circulating pumps driven direct from the main engine. The engines are designed to run at a speed of 90 revs. per min., and are capable of developing from 1,300 to 1,400 I.H.P. The diameter of the high-pressure cylinder is 24½in., and that of the low-pressure cylinder 53in., with a stroke of 42in. Both high and low-pressure cylinders are provided with automatic Corliss trip gear controlled by the governor, which is of the "Whitehead" isochronous type. In addition to the ordinary governing, an emergency governor of the inertia type is provided. The flywheel, weighing about 32 tons, is of the built-up type, with steel tension arms. Steel rings are shrunk on the hub as an additional safeguard. The condensers each have a cooling surface of 2,700 sq. ft. The exhaust steam from each engine passes through an oil separator on its way to the condenser. The air and circulating pumps are driven by

The field castings are divided in a vertical plane, and are mounted on cast-iron base plates. The armature is of the slotted drum type, having a multiple winding so arranged that the circuits will not become unbalanced by a slight displacement of the armature from the centre of the fields. The brushes are adjustable by means of a hand-wheel and worm gear, and the arms carrying the brushes are supported at the end next to the field casting, so as to leave the commutator free from obstruction. The brushes are of carbon. The arrangements for ventilation are very perfect in this type of machine; open ducts are provided for this purpose throughout the armature to the spider core and windings, the design of the spider being such as to set up a forced current of air through these ventilating spaces.

As previously mentioned, the switchboard is placed on a gallery which runs the whole length of the engine-room, the high-pressure portion being placed at one end and the low-pressure at the other. The high-pressure board is divided into the following sections:—(1) Dynamo board, comprising positive and negative dynamo panels for each generator, with

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paralleling panel in the centre; (2) trunk feeder board, comprising positive and negative panels for two high-pressure feeders; (3) transformer board, comprising panels for four transformers; (4) arc circuit board, with provision for three arc circuits.

The low-pressure board consists of positive and negative feeder panels for six low-pressure feeders. This switchboard will be used in connection with the continuous-current transformers for supplying the network in the neighbourhood of the station, and is arranged on the plug system, whereby any transformer can be plugged on to any low-pressure feeder. Both high and low-pressure switchboards have been supplied by Messrs. Cowans (Ltd.), of Manchester, the high-pressure board being of their special design, in which the high-pressure switches are mounted on horizontal slates, and the whole supported on an iron frame placed against the face of the wall, without the necessity of leaving a space behind for access to the working parts. All the main high-pressure switches are provided with reverse current cutouts of the Andrews type, and the switches can also be opened by means of a hand trip gear. These switches break through about 1in. of water. The instruments are of Messrs. Evershed and Vignoles make, with the exception of the voltmeters, which are of the Ayrton and Mather multi-cellular type. The recording instruments are by Messrs. Elliott Bros.

A feature in connection with the design of the switchboard is the chamber below the gallery, to contain the various resistances and the high-pressure omnibus bars. The spindles for working the regulating resistances are brought up through the floor of the gallery, and are operated from a convenient height, cast-iron pillars and handwheels being provided. A light gangway is provided in the chamber below the board for convenient inspection of the various regulating switches and resistances. The high-pressure omnibus bars, which are carried in the chamber below the gallery, are supported on oil insulators.

In addition to supplying the switchboards for the Whiston-street generating station, Messrs. Cowans have supplied the trunk feeder panels at the receiving end of the trunk feeders at the old station in Coronet-street, and have supplied the additional switchgear for the two sub-stations at Reeves-place and Evelyn-street respectively.

In conclusion, we desire to express our thanks to Messrs. Kincaid, Waller and Manville, the consulting engineers, and to Mr. C. Newton Russell, the resident engineer, for their valuable assistance in the preparation of this article.

CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.—PROGRAMME.

We have received the following official notice of the arrangements for the forthcoming seventh convention of the Incorporated Municipal Electrical Association. The meetings on July 2nd, 4th and 5th will be held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, Westminster, S.W., and on July 3rd at the Royal Agricultural Hall, Islington. Applications for visitors' tickets and for advance proofs of Papers, &c., must be made to the secretary of the Association, Mr. C. McArthur Butler, St. James's Hall, Piccadilly, London, W. The Westminster Palace Hotel, London, S.W., will be the headquarters of the Council during the convention.

Wednesday, July 2, 1902.

General meeting at 10 a.m., at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, Westminster, S.W.

The chairman of the London County Council (John McDougall, Esq.) has kindly consented to be present to meet and welcome the Association.

Presidential address by Mr. J. H. Rider, electrical engineer, London County Council tramways.

The following Papers will then be read and discussed:—

1. "Double-current Generators and their Application." By Mr. E. T. Ruthven Murray, electrical engineer, Willesden Urban District Council.

2. H. T. Continuous current Systems." By Mr. A. S. Barnard, city electrical engineer, Hull. The meeting will adjourn at 1 p.m.

At 2:15 p.m. prompt, brakes will leave the Westminster Palace Hotel for the generating station of the Central London Railway at Shepherds Bush, which will be open for inspection.

At 3:45 p.m. the brakes will be ready to convey the party to either of the following, afterwards returning to the Westminster Palace Hotel—the generating station of the Metropolitan Electric Supply Co. (Ltd.), Willesden;

Or to the works of the Incandescent Electric Lamp Co. (Ltd.), Brook Green, W.

Thursday, July 3, 1902.

General meeting at the Royal Agricultural Hall, Islington. Admission by special ticket. Members to meet in the committee room of the exhibition at 10:30 a.m., where the exhibition committee will receive them, and the party will then proceed to inspect the exhibits. Luncheon will be served at 1 p.m. to members, by special invitation of the exhibition committee. At 2:30 p.m. an adjournment will be made to Berners Hall (in the building), when the following Papers will be read and discussed:—

1. "Steam Turbines." By Mr. S. E. Fedden, city electrical engineer, Sheffield.

2. "The Correct Type of Engine for large Generating Stations." By Mr. A. A. Day, borough electrical engineer, Bolton.

Friday, July 4, 1902.

General meeting, at 10 a.m., at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, Westminster, S.W.

The following Papers will be read and discussed:—

1. "Some Notes *re* Earthing." By Mr. H. Faraday Proctor, city electrical engineer, Bristol.

2. "Two *v.* Three-wire Distribution." By Mr. J. F. C. Snell, borough electrical engineer, Sunderland.

The meeting will adjourn at 1 p.m.

During the afternoon the following works will be open for inspection:—The generating station of the City of London Electric Lighting Co. (Ltd.), at Bankside, or the conduit tramway construction on the Tooting lines of the London County Council. Representatives of Messrs. J. G. White & Co. (Ltd.) will meet the members of the Association at Victoria Station, London, Brighton and South Coast Railway, at 2:30 p.m., for the 2:45 p.m. train to Balham and Upper Tooting.

The Association smoking concert will be held in the Banqueting Hall of the St. James's Restaurant, on Friday, July 4, at 8 p.m.

Saturday, July 5, 1902.

The annual general business meeting will be held at 10:30 a.m., at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, Westminster, S.W.

Benevolent Fund.—A special general meeting of the contributors to the Benevolent Fund of the I.M.E.A., of which notice is hereby given, will be held at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, Westminster, S.W., at the close of the annual general business meeting, for the purpose of considering the following resolution, passed at a Council meeting of the I.M.E.A., held at the Westminster Palace Hotel, London, on Friday, February 21, 1902:—"That it be a recommendation from this Council to a special general meeting of the subscribers, to be held after the 1902 convention, to discontinue the Benevolent Fund and to hand over accrued donations and subscriptions to the like fund of the Institution of Electrical Engineers."

ON A NEW METHOD OF MEASURING SMALL SELF-INDUCTIONS.

BY W. MANSERGH VARLEY, B.SC., PH.D.

The measurement or comparison of self-inductions of small solenoids and coils is very difficult to carry out successfully by the ordinary methods in use. The method described below was devised for measuring the self-inductions of some small solenoids in the course of an investigation on the magnetisation of iron in rapidly-oscillating current fields, and is briefly described in the course of our account of this investigation in the *Philosophical Magazine* for May. A short account of the method in its simplest form may prove useful to those who wish to apply it practically to the determination of such small self-inductions.

The principle of the method depends on the relation between the maximum current obtained when a condenser is discharged through a circuit containing small resistance, and the self-induction in circuit. As is shown in the above-mentioned article, the maximum current, i, which flows when a condenser of capacity C is discharged through a circuit of low resistance containing self-induction L is given by $i = \frac{Q}{\sqrt{LC}}$, Q being the quantity of electricity stored up in the condenser before the discharge occurs. Now, if V is the potential difference between the condenser plates before discharge, $Q = VC$, and therefore $i = V\sqrt{\frac{C}{L}}$. If we keep the capacity constant and charge the condenser to the same potential every time, then the maximum current is inversely propor-

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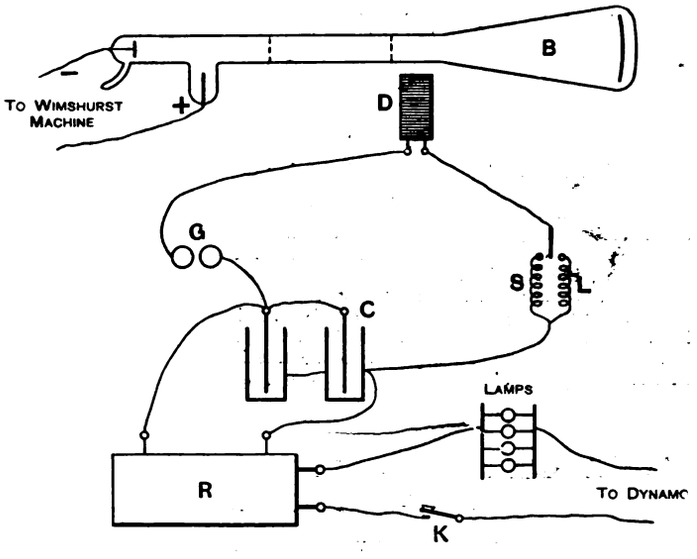
tional to the square root of the self-induction in the discharge circuit; and provided that we have a suitable means of comparing the values of the current for different self-inductions, we can compare the latter with one another. The condenser is best charged from the secondary of an induction coil through the primary of which an alternating current of 4 or 6 amperes is passed, and it is allowed to discharge through a spark-gap of 1mm. or 2mm., which ensures the potential being very nearly the same for each discharge. The maximum current is measured by passing it through a solenoid which is used to deflect a beam of cathode rays in a Braun's tube. (The Braun's tube is the only piece of apparatus required which is not found in every laboratory, and it is itself so useful for demonstration purposes in alternating and three-phase current work, that it will probably soon be found indispensable in a laboratory.) The sketch gives the arrangement of the apparatus.

The Braun's tube is excited by a Wimshurst machine, which may be driven either by a water or electric motor. The deflecting solenoid, D, is placed just beyond the second diaphragm of the Braun's tube, and must, of course, be mounted on an insulating stand, such as a block of paraffin. The alternating current which is sent through the primary of the induction coil R is conveniently regulated by passing it through a few lamps placed in parallel with one another. The secondary terminals of the induction coil are connected



to the two coatings of a battery of Leyden jars—two or three fair-sized jars usually suffice—the two coatings also being connected through the deflecting coil D, the spark-gap G and either the self-induction L (which we require to measure) or S (our standard of comparison).

The deflections obtained on closing the primary circuit by means of the key K may be read directly in millimetres on the screen of the Braun's tube if this be graduated, otherwise it is easy to project a scale cut in tinfoil and well illumined from behind on to the screen.

Coils whose self-inductions may be fairly accurately calculated by Maxwell's formula can be readily made by winding a known number of turns of well-insulated wire in a groove (rectangular) cut in a wooden frame whose diameter is large compared to the dimensions of the groove—say 10 times the depth or width of the groove. The dimensions of three such standard self-inductions are given in the following table:—

Coil.	Mean radius. cm.	Breadth of winding. cm.	Depth of winding. cm.	No. of turns.	Self-induction. cm.
I.	11·9	1·8	2·0	140	8·0 $\times 10^6$
II.	12·0	3·5	2·0	250	22·1 „
III.	10·85	2·3	1·7	47	0·77 „

It is necessary to have two or three such self-inductions in order to be able to measure over a large range of self-inductions. The method is very suitable for measuring self-inductions of from about $\frac{1}{1000}$ to 1 henry (1 henry = 10^9cm). It is also necessary to know the self-induction, D, of the deflecting solenoid, which should be of the same order, but preferably smaller than the induction to be measured. The dimensions of the deflecting solenoids used by the author were as follows:—Length of each coil 8·8cm., inner radius 0·85cm., thickness of winding 1·8cm. One coil had 645 turns of wire, 1mm. diameter, and another 140 turns of wire 2mm. diameter, the wire being well insulated. The self-induction of the first solenoid was 4×10^6cm., and of the second solenoid $0{\cdot}15 \times 10^6$cm.

The self-induction of the deflecting solenoid may be readily determined by the same method by comparing it with the standard S. For this purpose we need the deflection δ when the standard self-induction S is cut out of the circuit, and the deflection δ' when it is included in the circuit. Then, since the deflection varies inversely as the square root of the self-induction,

$$\frac{\delta}{\delta'} = \sqrt{\frac{D+S}{D}}, \quad \text{whence} \quad D = S \cdot \frac{\delta'^2}{\delta^2 - \delta'^2}.$$

Having determined D, we can determine any other self-induction L by obtaining first the deflection when S is in circuit, and then switching L instead of S into circuit. If δ and δ' be the respective deflections in the two cases

$$\frac{\delta}{\delta'} = \sqrt{\frac{D+L}{D+S}}, \quad \text{whence} \quad L = \frac{\delta^2}{\delta'^2}(D+S) - D.$$

It is advisable to take several readings of the deflections δ and δ' alternately, also to vary the capacity once or twice so as to obtain quite different deflections. The advantage of using an alternating current to drive the induction coil is to enable us to use the total or double deflection, as the spot will be deflected equally on either side the middle or zero position, whereas if the discharges only occurred from the one direction, the deflections would be a little different on the two sides owing to the damping of the oscillations. The capacity and deflecting coil should be so adjusted that total deflections of from 40mm. to 60mm. are obtained. The deflections can easily be read to ½mm., when the spark-gap terminals are in good order and the steady spot on the screen of the Braun's tube sharp and bright. For the mean of a dozen readings the self-induction can be determined to an accuracy of at least 3 per cent., and under favourable circumstances down to 1 per cent.

With some Braun's tubes it is necessary to wrap the tube in the neighbourhood of the diaphragm with tinfoil, so as to get rid of electrostatic surface effects. If these are troublesome the deflections will be much sharper if two equal deflecting solenoids are used, symmetrically placed on either side of the tube and connected up in series so as to deflect the rays in the same sense.

An example is added of the determination of the self-induction of a small coil of some 200 turns by comparison with a standard coil having a self-induction of $0{\cdot}77 \times 10^6$cm. or 0·00077 henry. The self-induction of the deflecting coil had been found equal to $0{\cdot}15 \times 10^6$cm.

δ = deflection when the known self-induction was in circuit.

δ' = deflection when this was replaced by the unknown self-induction L.

Then
$$L = \{(0{\cdot}15 + 0{\cdot}77)\frac{\delta^2}{\delta'^2} - 0{\cdot}15\}10^6\text{cm.}$$
$$= (0{\cdot}92\frac{\delta^2}{\delta'^2} - 0{\cdot}15)10^6\text{cm.}$$

Capacity used (value not required).	δ. mm.	δ'. mm.	L. cm.
1 Leyden Jar 1,580cm.	58·0	49·0	1·14 $\times 10^6$
	59·0	49·5	1·16 „
	57·5	48·0	1·17 „
	58·0	49·0	1·14 „
	56·5	47·0	1·18 „
2 Leyden Jars 3,810cm.	38·0	32·5	1·11 „
	37·0	31·0	1·16 „
	38·0	32·0	1·15 „
	38·5	32·5	1·14 „
	38·0	32·5	1·11 „

Mean value for $L = 1{\cdot}15 \times 10^6$cm.
$= 0{\cdot}00115$ henry.

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LANGDON-DAVIES MOTORS.

It is now six years since the Langdon-Davies single-phase motor was put on the market, and during that time its application to certain commercial undertakings has been steadily increasing. The technical features of the motor were entered fully into, as far back as 1896, in Vol. XXXVII, p. 247, of *The Electrician*, and as these have undergone practically no change, they do not call for comment now. The power-factor, we are informed has not been improved, and although this feature seems unlikely to be altered, the other many advantages of the motor afford it a position which places it in many respects on a level with its direct-current rivals. The original features of a closed circuit rotor are retained, this portion of the motor comprising a number of short-circuited coils wound on an iron core carried on the shaft. The stator coils are wound in slots in the laminated core, held up together by the cast-iron casing of the frame. The whole of the current-carrying parts are thereby protected from external damage, and as there are no brushes, the amount of attendance required is necessarily small. The lubrication is likewise automatic, and as the motor starts very easily by the operation of a switch, its advantages over a gas engine become at once apparent. It is in this

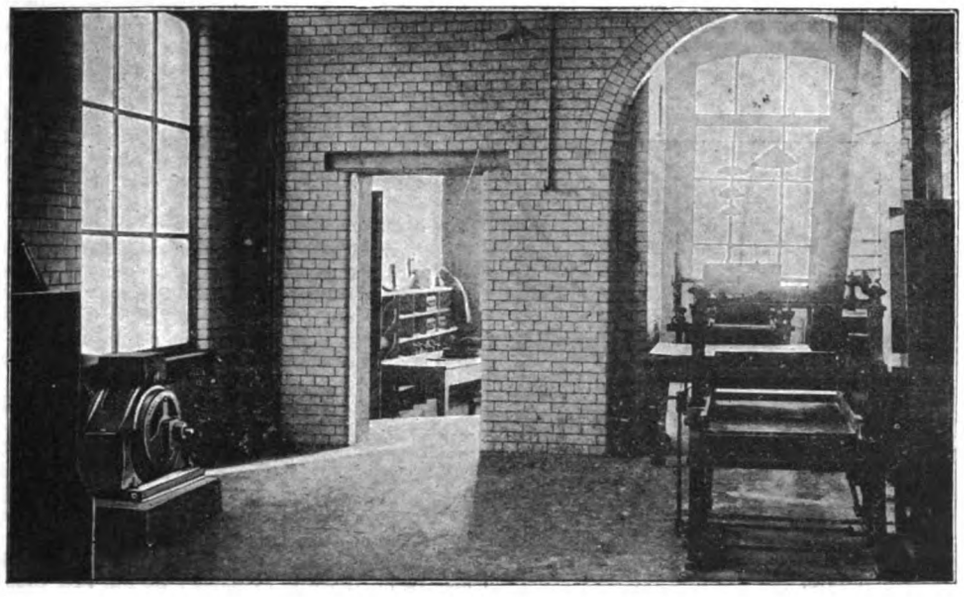

FIG. 1.

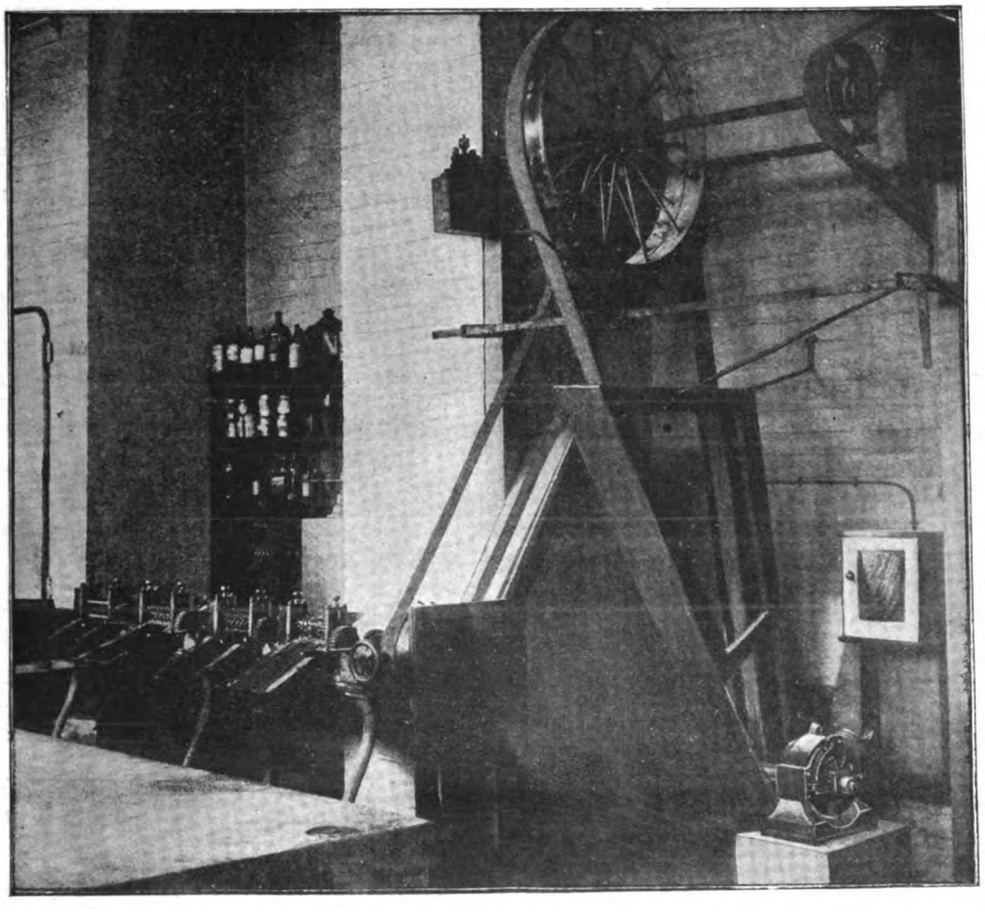

FIG. 2.

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respect that the makers claim features for the motor which enable it to compete with the small gas engine, as this latter finds great favour with a large number of power users. The fact that single-phase motors have created for themselves an unmerited feeling of distrust among engineers has, no doubt, much to do with the comparative paucity of manufacturers of such apparatus, but there are possibilities, as the industry expands, of their wider application for power purposes. Messrs. Langdon Davies have chiefly made use of their motors for the operation of sewing machines confectioners', bakers' and butchers' machinery, and also for the driving

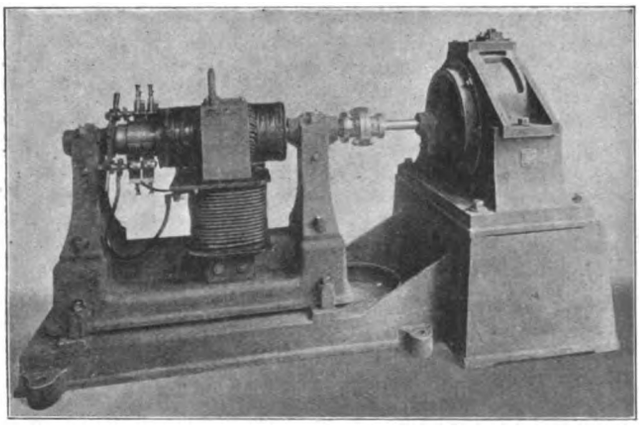

FIG. 3.

of refrigerating apparatus. In Fig. 1 a 16 H.P. motor is seen installed for the operation of a complete biscuit factory, and Fig. 2 illustrates a 6 H.P. machine in use for the working of spice rollers in a confectioner's establishment. In addition to these there are motors up to 35 H.P. in operation on the majority of the alternating-current systems in this country, notably at Derby, Bournemouth, Dover, and Harrogate. Fig. 3 shows the application

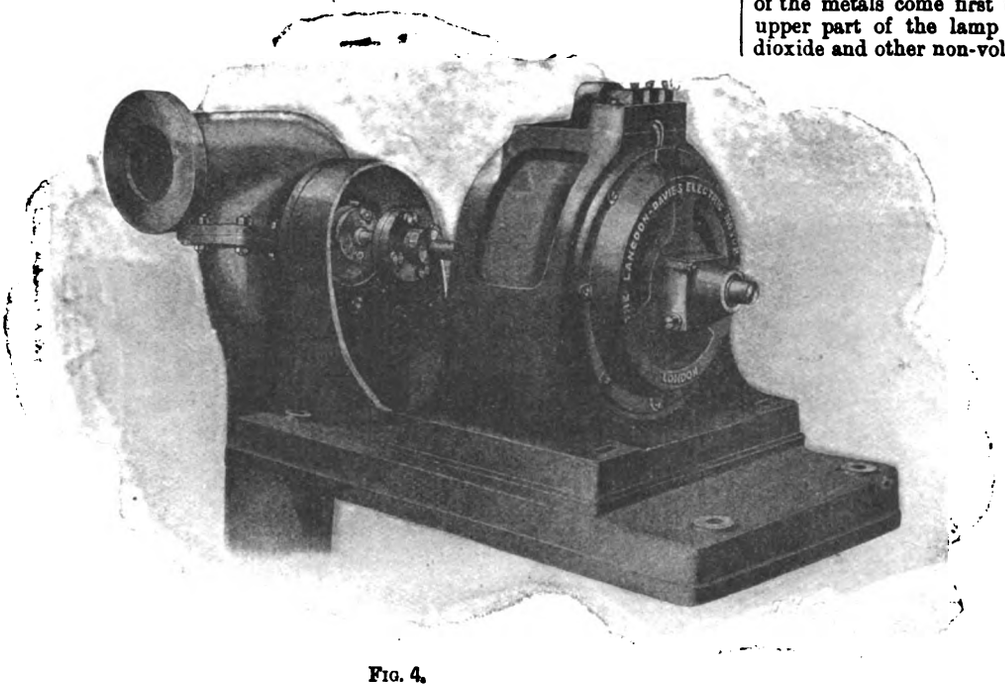

FIG. 4.

of the motor for driving a direct-current dynamo, and such a set of 25 H.P. should prove useful for the charging of automobile cells from single-phase supply mains. In single-phase stations where condensing plant is laid down, the use of centrifugal pumps for raising the circulating water to overhead tanks is now much practised, and the combined set shown in Fig. 4 should fill a useful place in such works. On the whole the progress of the single-phase motor may be regarded as slow but sure, and, as the sphere of its usefulness must extend gradually, it may be regarded as likely to fill a place in the industry when other apparatus now in favour shall be found wanting.

THE BREMER LAMP.*

BY SIEGMUND SAUBERMANN.

The Bremer arc lamp differs from others in two respects—the chemical combination of the electrodes and their arrangement at an acute angle. Neither principle is absolutely new. In the "Lampe Soleil" devised by Clerc and Bureau, two conveying carbon rods led through a marble block, so that the arc should bring the calcium carbonate above it to a white heat. And long before Bremer additions of metallic compounds of the most varying sorts were made to solid and cored carbons in order to obtain (and often with success) steadier burning of the arc. The essential of the invention is in the determination of the fact that, if the carbon electrode contains more than 20 to 25 per cent. of calcium, silicon or magnesium salts, a better utilisation of the high temperature of the arc for the emission of light is obtained than has been possible hitherto in practice. The best result is with halogen combinations of metals of the beryllium group. According to Bremer, the increase of the proportion of the salt to 50 or 80 per cent. even occasions a still greater gain in light; the small strength of such composite carbons and their quick decomposition, even at moderately high temperatures, prevents their practical application. As a matter of fact, in order to attain the necessary consistence and a certain rigidity, the electrodes containing 20 to 30 parts of calcium fluoride must be covered with a hard, glassy covering, formed by laying on a solution of a mixture of borax, silicic acid, soluble glass and similar substances. In addition, before the customary baking together, the electrodes are provided with small quantities of boron, common salt, potash, tartar and various silicates, which, acting to a certain extent as fluxes, prevent the otherwise unavoidable scorifying of the carbon points.

The considerable increase in light produced by all these processes may be fairly easily explained by the fact that the particles of the metal salts torn off and taken with the passage of electrical energy from the anode to the cathode are oxidised in the 3,900deg. electric flame and brought to bright incandescence. One must not only consider the ions streaming across, for in such composite electrodes the ends nearest to the arc are in a more or less liquid state, and thus groups of molecules, or even much greater particles, may be carried along. At all events—and spectroscopic examination offers grounds for this conjecture—it appears that in the arc all sorts of chemical processes favourable to the emission of light take place, of which the electrolytic decomposition of the salts and the subsequent oxidation of the metals come first under consideration, as the deposit on the upper part of the lamp consists mostly of calcium oxide, silicon, dioxide and other non-volatile metal-oxygen combinations.

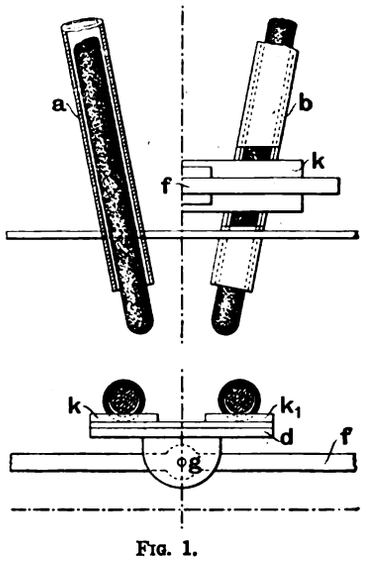

FIG. 1.

The construction of the lamp is based on the phenomenon observed by the Geneva physicist de la Rive, and already frequently utilised, that the arc formed between two electrodes which are parallel or slightly inclined to one another is much greater than in the case of electrodes in a straight line. To allow for the dropping off of the molten slag from the carbons it is absolutely necessary to support them from the top. In addition, the well-known effect on electric currents in magnetic and electrostatic fields is made use of in order to obtain a particularly large arc—a matter of considerable importance for the Bremer lamp, in which the space between the electrodes

* Abstract of a Paper read before the Elektrotechnischer Verein of Vienna.

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is the chief source of the light. In other lamps this is of secondary importance, for the carbon points and not the arc itself emit the main quantity of the light. The volume of the source of light in the Bremer lamp is 200 to 250 cubic mm., while in ordinary lamps it ranges from 50 to 100 cubic mm., and it is apparently in this that the main cause of the greater intensity of light for the same consumption of energy lies; for the arc, consisting as it does of white hot and, therefore, conducting metallic oxides, offers no more resistance to the passage of current than the shorter non-luminous one.

Merely the regulation of the acute-angled disposition of the electrodes offered some difficulties, but these have already been overcome for the greater part with the aid of an innovation patented by the Eos Company, of Neheim. Fig. 1 shows the simple system of the apparatus, in which the carbons are pushed forward as they burn.

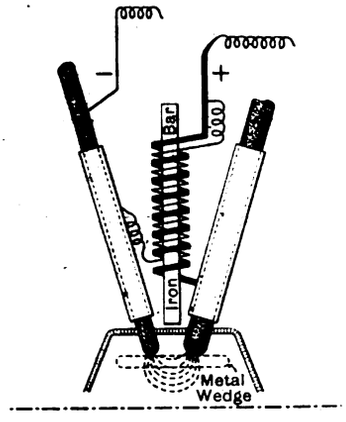

FIG. 2.

a and *b* are tubes which guide the carbons; they have a slit through which the clamping checks, *k* and k_1 press against the electrodes. *k* and k_1 are insulated from one another and fastened on the pressure plate *d*, in which two projecting metallic holders carry the arbour *g*. The latter is in direct connection with the electromagnetic regulating mechanism, and by means of it the keeper *f* acts on the plate. While the lamp is burning, the keeper *f* exerts a suitable pressure upon the plate *d*, through the link *g*, this is conveyed equally to the two carbons. As the current through the arc decreases, a differential or shunt current passes through one maguet coil, the magnet draws the keeper back, the pressure on the two carbons is diminished equally, and they sink downwards. This decreases the resistance of the arc again, and the magnet comes out of action and allows the keeper to return to its former position, pressing the carbons against the sides of the tubes.

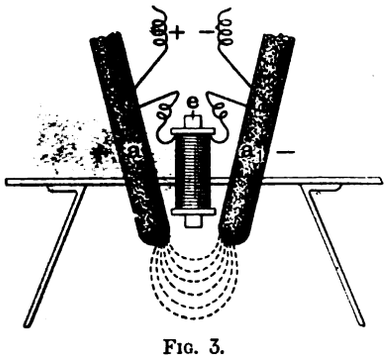

FIG. 3.

Several Bremer lamps can be connected in series, and, as the two carbons are normally clamped fast in the manner above described, and do not touch one another, the arc is struck as follows:—When the current is switched on, part of it passes through the relay, and presses forward the keeper, allowing the carbons to slide down upon a metallic wedge which then supports them. The main current then finds a closed circuit through this wedge, and the shunt coils are no longer magnetised. Consequently, the carbons are once again clamped, and the metal wedge, which is fixed to a movable lever, drops back by its own weight. Now, the arc which is formed is subjected to the action of the series electromagnet, which drives it downwards forcibly, and the action becomes greater as the arc approaches nearer to the magnet by the burning away of the carbons. The increased deflection increases the resistance of the arc, the magnet is exerted to a still greater extent, and acts on the carbon feed as already described, the carbons falling by their own weight. In continuous-current lamps only the positive carbon need be impregnated. Fig. 2 shows the arrangement of the differential winding, and is self-explanatory, and Fig. 3 the simple shunt-wound electromagnet acting as a blower. For the sake of clearness, the arrangement of the lever arm and carbon holder is omitted in these figures. *a* and a_1 in Fig. 3 are the two electrodes connected with the mains, and *e* is the magnet, which is in shunt.

Herr Bremer believes he can trace variations in the light to actual bodily oscillations in the arc, and on this assumption he endeavoured to remedy this trouble by a sort of throttling of the flame and by adding bulging "supports" for it as shown in section in Fig. 4. This pattern has not yet been introduced generally. These "supports" are insulated from one another, as it has been demonstrated

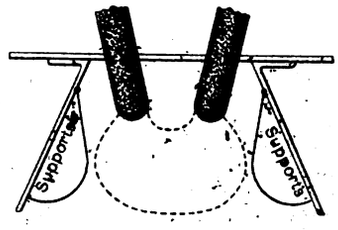

FIG. 4.

that all bodies are electrical conductors at high temperatures. They are made of very refractory material, which, however, only withstands the high arc temperature, because it is considerably reduced by the oxides. Supporting the flame in this manner prevents its being affected by the rising gases.

While the lamp mechanism is arranged in the upper case of the lamp, the carbon ends project into a conical reflector, which directs downward the light produced, and in this it is assisted by the dazzling white coating of lime and silica acid, which is being continually renewed upon it. In addition to this, the reflector forms a

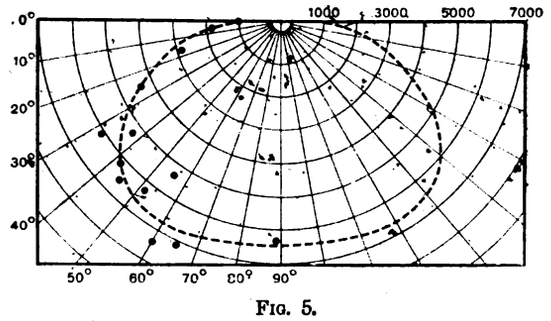

FIG. 5.

sort of reservoir for the hot gases which are developed, by means of which, according to the Harthmuth principle (of sheltering the carbon ends from the air), higher temperatures are obtained by retaining the heat near the carbons, and a slow consumption of the carbons is caused by the want of oxygen. The latter is of particular importance, as the consumption of impregnated electrodes is twice as fast as that of ordinary cored or solid carbons, even though the carbon consumption in the Bremer lamp is actually no more than in ordinary lamps in consequence of the diameter of the carbons of the former being only one-third of the carbons in the latter.

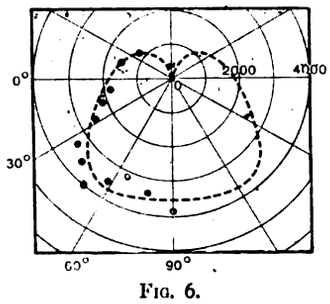

FIG. 6.

With the composition of the electrodes now employed, the light is uncommonly rich in rays of a wave-length of 680 to 500 millionths of a millimetre. Thus the red and yellow rays preponderate, and the blue and violet ones are not of much account, so that the general impression of the colour of the light is that of a golden yellow.

Of the numerous photometric measurements of the light given by electric flames containing oxides, those made by Prof. W. Wedding at the Charlottenburg technical college are of the greatest interest on account of the disinterestedness of the experimenter. The first was with a continuous-current lamp, without globe, which required a current of 12 3 amperes at 44·4 volts. The mean current varied at most by 0 3 amperes during the test, and the voltage 2·5 volts. The

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lamp worked fairly well, although it was one of the first made at the factory and did not include the more recent improvements. The candle power was measured at various angles to the horizontal, and was approximately :—

Degrees.	Hefner candles.	Degrees.	Hefner candles.
At 0	991	At 45·4	6,520
„ 6·7	1,470	„ 51·1	6,250
„ 16·8	3,202	„ 55·0	5,410
„ 26·0	4,060	„ 59·2	7,420
„ 32·0	6,080	„ 65·0	6,070
„ 36·8	5,220	„ 90·0	6,180
„ 42·0	6,070		

From this table one can see already that the conical reflector assists the illumination, for it directs the greatest part of the light actually downwards, and, in fact, fairly uniformly within an angle of 90deg. around the arc as centre. Above this it diminishes considerably to the horizontal, but still always amounts to 1,000 c.p. This is particularly clearly shown in Prof. Wedding's diagram (Fig. 5), in which the dotted line shows the approximate maximum candle-power. The same lamp, when provided with a frosted globe, gave the following photometric results :—

Above the horizontal—

Degrees.	Hefner candles.	Degrees.	Hefner candles.
At 48	497	At 12	1,160
„ 32	713	„ 8·5	1,040
„ 15·2	1,246	„ 0	1,440

Below the horizontal—

Degrees.	Hefner candles.	Degrees.	Hefner candles.
At 10·5	1,791	At 51·4	4,000
„ 21·2	2,133	„ 57·6	3,480
„ 30	2,782	„ 65	3,126
„ 35·2	3,440	„ 76	3,440
„ 43·4	3,774	„ 90	3,838

From this table and Fig. 6, it is seen that the frosted globe absorbs a not inconsiderable part of the light, but, on the other hand, it distributes it uniformly in all directions, so that a Bremer lamp does not show the usual shadow on the lower and upper hemisphere, but appears as an almost uniformly bright sphere. From the two measurements it will be noted with astonishment that an electrical source of light, with a consumption of 12·3 amperes at 44·4 volts (=546 watts), or, if the 10·6 volts lost in the resistances are reckoned in, 677 watts, can furnish a maximum candle-power of 6,400 and a hemispherical candle-power of 4,320 Hefner candles. This corresponds to 545/4,320=0·126 watts per Hefner candle, or, including the loss in the resistance, 677/4,320=0·157 watts per candle. The ordinary continuous-current arc lamp, with its 0·55 watts per candle shows badly in comparison. In the case of the alternating-current lamps on the two systems, the consumption in the Bremer lamp to that in the ordinary lamp is as 2 : 1.

ELECTRICITY WORKS ACCOUNTS.

Kingston-upon-Thames Municipal Electric Supply Works.

Last year's accounts of this undertaking are only in slight degree less unfortunate than were those of 1900-1. From the report accompanying that year's accounts we gathered that inadequacy of condensing arrangements, coupled with the high price of coal, were the chief causes of the hopelessly high fuel cost of 3·29d. In the report now to hand concerning last year's results it is stated that for three months of the period the heavy coal prices continued to rule, while the economies effected by chain-grate stokers and the new condensing plant was only felt for a few months. The chain-grate stokers made possible the use of a cheaper class of coal in the place of higher-priced Welsh coal. To these improvements and the use of economisers is no doubt largely due the diminution of the fuel item to 2·46d. per unit.

In the circumstances this reduction gives sanguine hope for reasonable total costs in the current year, because, excepting the fuel item, the several costs are most satisfactory, being below the average of similar sized works in 1900.

In comparing the financial results of this place with those of other municipal undertakings, it is necessary to note that although nothing was definitely allocated to depreciation the capital charges paid in the two years were respectively as much as 5·23 per cent. and 5·81 per cent. of the mean capital expended, but that, on the other hand, the total revenue from all sources was over 5d. per unit sold. Unfortunately for the prospects of the undertaking, the capital expenditure appears somewhat heavy—at any rate, in relation to the present output.

The following table gives some particulars of the undertaking since it was started :—

Year.	Units sold.		Receipts.		Total.		Int.	Sinking fund.	Total deficit.
	Private.	Public	Pvte†.	Pblic.	Rev.	Exp.			
1893–94	44,642	83,625	£1,157	£828	£1,985	£2,573	£455	£257	£1,299
1895	67,446	66,638	1,680	720	2,442	2,704	615	506	1,382
1896	88,620	67,061	2,253	720	3,013	2,712	802	826	1,326
1897	126,835	67,433	3,149	720	3,929	3,061	824	836	792
1898	164,413	67,957	3,960	720	4,701	3,480	1,102	1,231	1,112
1899–00*	264,155	99,845	6,411	1,049	7,512	4,774	1,347	1,439	48
1900–1	230,755	78,105	5,669	859	6,563	6,368	1,434	1,462	2,721
1901–2	266,110	80,222	6,389	867	7,379	5,836	1,744	2,093	2,295

* 15 months. † Including meter rents.

Winchester Electric Light and Power Co. (Ltd.).

The results recorded of this concern for 1901 are greatly to the credit of its management. With an output of no more than 192,885 units sold and a load factor of 13 per cent., the total costs at 2·32d. per unit are extremely low, especially considering the fuel charge.

With the exception of the coal item all the several costs present good figures, but particularly low are the repairs, the stores and the collective management and property charges.

At 5·4d. per unit the total revenue is perhaps somewhat high, but the financial results are very satisfactory, the working profit (exclusive of £237), profit on installation work, representing practically 6 per cent. on the mean capital.

The output for the year marked an increase of about 70 per cent. on the amount sold in 1900, and the lamp connections rose by nearly 88 per cent.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 1900
Ayr (Municipal)	Oct. 11, 1901	Kens'gton & Knigsbr'(Co.)	Apr. 11, 1902
Barnsley (Municipal)	Jan. 17, 1902	Kingston-upon-Hull (Mun.)	July 13, 1900
Bath (Municipal)	April 20, 1900	Kingston-on-Thames (Mun.)	July 20, 1900
Bedford (Municipal)	Aug. 8, 1900	Lancaster (Municipal)	Feb. 15, 1901
Belfast (Municipal)	Oct. 18, 1901	Leeds (Municipal)	Oct. 11, 1901
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 26, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal	Oct. 4, 1901	Leyton (Municipal)	Nov. 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Sept. 13, 1901
Bristol (Municipal)	Aug. 30, 1901	Morley (Municipal)	June 14, 1901
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	April 21, 1899	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	Aug. 9, 1901	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Nov. 29, 1901
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 16, 1901	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 22, 1900	Richmond (Company)	June 29, 1900
Croydon (Municipal)	Nov. 22, 1901	Salford (Municipal)	Jan. 24, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	Scarborough (Company)	Dec. 20, 1901
Derby (Municipal)	Jan. 26, 1900	St. Helens (Municipal)	Jan. 10, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dover (Company)	May 2, 1902	St. Pancras (Municipal)	July 5, 1901
Dundee (Municipal)	Dec. 6, 1901	Sheffield (Municipal)	Feb. 1, 1901
Eastbourne (Municipal)	Mar. 14, 1902	Shoreditch (Municipal)	Jan. 31, 1902
Edinburgh (Municipal)	Dec. 6, 1901	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Exeter (Municipal)	Aug. 5, 1898	South London (Company)	May 16, 1902
Folkestone (Company)	May 2, 1902	South Shields (Municipal)	Sept. 20, 1901
Glasgow (Municipal)	Sept. 27, 1901	Southampton (Municipal)	Feb. 8, 1901
Gloucester (Municipal)	Aug. 30, 1901	Southport (Municipal)	Jan. 17, 1902
Great Yarmouth (Mun.)	Dec. 13, 1901	Stafford (Municipal)	Aug. 16, 1901
Greenock (Municipal)	Aug. 30, 1901	Sunderland (Municipal)	Oct. 18, 1901
Guildford (Company)	Oct. 19, 1900	Taunton (Municipal)	June 16, 1899
Halifax (Municipal)	Dec. 27, 1901	Tunbridge Wells (Mun.)	Nov. 1, 1901
Hammersmith (Municipal)	Nov. 15, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hampstead (Municipal)	Nov. 22, 1901	Walsall (Municipal)	May 23, 1902
Hanley (Municipal)	Aug. 9, 1901	Wandsworth (Company)	May 9, 1902
Harrogate (Municipal)	Jan. 25, 1901	Westminster (Company)	April 4, 1902
Harlow (Company)	Dec. 21, 1900	Whitehaven (Municipal)	Feb. 8, 1901
Hast'gs & St. Leonards (Mun.)	July 12, 1901	Winchester (Company)	May 17, 1901
Hereford (Municipal)	Jan. 17, 1902	Windsor and Eton (Co.)	July 19, 1901
Hove (Company)	May 10, 1901	Woking (Company)	Dec. 22, 1899
Huddersfield (Municipal)	May 23, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Hull (Municipal)	Sept. 20, 1901	Woolwich (Company)	May 31, 1901
Isle of Wight Company)	Dec. 20, 1901	Worcester (Municipal)	April 18, 1902

REMARKS.

KINGSTON-UPON-THAMES.—*a* Lands, £500. *b* Over-expended. *c* Engineers' department £350, clerical £89. *d* Insurance £63, stores £15. *e* Engineers' department £350, clerical £91. *f* Insurance £69, stores £18.

WINCHESTER.—*a* Over-expended. *b* Auditing. *c* After deducting £198 preliminary expenses written off, and adding £188 profit on installation work. *d* Maximum demand system. *e* Includes £39 on land. *f* Rental of motors and wires. *g* Includes proportion of salaries of engineers and officers, £113. *h* Directors £75; salaries of managing engineers, secretary, accountants, clerks, &c., £116. *i* Auditing £16, law £2, insurance £38. *j* After adding profit on hire purchase and other installations, £237.

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	KINGSTON-UPON-THAMES.		WINCHESTER.	
Undertaking Worked by	Corporation of Kingston-upon-Thames.		Winchester Electric Light and Power Co. (Ltd.).	
Date of Commencement of Supply	November, 1893.		May, 1898.	
System of Supply	Alt.-current trans. sub-stations, also house trans.		Three-wire continuous current.	
Chief Engineer	J. E. Edgcome.		H. N. Warburton.	
YEAR ENDED	MAR. 31, **1901.**	MAR. 31, **1902.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	400,924	450,830	136,712	225,923
„ **SOLD (TOTAL)**	**308,860**	**346,332**	**113,267**	**192,385**
„ sold to consumers	230,755	266,110	113,267	192,385
„ sold for public lighting, &c.	78,105	80,222	nil	nil
„ sold for traction	—	—	nil	nil
„ used on works	14,370	16,264	8,764	16,389
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**16·8**	**16·3**	**11·0**	**13·0**
Actual maximum supply demanded	320 kilowatts	360 kilowatts	153·5 kilowatts	202 kilowatts
Load factor	11·0%	11·0%	8·42%	10·9%
Number of public lamps	41 arc, 17 (25 c.p.) glow	41 arc, 25 (25 c.p.) glow	nil	nil
Number of consumers	376	458	214	375
Connections to mains in 8-c.p. lamps at end of year	19,719	23,705	15,126	20,815
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	680	680	360	588
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	**£76,226** / **£112**	**£76,226** / **£112**	**£45,000** / **£125**	**£45,000** / **£76·5**
Share	— / —	— / —	25,000 / 69·5	25,000 / 42·5
Loan (including Debenture charges)	76,226 / 112	76,226 / 112	20,000 / 55·5	20,000 / 34·0
RECEIVED (TOTAL)	**58,426** / **85·9**	**70,426** / **104**	**32,375** / **90·0**	**45,000** / **76·5**
Share	— / —	— / —	12,375 / 34·4	25,000 / 42·5
Loan (including Debenture charges)	58,426 / 85·9	70,426 / 104	20,000 / 55·5	20,000 / 34·0
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**17,800** / **26·2**	**5,800** / **8·53**	**12,665** / **35·2**	nil / —
Share (unissued)	— / —	— / —	12,665 / 35·2	nil / —
Share (uncalled)	— / —	— / —	— / —	nil / —
Loan (including Debentures)	17,800 / 26·2	5,800 / 8·53	— / —	nil / —
REPAID (TOTAL)	**6,555** / **9·64**	**8,649** / **12·7**	— / —	nil / —
RESERVE OR SINKING FUND	nil / —	nil / —	— / —	— / —
DEPRECIATION FUND	nil / —	nil / —	— / —	— / —
EXPENDED (TOTAL)	**59,954** / **88·1**	**72,048** / **106**	**34,095** / **94·7**	**48,873** / **83·1**
Lands and buildings	11,968[a] / 17·6	15,031[a] / 22·1	3,351[e] / 9·31	3,978[e] / 6·77
Plant	27,933 / 41·1	34,831 / 51·2	17,279 / 48·0	22,119 / 37·7
Mains	18,219 / 26·8	20,248 / 29·8	12,837 / 35·7	17,756 / 30·2
Miscellaneous	1,834 / 2·70	1,938 / 2·85	627 / 1·74	5,019 / 85·3
BALANCE OF CAPITAL ACCOUNT	−1,528[b] / −2·25	−1,622[b] / −2·39	−1,720[a] / −4·78	−3,873[a] / −6·59
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	**£6,563** / **5·099d.**	**£7,379** / **5·112d.**	**£2,472** / **5·240d.**	**£4,334** / **5·410d.**
Revenue from supply	5,498 / 4·270d.	6,197 / 4·293d.	2,361 / 5·002d.	4,168 / 5·200d.
„ meters, &c.	171 / 0·133d.	192 / 0·133d.	110 / 0·233d.	124 / 0·155d.
„ public lighting	859 / 0·667d.	867 / 0·601d.	nil / —	nil / —
„ supply for traction	— / —	— / —	— / —	— / —
„ miscellaneous sources	35 / 0·027d.	123 / 0·085d.	— / —	43[f] / 0·054d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£6,388** / **4·963d.**	**£5,836** / **4·045d.**	**£1,172** / **2·484d.**	**£1,857** / **2·316d.**
TOTAL WORKS COSTS	**5,607** / **4·356d.**	**5,054** / **3·503d.**	**897** / **1·901d.**	**1,464** / **1·826d.**
Generation of electricity	*5,283* / *4·104d.*	*4,716* / *3·269d.*	*889* / *1·884d.*	*1,436* / *1·791d.*
Fuel (including cartage, &c.)	4,236 / 3·290d.	3,556 / 2·465d.	565 / 1·197d.	1,088 / 1·357d.
Oil, waste, water, stores	220 / 0·171d.	295 / 0·205d.	37 / 0·078d.	22 / 0·028d.
Wages at station	553 / 0·430d.	640 / 0·444d.	268 / 0·568d.	283[g] / 0·353d.
Repairs and maintenance at station	274 / 0·213d.	225 / 0·156d.	19 / 0·040d.	43 / 0·054d.
Distribution of electricity	*120* / *0·093d.*	*113* / *0·078d.*	*8* / *0·017d.*	*28* / *0·035d.*
Wages, &c. } Repairs, renewals of mains, &c.	120 / 0·093d.	113 / 0·078d.	8 / 0·017d.	28 / 0·035d.
Public lighting	*204* / *0·158d.*	*225* / *0·156d.*	nil / —	— / —
Attendance } Renewals	204 / 0·158d.	225 / 0·156d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	**781** / **0·607d.**	**782** / **0·542d.**	**276** / **0·585d.**	**392** / **0·489d.**
Rents	nil / —	nil / —	*91* / *0·193d.*	*20* / *0·025d.*
Rates and taxes	*128* / *0·099d.*	*127* / *0·088d.*		*73* / *0·091d.*
Management	*653* / *0·507d.*	*655* / *0·454d.*	*185* / *0·392d.*	*299* / *0·373d.*
Salaries	439[c] / 0·341d.	441[c] / 0·306d.	116 / 0·246d.	191[h] / 0·238d.
Stationery, &c.	53 / 0·041d.	57 / 0·040d.	15 / 0·032d.	36 / 0·045d.
Establishment charges	78 / 0·061d.	70 / 0·049d.	42 / 0·089d.	17 / 0·021d.
Law charges &c.	83[d] / 0·064d.	87[f] / 0·060d.	12[b] / 0·025d.	55[i] / 0·069d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	**£175** / **0·316%**	**£1,543** / **2·34%**	**£1,300** / **4·03%**	**£2,477** / **5·97%**
Sum carried to Depreciation Fund	nil / —	nil / —	nil / —	nil / —
Sum carried to Reserve Fund	1,462 / 2·64%	2,093 / 3·17%	nil / —	nil / —
Net interest on loans (incl. Debenture charges)	1,434 / 2·59%	1,744 / 2·64%	934 / 2·89%	1,000 / 2·40%
Net profit for the year	— / —	— / —	356[c] / 1·10%	1,714[j] / 4·13%
BALANCE FROM LAST ACCOUNT	— / —	— / —	**121** / **0·375%**	**126** / **0·304%**
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	**477**[c] / **1·48%**	**1,840**[j] / **4·43%**
Deficit	*2,721* / *4·90%*	*2,295* / *3·48%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	3% / —	5% / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	97·4%	79·1%	47·4%	42·9%
Expenditure per mean kilowatt capacity	£10. 16s. 5d.	£8. 11s. 10d.	£3. 11s. 0d.	£3. 18s. 5d.
REVENUE PER MEAN KILOWATT CAPACITY	**£11. 2s. 5d.**	**£10. 16s. 10d.**	**£7. 9s. 10d.**	**£9. 2s. 10d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**7s. 4d.**	**6s. 10d.**	**3s. 11d.**	**4s. 10d.**
Price charged for lighting, per unit	6d. (2 hrs.) to 4d.	6d. (2 hrs.) to 4d.	7d., 4d. and 2d.[d]	7d., 4d. and 2d.[d]
Price charged for power, per unit	3d. [per ann.	3d. [per ann.	4d. to 1½d.[d]	4d. to 1½d.[d]
Price charged for public lighting	£20 per arc, 70/6 per glow	£20 per arc, 70/6 per glow	—	—
Receipts per unit for private supply	5·72d.	5·59d.	5·00d.	5·20d.
„ „ public lighting	2·01d.	1·92d.	—	—

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SPECIAL NOTICE.

CORONATION WEEK.—The issue of "The Electrician" for June 27 will go to press on Tuesday evening, June 24, and communications for the Editorial and Publishing Departments should reach the Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London, as early as possible on Tuesday.

THE COST OF MUNICIPAL SUPPLY.

A circular, bearing the title "Does Municipal Management Pay?" has been freely distributed lately among the ratepayers in certain districts of London. Its *raison d'être* is somewhat obscure, but evidently it is directed to answer the above query in the negative, and, inferentially, to prove that results point in favour of companies as undertakers of electricity supply rather than of local authorities. A list is given of 60 towns with municipal supply which showed deficits as the net result of their working during 1900 (1901, it is stated, but this is evidently an error). To these losses, totalling £92,280, is added an allowance of £180,554 for depreciation, being at the rate of 8 per cent. on the capital, thus bringing up the total loss for the 60 towns to £272,884. While, unfortunately, this list is substantially true as regards the deficits shown, it is necessary, in all fairness, to point out that, by not presenting the whole truth, it is misleading. To show this we may select from the list the examples of Bradford, Edinburgh and Dundee. Of course, these undertakings are quite unrepresentative of the general financial status of the bulk composing the list. The three undertakings named paid out of revenue in capital charges during 1899 and 1900 an average respectively of 8, 5·7 and 8·6 per cent. on their mean capital with the low total revenues of 2·7d., 2·62d. and 3·68d. per unit sold. It will thus be seen that the mere detached statement of the net deficits is a misleading gauge of the financial status of the several undertakings, especially taking into account the abnormal cost of coal in the period. However, even making allowance for the adverse fuel prices, one thing emerges clear from the statistics, and that is that in the majority of instances the general ratepayer has to bear a material proportion of the cost of producing and distributing electricity to be sold at below cost price by the local authority.

A first requirement in dealing with this question is to fix on an adequate estimate of the capital charges which should be made on the working profit. In our annual summary of electricity supply costs last January, we essayed to make a common basis of comparison by adopting 6 per cent. of the mean capital as such a charge on revenue additional to the working costs. Taking 40 municipalities at random we find the redemption and interest charges in 1901 came to an average of about 5·4 per cent. on the mean capital, and to this there must be added depreciation, so that this estimate of 6 per cent. is certainly not too liberal. It will be found from our summary that on that basis only 14 out of 49 municipal undertakings had revenues sufficient to escape deficits, while the averages of the 49 towns indicated

that every unit was sold at more than a farthing under cost, on the above basis of capital allocation. The averages of these err if anything in being too favourable. It is alleged that in many towns the public lighting is paid for at extravagant rates. We do not think this is very often the case. Such a practice is equivalent in effect, where it exists, to that above referred to, of inflicting on the general rates the liability incurred by adopting too low a general tariff. An example of the exact converse is shown in the Kingston accounts, an analysis of which we publish on p. 343 of this issue. Here it is seen that the receipts for public lighting work out to 1·92d. per unit, and that the total costs are 4·045d., indicating that the public lighting is being supplied at less than half cost price. As the units sold for public lighting at Kingston represent nearly one-quarter of the total units sold, no wonder there is a deficit shown in the balance-sheet. In these accounts, the receipts for private lighting are 5·59d. per unit sold, so that if public lighting were charged on a reasonable basis a profit might have been recorded in spite of the high item for fuel. In this case, if the low price for public lighting is maintained next year and the accounts show no deficit, it will mean that the ordinary consumer is paying for the public lighting instead of the general ratepayers. The result now is simply that the ratepayers pay a fair price for their public lighting, but that part of the price has to go through the books of the electric lighting department as a deficit. And in general, comparisons of the possibilities for cheap supply, as between companies and local authorities, are always more or less risky, because it is notorious that, whether street lighting shows on the books as a burden or a profit on the undertaking, all the costs of municipal supply are not always included in the electricity department accounts.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

The Electric Arc. By HERTHA AYRTON. (London: "The Electrician" Printing and Publishing Co.) 12s. 6d.

To all who are interested in the phenomena of the electric arc this connected account of Mrs. Ayrton's researches must be especially welcome. A considerable proportion has already been published in *The Electrician* and in various Papers read before scientific societies. The hope is expressed that the book may appeal to the practical man as well as to the physicist. This remark confirms the general impression gained in its perusal that it is the physics of the arc that have primarily engaged Mrs. Ayrton's attention, and that it is to the physicist she looks chiefly for an appreciation of her work. Nothwithstanding this however, we believe that the practical utility of Mrs. Ayrton's research is at least equal to its physical science importance.

Although bearing a general title the book is confined to the study of the continuous-current arc, and there is nothing directly bearing on the alternate-current variety. At the same time Mrs. Ayrton's discoveries shed a great deal of light on the alternate-current arc, and it is probably through the simpler continuous arc that we shall arrive at an explanation of the whole general phenomenon. In a similar sense, although Mrs. Ayrton has deduced nearly all the quantitative laws from experiments on arcs between solid carbons, it is through the study of this simpler problem that she is enabled to attack, with a great measure of success, the more complicated phenomena and reactions introduced by the use of cored carbons. In arc lighting practice generally, the only use of solid positive carbons obtains in the enclosed type of arc, but the conditions and constitution of such arcs are, as Mrs. Ayrton also shows, radically different to the open type.

The value of the book is much enhanced because, in addition to being an account of Mrs. Ayrton's own research, it is virtually also a critique and to some extent a correlation of other people's work. The history of the arc in Chapter II. furnishes a most useful and entertaining collection of the researches of experimenters since the time of Volta. In Prof. Ayrton's ill-fated Paper read before the Electrical Congress at Chicago in 1893, he showed that a necessary preliminary to the experimental determination of the normal relation existing between the three variables of the arc—viz., current, length and potential difference—was the investigation of the time variation of potential difference after striking the arc or making any other sudden change in its other two variables. Mrs. Ayrton, therefore, disposes of this matter before giving the classical curves showing the relations between the above three quantities. Not only are solid carbon arcs dealt with, but so also are those produced with cored carbons. Neither time nor fresh research has diminished the great value of these curves. Their close study, in conjunction with Chapters VIII., IX. and XI., may, without exaggeration, be said to be absolutely essential to the engineer responsible for efficient arc lighting or arc lamp designing, and even were the book limited to these four chapters alone it would be invaluable.

Some of the more important conclusions which are furnished from a consideration of these curves and the laws governing the useful radiation of light from the arc as ordinarily arranged, are most interesting in relation to actual practice. On all counts from the standpoint of efficiency—viz., the attainment of a high ratio of available light to power transformed in the dynamo—the indications are towards the smallest possible diameter of the carbons (especially the negative carbon), large currents and very short arcs. As between cored and solid carbons the latter are clearly indicated. In actual practice what do we find? Considerations of the cost of labour in re-trimming arc lamps have led to the use of relatively large diameters compared with the current. The practical difficulties of devising reliable, and at the same time sensitive, feeding motions render the realisation of very short arcs—a millimetre or less—impracticable, while probably the greater steadiness and stability of arcs with cored positive carbons, and the desire to cut down their pressure for use on constant-pressure mains, has determined the employment of cored carbons. In fact, the practical difficulties of satisfactory lighting are greatly increased as we approach many of the theoretically ideal conditions. As Mrs. Ayrton shows, the shorter the arc the more tapering are the carbon ends. Thus the danger of "lapping" is increased by two of the distinct conditions for efficiency—small carbons and short arcs. It is to be remembered that by "length of arc" in this book is meant the distance between the two parallel planes respectively touching the negative tip and the crater edge. In the appendix are some very clearly-written pages on photometry and on the mean spherical candle-power of the arc and on Rousseau's figures. In the course of the valuable study of the conditions for greatest efficiency we note that Mrs. Ayrton appears to dismiss the hissing arc as outside the pale of practical use. One of the limiting conditions laid down is that the arc be silent. Of course, it appears established that a hissing arc crater is at a lower average temperature than a silent one, and for that reason the crater light efficiency is probably lower. On the other hand, the hissing state is a necessary accompaniment of the use of very short arcs, thin carbons and large currents—the otherwise ideal conditions—whilst in addition the hissing crater is more exposed. For many practical uses hissing arcs would be out of the question, but in lighthouse work, for instance, the arcs are often run, we believe, normally hissing. Possibly this may be a by-no-means inefficient practice, as it is to be remembered that the pressure is lower by about 10 volts, and the lower temperature may result in a more useful *colour* of light for the penetration of fog. Incidentally, the conditions for hissing are just those which would raise the carbon ends to a high temperature, increasing the proportion of less refrangible rays emitted.

Perhaps in commending this book to the "practical man," a word or two of caution would not be out of place. Detached references to some of the conclusions would, as likely as not, prove misleading for practical work, in the absence of a thorough study of almost the whole book. Thus care is

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necessary to distinguish between conclusions which refer exclusively to solid carbon arcs and those conclusions which are of a more general character. Again, in reading into the conditions of actual practice the results of the investigation of the laws of useful light radiation from the arc, it is necessary to remember that not only in completely enclosed arcs, but also in many "open" types of arc lamps, the different shaping of the carbons due to comparative protection from the action of the air would upset the validity of the argument, and it would have to be modified intelligently to particular cases. A slight baffling of the convection currents of air about the arc would be sufficient to greatly alter the hissing point on the P.D. current curve for a given pair of carbons.

Passing now to a consideration of the research from a physical standpoint. Our knowledge of the physics of the arc is largely due to Mrs. Ayrton, for her remarkably patient experimenting and the minute record of her observations of phenomena. The book is a monument to this patience, and also, in its theoretical parts, to an untiring attempt to bring order out of chaos in respect of our knowledge of the reactions occurring in the arc. Anyone having the slightest acquaintance with the phenomena will marvel that in such matters as measuring the diameter of the crater, the zones in arc, and its length, such generally consistent results have been obtained. It is because of the enormous practical difficulty of making such measurements, coupled with the relatively small range in which those quantities are variable, that we feel sometimes that the theoretical structure has been raised on somewhat insecure foundations of data. In the measurement of crater diameters the error due to refraction must be impossible to assess with any accuracy. We find no recognition of this source of error. Chapter VII. is devoted to an interesting experimental study of the distribution of potential in the arc by the aid of search carbons immersed in it. The values obtained are astonishingly self-consistent in the circumstances, and speak volumes for the patient care exercised. In view, however, of the inherent nature of this particular method of testing by exploring carbons, we feel that it would have been safer to have couched the conclusions in the summary in less positive language.

In Chapters IV. and V. the causes of the peculiar behaviour of cored carbons are dealt with. It would appear as though confirmation of the theory of crater ratios might be obtained by a mere inspection of the crater seat simultaneously with the taking of the corresponding P.D. and current values, and the question suggests itself, what is actually meant by the crater being seated on the core? Very soon after the arc is started with a new cored positive carbon the core is eaten away for quite a distance up from the carbon end, and if the crater happen on the material of the core the latter suffers erosion rapidly. In relation to this question one of Mrs. Ayrton's conclusions is of interest. She states that "there is no evidence to prove that the depth of the crater has any influence on the P.D. between the carbons."

In respect to the physics of the arc the *pièce de résistance* is Chapter XII. Here Mrs. Ayrton marshals her experimental results, and directs them to show that the mechanism of the arc is explainable and largely predictable without invoking the aid of the idea of negative resistance or a large back E.M.F. She proceeds to account for the known reactions on the theory that overlaying the crater, and arising from it, is a film of true carbon vapour, and therefore of high resistance.

At a very short distance from the crater this vapour condenses into mist, which constitutes the bulk of the conducting arc column. The high-resistance vapour film furnishes Mrs. Ayrton with a reason for the great drop of potential near the crater and for the heat developed therein. In other words, it is not the crater itself that is the *source* of the heat of the arc, but a thin film of carbon vapour in intimate contact with it. Mrs. Ayrton next proceeds to show that this film of vapour acts as if it were the seat of a back E.M.F., and that the equation for the drop of P.D. at the crater as determined experimentally by the search-carbon method is of the same form as that which can be predetermined from the resistance theory. In showing this, Mrs. Ayrton apparently assumes that the quantity of carbon volatilised per second must be proportional to the area of surface from which it is volatilised. Perhaps this is considered as a necessary result of a reaction, which is referred to a page or two earlier. Here Mrs. Ayrton makes a valuable suggestion as indicating the *process* by which the vapour film is caused to vary in sectional area with the current. The crater is said to owe its volatilising heat to being in contact with the vapour film. The extra heat energy developed in the latter with an increase of current cannot raise the temperature of the film, because there is no increase of pressure, consequently the film expands and spreads over a larger area of carbon—increasing the crater area. Mrs. Ayrton next takes up the time changes of P.D. and resistance accompanying a sudden change in current, and this naturally leads up to the problem of what frequency of superimposed alternating current may be used to measure truly the resistance of the arc.

An investigation follows this of the criterion for determining whether or not there is a counter E.M.F. in the arc. The reader does not get far on this quest before wishing that he had been started well armed with a definition of "resistance." In the absence of this definition he has perforce to be content with the assumption that, if a fall of P.D. is found to be a simple function of the current, then it is due to resistance. Can we be so certain, even if $\frac{dV}{dA}$ is measured by an alternating current of the requisitely high frequency, that when $V - A\frac{dV}{dA} = 0$, where V is a P.D. and A the current, therefore there is no back E.M.F.?

Mrs. Ayrton concludes that it is quite probable that the resistance of the arc follows the ordinary ohmic laws obscured only by the varying resistivities of its several parts, &c. One unexplained phenomenon is drawn attention to, however, and that is the fall of potential between the arc and the negative carbon. This sudden fall, which Mrs. Ayrton has found to exist and to vary between about 8·3 and 14 volts with currents over 4 amperes, she finally regards as a true back E.M.F. In her preface Mrs. Ayrton states that she would have liked to discuss Mr. Duddell's Royal Society Paper "On the Resistance and E.M.F.s of the Electric Arc" in connection with her book, but that the Paper was not published in full at the time of her writing. Such a comparison of notes would indeed have been most interesting in view of Mr. Duddell's main conclusions, some of which are hard to square with those of Mrs. Ayrton.

It would extend this review unduly to state the objections to the view Mrs. Ayrton takes of the mechanism of the arc. "One story is good till another is told," and while Mrs. Ayrton has very pluckily presented a case for what may perhaps be called the simple resistance theory, she herself indicates that, if it be a part of the truth, it is certainly not the whole.

Before concluding this inadequate sketch of the book, we must not omit to state that there are features in it which, while making it somewhat tedious in parts to the more advanced reader, render it of great educational value to students. There are some wrong references, we believe, on pp. 228, 345 and 372.

G. THOMAS-DAVIES.

MR. MARCONI AT THE ROYAL INSTITUTION.

The progress of space telegraphy was luminously sketched by Mr. Marconi at the Royal Institution on Friday evening last. The famous inventor, after pointing out that, logically, electrical telegraphy without wires should be considered less wonderful than telegraphy with wires, proceeded to describe the developments made in his own system since his discourse at the Royal Institution two years ago. He explained how, about that time, he modified and magnified Lodge's experiment of the syntonic jars till he arrived at a practical syntonic system which enabled several messages to be dispatched simultaneously from a single air-wire and picked, separately, from one receiving wire. The modification consisted in placing at each station an elevated radiating conductor in

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inductive communication with the oscillatory current in the jar circuit, thus remedying those feeble radiating and absorbing qualities of a simple jar or condenser circuit which, Lodge had pointed out, prevented its use in distance transmission. And the magnification was effected by making the jars of zinc cylinders 7 metres (23ft.) high and 1·5 metres (4½ft.) diameter. The chief requirement for success, he quickly found, was that all the vibrating circuits concerned should have the same period. Mr. Marconi's recent achievements in long-distance work have been due to improvements in these various adjustments—that is, in tuning, to the employment of more powerful transmitting machinery, and to the use of suitable coherers.

For true syntonic work, where the action of the receiving condenser is a gathering up into an oscillation of appreciable amplitude of the successive small impulses dealt by a train of regular waves, it is important that the condenser circuit be kept unclosed. Since a coherer must be included in that circuit, it should have, till coherence actually occurs, a resistance practically infinite. This may be attained by making the coherer of very fine filings, and with a gap not too small. Such coherers are the best of those Mr. Marconi has used, among which he mentioned the carbon auto-decoherer of Tommasina, a carbon-cobalt auto-decoherer of his own, and the mercury instrument of the Italian navy. With all these auto-decoherers a telephone is, of course, used to render their coherence evident, and of these the mercury type is especially suitable for temporary work. These mercury decoherers were used in Newfoundland when, on a wire elevated by kites, the first signals were received from across the Atlantic. Later comparisons made during the outward voyage of the liner "Philadelphia" showed that the self-restoring coherers failed at 900 miles, while the tapped ones responded at over 2,000 miles. This great distance, it should be noted, was negotiated at night-time, for signals transmitted during the day were imperceptible beyond 700 miles—a remarkable effect which is attributed by Mr. Marconi to the discharging influence which light exerts on conductors so highly electrified as the radiator at Poldhu.

At these great distances, however, the best coherer is liable to serious disadvantages, and demands, doubtless, great skill and care from the operator. If a substitute could be found as simple, as sensitive, and yet less liable to derangement, the practical application of wireless telegraphy would receive a new impulse. Mr. Marconi has found such a substitute—one which he is confident far transcends the coherer in sensitiveness, in reliability and in speed, while being in essence quite automatic. It is founded on the demagnetising action of rapid oscillatory currents on magnetised iron. In its simplest form it consists of a few short pieces of somewhat hard iron wire wound with a layer or two of fine covered copper wire. Over this primary winding a secondary of coarser wire is wound. The ends of the secondary are connected to a telephone receiver, and through the primary the oscillations to be detected are led. If now, while oscillations are passing through the primary, the iron core be submitted to a slowly varying magnetic field, their existence is indicated by sounds in the telephone. That the magnetic state of the core should be changing is essential, the demagnetising powers of the oscillations being then devoted to effecting sudden alterations in the lag (hysteresis) of the magnetic state of the iron behind the magnetic field.

These sudden alterations in the magnetic state of the iron induce in the telephone coil corresponding currents which are great enough to affect the telephone audibly. In the crude form of the apparatus, just described, the variable magnetic field desired is obtained by moving to and fro an ordinary bar magnet. It is then found that signals are heard best when a magnet pole is approaching the core, more feebly when it is receding, and not at all when the magnet is stationary. In improving the device, it was an obvious step to impart a continuous motion to the magnet by rotating it by clockwork, and such a form of apparatus was shown and had been used by Mr. Marconi. With such an arrangement, however, inequalities in the strength of the signals must necessarily arise, because of the alternate approach and removal of the poles. This difficulty had been overcome in the final arrangement exhibited. In this the magnet is fixed and the core moves, the core being, in fact, an endless band of several strands of iron wire running in two grooved pulleys rotated slowly and uniformly by clockwork.

This wonderful detector has been used successfully between Poldhu and Poole, receiving 80 words per minute. But, Mr. Marconi hinted, it may be expected shortly to be recording—on a tape, presumably—more than 100 words per minute. If this anticipation be fulfilled Mr. Marconi has, it must be admitted, in this remarkable invention scored the greatest of his achievements.

CORRESPONDENCE.

INDUCTION MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I would like to make a few remarks with reference to the article on the above subject by Mr. H. S. Meyer which appeared in your issue of June 13th. I note that this gentleman, for some reason best known to himself, has been good enough to misrepresent completely certain views I hold on the subject of squirrel-cage induction motors, which I have stated in public from time to time. I do not wish to take up your space by discussing this point in detail, as far as I am personally concerned, but would merely refer those interested to what I have really said, as given in the Institution *Journal*, No. 146, 1900, *The Electrician* for January 10, 1902, and the *Electrical Review* for June 18, 1902, from all of which it will be seen or inferred that I referred only to motors used for ordinary industrial purposes in connection with three-phase lighting and power schemes. Such schemes (as exemplified at Prague, Strasburg, Lyons, Bockenheim, &c.) are, I believe, practically unknown to Mr. Meyer's American friends, and their experience with them is practically nil; it may, therefore, be assumed that they have something to learn if ever they do forego the use of rotaries, and face the question of putting down a uniform three-phase system to meet the electrical requirements of towns in which lighting forms the bulk of the load. It may be noted in this connection that, in the Newcastle scheme cited by Mr. Meyer, the three-phase supply is utilised almost entirely for power purposes alone, the bulk of the lighting being done indirectly from it—that is, through motor-generators—and for this reason it certainly cannot be held up as an example of the system referred to above.

With regard to Mr. Meyer's article in general, I am in agreement with all he says, for it only states at great length what everyone who is familiar with the subject has known from the earliest days of the (polyphase) industry. For instance, take the B.T.H. starting transformers, described at such length by the author—I remember quite well that the polyphase motors installed by Messrs. Brown, Boveri & Co. in their Baden shops about 10 years ago were all fitted with exactly similar starters (in oil) to the B.T.H. devices illustrated by Mr. Meyer, the only difference being that they were not called "compensators," and these starting transformers are now standard with all European firms for small and special motors. So it is with many of these American designs—quite old ideas are given new names, and are put forward by those interested as being something quite special and new.

The test of the 7½ B.H.P. motor described will be of interest to those unfamiliar with such machines, although the design is not too good for a standard machine (see the efficiency figures, which are low, compared with those obtained with most Continental motors), and for this reason the difference in performance with the two types of rotor winding is greater than that usually found. But it must certainly be conceded that, with a given stator, both the efficiency and power factor are somewhat higher when the rotor is of the squirrel-cage type; for this reason it will be found that many Continental makers give their standard types slightly different ratings, according to the nature of the rotor. Thus a certain motor having a squirrel-cage rotor might be rated at 8 B.H.P., while

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if supplied with a wound rotor it would be rated at 7 B.H.P.; under these circumstances the electrical performances will be about the same, and the only difference, as far as the consumer is concerned, will be the increased cost for a given output. It is unnecessary to add that, as far as a manufacturer making both patterns is concerned (and all works known to me standardise both types), it is quite immaterial to him which type his client selects. I imagine not even Mr. Meyer will claim that the design of a squirrel-cage rotor is more difficult than that of a wound rotor. As a matter of fact, for the reasons stated in the article in question, the opposite is the case, although there is, of course, not much in it anyhow. But, on the other hand, I have often noticed that in competing for the order of a client who wants a machine of a given power, and who does not know very much about the subject, the advantages of the squirrel-cage type of motor are generally run for all they are worth, and more besides, by certain firms, for in this way the order in question can be often secured at the expense of another firm who has some regard for the requirements of the service, as well as for those of the client, which obliges him to recommend a more expensive machine.

The whole question turns upon the starting current permissible in combined systems of lighting and power; consider, for instance, such a scheme, in which the proportion of the power for lighting to that for motors is, say, 3 : 1 or 2 : 1. The motor with wound rotor starts against full load with a starting current about equal to the full-load current, and with a high power-factor. That with a permanently short-circuited rotor starting under the same circumstances requires about *four times* the full-load current with a very poor power-factor. Or again, compare the two types of motor when they start up nearly light (say on a countershaft), the starting torque being about *one-third* of the full-load torque; the motor with wound rotor will take not more than half the full-load current, with an excellent power factor, while that with the squirrel-cage rotor starting with a compensator (using Mr. Meyer's figures) will take a current equal to *two and a-half times the full-load current with a power factor of 0·2!* Bearing in mind what such enormous *lagging* currents mean to the system generally, and to the regulation of the generators and transformers in particular, it should be clear to everyone that the use of many motors of this kind on a large lighting and power system would be disastrous, unless some limit was placed on the size by the power-station superintendent. Otherwise poor pressure regulation over the system (the Board of Trade rules would not be in it) and more expensive plant and cables would be the direct consequence, accompanied by incessant complaints from consumers. As for the statement that complications and troubles are brought about by the use of slip rings and starting resistances, I consider this simply an absurdity—even with direct-current motors no complaints are heard nowadays from any class of user, and such motors cannot be compared with induction motors from this point of view. Of course, mining and other special work must be excepted, as this is quite another matter. Here, undoubtedly, the use of the induction motor with squirrel-cage rotor presents such solid advantages that it will be invariably used, and this is a point I have frequently put forward in the past.

Finally, regarding Mr. Meyer's reference to the subject in connection with the Institution (which reference will doubtless be taken exactly for what it is worth), I might say that I am of the opinion that now is the time to clear up all such points as these, seeing that polyphase work is now coming in on a large scale. I have seen for years what an enormous amount of harm has been done by the indiscriminate use of poorly designed single-phase motors (there are many station engineers in this country who still discourage a motor load, simply on account of the trouble they have had with single-phase motors in the past), and much of this could have been avoided if the engineers of single-phase stations had insisted upon *rotor* starting resistances being used with the motors, just as most direct-current station men insist upon proper starting arrangements being provided with direct-current motors. I am one of the very few in this country who consider that the sub-station business for lighting and (industrial) power is being overdone, and believing as I do that properly designed three-phase systems meet all the power and lighting requirements of many places where direct-current systems cannot be employed with economy, and that such three-phase systems will be bound to come in eventually, I think it is of importance that a clear understanding should be arrived at from the beginning regarding all fundamental matters such as that under discussion. I give it simply as an expression of opinion (for reasons I have fully stated in other places) that no matter how large such a system is, it is best, *as a general rule*, to limit the size of induction motors fitted with permanently short-circuited rotors to 8 B.H.P. if they are required to start with a comparatively small torque, and to 5 B.H.P. if they have to start with full-load torque, or more. The results of future experience with such systems in this country can be the only test of the accuracy or otherwise of my views on the subject, which views, it may be noted, are shared by most Continental engineers.—Yours, &c.,

A. C. EBORALL.

London, June 15.

THE INSTITUTION OF ELECTRICAL ENGINEERS AND ELECTRICAL LEGISLATION.

THE DEPUTATION TO MR. GERALD BALFOUR.

On Tuesday last the President of the Board of Trade, the Right Hon. Gerald W. Balfour, M.P., received a deputation from the Institution of Electrical Engineers on the subject of electrical enterprise and legislation. There was a large attendance of members of the Institution and other interested persons, among them being the following:—

Mr. James Swinburne (president), Lord Kelvin, Prof. J. Perry, Mr. C. E. Spagnoletti, Prof. S. P. Thompson, Major-Gen. C. E. Webber and Col. Crompton (past presidents), Mr. S. Z. de Ferranti (vice-president), Mr. Henry Lea (chairman of the Birmingham Local Section), Mr. H. A. Mavor (chairman of the Glasgow Local Section), Messrs. H. E. Harrison, J. E. Kingsbury, S. Morse, W. H. Patchell and A. A. C. Swinton (members of Council), Earl of Rosse, Lord Greenock, Sir Michael Foster, Sir Thomas Wrightson, Mr. W. L. Madgen, Mr. W. M. Mordey, Mr. R. P. Sellon and Dr. R. Spence Watson.

The Right Hon. Lord Kelvin, F.R.S., having introduced the deputation, Mr. JAMES SWINBURNE, President of the Institution of Electrical Engineers, said: The Council of the Institution of Electrical Engineers formed a committee to advise them whether they should take any action that would assist the electrical industry in connection with the legislation that especially concerns it. This committee asked various prominent people to give evidence, and included in their invitation prominent exponents of municipalisation as well as of individualism. Their report is before you, and speaks for itself.* On receipt of this report the Council asked Lord Salisbury to receive a deputation on the subject of the effects of legislation on electrical enterprise. He replied that he concurred in thinking it desirable that His Majesty's Government should be put in possession of the views of the Council of the Institution, and that as the matters almost all fall within the cognisance of the Board of Trade, it is desirable that the deputation should be addressed to you. We therefore come to you, Sir, not only as president of your department, but as a member of His Majesty's Government, and we ask you to be kind enough to communicate the results of this conference to the Cabinet.

Twenty years ago the distribution of electrical energy for lighting became practical, but even electrical engineers only considered distribution over comparatively small areas. As the distribution involved underground wires and the opening of streets the local authorities had to be considered, as they have to do with streets. It is merely through this accident as to control of streets that the local authorities have become involved in the electrical industry. If it were not for the question of control of streets and, therefore, also of tramways, local authorities would have no more to do with distribution of electrical energy than of bread, meat, coals, clothes, wine, newspapers, or any other commodity. The almost accidental circumstance of electric distribution needing wires has thus involved electrical distribution in the most complicated legal relations with local authorities. In 1882 it was not contemplated that a station would distribute over more than a parish or part of a parish, and the Electric Lighting Act was drawn on parochial lines. But there was more than this. So tender was Parliament of the interests of local authorities that they were given an option of purchase of local undertakings at the end of 21 years. Thus the private companies were to take all the risk and the local authorities all the benefits. This discouraged the industry, until it was to some extent relieved by having the 21 years extended to 42. But since 1882 the industry has advanced. Electrical engineering no longer deals with small areas of a few acres. We now deal with areas of 1,000 sq. miles and upwards, covering not only parishes but counties. We deal with electrical tramways or street railways which connect town with town and district with district. But we are hampered with parochial legislation. We hold that electrical enterprises should have their limits and boundaries set by economical considerations only, and that arbitrary boundaries, mostly of mediæval ecclesiastical origin, should not limit the distribution or the growth of electrical systems. Apart from the questions of fairness, the purchase clauses are entirely out of date

* See *The Electrician*, Vol. XLIX., pp. 46, 60 and 103.

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now, and are becoming as inapplicable to electrical undertakings as to railway systems.

We do not come before you to oppose municipal trading. We have no mandate to that effect. But what we do earnestly ask to have checked is the abuse of their legal powers by local authorities. We want to see the electrical industry flourish here as elsewhere, and we want to see ratepayers obtain the best thing available. Their interest is the industry's interest. We want to prevent the injudicious action of local authorities in opposing electrical progress because they have already risked ratepayers' money in gas works, or preventing ratepayers getting the advantage of supply from a power company because the authorities have invested in their own electric supply. We want to prevent the pure unreasoning obstruction by local authorities, who get orders themselves and do not work them, preventing others coming in. We urge that local authorities should not have power to prevent schemes even coming before Parliament on their own merits.

As to compulsory purchase, we urge that that is now only a legal incubus on the industry. As systems extend over larger and larger areas the difficulties are greater, and the laws so little fit the circumstances, that there is really no saying what an undertaking is liable to at the end of the term. We would urge that there is no more justice in compulsory purchase of electrical systems than of other local industries. The control of roads and streets is a distinction, not a difference, that puts electrical distribution on a different footing as regards monopoly than, say, coal supply; nor does it make electric tramways any more a monopoly than omnibuses. We would also ask, and in this other industries would no doubt join us, for simpler, more efficient, and less costly procedure in connection with Parliamentary Committees. We only represent a small part of the engineering industries that are hampered by the expense and inefficiency of Parliamentary procedure generally; but if it is indeed hopeless to improve the working of the committee system generally, we only ask for such facilities as can be easily granted as regards electrical bills.

So far I have dealt with matters concerning the Government generally, I will now deal with the department of which you, Sir, are the head. With the officers and electrical inspectors of the Board of Trade we are well satisfied, but we have not enough of a good thing. It is not for us to say how it should be done; we suggest, however, a more liberal supply from the Treasury to enable you to have a larger electrical staff. The organisation of the Board of Trade does not seem quite perfect. The electric light even of inland towns comes under fisheries and harbours, perhaps because it was originally used in lighthouses, and electric traction comes under railways. The regulations are behindhand. For instance, the tramway regulations were drawn up when only small systems were contemplated, and now urgently require revision. We ask to have the question of permitting overhead wires opened again. We ask that the overhead systems used for tramways at 500 volts should in some cases be available for lighting. We ask for re-opening of the question of overhead wires generally. The limits of size of converters and trunk mains also require revision. Should your department care to avail itself of the help of the Institution in discussing regulations, it is at your service.

Though we urge certain improvements in your department, we are very much more concerned in the broader question of the effect of legislation on our industry. We feel very deeply that the effect of legislation on our industry has been very repressive. Electrical science has always been well ahead in this country, but the industry has lagged behind compared with other countries and with other industries in this country. As to whether municipal trading is good or bad in itself we say nothing. But through the fact that though they do not own them, the local authorities control the streets and roads, our industry has become tangled up with municipalisation. If municipal trading is a good thing when worked properly, we are anxious to help it, as we receive most benefit from it; but if it is a bad thing our industry is the chief sufferer. Municipalisation may be a good thing if carried out on sound principles, but without complaining of it, we feel that the powers of local authorities are capable of very serious abuse. We think, therefore, the effect of municipal trading, as far as it concerns us, should be investigated, so that His Majesty's Government may know whether it is a good thing, not for muncipalities considered alone, but for the community at large, having regard to questions of engineering, local indebtedness, housing, rapid transit and concentration in cities. We ask you, therefore, to do what is necessary to cause the appointment of a Royal Commission to consider the whole question of electrical legislation.

Lieut.-Col. CROMPTON, who followed, desired to suggest for Mr. Gerald Balfour's consideration various ways in which the deputation believed that the Board of Trade, as at present constituted, could help the electrical industry, and, again, the extent to which it could help it if strengthened with further powers from the Government. Leaving for the present the very important question of the municipal veto as one which the Board of Trade cannot deal with under present conditions, Lieut.-Col. Crompton gave from his own personal experience an example of the manner in which municipal interference had damaged the interests of shareholders in a private electrical enterprise. Twelve years ago the Hove Commissioners obtained powers to carry out electric lighting. They let it lie in abeyance for two years. The inhabitants then, being anxious to obtain the electric light, invited him (Lieut.-Col. Crompton) to form a company to take over the statutory powers from the Commissioners. After some delay an agreement was made between the Commissioners, and a company was formed which had the approval of the Board of Trade. During the first few years—*i.e.*, the period when the company was working at a loss—the Hove Corporation remained neutral, but so soon as the company began to make profits the Electric Lighting committee of the Corporation had shown themselves actively hostile to the company, and had done everything in their power to impede its operations. They had thrown every possible difficulty in the way of the company obtaining a site for the extension of their works; and, when the company had obtained a suitable site, they refused to allow it to carry its mains through a short distance along the Shoreham road into the area of the company's operations. Again, on the question of the change-over from 110 to 220 volts, a question which has had the careful consideration of the Board of Trade during a recent inquiry, the Corporation had actively and passively opposed the change, by canvassing even those consumers who desired of their own free will to change over and accept the benefits offered them by the company. This opposition to the company's operations could only be explained by a desire of the officials of the Corporation by all possible means to prevent the company working at a profit. He cited this as a case where he was able to prove his facts. He suggested as a remedy that if sufficient *prima facie* evidence were given of such unreasonable hostility on the part of a local authority, the Board of Trade should hold an inquiry of experts, who should report and advise them, and that on such reports they should, if necessary, take action to protect the private enterprise. Referring to the Board of Trade regulations, he said that the deputation thought that the existing staff of inspectors should be strengthened, or a standing committee of experts be appointed to assist those inspectors in reporting on new methods of electrical supply proposed from time to time, which could not be carried out because of clashing with the existing regulations. By the aid of such a committee of experts, which might either be appointed from a list to deal with each case as it arises, or which might be a standing committee appointed from year to year, delay could be avoided, and the work of the Board of Trade inspectors might be lightened. Up to the present the time of the Board of Trade's sole electrical inspector had been fully occupied in investigating the accidents and troubles which must necessarily occur in the development of a new industry, and which must increase year by year with the increase of the industry itself. In regard to this matter of the employment of outside experts, Lieut.-Col. Crompton recalled the fact that Germany and Switzerland at present availed themselves of the services of eminent scientific men for this purpose. The question of the municipal veto was one which must be eventually dealt with by Parliament; the Institution was advised that the best method of dealing with it would be the appointment of a Royal Commission to take evidence and advice as to the legislation necessary.

Dr. R. SPENCE WATSON enlarged further upon the disastrous effect of the local authorities' veto, by which they could give a refusal and assign no reason for it. They could demand terms from a company which were really paid for by the persons dealing with the company, as anything of this nature involving an increase of price obviously fell upon the public. And in this way the whole country was affected, for the fewer the people who took a supply owing to prohibitive prices the fewer the workmen employed. He did not think that the taking away of the veto of the local authorities would injure them; it would only prevent them from being unreasonable.

Mr. SYDNEY MORSE, speaking on the question of the veto of local authorities, quoted two expressions of opinion on this matter which had been given in Parliament. In the House of Lords on July 11, 1901, Lord Morley, in discussing Standing Order 22, as to the veto in the case of tramways, had stated: "That it is not theoretically right that anyone or any body of persons should have an absolute power of veto, and should be able to prevent a scheme coming in any shape before Parliament against their will; that it is against the principles of modern legislation, especially against the principles of the Light Railway Act; that it is not right for a rival proprietor (as it is in the case of large municipalities) to have the power of absolutely stopping any rivals from coming into the field; that there is an inconvenience in the double veto of the road authority and the local authority, and, above all, that it is not expedient or in the public interests that you should give to the local authorities such a strong power of exacting conditions that may be very onerous upon an important national industry." The second was from a debate on the same standing order in the House of Commons on May 15, 1902, when Mr. John Burns said: "In three sessions 38 proposals for tramway extensions and improvements have been vetoed by the borough councils in London. In nearly all these cases the veto, in my opinion, was unreasonably exercised. Some of the vetoes by borough councils of County Council projects have been unreasonable, some have been facetious, and some have been almost on the verge of blackmailing the tramway authorities for local street improvements to an extent that the borough councils ought not to have been guilty of. In consequence of the unreasonable veto of some of the borough councils, 38 proposals for tramway extensions have been vetoed, 35 double miles of tramway traction have been refused, and consequently denied to London, during the last three years." Continuing, Mr. Morse said that probably few members of Parliament knew the extend to which some local authorities would go in these matters. At Wolverhampton, for instance, a tramway scheme involving £1,000,000 had been wrecked because the local authority had asked a prohibitive price for the current which the tramway people were to be bound to take. At Swansea, too, the tramway company found the passing places of the horse tramways were not sufficient for the electric cars, but they had only been allowed to make additional ones on payment of £5,000. Similar cases occurred in connection with electric lighting. The matter had been considered by a Joint Committee, and in their report the Committee appointed on Electrical Generating Stations and Supply stated:—"The Committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order, should be amended. In their opinion the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto, only to be dispensed with in special cases by the Board of Trade. Mr. Morse then referred to the recent departmental committee appointed by the Board of Trade to consider the question of light railways and tramways, of which

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he was a member, and he stated that the report made by that committee was unanimous. He believed that if the Government could find time to introduce the bill which he understood they had prepared as a consequence of that report, they would find Parliament willing to pass it, and so put the business of tramways and light railways on a basis which, if not freeing the companies entirely from the veto in those matters, would, at any rate, guard the interest of all parties. With regard to electric lighting, he would respectfully suggest that the recommendations of the Joint Committee of 1898 should be carried out by the Government. The whole question could be summed up in one sentence—namely, that all schemes involving expenditure of capital for works in the public interest should be heard and decided upon their merits, and that it should not be necessary to obtain the consent of the local authority, however important or unimportant, before Parliament or the Board of Trade could consider whether the scheme was one which was or was not in the public interest. Tramways had come to be a secondary means of communication between great towns and not between street and street. In the same way electric lighting had become the necessary means of giving manufacturers the power they needed for workshop use, and had not remained merely a means for lighting houses.

Sir MICHAEL FOSTER, F.R.S., M.P., said that electrical science had met with greater obstacles in its application than any other science, and there ought to be some changes which would give freer development.

Mr. S. Z. DE FERRANTI said it was now pretty generally realised that for the general prosperity of the country they could not do better than give facilities for the supply of electrical energy over the largest possible areas. He was interested with others in a scheme which was just commencing supply in the Midlands, and it was found that there had at first to be done what he might call a lot of pioneer work. Pioneer work should be able to be done at the lowest cost, but as the regulations now stood it meant that a large amount of capital had to be spent to begin with, in order to produce any result at all. Had they been in Switzerland or in Germany—two countries which he thought it was admitted gave every protection to their inhabitants—they would have had every facility for reaching the various points of the districts in question, with big security, by means of overhead wires, but here they had to lay down costly underground mains. No doubt eventually all large quantities of electric power would be transmitted by underground mains, but it was necessary to make a business before they could afford to spend such very large sums of money as those required. The Board of Trade, very wisely, many years ago, provided a maximum limit of variation of voltage for supply in towns. But although these limits had to be adhered to strictly by the companies because there was always some one looking after them, they were not always followed by local authorities. What he thought was required was the making of different rules with regard to the voltage variation where the supply came from power companies. Many manufacturing people would like to have the use of electric power, and in order to develop the industry round about large towns it was thought very desirable to be able to supply both lighting and power from off the same circuits.

The Right Hon. GERALD BALFOUR: Are you suggesting that the rules should be different in the case of companies?

Mr. FERRANTI said no. What he meant to do was to call attention to the fact that although the rules were very good originally they were too narrow at present and asked for too good a supply to be given to enable it to be given at a sufficiently low price to make it pay in new industries. If it were not for the strictness of the voltage variation limit, supply could be given more cheaply and at an earlier date than people at present got it. With regard to the regulations in respect to the amount of electrical energy which it was allowed to send through one feeder, and the size of transformers, both these things injuriously affected the supply of electricity for power purposes over large areas. What was thought with regard to these rules was that the industry was progressing very rapidly, and that the Board of Trade had not at its command a sufficient staff to deal with all the electrical work in the country. At present the rules tended to hamper the progress of the industry because they had not only to get over the mechanical and electrical difficulties of doing the work, but also over the inertia attendant upon the drafting of these rules, which fitted circumstances some years back, but which did not fit the present rate of progress at all. As an instance of the repressive tendency of legislation with regard to electrical matters, he referred to the purchase clause in the Tramways Act, the effect of which was that Germany and America had gone ahead in this department and gained a great deal of practical experience before we in England had made a start. The present time seemed to be one of international industrial war, and he thought that everything which would encourage the progress of work of all kinds at home must be to our own advantage in supplying the markets of the rest of the world.

Mr. GERALD BALFOUR said that, with regard to overhead wires, he could say that the Board of Trade would be prepared to consider every case on its merits, and, indeed, at present no hard-and-fast rule was laid down in this respect. Only quite recently, at St. Helens, they had permitted the use of overhead wires. With regard to voltage variation limits, he was aware that this had been brought before him on previous occasions, as well as the amount of supply through one feeder, but, speaking generally, the Board of Trade was extremely anxious to meet the reasonable requirements of promoters as far as possible, and he did not think it would be found that they were anxious to interpose any unnecessary obstacles whatever. With respect to any change in the regulations, he would be most anxious to receive from the Institution any suggestions it might have to offer, and he could promise that these suggestions would receive the fullest consideration. He did not, however, quite understand the suggestion that the staff of the Board of Trade should be increased or in what particular way that would assist in the objects which the Institution had brought before him. If it could be shown that the staff was inefficient for the work that was quite another matter, but he did not see how the mere strengthening of it would enable the Board of Trade to "march more with the times," so to speak.

Mr. FERRANTI said he thought matters were changing so rapidly in the electrical industry that the electrical staff of the Board of Trade had a very difficult time to keep up with it. He considered that a change in the regulations should be made from time to time. In fact, if there were to be regulations at all they should be changed every six months, or at any rate modified so as to suit the circumstances of the case. With regard to overhead wires, people were held back by the regulations which were enforced at the time, and commercial people did not like to have to count upon regulations being altered after they had got their scheme going. What he did suggest was that the regulations should proceed with the demands—*i.e.*, that the Board of Trade should investigate what was being done in other countries, and see that our regulations in no way hampered us in doing just as much as other countries did in electrical matters.

Mr. GERALD BALFOUR: You consider that the staff is overworked and cannot keep pace with the industry.

Mr. FERRANTI: Yes.

Mr. SWINBURNE said the Institution would greatly welcome an opportunity of laying before the President of the Board of Trade, in concrete form, a statement of the regulations it would like to have considered.

Mr. GERALD BALFOUR said he would be very glad to have such a statement.

Mr. SWINBURNE, continuing, said it seemed to him, having regard to the questions which had been put to Mr. Ferranti, and the fact that the Institution were asked to come forward with a statement of regulations which it thought should be altered, an admission had practically been made that the Board of Trade staff was unable to keep up to date. Regulations ought to come before the industry and not afterwards.

Mr. W. H. PATCHELL, speaking on the question of the existing regulations, said he did not think that some of them were altogether bad, but they were uncertain.

Mr. GERALD BALFOUR: Would not the uncertainty be increased by continual change, as suggested by Mr. Ferranti.

Mr. PATCHELL said he thought Mr. Ferranti had rather given himself away in saying that a change ought to be made every six months. But one of the regulations which had tied them was as to voltage. He had seen the technical officers of the Board and discussed this matter with them, and it had been at last discovered that the existing regulations only referred to high pressure and not extra high pressure. But construing literally the regulations as at present constituted, large sums of money had been spent in extra insulation which should not be required, and in Germany, for instance, it would not be required. He had had very many opportunities of seeing work in Germany and Switzerland, but although in those countries they were tied in a way, yet they got along more quickly. The restrictions were more of a personal nature as to the protection of life and limb, and were on broader lines than was the case in this country. Another matter was the earthing of the neutral point of a three-phase system. This had been tried and abandoned in Germany, and from an engineering point of view it was bad. He did not mean to say that he could not get a ready answer from the technical advisers to the Board of Trade. He did. They had always found them most ready to meet them as far as possible, but the present regulations left them in a state of great uncertainty as to what was actually required.

Mr. GERALD BALFOUR said he thought some of the matters mentioned were hardly the subject of cast-iron regulations. The rules, as observed by the Board of Trade, were rules for ordinary cases, which did not necessarily apply to exceptional cases, which latter were judged upon their merits.

Mr. PATCHELL replied that the rules, at the time they were made, were for ordinary cases, but now they were getting so many exceptional cases that these were all becoming ordinary cases.

Mr. SWINBURNE thought the discussion was getting away on to a lot of small details, and of this he had been afraid from the beginning. The question was not intended to be considered as concerning the Board of Trade and not the Government. If the President of the Board of Trade would let the Institution go through all the rules which it thought existed, and all the rules which it thought did not exist, that would settle part of what the deputation had come for. But the main part had reference to general legislation, and upon this he would like to hear what Mr. Balfour had to say.

Mr. GERALD BALFOUR said he fully recognised the very great importance of the subject which had been brought before him, and to a very large extent he was in sympathy with much that had been said. He was afraid it was an undeniable proposition that the electrical industry in this country was behind what it was in America and Germany, and perhaps some other of the Continental countries. He doubted, however, whether that backwardness was to be entirely, or perhaps even chiefly, attributed to defects in our legislation or to regulations of an oppressive character, or even to the abuse of their powers by local authorities. He did not for a moment mean to contend that legislation, as applied to electrical industry, was not susceptible to considerable amendment, or that the regulations might not in some instances have proved restrictive, or that local authorities had not abused the powers conferred upon them by Parliament, but he doubted whether that fully accounted for the comparative backwardness of this country in these matters. Certain things must always be recollected. America was a new country, very sparsely inhabited, with towns growing up like mushrooms; above all, with comparatively few established interests to contend with. The field was open and capital could readily flow into it from these new channels. Things were different in this country. This was an old country with a very dense population, and with a large number of strongly-established interests; and strongly-established interests always produced that conservatism which we had very strongly developed in this country. He believed that it was these fundamental conditions rather than any actual local enactments which had tended to retard the development of the electrical industry in Great Britain as compared with the same industry in other countries. But while

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he held this view he did not for a moment contend that changes in the direction indicated by the speakers might not be of a beneficial character. It appeared to him, however, in listening to the speakers, that the really important question was not so much that impediments had been thrown directly by the Legislature in the way of the development of the electrical industry, as that a power had been given by the Legislature to local authorities to veto schemes. In respect of this they had to consider the two branches of the subject—viz., electric supply and electric traction. In the case of the latter, under the Tramways Act of 1870 the local authority had an absolute veto. To some extent the evils flowing from that condition of things had been remedied by the adoption in many cases of light railway procedure, even when the scheme had been in the proper sense a tramway, and it was true, as Mr. Morse had pointed out, that the Light Railway Commissioners, and also the Board of Trade, had considered themselves more or less bound by the rules laid down in the Tramways Act and in the standing order of the House of Commons. But he did not think either body had gone the length of giving the local authority an absolute veto, although they had undoubtedly been influenced by the legislative conditions on this subject. The subject of traction had further been considered by a departmental committee appointed by the Board of Trade upon which both promoters and local authorities were represented. As a result of the deliberations of that committee, a bill had been drafted which he thought would go very far towards meeting all the reasonable objections which had been urged against the present powers of local authorities. He trusted that that measure, when introduced, would prove satisfactory to both parties. But it was idle to conceal from themselves the fact that local authorities had a very great power in this country, and they saw that it was strongly to their interests to possess, if not an absolute veto, at all events a *locus standi* which would enable them to make their views powerfully felt. As an illustration, he would remind the deputation that the other day an attempt was made to alter the standing order of the House of Commons,* but the motion giving effect to that view was received in so hostile a manner that the mover of it did not venture to bring it to a vote. This showed the difficulties which stood in the way, not merely of the Board of Trade as a department, or the Government as a government – difficulties would stand in the way so long as the local authorities took so strong a view as to the powers which ought to be reserved to them in connection with these enterprises. Nevertheless, in spite of the refusal of the House of Commons the other day to alter this standing order, he had considerable hopes that the compromise which had been arrived at by the departmental committee, and embodied in a bill which had not yet been introduced, would be found fairly satisfactory. As regards electric supply the case was somewhat different. A House of Commons Committee had already sat upon this matter in 1898, and made a series of recommendations. Where an enterprise for the purpose of electric supply was promoted by bill he believed that the House of Commons Committees usually now acted upon the recommendation of that Committee, but legislation would be required to enable the Board of Trade to act upon those recommendations in respect of provisional orders. However, a bill had also been got ready to give effect to these recommendations, but he was afraid he could not hold out any hope of being able to pass either this bill or the other one this session. It was the desire of the Board of Trade to introduce and pass both these measures, and by this it would be seen that they were by no means insensible to the considerations brought forward by the deputation, but, on the contrary, had really, on their own initiative, taken the preliminary steps to bring about a more satisfactory state of things. He could only repeat what he had already said—viz., that the Board of Trade would always be happy to listen to any suggestions that might come from such a body as the Institution of Electrical Engineers, and it was really just as anxious as anyone to secure that the public interests should be properly served by that great industry represented by the deputation.

Mr. SWINBURNE said that what they had asked for was the appointment of a Royal Commission, and the idea in doing so was that they would not be so much "under the thumb" of the local authorities, if he might so put it. His Majesty's Government would be very much guided by an impartial report from such a Commission, whereas if the matter was left in the way proposed by Mr. Gerald Balfour it was a little uncertain as to how far they would be able to get such an impartial examination. He would, therefore, again express a wish to have a Royal Commission.

Mr. GERALD BALFOUR said he would be quite ready to consult his colleagues on this matter. It was a question for the Cabinet to decide, and he did not feel in a position to say, without further consideration, whether he should recommend his colleagues to adopt the suggestion.

The deputation withdrew after thanking Mr. Balfour.

PHYSICAL SOCIETY.

The meeting of this society on June 13th, Prof. S. P. Thompson (president) in the chair, was held in the National Physical Laboratory, by the kind invitation of the director.

Dr. GLAZEBROOK made a brief statement and said that the task of fitting up an ordinary house as a physical laboratory had been a difficult one, much more difficult than that of designing a new building. The general scheme of the laboratory is such that the main departments, including those of electricity, thermometry, and chemistry, occupy the principal rooms in four of the wings, together with the portions of the basement most nearly adjoining, while the first floor and a number of small rooms are fitted up as general laboratories. An additional building has been constructed for carrying on the work of the engineering department. Electric current is supplied by 50 storage cells and distributed by bare wires carried by porcelain insulators. From the main switchboard and four subsidiary switchboards circuits are led to almost every room in the building, and to these any voltage from 2 to 110 can be applied by making a suitable connection.

The meeting then adjourned, and the fellows were allowed to inspect the laboratory.

Thermometry.– Dr. HARKER showed apparatus for testing thermometers at high and low temperatures, including :—

(i.) An oil-bath. Temperatures 100°C. to 240°C.
(ii.) A bath of fused nitrates of sodium and potassium. Temperatures 240°C. to 550°C.
(iii.) Electric ovens. Temperatures up to 1,250°C.
(iv.) A vacuum vessel with suitable cooling agents.

High-temperature mercury thermometers, platinum thermometers, and thermopiles were shown in operation, and a demonstration was given with the Hampson apparatus for the liquefaction of air.

Electricity.—Mr. CAMPBELL and Mr. MELSOME showed :—

(i.) A Kelvin electrostatic voltmeter with a long scale and arrangements for calibrating against a Clark's cell.
(ii.) A Kelvin current-balance.
(iii.) Apparatus for determining the capacity of the standard air-condensers of the British Association.
(iv.) Apparatus for tests on iron by the ballistic method.
(v.) Ewing's permeameter.
(vi.) Bridge for resistance measurements.
(vii.) Methods for measuring a small resistance :
  (*a*) Thomson's double bridge.
  (*b*) Potentiometer method.
  (*c*) Differential galvanometer method as described by Crawley.

Electrical Standards.—Mr. SMITH showed the British Association standards of resistance and the standard cells in a room maintained at a constant temperature by a gas fire and a regulator.

Terrestrial Magnetism.—The latest form of unifilar magnetometer, designed for the Indian Survey, together with some recent magnetic and seismographical charts, were shown by Dr. CHREE. Mr. Watson's magnetographs, arranged for the special magnetic observations in connection with the Antarctic Expedition, were exhibited.

Microphotography.—Dr. CARPENTER exhibited the Zeiss microphotographic outfit, and showed some microphotographs of steel.

Metrology.—The following apparatus was shown by Mr. KEELING :—

(i.) A Whitworth measuring machine.
(ii.) A Pratt and Whitney measuring machine.
(iii.) A dividing engine by the Société Genevoise.
(iv.) A simple comparator.
(v.) A comparator by the Société Genevoise.

Photographic Lens-testing.—Mr. HUGO exhibited the Kew apparatus for testing photographic lenses.

The chemical laboratory, the metallurgical laboratory and the main switchboard room were also open for inspection.

In the engineering laboratory Dr. STANTON and Mr. JAKEMAN showed the steam turbine and dynamos, the gauge-testing apparatus, the experimental testing machine, and the other machines which have been installed.

THE STORAGE BATTERY IN ELECTRIC AUTOMOBILES.*

BY W. H. PALMER.

In discussing the merits of the various systems of automobile propulsion, the electrically-driven vehicle is too frequently dismissed with the arbitrary statement that, although ideal in so far as motor, controlling mechanism, &c., are concerned, it is rendered impracticable for commercial use by reason of the great weight of the necessary storage battery, its unreliability and the great amount of attention which it demands. On the other hand, there are not lacking those who maintain that, thanks to the unremitting efforts of the past few years, the storage battery is, in the special types furnished for automobile work, freed to a great extent from those objections.

The greater the scale on which operation is conducted, and the more perfect the knowledge of the conditions surrounding it, the more accurate and interesting should be the conclusions drawn therefrom. Electric cab service in New York city was inaugurated in the spring of 1897 by the Electric Carriage and Wagon Co., with an equipment of twelve hansoms and one surrey. To-day that service, conducted by the New York Transportation Co., has grown to such proportions that upwards of 300 vehicles are in daily operation, running an average of nearly 5,000 cab-miles per day. That the service performed by these vehicles is successful, from the point of view of the patrons, is shown by the fact that, at rates equal to, or in excess of the rates charged for the highest class of horse livery

* See *The Electrician* of May 23, pp. 184 and 197.

* Abstract from the *Electrical World*.

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service, far more applications for service are received daily than the company, even with its increased equipment, is able to accept. While vehicles of nearly every description are included in the equipment, the operation of hansoms and broughams constitutes the greater portion of the company's business, and the portion upon which accurate figures are most easily obtainable, and the statements which follow, have been based upon the vehicles and batteries used in that service. About one and-a-half batteries are kept in commission for each vehicle operated. This number is sufficient to meet the requirements of service calling for the use of vehicles at all hours, both day and night. Of these about two-thirds are, at present, of the "Chloride-Manchester" type, and one-third of the "Exide" type—both the product of the Electric Storage Battery Co.—one or the other being used according to the nature of the work to be done by the vehicle. No batteries of any other type are used by this company.

The Chloride-Manchester elements are so well known that a detailed description of them should be unnecessary. The standard brougham or hansom battery of this type consists of 44 cells having three Manchester positive and four Chloride negative plates. The weight of the battery complete in the tray, with all connecting straps, &c., is 1,790lb., and the capacity 108 ampere-hours at the three-hour rate of 36 amperes. These batteries, as originally furnished, were assembled with corrugated perforated hard rubber separators between the plates. These separators were unsatisfactory for various reasons. One of the principal sources of trouble was in the tendency of these separators to flatten out if, during the hot weather of the summer months the batteries, for any reason, became slightly overheated.

The Electric Storage Battery Co., therefore, set itself the task of providing a substitute for this expensive and unsatisfactory separator, and about a year ago brought out a grooved wood separator, without perforations, which is now used in all batteries of this type, and which is free from all of the above objections.

Partial short-circuits are almost entirely prevented, and, in the rare cases where they do occur, can be readily removed.

Connection between the battery and vehicle wiring is made by means of copper terminal plates mounted upon the sides of the tray. On the sides of the battery compartment in the vehicle are spring-mounted contact-blocks, which have pressure contact with the plates on the tray when the battery is in position in the vehicle.

The 44 cells comprising a battery are connected in one series. This is a decided improvement upon former practice, when two, and even four series were the rule.

The weight of a standard brougham, with battery, driver and two passengers, is about 5,300lb. Such a vehicle, when in good condition, will consume, at the normal running speed, on level asphalte, about 50 watt-hours per 1,000lb. per mile, or 265 watt-hours per vehicle mile. A fair average for reasonably clear streets has been found to be 60 watt-hours per 1,000lb. per mile, or 318 watt-hours per vehicle mile.

The capacity of the battery at the three-hour rate is, as stated, 108 ampere-hours. As the average voltage of discharge of 44 cells at this rate is about 84 volts, the watt-hour capacity is about 9,072 watt-hours.

The mileage capacity under average conditions will, therefore, be 28·5 miles. The weight, and consequently the power consumption, of the hansom are slightly below these figures, but the difference is not great.

The standard brougham or hansom battery of the Exide type consists of 44 cells of the TV 9 size, having four positive and five negative plates. The rubber jar is the same as that used for the TV 7 Chloride-Manchester cell, and the batteries are assembled in trays of the same size, making the two types of battery interchangeable in the vehicle. The weight of this battery complete with tray, &c., is 1,650lb., or 140lb. less than that of the Chloride-Manchester type. The capacity is 156 ampere-hours at the 4-hour rate of 39 amperes. The average voltage during discharge is 87 volts; the watt-hour capacity, therefore, is 13,572 watt-hours, an increase of 50 per cent. over that of the Chloride-Manchester batteries and of 62·5 per cent. per pound. Using the figures for average vehicle consumption already given, the mileage capacity will be, under average conditions, 42·7 miles.

The battery policy of the New York Transportation Co. necessarily depends very largely upon the question of cost of operation per vehicle-mile. It has, therefore, been most gratifying to find, after a year of operation, that the Exide battery not only provides a sufficient mileage capacity for all classes of metropolitan service, but at the same time can be operated at a cost, including maintenance, but little in excess of that of the Chloride-Manchester and within the limits of reasonable expense. This conclusion is based upon the results obtained from 75 batteries, which have been in continuous service for about one year.

In calculating the battery expense per vehicle-mile, the cost is divided under two general heads, "Operation" and "Maintenance." The latter is sub-divided into "Renewals," "Cleaning" and "Repairs." In the cost of "Operation" are included the expense for current and labour used in charging and handling the batteries, and also of the acid and labour used in regulating and replenishing the electrolyte. All batteries are removed from the vehicles for charging. This is done both to facilitate inspection and to avoid the loss of time and the other complications that would result from having the vehicle lie idle during the charging period. The batteries are handled entirely by machinery. Labour is thus reduced to a very low figure. Current for charging purposes is taken direct from the high-tension alternating mains of the New York Edison Company, at 6,600 volts, 25 cycles. This is transformed and converted to direct current at pressures from 98 to 110 volts. The equipment of static transformers, rotary converters, &c., necessary to accomplish this is owned and operated by the Transportation Company. The capacity of this installation is 800kw. Four sets of large stationary storage battery cells are also included in the equipment, being used as booster and crusher batteries to secure a number of 'bus pressures from a single rotary converter. Four 'bus pressures are provided at the charging switchboard, being 98, 102, 106 and 110 volts respectively. The batteries are put in charge on the lowest, and moved up as the current falls, until the highest 'bus is reached. When the current taken on this bus falls to a value depending somewhat upon local conditions, but which averages 10 amperes for Chloride-Manchester and 7 amperes for Exide batteries, the charge is complete and they are cut out. The batteries, being kept in good condition, can stand fully charged for 24 hours without appreciable loss of charge, the loss in the course of a week being only about 10 per cent. By careful attention to this portion of the work, and by keeping the batteries in an efficient condition, a very fair degree of efficiency between the charging switchboard and the vehicle motors has been attained, the figure being about 50 per cent. watt efficiency, which, considering the high rates of charge and discharge, and the loss of efficiency by operation on partial discharges, as will be explained later, is very creditable. The charging of all of the batteries is controlled from a single central switchboard. Under the system adopted, this portion of the work is so simplified that even during the hours when the greatest number of batteries are being charged, one boy is able to handle the entire board.

The specific gravity of the electrolyte of the Chloride-Manchester batteries is 1,250 when the cells are fully charged, and that of the Exide batteries is 1,300. The maintaining of the density of the solution at the proper point and the replacing, with water distilled on the premises, of the loss by evaporation is very important. This work is in the hands of specially trained men. Maintenance includes, under the sub-head of "Renewals," the cost of plates, separators and incidental supplies used in maintaining the integrity of the equipment. The most accurate figures on the cost of renewals are based on the life of the plates, &c., in vehicle-miles. This will, of course, depend greatly upon the conditions of service. The greater the mileage made on each charge the longer will be the life, other things being equal; an Exide battery which had made 1,480 miles on 40 charges, or an average of 37 miles per charge, showed no more deterioration than one which had made but 1,040 miles on the same number of charges, or an average of only 26 miles per charge.

A very rigorous standard has been adopted in determining the end of the life. No battery is allowed to remain in service after it falls below its rated capacity, as given above. This is made possible by reason of a most valuable characteristic of cells of the Exide type—*i.e.*, the maintenance of a very constant capacity during most of the life of the plates. In other words, the capacity upon which the above figures are based is not the maximum reached by the cells in the course of their life, nor the average capacity during that life, but is the minimum capacity. The initial capacity is about 6 per cent. above this capacity, or 4¼ hours at 39 amperes. This increases during the first 20 to 25 discharges to a maximum of 25 per cent. above the rated capacity, or five hours at 39 amperes. From this point it gradually falls until the rated capacity is reached. The end of the life is then at hand, the fall in capacity from this time on being very rapid. Rating the cells on this basis results in great satisfaction to the user, as the average capacity during the whole life is upward of 12 per cent. in excess of the rating. The average maximum capacity has been given as 25 per cent. higher than the rated capacity, or five hours at 39 amperes. This is a conservative figure, many batteries rising as high as 5¼ to 5½ hours at that rate, and few failing to go as high as five hours. The high capacity attained by these batteries has made possible continuous runs on a single charge far in excess of the 42·7 miles miles given as the mileage capacity under average conditions. The New York Transportation Co. appreciates that an abnormal performance under special conditions has little practical value, and no special effort has been made to establish a record. Runs of over 60 miles have, however, been made on several occasions, both in regular operation and under test conditions. The average capacity, as ascertained by recent test discharges, of the seven batteries which had made, up to February 1st, over 4,500 miles, is 4¼ hours at 39 amperes. All of these batteries are still in operation and doing as good work as at the beginning of their life. The average capacity of all the other batteries still in service (62 out of the original 75) was, on February 1st, about 4½ hours at 39 amperes. A conservative estimate of the average life

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which will be obtained would seem, therefore, to be not less than 4,500 miles. This refers only to the positive plates. The negative plates in all of these batteries show much less deterioration than do the positives, many being apparently as good as when first placed in service. There is no doubt but that a majority of them will be able to outlast a second set of positives. Assuming that only one-half will have a life double that of a set of positives (and this estimate is a safe one), the total life of one-half will then be 4,500 miles, and of the other half 9,000 miles, or an average life or all negative plates of 6,750 miles. If, then, the life of the positives be 4,500 miles, the average life of all plates will be 5,625 miles. At the end of this life the plates are still worth from $30 to $40 as scrap lead.

Prior to the introduction of the wood separator, and during the months just previous to the removal of the company to its present station at Forty-ninth-street and Eighth-avenue, operation was conducted under great difficulties. The old station, located at 1,684, Broadway, had been outgrown, the business having assumed such proportions that the equipment and floor space were no longer adequate. During this time the batteries did not receive the attention necessary to satisfactory results, and for a time deterioration was rapid. Many of the older vehicles were sold and others were reconstructed to adapt them to use the new size of battery. The older batteries, therefore, became obsolete before the end of their life had been reached. The company still has in its possession many of these old sets, and they are gradually being made use of by reconstruction and adaptation to the present equipment.

Under "Renewals" come also the separators. The life of these has already been mentioned, and this expense is small. Cleaning, the next item in the cost of "Maintenance," is made necessary by the gradual accumulation of sediment in the bottom of the jars. The plates rest on ribe, which are 2in. high. The active material is thrown down more rapidly from the Exide than from the Manchester plates. Cells of the former type require cleaning after each 1,500 to 1,800 miles, and of the latter after each 2,400 to 2,800 miles. With the corrugated perforated hard rubber separators Chloride batteries had to be cleaned after only 600 to 1,200 miles, due to the sediment lodging between the plates instead of falling to the bottom. If cleaning be delayed after the sediment accumulates in sufficient quantity to touch the bottom edges of the plates, deterioration is very rapid. A watch is therefore kept on the mileage, and examination made from time to time, and the cells cleaned out promptly when it becomes necessary. The work of cleaning is systematised, and is not a serious matter. A set of clean jars in a tray is provided, the connecting straps are cut and the elements lifted out, rinsed off and placed in the clean jars. Fresh acid is then put in, the straps re-burned, and the battery is again ready for service.

The business of the New York Transportation Co. has increased greatly within the year, and is limited only by the capacity of the equipment. Disregarding pleasure vehicles, suitable only for summer use, over 90 per cent. of the vehicles owned are in constant operation, less than 10 per cent. being the proportion out of commission from day to day for repairs of all kinds. To sum up this presentation of the situation, the New York Tranportation Co. is demonstrating, in its daily business, that the electric automobile has been developed to the point where, in reliability, radius of action and operating costs, it meets all the requirements necessary to commercial success, and that the development of a storage battery especially adapted to work under the rigorous conditions imposed, has contributed greatly to this result. So far from being an insuperable obstacle to the success of electrically-propelled vehicles, the battery is to-day better adapted to its work than some other portions of the equipment, and, in point of maintenance cost, a smaller factor in the total expense of operation than are, for instance the rubber tyres on the vehicle it runs.

PROGRAMME OF THE INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS CONGRESS.

The twelfth congress of the Union Internationale Permanente de Tramways is to be held at the Berners Hall, Agricultural Hall, London, N., on June 30th and July 1st, 2nd, 3rd and 4th. The congress will be opened at 12 noon on June 30th by the Right Hon. G.W. Balfour, M.P., President of the Board of Trade:—

12:30 p.m.—The Tramway and Light Railway Exhibition will be formally opened also by the President of the Board of Trade.

1 p.m.—Lunch offered by the Exhibition committee.

3 p.m.—Visit to City of London, Guildhall, &c.

8 p.m.—Reunion of the International Union of Tramways at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park. (By kind permission of the Council.)

Tuesday, July 1.

The names of the members who have prepared each report (*rapporteurs*) are placed after the respective subjects with which they are charged.

9:30 a.m. to 12:30 p.m.—"Transfer Tickets" (correspondence), M. Lavallard, manager, Paris Omnibus Company; "Narrow *v.* Ordinary Gauge," M. C. de Burlet, general director, Belgian Light Railway Co.; "Brakes," M. Poetz, engineer-in-chief of the Hamburg Tramways Co.; "Proposed Basis for Estimating Power of Motors," Dr. G. Rasch, of the Polytechnic School, Aix-la-Chapelle.

12:30 p.m.—Lunch offered by the Mayor of the Borough of Islington in the Welcome Hall.

2 p.m.—Visit to the Islington power station.

3 p.m.—Visit to the City and Great Northern underground (tube) works in construction.

9 p.m.—Conversazione given by the President and Mrs. Swinburne and the Council of the Institution of Electrical Engineers at the Natural History Museum, Cromwell-road.

Wednesday July 2.

9.30 a.m. to 12.30 p.m.—"Conditions [under which Tamways may be Laid on Roads," M. Albert Janssen, general secretary and director of the Brussels tramways; "Laws Regarding Tramways and Light Railways," Mr. R. H. Scotter; "Car Sheds," M. Trautweiler, engineer-in-chief, Strasburg Tramways Co.; "Traction Systems," M. Ziffer, director of several Austrian light railway companies.

1 p.m. Train to Bank Station by City and South London Railway, Bank to Shepherds Bush Station by Central London Railway; visit to power station, return to Bond-street Station.

3 p.m. to 5 p.m.—Visit to Westminster and the House of Commons; visit to the art studio of the Royal Doulton Potteries, Lambeth; visit to the power station of the Westminster Electric Supply Corporation; visit to the Westminster pumping station of the London Hydraulic Power Co.; visit to the Baker Street and Waterloo underground (tube) Railway (limited to 20); Drive in the evening.

Thursday, July 3.

9:30 a.m. to 12:30 p.m.—"Profitable Employment of Rolling Stock," M. J. H. Neiszen, manager of the Amsterdam Corporation Tramways; "Central Stations," M. Ch. Thonet, director of the General Contract Company of Liége; "Cost of Electric Energy," M. Ch. Thonet.

1 p.m.—Train from St. Pancras station and thence to Chelmsford. Visit to the electrical works of Messrs. Crompton & Co. A tea will be offered by Lieut.-Col. Crompton, member of Council.

5 p.m.—Return to Liverpool-street.

6 p.m.—Train to Crystal Palace.

Friday, July 4.

9:30 a.m. to 12:30 p.m.—"Underground (Tube) Railways," Mr. P. W. McMahon, chief engineer of the City and South London Railway; "Carriage of Luggage, Goods and Mails," Mr. G. Marsal, manager of the Biella Light Railways; "Heating of Cars," M. Peiser, chief engineer, Great Berlin Tramways Co.; Report by Messrs. Leon Janssen (managing director of the Brussels Tramways) and Geron (director of the Cologne Tramways Co.) on "A Uniform System of Accounts"; various communications; close of the congress.

1:30 p.m.—General meeting of the International Tramways Union.

3 p.m.—From the Angel station to Stockwell by the underground (tube) City and South London Railway; visit to Stockwell power station.

6 p.m.—Parade of heavy motor waggons on Embankment.

8 p.m.—Banquet given by the Tramways and Light Railways Association to the foreign members of the International Tramways Union, at De Keyser's Royal Hotel, Victoria Embankment. The chair will be taken by the Right Hon. J. Bryce, M.P.

REICHSANSTALT TESTS OF THE NERNST LAMP.

We have just received from the Allgemeine Elektricitäts Gesellschaft the results of official tests made at the Physikalisch-technische Reichsanstalt on two specimens of the Nernst lamp. The certificate of the tests is dated May 26, 1902. Two types of lamp were tested, one pattern having a straight and the other a curved filament. The former of these is the one now on the market, and the latter is an experimental pattern which the company hopes to perfect in a short time. The following are the records of the two sets of tests:—

I.—Lamp with Straight Filament. Mean of Five Lamps. Pressure 220 Volts.

Time (hours).	Current (amperes).	Candle-power.	Per cent. decrease in c.p.	Watts per candle.
0	0·264	35·1	0	1·65
50	0·261	32·4	7·7	1·77
100	0·260	32·3	8·0	1·77
200	0·253	30·1	14·0	1·85
300	0·242	27·5	21·6	1·93
400	0·237	26·5	24·5	1·97
Mean during 400 hours	0·251	30·1	...	1·83

One of the filaments burnt out after 310 hours, another after 379 hours, and the remaining three were intact after 400 hours. The mean life is, therefore, over 378 hours. The heating spirals were not damaged.

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II.—Lamp with Curved Filament. Mean of Five Lamps. Pressure 220 Volts.

Time (hours).	Current (amperes).	Candle-power.	Per cent. decrease in c.p.	Watts per candle.
0	0·259	40·1	0	1·42
50	0·259	36·3	9·5	1·57
100	0·259	38·1	5·0	1·49
200	0·247	34·1	15·0	1·59
300	0·238	33·2	17·2	1·58
400	0·219	27·6	31·0	1·75
Mean during 400 hours	0·245	34·4	...	1·57

One filament burnt out after 150 hours and the other four were intact after 400 hours. The mean life of the filaments was, therefore, over 350 hours. The heating spirals of two lamps broke down after 110 and 395 hours respectively. Therefore the mean life, taking account of the heating spirals, was 291 hours.

PARLIAMENTARY INTELLIGENCE.

MEDWAY AND THAMES CANAL.

A Committee of the House of Commons, presided over by Mr. Tatton Egerton, resumed consideration of the Medway and Thames Canal Bill on Monday. This bill has passed a Committee of the House of Lords, and its object is to make a canal from the river Medway, near Rochester, to the river Thames about 2 miles below Gravesend. The proposal is to employ electric haulage, and a description of the scheme will be found in our report of the House of Lords Committee stage (*The Electrician*, Vol. XLVIII., pp. 788 and 829).

Mr. H. O. O'HAGAN, chairman and managing director of the City of London Contract Corporation (Ltd.), and also chairman of the London and Chicago Contract Corporation (Ltd.), said there had been a combine of the cement manufacturers, and the Thames and Medway had to be associated with the manufacture of cement on the Medway. The manufacturing capacity of the cement works was 2,000,000 tons a year, about 1,000,000 on each river. Those interested in the combination soon came to the conclusion that the various works on the Medway were, in point of situation, at a considerable disadvantage as compared with those on the Thames. About 90 per cent. of the cement had to find its way to London, and at present they had to send it round by the Nore. The proposed canal would also be useful for the carriage of clay to the Thames works from the Medway and of coke to the Medway from the Thames, besides being of use to the large paper, oil and brick industries on the Medway. It might be expected that at least 3,000,000 tons would take that route per year, and he thought the canal would pay. His company would, if necessary, find the whole of the capital, but other cement manufacturers were prepared to subscribe. When the bill was before the House of Lords it was opposed by the South-Eastern and Chatham Railway Co., but they had since come to terms with them. It would be an advantage to the lower reaches of the Thames to get rid of this barge traffic, because they had to tack a good deal, and it was not always easy to avoid them.

Col. HOLLAND (one of the promoters) said if they got an average of 3d. or 4d. per ton the canal would pay, but they would probably get more.

Mr. H. POPE (connected with the Wickham Cement Works) was asked as to the charges for the electrical hauling of the barges. He said if the charges were excessive people would not use it, but use steam tugs.

Mr. P. J. Neate (deputy-mayor of Rochester), Mr. E. A. Gill (managing director of the London and Rochester Barge Co.), Mr. Gamman (a Chatham carrier by boat), Mr. Morris Spencer (in the seed-crushing trade at Strood) and Mr. Alfred Brooks (of the Associated Portland Cement Manufacturers, 1900, Ltd.) gave evidence, and every witness was cross-examined at some length by Mr. Freeman, K.C., Mr. Baggallay, K.C., and Lord Robert Cecil, K.C., the bill being opposed by the Ecclesiastical Commissioners, St. John's College, Cambridge, and the Mercers' Company.

Mr. EDWIN FOX, the surveyor, gave evidence as to the surveying portion of the scheme, and said that the proposed canal was 5 miles long, and they proposed to acquire 76 acres of land in addition to easements.

On Tuesday, Capt. PIRRIE, retired naval captain, said he was intimately acquainted with the reaches of both rivers. In the very finest weather it wou'd take from two to three tides for a barge to get to London. In bad weather barges were often delayed for days. The canal would be useful for passing torpedo boats and small destroyers through, and he should imagine it would also be good for trade.

Mr. J. E. WALLER (of Messrs. Kincaid, Waller and Manville), engineer to the scheme, said he did not consider there were any engineering difficulties.

Mr. HUTCHINSON: You do not propose to bind persons using that canal to take their haulage from you?—I do not think we have any powers to do so; the captains can do as they like.

Although you are taking the powers to work the canal by electricity you do not say the people who use the canal must of necessity use the electric power?—No, I think we are only in a position to say that, "if you do use our power you must pay us for it."

Witness went on to say that the traffic could be moved by steam, oil or electrical power. There were two tunnels in the course of the canal, each of which was ¾ mile long, and the reason they preferred tunnelling to cutting was summed up in the one word, "cost." The capital was £240,000, but with borrowing powers it reached £320,000, and the estimated cost of construction was £245,310. He said that there was nothing in the opposition which could not be met by compensation and accommodation. They proposed to go through the chalk lands of the Ecclesiastical Commissioners, but, of course, for whatever chalk they took the Commissioners would be compensated. Witness said the promoters did not intend erecting a generating station if they could come to a satisfactory arrangement with the Kent Electric Power Co.

Mr. Bamber and Mr. White, local witnesses, gave evidence, and this concluded the case for the promoters.

Mr. HARRY KEEP, senior partner in a firm of lighters and barge owners, said he did not think there would be a difference of above half-an-hour in the two routes, although the proposed route was much shorter than the existing one.

Half-a-dozen similar witnesses were called, and upheld the opposition counsel's contention that there would be no saving of time by the proposed canal.

At Wednesday's sitting further witnesses were called on behalf of the opposition. Among them was

Mr. TUFF, Mayor of Rochester, who said he was joint owner of over 40 barges, and he could not see that the canal would be of any use to the trade. As Mayor of Rochester he could not hear of any great public feeling for the canal, and he was afraid it would not be beneficial to the city. The canal would not, he thought, be of any benefit in the case of fog. The matter had never been discussed in his council, and he did not attend to represent the opinion of the Corporation of Rochester.

One cement manufacturer said if they had the privilege of going through the canal for nothing he thought they would hardly ever use it, whilst Mr. Tatham, clerk to the Navigation Commissioners of the Lower Medway, said they had about half a million tons of traffic, and he did not think a single barge would take the canal.

Mr. CLUTTON, surveyor to the Ecclesiastical Commissioners, said the Commissioners were constructing a road from their chalk works to Strood, and the canal would sever that road. He also said there must be considerable value in the chalk lands proposed to be taken by the promoters, and that the amount put down in the estimates was not sufficient.

Mr. WATNEY, a past vice-president of the Surveyors' Institute, estimated that the chalk the promoters would obtain from simply the cuttings through the Commissioners' land would be about a million tons, and the Commissioners got 6d. a ton out of their chalk. The promoters estimated they could satisfy all claims for land and severance with £12,000, but witness said it was inadequate for the Commissioners' claim alone.

Mr. Abernethy and Mr. Galbraith, engineers, also gave evidence, chiefly in regard to the chalk dispute and the cost of construction.

Mr. FREEMAN, K.C., then addressed the Committee on behalf of the Ecclesiastical Commissioners, contending that there was no public necessity for the canal, that the estimates were not sufficient, that insufficient evidence had been given as to how the capital would be obtained, and that, if constructed, the canal would not pay.

Yesterday (Thursday), Mr. PAGE, K.C., replying to the opposition, submitted that the case of the promoters was an overwhelming one of the public need. Twice a similar canal to this had been promoted, once about 100 years ago and once in 1885, but at neither of those dates was the trade anything like what it was to-day, and the schemes failed. By the proposed route the distance would be 28 miles as against 59 miles by the present route round the Nore—a saving of more than 50 per cent. The estimates of chalk by the opposition witnesses were absolutely fallacious.

After considering in private the Committee declared the preamble proved subject to certain protective clauses, and a clause guarding against the abandonment of the canal to the west of the railway.

LONDON UNITED TRAMWAYS BILL.

On Friday last, before the Committee of the House of Commons which is hearing this bill, further evidence was taken in opposition to the Wimbledon lines, and chiefly to the tramway up Wimbledon Hill.

Mr. C. GILES, a resident at Wimbledon and a former member of the House of Commons, said that in North Wimbledon there were many residences of large rateable value, some being as high as £1,000 per annum, but in South Wimbledon there was practically a working men's population, who only went to the common on such occasions as bank holidays and fine Sundays. Wimbledon Hill even now was none too wide for the traffic which had to zig-zag up it, and the tramway would increase the difficulty. Feeling in North Wimbledon was very keen against the line. There would be some advantage to the houses on Wimbledon Hill in the tramway, because it would give constant means of communication with Wimbledon station, there being at present no public means of communication; but the occasional convenience of the line would be entirely outweighed by the everlasting inconvenience and the noise.

Mr. J. W. BENN, chairman of the Highways committee of the London County Council, said the policy of the London County Council, since they had been the tramway authority for the county of London, had been to refuse to sanction the entry into the county of London of private undertakers for the purpose of tramway construction. The County Council objected to some of the proposals in the present bill because they had proposals which would cover the same ground. Their chief objection to the line from Hammersmith through Barnes and Mortlake to Richmond was as to its crossing Hammersmith Bridge. He admitted that last year, in giving evidence in regard to a tramway over this bridge, he made an offer not to object to the company taking a line across the bridge upon conditions for strengthening the structure. But since that time the County Council had changed their engineer, and their present engineer, Mr. Fitzmaurice, who was an expert more especially in relation to bridges, had given an opinion

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which led the Council to take a more serious view and modify the opinion they had held. He would much prefer that the County Council should build a new bridge and undertake the responsibility of constructing the line themselves. That recommendation he would be prepared to make to the Highways committee. If the bridge were reconstructed it would be with a view to meeting all public requirements irrespective of tramways, and it would include space to allow two lines to be laid. Suspension bridges were certainly not a desirable form of bridge to carry tramway traffic, and the width would not allow of two lines being laid, because there would only be 5ft. free on either side. If the County Council crossed the bridge they would undoubtedly connect with the tramway systems north and south.

Cross-examined: He agreed that Brooklyn Bridge, which is a suspension bridge, stood the strain of a double line of trams.

By the CHAIRMAN: It would be very difficult to obtain an undertaking from the London County Council as to the reconstruction of the bridge because the County Council would have first to see that there were responsible promoters prepared to meet the Council on the other side of the bridge. Assuming that there were such responsible promoters, he could not give an undertaking on behalf of the London County Council. The subject would have to be considered by the Highways and Bridges committees and by the Council itself, and that could not be done in less than three weeks or a month. Last year he made an offer to rebuild the bridge, and that offer had been in no way withdrawn.

The CHAIRMAN said the Committee were in a difficulty. Last year the promoters came to an agreement or understanding with the County Council, and they assumed this year that that understanding was renewed. Now, for the first time, the company found there was strong opposition to the bridge being used at all. There was all the difference in the world between a line which would have a line connection with the north of London and one which started from the south side of the bridge for Richmond, and which might not obtain that connection, or perhaps only obtain it on onerous terms as regarded some part of the company's system in another part of London. The Committee might adopt the course of allowing the tramway over the bridge for a certain period, at the end of which the London County Council would take it over. It was, therefore, most desirable that the County Council should not be prejudiced by the Committee passing the bill with any conditions that would embarrass them. It was worth an effort, therefore, to see if a definite understanding could not be arrived at.

After an adjournment, Mr. MOON, K.C. (for the London County Council), said his clients had considered what had fallen from the Committee, but they could not act without certain formalities being observed. It was not possible to go further than Mr. Benn had gone in stating that he would recommend that the trams on the south side of the bridge should be constructed, and in expressing the belief that the Council would adopt that recommendation.

Mr. FITZMAURICE, chief engineer to the London County Council, was then called. He said the roadway over Hammersmith Bridge, a light suspension bridge, was 27ft. wide for the greater part of its length, but at two points it was only 19ft. 9in. wide, and at two others 21ft. The bridge was not at all suitable for a double service of trams, which even at the wide part would completely block the traffic. The bridge was always shut up at holiday or other times when there was the likelihood of there being a crowd of people, the danger arose from the strain on the bridge; and the oscillation was a serious matter. It was impossible to say what the effect of the oscillation would be. To reconstruct a bridge of that width would be to throw away money, and the proper thing to do would be to construct a fresh bridge.

By the CHAIRMAN: If only one tramway line were authorised across the bridge it would remove part of the weight. His opinion would not be modified favourably to the scheme if it were limited to seven years. His objections would be fully alive during such a period.

This closed the evidence for the London County Council.

A number of additional witnesses (including Mr. T. Jackson, R.A.) were then called in opposition to the line up Wimbledon Hill, by the side of the common.

On Monday Mr. MOON addressed the Committee on behalf of the London County Council, whose opposition to the bill related only to the portion of line which crossed Hammersmith Bridge and was in the area of the London County Council between Hammersmith Bridge and a point near Hammersmith-broadway. He admitted the desirability of the line, but he said the objection of the County Council related first to principle, and, secondly, to expediency. The County Council had purchased 95 miles of tramway in London, and they had given notice to purchase 16 miles more, and by Jan. 1 next there would be only 5 miles of tramway not owned by the County Council in the whole area of the administrative county of London. In 1896 the Council obtained power to work tramways, and in 1900 power enabling them to use electricity to work them, and by the end of the present year it was hoped that some portion of the tramways south of the Thames would be run by electricity. The Council also, in pursuance of the general policy that they should provide a comprehensive system of communication with all parts of London, had introduced and obtained power to construct a number of additional lines. The lines of the London United Company coupled up, or nearly coupled up, with the tramways of the County Council at or near the county boundary, and arrangements were being made with the tramway authorities in Middlesex, Essex and Surrey on the north, east and south of the county for exchanges to take place between the lines of tramway and light railways in those counties running up to the boundary of London, so that there should be through services and passengers should not have to alight at the boundary. It was not, therefore, an exceptional thing for a tramway to stop at the boundary. The County Council had uniformly resisted any attempt on the part of tramway undertakers to enter the county of London without the consent of the County Council.

The CHAIRMAN: What satisfaction can you give the Committee that the County Council will construct or reconstruct this bridge, lay this link from Hammersmith-broadway, couple up with the line brought to the south end of the bridge, and make such arrangements as may be mutually convenient if the Committee hold their hands at the south side of the bridge?

Mr. MOON: I can only repeat the evidence Mr. Benn has given.

The CHAIRMAN: That so far as you are able to pledge the Council you will pledge them to apply next session to Parliament for power to reconstruct the bridge and construct this line.

Mr. MOON: Yes. Continuing, he said the County Council were advised by their present engineer that there would be no difficulty in adapting the bridge to tramway traffic, but the expense would be very considerable; and further, that when the line was carried across the bridge the tramway service would not be efficient because of the narrow parts. Therefore the Council had come to the conclusion that the method suggested last year of dealing with this matter was not the proper solution.

The CHAIRMAN: The Committee are quite agreed that the Council have no ground for changing their opinion.

Mr. MOON, concluding, urged that the County Council ought to be left to deal with this question in the manner which would be best not only for this district but for the whole of London. They thought the best way would be to construct a bridge which would take the place of the existing bridge; and therefore they submitted that the powers sought by the promoters ought not to be granted so far as regarded Hammersmith Bridge.

Mr. BALFOUR BROWNE, K.C., briefly replied on this part of the case, urging that no new circumstance had arisen since last year, when the London County Council made an arrangement with regard to crossing the bridge. The present offer of the County Council was indefinite, and there was no guarantee that the tramways would be carried over the re-constructed bridge by the County Council, because the Hammersmith Borough Council had refused to sanction various proposals of the London County Council. The London ratepayers might very justly object to a large expenditure for a bridge which was to replace one that was only built in 1884 and pronounced safe by engineers. The suggestions of the London County Council meant prolonged delay, two years before Parliamentary powers could be obtained, and five or six years before the bridge would be completed. If power to cross the bridge were given the company they would do all that was necessary to make the bridge safe.

The CHAIRMAN, after consulting with his colleagues in private, said that the Committee would not allow that portion of the bill which related to the line from the south side of Hammersmith Bridge to the Broadway, and they were unanimous.

Several witnesses were then called in opposition to the Wimbledon lines. One of these witnesses,

Mr. E. S. EVANS, resident manager at Wimbledon of Messrs. Hampton & Son, house and estate agents of Pall Mall, said the construction of the tramways proposed in Wimbledon would very seriously depreciate the property on the line of route, especially the property of high value. Houses of £100 per annum or more would be increasingly difficult to let. He knew of houses in Ealing which had been unlet since the tramways had been constructed there. No house on the route of the Ealing trams above £50 a year had risen in value.

On Tuesday Mr. W. WISE, a builder living in Worple-road, Wimbledon, and possessing property there, said the tramways along Worple-road and to the Common were unnecessary, and as regarded property in North Wimbledon they would be detrimental to it to the extent of 25 per cent.

Cross-examined by Mr. COWARD: He did not know that Worple-road, at present 24ft. wide, was to be made 49ft. wide. No tramway should be allowed in a roadway of less width than 50ft.

Mr. D. GRIFFIN, of Messrs. J. Griffin & Son, estate and house agents, of Ealing, was then called on behalf of the promoters. Examined by Mr. COWARD, he said when the London United Tramways Co. promoted a bill for the construction of tramways through Ealing he strongly opposed it because he thought they would do the place harm, and because he considered that the property on the line of route would be depreciated. Since the introduction of the services he had altered his opinion absolutely. He found that all property had appreciated in value, not only on the main road but also in the by-roads. He would describe Ealing as essentially a residential neighbourhood of a high-class character. There were now fewer empty houses in Ealing than before the tramways came there. A certificate from the rate collector showed that just before the construction of the trams there were 20 houses empty in the main road, whereas now there were only six.

Mr. WEDDERBURN having addressed the Committee on behalf of the Wimbledon frontagers, evidence was called in opposition to tramway No. 10, along Merton-road and Merton High-street to the boundary of the county of London.

Mr. F. J. ALDIS, a frontager, said there was a good local train service, and a line of omnibuses between Raynes Park and Clapham Junction. In particular he objected to the bill because the promoters proposed to reduce the width of the pathway from 15ft. to 8ft.

The Hon. J. SCOTT MONTAGU, M.P., said he was of opinion that tramways should only be sanctioned on roads of sufficient width to allow of the development of automobile traffic.

Col. R. E. B. CROMPTON said that tramlines were of considerable inconvenience to general traffic, and largely diminished the carrying capacity of a road. He found that omnibuses could carry past a given point in one hour 8,000 passengers; yet a tramway, as at Shepherds Bush, where it blocked the roadway and generally interfered with the traffic, could only carry 7,000 passengers in the same period. He held that the development of locomotion in future would not be in the direction of tramways but in the direction of automobiles.

The Rev. C. P. CLARKE, incumbent of Holy Trinity, Merton, objected to the proposed line past his house, because it would interfere with his land and create noise during the progress of church service.

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Mr. CLIFTON ROBINSON, recalled, said it was not proposed to take any of Mr. Clarke's property. The tramway past the church could be worked by interlaced lines, on the opposite side of the roadway, and thus the necessity for taking any portion of the church property would be avoided.

On Wednesday the Rev. C. P. CLARKE, re-called, stated that he had made an agreement with the promoters under which he withdrew all opposition to the bill. The terms provided that the promoters should acquire the lands scheduled by them in front of the Holy Trinity Church and parsonage, paying to him £750 in full satisfaction of all claims in relation thereto. The promoters also undertook to construct a fence or wall to his satisfaction, and agreed that there should be no sounding of gongs or bells during divine service on Sundays by cars while passing the church, and, further, that the cars should not stop in front of the church or parsonage.

In reply to the Chairman, he said he had the authority of the Ecclesiastical Commissioners for entering into this arrangement.

Mr. RAVENSHIRE, an auctioneer and surveyor, of 49, the Broadway, Ealing, said that the large houses on the line of route of the tramways in Ealing had depreciated considerably in value in consequence of the construction of the tramways. The trams ran nearly all night, and interfered with one's sleep and general comfort. The weight of the cars was such as to cause slight earth tremors. The tramways had caused a slump in the market in regard to high-class property, by which he meant houses of over £70 or £80 per annum.

Further local evidence in opposition to the Hammersmith and Richmond line was then taken. One witness,

Mr. MORLEY, a resident on The Terrace, Barnes, said that a memorial against the tramway had been signed by some 600 persons. A meeting of owners and ratepayers in the district, summoned by the District Council, was held on Feb. 21 last, to sanction expenditure of rates in opposition to the bill. At about that date the agreement with the promoters was signed by the Council. At the meeting the Council were accused of not having a bonâ fide intentions to oppose, and they were therefore requested to state their intentions with regard to the tramway company. They declined to do that, and the meeting almost unanimously, with the exception of the district councillors, declined to allow them to oppose the bill.

Cross-examined: The London General Omnibus Co. were paying a portion of the expenses of the opposition to this part of the line.

The Rev. B. J. KITSON, rector of Barnes, said the majority of the residents of Barnes regarded the line from Hammersmith Bridge to Richmond as unnecessary. They were quite satisfied with the present service of omnibuses. In the district there was a working-class population of about 2,000, a considerable number of whom were employed by the London and South-Western Railway at Waterloo.

Dr. BATHER, another resident on The Terrace, expressed a very strong opinion in opposition to the new service of trams, which would pass very near his house. They would involve the taking of a part of his forecourt, and by their noise and vibration spoil his house for the purposes of quiet scientific research, for which he took it.

Sir C. ELLIOT, chairman of the Finance committee of the London School Board, and chairman of the Wimbledon Elementary Schools committee, considered the tramways, if they passed the school, would cause great additional danger to the children as they left the school in Merton-road. The Board of Education now required schools to have separate entrances for boys, girls and infants. It would be practically impossible for the school authorities to make additional entrances in the side road without acquiring additional property. He suggested a clause preventing the company from taking, otherwise than by agreement, any portion of the property belonging to the trustees of the Wimbledon public elementary schools, and providing that the trustees of the schools might make such alterations in the entrances and playgrounds as the Board of Education might consider to be adequate to prevent risk of danger to the children, this being done at the expense of the company, who should also acquire for the trustees so much of the land adjoining the playground as the Board of Education might consider necessary for the purpose.

The CHAIRMAN: If you can accept a new clause, Mr. FitzGerald, which would not bind you to purchase any property, but which would simply regulate the pace of the cars past the school during school hours, and so long as the school existed, to walking pace, the Committee think that would be sufficient.

Mr. FITZGERALD said he would have a clause to that effect drawn up.

Mr. EDWARDS-JONES, representing the Wimbledon Elementary School committee, however, obtained permission to address the Committee. He pointed out that it would be difficult for a private individual to enforce such a clause, and he urged that, if the promoters were not required to provide the land with the aid of which to make extra entrances, they should at least pay the expense of alterations at the school rendered necessary by the working of the tramway.

Mr. COWARD (for the promoters) said he was prepared to accept the clause, but leaving out the last part requiring the company to acquire land for the trustees; he could not accept both this and the speed-regulating clause suggested.

The CHAIRMAN: If we pass that section we shall give a regulating clause and no more.

Mr. BURROUGHS, the architect to Dr. Bather, was then called with reference to that gentleman's statement as to the possibility of the river wall affecting the subsoil drainage. He said he had had no specific measurements made, and he was unaware what arrangements the company had made with regard to drainage; but in the case of his own house, the water being drained away from the clay soil, the house cracked. The cars of this company were very heavy, and Dr. Bather's house being an old one vibration might occur; but he had never known a case of vibration arising from tramways.

Yesterday (Thursday) further local evidence having been adduced in opposition to the Barnes section, Lord ROBERT CECIL, K.C., addressed the Committee on behalf of frontagers on the Barnes section. He contended that the line was unnecessary and contrary to the wishes of the residents, and that the proposed embankment was introduced as an afterthought. He also commented adversely on the agreement of the Barnes Urban District Council to extend the period at the end of which they could purchase the tramway undertaking, and agreeing, further, to purchase as if it were a going concern instead of at old iron price, as would be the case under the Act of 1870. He had never heard of such an extension of the period.

The case in opposition of the London and South-Western Railway Co. was then proceeded with.

Mr. CHARLES OWENS, general manager of the London and South-Western Railway, said it had been suggested that the South-Western Railway Company had acquiesced in the tramway proposals of the promoters. Those proposals when made had been seen to be competitive and injurious to the interests of the railway company, but in the absence of direct evidence of the effect of tramways on the railway, witness did not advise his directors that they should offer opposition to them. He had now had actual experience of the effect of tramway competition and found that it was a very serious matter. His railway had had considerable traffic between Shepherds Bush and Hounslow, and that traffic has been very seriously prejudiced by the competition of the London United Tramways. It has been reduced by 64 per cent.

Having taken away rather more than half your traffic has it been possible for you, by economies, to make any saving?—No, on the contrary; in order, if possible, to meet the competition we reduced our fares and put on additional trains, but the result is as I have stated. The gross traffic receipts, he continued, between Kew Bridge, Brentford, Isleworth and Hounslow, formerly £1,516, had been reduced to £522 in the half-year ending Dec. 31 last, the first half-year in which these lines were open. Beyond that, the receipts from certain selected stations had fallen from £2,589 to £925 in the same year. The railway company's accountant estimated that the total net loss in that half-year from the competition of this company's tramways amounted to £10,000, and he had been unable to find any advantage to the company arising from the tramways acting, for instance, as feeders.

In further examination, witness stated that the line from Richmond to Hammersmith Bridge, between Barnes and Richmond, was an absolute duplication of the South-Western Co.'s railway. At hardly any place was there more than ¼ mile between them. He then gave particulars of other portions of tramways which would or might compete with the railway. He feared also that if the present proposals were sanctioned the promoters would seek to make a connection which would seriously affect the whole of the railway company's traffic to the Thames Valley. Arrangements were being made between the London and South-Western Railway Co. and the Metropolitan and Metropolitan District Companies under which electrical trains would be run from Richmond over the whole territory of the Metropolitan and Metropolitan District Railways. A much more frequent service could be organised on an electrical line than, with present appliances, on a steam railway. By this means the railway company would be enabled in this locality to offer the same facility to the public as the tramway offered. It was a moral certainty that there would be an opportunity given to the public of going by an electrically-equipped line the whole distance between Richmond and London very shortly indeed, when the arrangement between ourselves and the Metropolitan and Metropolitan District has been carried out.

The CHAIRMAN: That will put you in a better position to compete with the tramway?—It will assist the Metropolitan and Metropolitan District Companies in their competition. More trains could be put on, and the facilities would be equal to those offered by a tramway.

Mr. PAGE: The result will be that whereas you will have an electrically-equipped railway on land bought at your expense, the London United Tramways Co. will have a competitive electrical railway on land which cost them nothing?—That will be so if the Committee see fit to pass the tramway company's proposals. On the railway between Wimbledon and Raynes Park to stations on the route of competition, 838,819 passengers were carried in 1901, and the receipts were £9,479, the average fare being 4¾d. per passenger. A reduction of that traffic in proportion to that which had taken place in his past experience would mean a loss of £6,066. If a connection from the Wimbledon line were made with the Lower Tooting line of the London County Council the railway company would be deprived of some of the railway traffic from Wimbledon to London. The railway company were spending no less than £1,700,000 on improvements of the line between Clapham Junction and Waterloo to enable the company to give better services to the whole of the suburbs served by the company.

By the CHAIRMAN: At one time he thought the trams would create traffic for themselves, but he had not found that that was so. The growth of population in the district so far had not compensated the railway in any way for the actual loss they had suffered. Witness went on to point out that a number of obligations were imposed on railways which were not imposed on tramways. Thus, last year the railway company had to pay passenger duty amounting to £35,371, or ¼ per cent. on its ordinary stock, from which the tramways company would be free, and rates and taxes fell much more heavily on railways than on tramways. Further, the London and South Western Company had had to pay £56,000 a mile for the land for its line between Hammersmith and Shepherds Bush, whereas the tramway company obtained free roads.

Do you find the suburban traffic per passenger more profitable than the other traffic?—Yes, because it is carried on morning and evening in absolutely full trains with no luggage.

Therefore the loss of it is important to you?—It is, Sir; extremely.

Further examined: At present the tramway company had in operation only 16 lines out of 62 they were authorised to construct. He had put before the Committee the effect of the lines so far constructed, and the question arose in his mind as to whether it would not be reasonable for the

company to wait for further powers until the railway company could tell Parliament what had been the effect of the construction of the other lines on the railway.

Are you satisfied it is not wise in the public interest to jeopardise the financial stability of such an enterprise as the London and South-Western Company?—It is a very important thing. When one remembers the enormous capital invested in railways, it becomes of serious importance whether the interest or that capital is to be jeopardised or not.

The witness was then examined at length with regard to evidence already given as to the dearness and inefficiency of the services of the London and South-Western Railway Co. in the districts to be served by the tramways. He gave a direct negative to the charges made and maintained that all the services were adequate and cheap.

In cross-examination by Mr. FITZGERALD Witness estimated that the London United had carried along the same route as the South-Western Railway between Hounslow and Hammersmith 20 times the traffic the railway had before the tramway was opened.

Therefore they live, not by the traffic they take from you, but by the traffic they create for themselves?—You are comparing London traffic with the local traffic. He agreed that whereas the ordinary third class fare by the London and South-Western Railway Co. from Hounslow to the Bank was 1s. 9d. return, by the new system of tramways, in connection with the tube, it was 1s. The workmen's fares and the third class season ticket charges, however, were much lower. He could not tell on how many occasions trains on the London and South-Western Railway were suspended on account of the race traffic. Railway managers did not prefer race traffic. It was an unmitigated nuisance, but the demands of the public had to be met.

The witness was still under examination when the Committee adjourned.

SOUTHPORT AND LYTHAM TRAMROAD BILL.

The Committee of the House of Lords, presided over by Lord Brougham and Vaux, on Friday, June 13, sat to consider the Lytham and Southport Tramroad Bill, which seeks to extend the time limit for the acquisition of land and completion of works under the Southport District Tramroad Act, 1879, and the Southport and Lytham Tramroad Act, 1900, for authorising the issues of preferred and deferred half-shares, and for other purposes. The bill has already passed the House of Commons.

Mr. BALFOUR BROWNE, K.C., explained that the scheme was to construct a tramway from Southport to Lytham, crossing the estuary of the Ribbie by means of a transporter bridge. The tramroad from Southport, along the south bank of the Ribble, was authorised in 1899, but the transporter bridge was not sanctioned until 1900. The object of this bill was to make up the year thus lost, because the one scheme could not be begun before the other was sanctioned. Owing to the war, the promoters had not hitherto appealed to the public, but they believed they would be able to raise the capital and to carry out the scheme. The Corporation of Southport, and indeed all the local authorities, were in favour of the bill.

The only opponent was Mr. C. H. B. Hesketh, who owned a portion of the land to be taken on the south side of the estuary.

The Committee decided that the preamble was proved, and on Monday the clauses were adjusted and the bill was ordered for third reading.

DUMBARTON ELECTRICITY SUPPLY.

The Local Government Board Provisional Order (No. 5) Bill came before a Select Committee of the House of Lords during the week, and was finally disposed of yesterday. Its object, amongst other things, was to confirm a provisional order to enable the Town Council of Dumbarton, in Scotland, to establish an electric generating station for the purpose of supplying electricity for lighting as well as for power purposes. The measure was opposed by the North British Railway, the Lanarkshire and Dumbartonshire Railway, and the Dumbarton and Balloch Joint Lines Committee. The opposition was based on the ground that Dumbarton was too small a town to be entrusted with an electric lighting station of its own, that the scheme would be a financial failure, and, consequently, would entail an increase in the rates, to which the petitioners were large contributors. The promoters, on the other hand, pointed out that the authority here sought had already been given to eight or nine boroughs in Scotland with a much smaller population than Dumbarton.

Provost MACFARLANE, of Dumbarton, was examined, and stated that it was the intention of the promoters to begin with a small installation, costing probably £21,000, and gradually to extend the works as the demand for electricity grew. Dumbarton was exceptionally situated, by its proximity to the coalfields and its compactness as a burgh, to work an electric lighting scheme economically. It was quite true that some of the large works in Dumbarton already supplied their own electricity, but there were a number of small works which would be glad to avail themselves of the Corporation supply. He stated that the rates of the Corporation had been protected by the Clyde Valley Electrical Power Bill, which was passed last year, the Committee which passed the bill inserting a clause prohibiting the Clyde Valley Company even appearing as petitioners against any bill promoted by the Corporation. There was no sign of the Clyde Valley Company approaching the burgh.

Mr. THOS. YOUNG, an electrical engineer of Glasgow, gave evidence in favour of the scheme, and said he believed that the Corporation could supply current at 3d. per unit although power was taken in the bill to charge a maximum of 7d. After speeches by counsel, the Committee found that the preamble of the bill had been proved.

OTHER ELECTRICAL BILLS.

The Electric Lighting (London) Bill is to be committed to a Select Committee of five members of the House of Commons.

The tramway portion of the Newport Corporation Bill, referred to in our last issue, has been passed by the House of Lords Committee, with the exception, however, of the line which it was proposed to run over the Great Western Railway by means of a level crossing.

The Cavehill and Whitewell Tramways Bill, which has already been read a third time in the House of Commons (see *The Electrician*, May 2, p. 56), came before the House of Lords on Tuesday, when the preamble was declared proved. The only opposition was from the Belfast Corporation, which maintained that the bill was an effort to override the general provisions of the Tramways Act, and urged the Committee to grant them a power of purchase after the expiration of a certain period.

The Kent Electrical Power Bill came before the Chairman of Committees of the House of Lords this week as an unopposed measure, and was ordered to be reported for third reading. The House of Commons Committee proceedings were reported in *The Electrician*, Vol. XLVIII., p. 829.

The opposition to the South Wales Electrical Power Distribution Bill having been withdrawn, this bill will be dealt with as an unopposed measure in the House of Lords.

The Eastbourne Corporation Bill, recently passed by the House of Commons Committee, contains a clause empowering the Corporation to run electric omnibuses. It is proposed to start with eight vehicles, each seating 14 passengers, and costing £588.

The Leicestershire and Warwicksbire Electric Power Bill passed through the Committee stage of the House of Lords last week unopposed. The House of Commons Committee proceedings were reported in *The Electrician*, Vol. XLVIII., pp. 788 and 825.

The Patent Bill, according to Mr. Balfour in the House of Commons on Wednesday, has a good prospect of being passed during the present session.

In the House of Lords, on Thursday last week, the Norwich Corporation (Electricity, &c.) and the Croydon and District Tramways Bills were read a second time, and the Preston Corporation Bill a third time.

The Huddersfield Corporation and Metropolitan District Railway Bills were read a second time in the House of Lords on Friday last, and the Nottingham Corporation and Scarborough Tramways Bills a third time and passed.

On Monday, in the House of Lords, the Birmingham and Midland Tramways, Birkenhead Corporation and Erdington Tramways Bills were read a second time. In the House of Commons on the same day the Wrexham District Tramways Bill was read a second time.

In the House of Lords, on Tuesday, the Belfast Corporation Bill was read a third time and passed.

GENERAL ELECTRIC CO.'S FIRE.

In the House of Commons on Thursday last week, the Secretary of State for the Home Department was asked whether the premises at 67, Queen Victoria street, where the unfortunate fire occurred on the 9th inst., were registered under the Factory Act.

Mr. RITCHIE replied that he was causing enquiries to be made. The matter was a very serious one, and the question whether any part of the premises in question were so utilised as to entail an obligation that they should be registered was a very difficult one to determine. He understood that there were only 22 persons employed there. Before arriving at any decision as to whether further legislation was necessary in this connection, he must await the result of the inquest in the case under notice.

In answer to a further question on Monday,

Mr. RITCHIE said the General Electric Co. had not registered the premises because they were considered to be a warehouse and not a factory, inasmuch as the only work done there was the putting together of electric lampholders. After careful consideration the Home Office had come to the decision that this was not a manufacturing process, and he did not propose to take any steps in the matter.

SOUTH AFRICAN CABLEGRAMS.

Mr. AUSTEN CHAMBERLAIN, in the House of Commons last week, replying to Sir John Leng, said that at present no date could be fixed for the withdrawal of the prohibition of the use of private telegraphic codes in connection with cables to South Africa.

LEGAL INTELLIGENCE.

Société Anon. d'Electricité et d'Automobiles Mors v. Friswell & Co.

Before Mr. Justice Grantham and a special jury, in the King's Bench Division, on Tuesday, plaintiffs, a French company manufacturing in Paris the Mors electrical motor car, sued to recover the balance of the price of three motor cars sold. Defendants, who are agents, and have a depôt for the sale of motor cars, pleaded that the cars were not delivered within the agreed time and were not manufactured in accordance with contract. They also counterclaimed for £100 damages.

Mr. RUFUS ISAACS, for plaintiffs, said the claim arose out of contracts entered into in January, 1900, for the supply by plaintiffs of 12 motor cars of 4 H.P., known as the "Petit Duc" car, and for three cars of 6 H.P., which were described as dog-cart cars. The price of the former was £213. 8s. each car, and of the latter £306. 9s. each. The claim related only to two of the Petit Duc cars and one of the dog-cart type, the other cars having been delivered, accepted and paid for by defendants. The terms agreed to were payment of one-third value as deposit at time of order and remaining two-thirds on delivery. His case was that the cars were delivered within contract time, and, further, that, even if the defendants' view was correct, they had waived any right they might have. As to the defence that the cars were not of good workmanship, they had been tested by two gentlemen well known as motor drivers.

Evidence having been given as to the efficiency and general working of the cars, the jury returned a verdict for plaintiffs on the claim and counterclaim, and judgment was entered accordingly

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Attorney-General and Poole and District Electric Traction Co. (Ltd.) v. Bournemouth Corporation.

Before Mr. Justice Swinfen Eady in the Chancery Division last Thursday, an action was heard for an injunction to restrain defendant Corporation from commencing or continuing to construct a certain tramway, or, alternatively, to restrain the Corporation from constructing that portion of their line on the conduit system, instead of on the overhead trolley system, similar to that adopted by the company on their lines in the Bournemouth district, which were to form a junction with the Corporation lines, over which the company has obtained running powers. Or, in case of difference, that the question be decided by the Board of Trade. Under the act obtained by the company they were not to commence the construction of a certain portion of their lines until August 1, 1902, and if before that date the Corporation, under their order of 1900, had constructed and completed a certain portion of their lines, the powers owned by the company for the particular section of line in dispute should cease and determine. The plaintiff company urged that the Corporation had not constructed and completed the line under the terms of their order, and sought an injunction to restrain them from commencing the building of this portion. For the alternative it was urged by the plaintiffs that the construction of a section of the Corporation's tramways on the conduit system would render the running of the company's cars over such lines difficult and costly. The plaintiff company had informed the Corporation that what was proposed to be done was illegal, and had asked for an undertaking, which was refused. If the work of construction on the conduit system was proceeded with the plaintiffs would be put to heavy loss. Defendant Corporation denied the statements made by plaintiffs that no work had been done in connection with this section of their tramways. It was true that no agreement had been come to with reference to the system to be adopted, but the plaintiff company had objected to the system suggested by the defendant Corporation, and the latter had applied to the Board of Trade, by whom the matter was to be considered. Defendants' counsel denied that no construction work had been done. The Corporation had obtained tenders for the construction of plant, and had entered into contracts with the British Thomson-Houston Co. and the British Westinghouse Co. for the supply of dynamos and cars.

After hearing counsel, his LORDSHIP gave judgment. He held that it would be too narrow a construction of the act to hold that the word "works" meant the actual tramlines, and he was of opinion that the defendant Corporation had substantially commenced the works within the 12 months of the date of the provisional order within the meaning of sec. 18 of the Tramways Act, 1870, by having entered into substantial contracts for the supply of plant, machinery and rolling stock, and having actually purchased sites for the erection of a generating station and offices. In his opinion it was proper and for the public convenience to postpone the actual laying of the lines, and consequent interference with the streets to as late a date as possible. There would be judgment for defendants, with costs as between solicitor and client.

Enright v. Ormskirk Urban District Council.

At Ormskirk County Court last week, before his Honour Judge Goldthorpe, Messrs. J. and J. S. Enright, consulting engineers, sued the defendants for £10. 10s., money alleged to be due for furnishing a preliminary report on electric lighting.

Mr. PEARSON, for plaintiffs, said his clients had had considerable experience in municipal electric lighting work, but had had no communication with the Ormskirk Council until October last, when they received a letter from Mr. Chadwick, the Council's surveyor, who stated that the Ormskirk Council were contemplating lighting some of the streets of the town by electricity, and he would esteem it a great favour if they could supply him with as much information as possible relative to the question of cost for public and private lighting. In reply a report was sent containing particulars as to the probable cost of lighting the town, and for preparing that report his clients sent in an account for 10 guineas.

Mr. J. S. ENRIGHT said he had practised as consulting engineer for seven or eight years, and had acted for a large number of municipalities. A great deal of time and trouble had been spent in preparing the preliminary report, the subject of the action. When he was notified that the firm would not be employed to actually carry out an electric light scheme for Ormskirk, he sent in the bill for 10 guineas, which had been repudiated.

Mr. GLOVER, in cross-examination, asked if it was not the custom for the report to be a more formal document for the members of a council as a body, but witness said he had never prepared such a report. If his firm had been employed to carry out the electric light scheme the 10 guineas would have been merged in the contract. He had never made a preliminary report without being paid for it, unless it had been merged in a contract. Mr. Chadwick addressed the firm as consulting engineers. It was impossible for him to arrive at the cost of an electric lighting scheme without going into details.

For the defence, Mr. GLOVER said that it was absolutely necessary to ascertain whether or not the report was furnished upon the instructions of the Council. If Mr. Chadwick acted on his own responsibility then the Council was not liable, and the Council denied that they had instructed Mr. Chadwick to write to the firm for particulars.

Mr. CHADWICK said he was not instructed by the Council or by any committee to obtain a report from Messrs. Enright. He had no power to enter into contracts without being instructed by the Council to do so. He admitted that the letter he sent to plaintiffs was on official paper. He could not say whether the fee charged for the report was reasonable or not. He was not very well acquainted with electrical matters. He was asked by a gentleman connected with the Council to get some information in reference to the cost of supplying Ormskirk with electric light.

Mr. HILL, clerk to the Council, read the terms of agreement on which Mr. Chadwick was appointed by the Council. In the present case Mr. Chadwick had no instructions from the Council to ask for the report from Messrs. Enright.

Other evidence having been given, Mr. PEARSON contended that there was a kind of loose authority given to the surveyor to obtain information, and upon that authority he wrote to Messrs. Enright.

His HONOUR said the only question they had to consider was whether the Council were responsible for the report or not. He thought the report had been carefully prepared, was valuable, and gave good information upon the facts that were laid before the plaintiffs. It seemed strange that reports like that should go without some adequate recompense. There was no doubt that the letter was written by Mr. Chadwick, but it was clear that the information was not obtained by order of the Council. It was for the jury to say whether the Council afterwards ratified the action of Mr. Chadwick. The surveyor might have exceeded his powers, still if they found that the Council acted upon the information obtained, or confirmed Mr. Chadwick's letter in any form, defendants were liable.

The jury found for the defendants, and Mr. Glover said he would not ask for costs.

Norwich Telephone Co. v. Humphrey.

At the Norwich County Court on Wednesday, before his honour Judge Willis, K.C., the company sued for the recovery of £3. 12s. 6d., one year's telephone rent alleged to be due under a contract dated Dec. 14, 1900. It appeared that the contract was signed for laying a private wire from defendant's private house to his business premises. It was found impossible for plaintiffs to complete the contract in the specified time, and eventually a new cable was laid to carry defendant's wire, and the company then applied for permission to put up the telephone instruments. Defendant, however, refused to allow the instruments to be put in, on account of the delay of 15 months that had taken place in the execution of the order.

After hearing evidence, his Honour found that the delay was unreasonable, and entered judgment for defendant with costs, and refused leave to appeal.

London and Provincial Electric Construction Co. (Ltd).

An application was granted by Mr. Justice Buckley, on Tuesday, for the petition of Mr. J. W. Vickers for the winding-up of this company to stand over, as there was a likelihood of petitioner's debt being satisfied.

Workmen's Compensation Act.

At Wakefield County Court on Tuesday, before his Honour Judge Greenhow, Mr. Mellor applied, on behalf of Emma Thorpe, for an award of £249. 12s. damages under the Workmen's Compensation Act against the National Telephone Co. for loss of her husband (a linesman), who was killed by falling over 50ft. while repairing telephone wires.

Mr. J. L. BOOTH, for the company, contended that the occupation in which deceased was engaged could not be brought within the act, as the "place" where deceased was employed at the time of the accident was neither a factory nor engineering works, nor did it come within any of the employments named in the Factory and Workshops Act.

Mr. MELLOR, for the applicant, argued that telephone wires placed on the roofs of buildings constituted part of such buildings, and further, that ladders placed against a building over 30ft. high for work of the character named really formed a scaffolding.

His HONOUR decided in favour of the company, as he was of opinion that telephone wires on the top of a building were not part of it; that it did not matter whether the building was a factory or not, because to render respondents liable the building must be one in their occupation, which was not the case here. In his opinion a ladder placed up against a building was not a scaffolding. He found for respondents, but without costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Indian Telegraph Department invite applications for five appointments as assistant superintendents in the telegraph department of the Government of India. Commencing salary Rs. 4,200 a year. Further particulars of the secretary, Judicial and Public Department, India Office, Whitehall, London, S.W., to whom applications by June 30. Some further particulars will be found in an advertisement.

The Council of University College, Bristol, require a demonstrator in engineering, with workshop experience and training, &c. Salary, £120 per annum. Applications by July 4 to Mr. James Rafter, registrar and secretary. See advertisement.

A shift engineer is required at the Hull electricity works. Applications to the city electrical engineer, Mr. A. S. Barnard. See advertisement.

A demonstrator in electrical engineering is required for University College, Nottingham. Applications to secretary by June 30.

A shift engineer is required for Blackpool Corporation electricity works. Salary £125 per annum. Applications to Mr. Charles Furness by 23rd inst.

The position of principal of the Wandsworth Technical Institute is vacant. Applications to honorary secretary, 4, Galveston-road, Putney, London, S.W., by June 30.

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An assistant master in engineering and mathematics is wanted for Birmingham Municipal Technical School. Salary £125. Applications by June 30.

Mr. J. Mordy Lambe, chief assistant electrical engineer to the Cape Peninsula Lighting Co., has been appointed by the Kimberley Borough Council, out of 14 applicants, to the position of chief electrical engineer. Mr. Lambe received his engineering training with Messrs. C. A. Parsons & Co. and at the Durham College of Science.

Mr. James Foulds, A.R.C Sc. (Lond.), F.C.S., of Heckmondwike, Yorks, has been appointed additional science master at the Tunbridge Wells Technical Institute.

Mr. A. C. Cramb, of Hampstead, has been appointed chief assistant electrical engineer at Croydon.

Mr. Bamber, an assistant engineer at Blackpool electricity works, has received a similar appointment at Manchester.

Mr. E. E. Putland, who has been chief engineer and manager of the Aberystwyth electricity works for about seven years, has resigned in order to rejoin the technical staff of Mr. G. Croydon Marks.

Aberdeen.—By 20 votes to 12 the Council have decided to run a tramcar service on Sundays.

Bilston.—Trial trips have been made on the electric tramway from Bilston to the Fighting Cocks, at the boundary of Wolverhampton and Sedgley. The Board of Trade inspection will take place in a few days.

Bingley.—The Council will enter into an agreement with a syndicate for the construction of an electric tramway from Shipley to Keighley. Mr. R. C. Quin is consulting engineer for the syndicate, which offers to construct the tramway and equip the portion in the Bingley district (a total length of 3¼ miles). Current will be taken from the Council, and the syndicate also undertake to pay £500 a year for 30 years for the tramway lease. The Council are to apply for a provisional order for power to construct and work electric tramways, but at the expense of the promoting syndicate, which would take a transfer of it for 21 years, with the option to extend to 30 years. In addition, the syndicate engage to contribute £2,000 towards the cost of making a new road.

Birmingham.—The negotiations for the conversion of the Birmingham and Midland Tramways to electric traction by the British Electric Traction Co. have been completed, and only await the sanction of some of the local authorities interested. The conversion will be made on the following terms :—

West Bromwich Corporation agree to purchase the small portions of the Birmingham and Midland Tramways within their borough for £5,500, and these lines are to be electrically equipped in conjunction with the remainder acquired by the Corporation from the South Staffordshire Tramway Co. The Smethwick and Oldbury Councils will purchase the lines within their district, but have come to an arrangement with the British Electric Traction Co. for the latter to work the lines, the local authorities receiving a percentage of the profits. The terms made with the Smethwick Corporation provide for a contribution of at least £500 a year from the company in aid of rates, the Corporation agreeing to lease the lines or suspend their purchasing powers for 21 years. The Corporation also receive a royalty on all current generated by the company at their works in Smethwick for use either in Smethwick or in outside areas. Concessions in the matters of cheap fares and workmen's cars, &c., have been stipulated for. In regard to Oldbury, a settlement has been arrived at on the basis of the payment of a lump sum of £700 by the B.E.T. Co.

Blaenau Festiniog.—This district abounds in water power available for the generation of electric current, and the Yale Electric Power Co. was established some three years back to utilise this power for supplying the quarries with machinery for pumping, driving the slate mills, hauling and similar purposes, as well as for lighting the collieries and the district generally by electricity. Power is supplied at about 1d. per unit, and the District Council has a 15-year agreement with the company to supply current for public and private lighting at 4d. per unit. Motors to the extent of about 400 H.P. are already connected to the mains, and current to the equivalent of about 3,000 8 c.p. lamps is supplied for lighting. A 24-hour supply is available. Several of the large quarries in the district are provided with winding engines, electrically-driven pumps and other plant. Recently the important quarries of Fotty and Bowydd have been equipped for electric driving. On the occasion of the recent inauguration of a new sub-station at Diphwys, Lord Newborough, who switched on the current, presided at a banquet given at the Queen's Hotel, when over 100 principals and managers of the quarries in the district and officials of local authorities were present. A number of street arc lamps were switched on for the first time on the occasion, and the public supply of electric current declared available. Mr. T. P. Osborne Yale, managing director of the Yale Company, was congratulated upon his success in bringing about the general adoption of electric lighting and power transmission in the district, which has the largest population but one in North Wales.

Bradford.—Last week a coroner's inquiry was held by Mr. J. G. Hutchinson at the Town Hall into the circumstances attending the death of a labourer named Judge, who was killed in an electric hoist accident on May 26. The contractors for the work upon which Judge was employed were Messrs. Wray & Co. Evidence went to show that the hoist weighed 11·3cwt. and the contents 8·45cwt., while the counterbalance was only 12·66cwt. The hoist, loaded with bricks and mortar, and with three adults as passengers, fell 55ft., rebounding about 6ft. on reaching the basement of the building in which it was working.

Mr. JOHN WAUGH, C.E., stated that the hoist was provided with safety apparatus and was electrically driven by a motor. The machinery at the top of the hoist had been forced from its position by the jamming of the metal oil catcher, which removed a worm wheel beyond its worm, and allowed the hoist to fall. The safety apparatus could only come into action at the breaking of the rope, which did not occur. He had investigated 10 similarly fatal cases in which the cause of the accident had been precisely the same, and he urged that all hoists should be periodically inspected by competent persons. The jury, in returning a verdict of accidental death, recommended the adoption of Mr. Waugh's suggestion as to inspection.

Bridgend.—An inquiry was held here on Wednesday into the application of the Council to borrow £6,900 for establishing electricity works. The Council obtained a provisional order in 1893, and have agreed to take electricity in bulk from the South Wales Electrical Power Distribution Co. Under their contract with that company a supply will be given on a sliding scale, the Council obtaining current at 2½d. per unit. The Council will supply current for public as well as private lighting, the charge for the latter being 5d. per unit. The estimates submitted anticipate a profit of £225 per annum. The Council's consulting engineer (Mr. H. D. Sully) gave technical details. Some opposition was offered by ratepayers.

Brighton.—The Tramways committee have appointed Mr. H. F. Parshall consulting tramway engineer.

Burton.—It has been decided to repay, out of profits of £545. 6s. 8d. for the past year on the electric lighting department, £520 to the gas works department, on account of £1,020 advanced for electric lighting.

Canadian Telegraphs.—It is announced that the Minister of Public Works of the Dominion is arranging for the laying of a submarine telegraph cable between Anticosti and the Magdalen Islands, a distance of 116 miles. Magdalen Islands and Cape Breton, 58 miles distant, are already connected by cable. The laying of the Anticosti–Magdalen line, and the erection of two land-line links will bring Quebec into telegraphic connection with the Atlantic cables at Canso.

Cardiff.—Two additional routes of the municipal electric tramways were opened for traffic on Thursday last.

China.—At Brussels a company, entitled La Compagnie Internationale d'Eclairage et de Tramway à Tientsin, has been formed, with a capital of £250,000 to establish electricity works and to construct electric tramways in Tientsin.

City and Surrey Electric Railway.—Some particulars of a scheme for the construction of this line have been issued. The directors have acquired a terminus in King William-street, City, and have entered into a working agreement with the City and South London Railway Co. for joint use of its tunnel under the Thames. Starting from King William-street, the route runs parallel to that of the existing South London line to a point a little south of the Borough station. The line will then pass through St. George's-circus by Lambeth, Kennington, the Oval, and Lorn-road to Brixton, and on to Balham, Norbury, Thornton Heath and Croydon to Warlingham. One branch will then proceed east to Westerham, and the other west to Redhill and Reigate.

Cleckheaton.—Power is sought to borrow £6,000 for electricity works extensions. The charges for current for lighting and motive power have been fixed at 5d. and 2d. respectively.

Colne.—Customers of the electricity department have now the option of taking current on the maximum-demand system (6d. per unit for the first hour and 2½d. after) or at a flat rate of 4½d.

The promoters of the Colne and Trawden light railway order have handed to the Council a bond for £2,500 as security for the construction of the line.

Croydon.—Croydon Corporation have asked the Board of Trade to appoint Mr. Hugh Erat Harrison, B.Sc., electrical inspector under the Corporation Electric Lighting Order, 1890.

The Dulwich–Crystal Palace light railway scheme is to be opposed by the Corporation.

Customs Dues.—An ad val. duty of 15 per cent. has been fixed by the Australian Commonwealth for imported electrical machinery and electrical appliances, dating from April 10.

Cutting an Atlantic Cable.—The cable of the Compagnie Française des Câbles Télégraphiques was recently wilfully cut at a point about two miles south of Coney Island, off New York. There is at present no clue to the perpetrators of the outrage, and the company offer a reward of £100.

Dartford.—Nernst lamps are to be substituted for the existing incandescent electric lamps for a portion of the street lighting.

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Epsom.—An inquiry was recently held into the application of the Council to borrow £10,282 for electric lighting extensions. Evidence was given by the consulting engineer (Mr. W. C. C. Hawtayne), who said the present capacity of the station was equivalent to 4,000 8 c.p. lamps and 200 public lamps, and by the resident engineer (Mr. H. F. Foster), who stated that the present demand for current for private lighting was equivalent to 3,000 8 c.p. lamps. The demand was increasing, and it was necessary to be prepared to meet it. The chairman of the Lighting committee (Mr. Ledger) stated that condensing plant was absolutely necessary, because the exhaust from the engines had been a source of serious complaint, and they had been threatened with legal proceedings.

German East Africa.—With the object of connecting up German East Africa with the Cape-to-Cairo telegraph system, an overland telegraph line has recently been completed from Dar-es-Salaam through Mafisifätere, Mrogoro, Kilimatinde on to Mpapua. Later this is to be continued to Tabora, and eventually to Ujiji, where the transcontinental line will be connected. The telegraph operators are natives and Goanese, and are said to be giving satisfaction in their duties.

Glasgow.—The salary of Mr. Wm. Clark, chief engineer of the Corporation tramways, has been increased from £550 to £600, and that of Mr. M. B. Field, electrical engineer, from £450 to £500.

Gravesend.—The contract with Messrs. Davey for the building of the electricity station buildings has been determined, and the Electric Light committee are negotiating with Messrs. Multon and Wallis for finishing the work.

Great Yarmouth.—The official inspection of the electric tramways took place on Wednesday.

Halifax.—The Tramways committee have refused to extend the municipal electric tramways to Elland.

Hanley.—The Council have decided to petition the House of Commons for the insertion of a clause in the bill promoted by the North Staffordshire Tramways Co. (Ltd.) and the Potteries Electric Traction Co. (Ltd.) empowering local authorities affected to jointly purchase the generating stations of the company as part of their undertaking.

Huddersfield.—The whole of the tramways have now been converted to electric traction, with the exception of about 1 mile of the Bradley section, which will be finished early in July.

Inverness.—The scheme for the erection of electricity works, prepared by Mr. James Fraser, has been submitted to Mr. Davidson, engineer of the Caledonian Canal, for report. It is proposed to utilise water power.

Islington (London).—Further extensions of the electric light mains, estimated to cost £2,100, have been authorised.

Kirkcaldy.—The Board of Trade have authorised the use of double-deck cars on the local electric tramways on condition that each car is fitted with an extra brake.

A proposal to adopt electric lighting for the harbour has been referred to the provost and clerk for report.

London County Council.—At Tuesday's meeting an electricity loan was made to Bermondsey for £13,925.

On the recommendation of the Tramways committee it was agreed that a further official should be appointed in connection with the reconstruction of the tramways, to be designated "distribution engineer," at a salary of £350 per annum.

The Highways committee recommend that the Council join with the Corporation of London in an application to Government to promote legislation next session for regulating the breaking up, by companies and others having statutory rights, of the London thoroughfares.

London United Tramways.—The electric tramway from Bush Corner, Isleworth, to Twickenham was opened for traffic on Saturday.

Londonderry.—At a recent meeting of the Corporation the proposal to borrow £35,000 for the establishment of electricity supply works was approved, and the scheme, which is based upon a report by Sir William Preece and statistics prepared by the Council's late engineer, Mr. Christie, is to be proceeded with at once.

Lytham.—The Council, having considered the report of their consulting engineer (Mr. T. Parker) on the tenders recently received for the supply and erection of electricity generating plant, have resolved to apply to the Board of Trade for an extension of time for complying with the terms of their electric lighting order.

Madras.—The Government of Madras has authorised the expenditure of 50,000 rupees for electric lighting the buildings of the Government Press.

Middlesex Electric Tramways.—Middlesex County Council have decided to proceed with their electric tramway scheme, and the Finance committee is providing £1,000,000 for the construction of the permanent way.

Patent Law.—Messrs. J. E. Evans-Jackson & Co., 19 and 20, Holborn-viaduct, London, E.C., inform us that a new law for the protection of patents and trade marks in Spain came into operation on June 7. The working conditions of patents have been greatly modified, and the period for compulsory working has been extended to three years. The time for payment of taxes has been extended under a fine, and these taxes can be paid in advance with discounts ranging from 5 to 20 per cent. Applicants who have made prior applications in other countries for patents must make application in Spain within 12 months, or the patent will be limited in that country to five years. The regulations relating to trade marks extend the definition, and the Spanish law in this respect becomes now very much the same as that of Great Britain. Registration is limited to 20 years, instead of being, as previously, unlimited, and taxes have to be paid in five years, failing which registration lapses. Trade marks registered under the old law are regarded as having been registered under the new conditions, and must be renewed within a certain period, or they lapse.

Plymouth.—In moving the adoption of the report of the Tramways committee at the Council meeting last week, Mr. Monk said that, although there had been a falling off of £112 in the receipts during the last four weeks, due to unseasonable weather, there had been an increase of £1,406 from January to May. Mr. Lethbridge moved, as an amendment, that the committee's proposal to apply to the Board of Trade for sanction to a loan of £19,000 for buildings, machinery, &c., for supplying electricity for the tramways should be referred back to the Finance committee, but the report was ultimately adopted

The Board of Trade inspection of the short length of line connecting the Corporation tramways with the system of the Plymouth, Devonport and Stonehouse Tramways Co. took place on Thursday last.

Presentation—On the completion by the British Insulated Wire Co. of its contract with Glasgow Corporation for the underground work of the Telephone department, Mr. A. C. Devey, the company's resident superintendent, was presented by the principal members of the department with a silver cigarette case, and by the company's local staff and workmen with a pair of statuettes and a silver cruet. The former presentation was made by Mr. John Macfee, deputy manager of the Corporation telephones, and the latter by Mr. J. C. Jones, the British Insulated Wire Co.'s assistant superintendent in the north. The work just completed comprises 100 miles of underground 3in. cast-iron piping and 150 miles of cable (equal to about 30,000 miles of single wire). This is claimed to be the second largest underground telephone system in the world, coming next to London. Glasgow, however, has put down the largest telephone cable ever made. This, being too large to go into the 3in. pipes, has been placed in a 6in. pipe.

Prestwich.—An agreement has been entered into with Salford Corporation for the construction and working of electric tramways in this district.

Railway Station Lighting.—The London and North Western Railway Co. have placed a large order with Arc Lamps Limited, for W. J. Davy lamps for lighting their Sheffield station. This is the second large station in Sheffield that will now be lighted by this type of arc lamp.

School Lighting—The City of London Schools committee has been authorised to expend £700 in wiring the City School for electric lighting.

Slough—The Council have decided to dispose of their provisional electric lighting order for Slough and Datchet to the Windsor Electrical Installation Co.

Straits Settlements.—The value of telegraph and telephone materials exported from the United Kingdom to the Straits Settlements in 1901 was £92,000, compared with £58,000 in 1900. Some supplies were also drawn from the Continent, valued in 1901 at £3,000, in 1900 £4,000.

Spain.—Señor Teodoro de Mas, of Vich (Spain), has obtained a concession to construct and work, within the period of six years, an electric railway between the towns of Vich and Amer (Gerona). The line is estimated to cost about £240,000. A memorandum showing the plant and material required, and giving other information, has, we understand, been prepared for the information of capitalists and others by Señor Mas, from whom further information may be obtained. Correspondence should be in Spanish.

A report having been published that the Orense and Vigo Railway Co. are about to discuss a scheme for adopting electric traction for their lines in the province of Galicia (the line from Vigo to Orense is 82½ miles in length), we are able to give an emphatic contradiction to the report. We learn that no such meeting has been or is at all likely to be held, at any rate for the present.

The Cia Electrica Madrileña de Traccion has obtained authorisation to construct and work a branch line connecting up the Central Electric Tramways of Madrid and the Metropolitan Tramways of that city, via the Calle de Zurbano and the Calle de Caracas.

Authority has been given by the Municipal Council of Malaga to the local tramway company to convert their existing horse lines to electric traction. There is at present about 8 miles of line, but the company owns concessions which will add considerably to this mileage. The headquarters of the owning company is at Brussels,

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the directors being Messrs. Hault, Hammebeath, Lucas, Mayer, and Ryndzunsky.

Swansea.—The financial statement of the first year's working of the electricity department shows that the gross profit was £2,163. 4s. 1d., and after paying interest (£1,970. 9s. 2d.) there was a net profit of £292. 14s. 11d. The debit balance on March, 1901, was £642. 4s. 9d., and the deficit (excluding sinking fund) £349. 9s. 10d. The total capital expenditure is £60,230. 15s. 9d. The percentage of gross profit to capital was 3·75 per cent. The total units sold were 319,215, and the units sold per 8 c.p. lamp 13·77. The average price obtained for current for private lighting was 3·54d., and for public lighting 3·14d. In the report of the borough electrical engineer (Mr. C. A. L. Prusmann) accompanying the statement it is stated that power consumers are increasing largely.

Trowbridge.—The claim of Mr. D. Stevenson, consulting engineer, for £214. 4s. 9d. for advising the Council on electricity supply has been settled by the payment of £200, all plans to be handed over to the Council.

Ware (Herts.)—Mr. H. Wall Wilkinson has been instructed by the Council to report on electric lighting.

Woolwich.—The Council will apply for sanction to borrow £101,000 for purchasing the undertaking of the Woolwich District Electric Light Co.

Cricket.—A cricket match, played at Dukinfield on 14th inst., between the employés of the Tudor Accumulator Co. and the Chloride Electrical Storage Co., resulted in a victory for the former, the respective scores being 102 and 46.

Concert.—The annual smoking concert of the Electrical Trades Union took place on Saturday last at the Finsbury Town Hall, London. Owing to the inclemency of the weather the audience was small. The several members of Parliament who were down to attend—Capt. C. Norton, M.P., Mr. John Burns, M.P., Mr. T. Lough, M.P.—failed to put in an appearance. Mr. Will Crooks, L.C.C., mayor of Poplar, unveiled a new silk banner.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Teddington Urban District Council invite offers from persons and companies willing to take over the Teddington provisional order, 1901, and to submit a scheme for the electric lighting of the district. An advertisement contains some further particulars, and tenders have to be sent to the clerk to the Council, Mr. G. H. Salmons, Elmfield House, Teddington, S.W., by July 12.

Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board require tenders for three 500kw. steam-driven, direct-coupled, three-phase alternator sets; three 50kw. ditto continuous-current exciters, &c.; and permanent way (including copper bonding and conduits for cables). Specifications, &c., from the clerk (Mr. Frank Schofield), Town Hall, Stalybridge, to whom tenders by July 7. An advertisement gives further particulars.

West Ham Borough Council require 50 double-deck electric tramcars, complete with electrical equipment. Specifications, &c., from the borough electrical engineer (Mr. James K. Bock). Tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E., by 4 p.m., July 8. Further particulars are given in an advertisement.

Lowestoft Corporation invite tenders for rails, fish-plates and bolts and permanent way construction for their electric tramways. Specification, &c., from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C. Plans can also be seen and information obtained from Mr. Walter Beer, 47, Victoria-street, Westminster, London, S.W. Tenders to town clerk (Mr. R. Beattie Nicholson) by 5 p.m. July 12. An advertisement gives additional particulars.

Gillingham Urban District Council invite tenders for the supply and erection of water-tube boilers, steam and exhaust piping, condenser, cooling tower, three high-speed engines, 250kw. tri-phase alternators, switchboard, underground cables, arc lamps, crane and well. Specifications, &c., from Mr. W. H. Trentham, 39, Victoria-street, Westminster, S.W., and tenders to the clerk (Mr. F. C. Boucher), Council Offices, Gillingham, Kent, by 3 p.m. July 17. An advertisement gives some additional particulars.

Romford Urban District Council are open to receive offers for the construction and maintenance of electricity supply works for the district. General description of the scheme and form of offer from the clerk to the Council (Mr. Charles T. King), Council Offices, Romford, to whom offers by noon of June 30. An advertisement gives additional particulars.

Falkirk Corporation invite tenders for steam, exhaust, drain and other pumps, feed pump, tank, &c.; balancing transformers and motor generators; storage batteries; switchboard and connections; arc and incandescent lamps and fittings; cable work and travelling crane. Specifications, &c., from the consulting engineers (Messrs. Burstall and Monkhouse), 14, Old Queen-street, Westminster, S.W. Tenders to town clerk (Mr. A. Balfour Gray), Municipal-buildings, Falkirk, N.B., by noon July 14. Further particulars are given in an advertisement.

Epsom District Council invite tenders for a semi-marine bry-back boiler, with fittings, &c.; ejector condensers, circulating pumps and pipework; spray cooling ponds; steam feed and drain pipes, &c.; and a 150kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, &c. An advertisement contains additional information. Specifications from the clerk (Mr. E. G. Wilson), Council Offices, Epsom, to whom tenders by noon July 18. Further particulars can be obtained from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C.

Chester Corporation invite tenders for permanent way construction, bonds, overhead equipment and cars. Further particulars are given in an advertisement. Drawings and specifications may be inspected after 23rd inst. at the Town Hall, on application to the city surveyor (Mr. I. M. Jones) or to the city electrical engineer (Mr. F. Thursfield), from either of whom specifications and forms of tender may be obtained. Tenders to the town clerk (Mr. Samuel Smith) by 10 a.m. July 7.

Chester Corporation also invite tenders for accumulators and reversible battery booster. Specifications from the city electrical engineer, Mr. F. Thursfield. Tenders by July 7. See advertisement.

The Electricity committee of *Nuneaton and Chilvers Coton* Urban District Council invite tenders for supply and delivery of private lighting cables (paper), public lighting cables (rubber), joint boxes and compounds; also for supply, delivery and erection of 20-arc lamp columns with incandescent brackets, complete with lamps, cut-outs, switches, resistances and accessories. Specifications, &c., from the chief electrical engineer (Mr. S. Cameron Gibson), Electricity Works, Coton-road. Further particulars are given in an advertisement, and tenders (addressed chairman) by June 30.

Sunderland Corporation tramway department require tenders for the supply of permanent way and overhead equipment and cables. Specifications, &c., from the borough electrical and tramways engineer (Mr. John F. C. Snell), Town Hall, Sunderland. Tenders to chairman Tramways committee by July 9.

Ipswich Corporation invite tenders for engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains and road work, permanent way construction of tramways, and arc lamps. Tenders to town clerk by noon July 5.

Blackpool Corporation invite tenders for carbons for the year to March 31, 1903. Specifications, &c., from Mr. Charles Furness, Electricity Works, Blackpool.

Walsall Corporation invite tenders for supply of reversible booster and switches to work in series with battery on tramway circuit. Tenders to town clerk by June 27.

Wellington (Salop) District Council invite offers for a lease of their electricity supply powers. Offers to Mr. Thos. L. Miller, 7, Tower-buildings, N. Water-street, Liverpool, by June 25.

Newcastle-on-Tyne Guardians invite tenders for lighting three relief offices. Tenders by noon July 11 to Mr. J. W. Gibson, 127, Pilgrim-street, Newcastle-on-Tyne.

Bournemouth Town Council invite tenders for station and car depôt lighting and wiring, motors, testing instruments and accessories. Tenders by noon June 23.

Bexley District Council invite tenders for points and crossings and boilers. Tenders by July 7.

Cheltenham Guardians invite tenders for providing inter-communication telephones at the workhouse. Tenders by 5 p.m. July 2.

Willington Quay and Howden Industrial Society invite tenders for electrical plant. Tenders by July 14.

Kirkcaldy Corporation invite tenders for wiring the central station. Tenders by 10 a.m. June 21.

Manchester Electricity committee invite tenders for 12 months' supply of stores. Tenders by July 1.

London County Council require tenders for steam, exhaust and other piping, valves, &c. Tenders by July 8.

The Telegraph Department of the *Australian Commonwealth* invites tenders for the supply of 17 miles of telephone cable and five metallic circuit 100-line telephone switchboards. The cables are to be supplied to specifications Nos. 6 and 7, and the switchboards to No. 8. These specifications can only be seen and tender forms obtained at the General Post Offices at Sydney, Melbourne, Brisbane, Adelaide, Perth and Hobart. Tenders have to be in by noon July 28.

Messrs. Preece and Cardew, by authority of the Municipal Council of *Sydney* (*N.S.W.*), invite tenders, on the Council's behalf, for the

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supply, delivery, laying and erection of a complete system of high and low-pressure cables, and of arc lamps for street lighting. Specification, &c., from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, London, S.W., to whom tenders must be sent before noon July 23.

La Société d'Electricité de *Leskovatz* (Servia) invite tenders until July 1 for the supply and erection of two 200 H.P. turbines, two 200 H.P. three-phase alternators and the necessary accessories for power transmission over a distance of 17 kilometres.

TENDERS RECEIVED AND ACCEPTED.

Two large electric power contracts have been secured by the Australian representative of the British Westinghouse Company, one for the complete conversion to electric traction of the horse tramways system of Adelaide, aggregating about 65 miles of track; and the second for a power installation at the new railway works at Ipswich, near Brisbane, of the Queensland Government. The total plant aggregates 800 H.P. on the two-phase system. The amount of this contract exceeds £250,000, and covers steam, electric and auxiliary plant and apparatus.

Messrs. Willans and Robinson have received an order from H.M. Post Office for four 250 H.P. compound engines for direct coupling to Siemens dynamos for the G.P.O. new savings bank, West Kensington. An order for two 360 H.P. compound engines for direct coupling to dynamos by Dick, Kerr & Co. for the Mount Pleasant telegraph factory has also been received.

London County Council received the following tenders for fixing a battery of accumulators for an energising electric lighting installation at the Horniman Museum :—

Pritchetts and Gold (*accepted*)	£66 4	Electrical Power Storage Co.	£76 8
Drake and Gorham	83 0	Chloride Elec. Storage Co.	73 5

The British Thomson-Houston Co. have obtained a contract from the Metropolitan District Railway Co. for the switchboard to control the 10 5,000kw. 11,000-volt generators and other electrical auxiliaries at their new generating station at Chelsea. It will consist of 47 black-enamelled slate panels, divided as follows :—4 generator exciter panels, 1 exciter feeder panel, 2 rotary converter panels, 1 direct-current generator panel, 1 storage battery panel, 2 direct-current feeder panels, 1 low-tension transformer panel, 3 induction-motor panels, 12 feeder panels, 10 generator instrument panels, and 10 generator controlling panels. All generator and feeder circuits are to be controlled by B T.H. high-tension oil switches of type H, mounted in fire-proof brick compartments, capable of opening a dead short-circuit of the entire station, and which are to act as automatic circuit-breakers in the feeder circuit. Being capable of adjustment within wide limits, they will also be capable of opening the circuit in case of reversal of current, thus forming an automatic circuit-breaker without the interposition of high-tension fuses.

Hackney (London) Borough Council have received the following tenders :—

Three water-tube boilers, feed pump, steam water pipes, &c.

Babcock and Wilcox (*accepted*)	£6,910	W. R. Renshaw & Co.	£6,995
E. Danks & Co.	9,594	Hughes and Stirling	6,954
R. Hornsby & Sons	7,620	Stirling Boiler Co.	6,653
John Thompson	7,385		

Water-softening Plant.

Babcock & Wilcox (*accepted*)	£1,120	Doulton & Co.	£1,696
J. Thompson	2,485	Stanhope Water Eng. Co. ...	1,626
J. Wright & Co.	2,442	Masson, Scott & Co.	1,540
Porter-Clark Water Softening Co.	2,201	Desrumaux's Automatic Water Softener & Purifier	1,490
Sir Hiram Maxim Elec. and Engineering Co.	2,140	Lassen and Hjort	1,300
Mather and Platt	1,795	Baker's Patent Appliance Co.	1,206
Potter & Co.	1,725	J. Barrett	1,070
		Glasgow Patents Co.	1,043

Hackney Borough Council have also accepted the tender of the National Electric Wiring Co. for wiring the public offices at £130. 15s. 9d. Five tenders, varying in amount from the accepted tender to £220, were received

Glasgow Corporation have accepted the tender of Messrs. Mavor and Coulson for three motor-driven boosters and accessories for £2,088; that of the Mirrlees-Watson Co. for condensing plant for the Pollokshaws-road station at £1,852; and that of Messrs. E. Green & Son (Ltd.) for fuel economisers at £1,010. 15s.

The Tramways committee of Manchester Corporation have placed an order for 34,000 copper railbonds with Messrs. R. W. Blackwell & Co., of the "Crown" and "Chicago" types.

An order has been placed with Messrs. Willans and Robinson, through Messrs. Dick, Kerr & Co., for a 1,200 H.P. triple expansion engine for Dundee Corporation.

Woolwich (London) Borough Council have accepted the tender of T. Harding Churton & Co. for a 70 B.H.P. enclosed motor for driving machinery in connection with the refuse destructor.

Walsall Town Council have accepted the tender of Babcock and Wilcox (Ltd.) for the supply of boiler, &c., at £1,080, and that of the Electrical Power Storage Co. for a storage battery at £1,117. 16s.

A contract for the supply of two economisers at Bedford has been let to Messrs. E. Green & Son at £850. 10s.

Dartford District Council have accepted the tender of Messrs. J. Carter & Sons for a Lancashire boiler, feed pump, &c., at £860. 8s, and that of Messrs. Reavell & Co. for a dynamo, steam and exhaust piping, extensions to switchboard, &c., at £2,248. 10s.

A contract has been let to Messrs. Willans and Robinson by Messrs. Player & Co. for a Willans standard compound engine for direct coupling to a dynamo by Messrs. P. R. Jackson for supplying power and lighting to the Clydach shops.

Sculcoates Guardians have accepted the tender of the Hart Accumulator Co. for accumulators at £581. 8s., and that of Messrs. G. Wokes & Co. for switchgear at £105.

Burton-on-Trent Town Council have accepted the tender of the British Thomson-Houston Co. for supply of three 100kw. high-speed tramway generators and switchboard at £4,099.

Messrs. Willans and Robinson have received an order from the Guildford Electric Supply Co. for a 240 H.P. compound engine for direct coupling to a Newton dynamo.

BUSINESS NOTICE.

The name of the manufacturers of the well-known Chloride storage cells has been changed from the Chloride Electrical Storage Syndicate (Ltd.) to the Chloride Electrical Storage Co. (Ltd.).

LIQUIDATIONS.

A meeting of the Gateshead Electric and Mechanical Supply Co. (Ltd.) will be held at 21, Collingwood-street, Newcastle-on-Tyne, on July 18 to receive an account of the winding-up.

The first meetings of creditors and contributories of the Meyra Electric Co. (Ltd.) will be held at the Official Receiver's, Carey-street, London, W.C., on July 1.

Plant, &c., for Sale.—Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

A number of electric motors, a 100 ampere dynamo (110 volts), a 58-cell battery and two Crossley gas engines of 9 B.H.P. and 12 B.H.P. are for sale. Offers to the Era Press, Leyton. See advertisement.

A 20 B.H.P. gas engine, dynamo, switchboard, belting, &c., nearly new, is advertised for sale by the secretary, Northgate Mansions (Ltd.), Gloucester.

Mr. James E. Ward, C.A., 122, Cannon-street, London, E.C., receiver and manager of the British Electrical Mfg. Co. (Ltd.), advertises for disposal the goodwill of the business, machinery, plant and fittings, and a number of patents owned by the company. The works are situate at Putney Bridge Station, London, S.W., and the whole is for sale as a going concern. An advertisement gives some further particulars.

An E.P.S. battery, in good condition, consisting of three sets of 55 K 33 cells, complete with stands, &c., is for sale. Applications to Messrs. Owen Lucas and Pyke, 39, Victoria street, London, S.W See advertisement.

Fire.—The General Electric Co. wish their clients to understand that the large stocks held at their branches and the facilities for manufacture which they possess enable them to fill all orders with promptitude. It is possible, however, that some order sheets may have been lost in the recent fire, and in the event of any customer finding his order unexecuted he is requested to notify the company.

The inquiry into the cause of the disastrous fire on the premises of the General Electric Co., in Queen Victoria-street, London, E.C., was resumed by the coroner for the City of London yesterday (Thursday), and evidence as to the probable origin of the fire was tendered by a number of witnesses, after which the inquiry was again adjourned.

Ventilating Fans.—It is difficult to imagine the application of any new feature to improve the all-conquering electric fan, but Messrs. Drake and Gorham, who have been appointed sole agents for Great Britain and Ireland of an American fan known as the "Comfort," claim that by the introduction of the oscillating principle to the electric fan, a distinct advance has been made, and brings into practical working the "punkah" effect. This has suggested the adoption of the title "Punkah," by which name this fan will be known in this country.

Howard Conduits.—We have received from the Howard Conduit Co. a copy of their latest catalogue and a sample of their asphalt solid conduit system. A detailed illustrated description of this conduit was given in *The Electrician*, Vol. XLVIII., p. 214, and the company now inform us that among other places the system is being employed at Windsor, Trafford Park, Bournemouth, Nottingham

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Eccles, Lancaster, &c., and that they have also secured the contract for one year's supply of their asphalt troughing from Salford Corporation, and the whole of the troughing for the Leatherhead electric lighting scheme.

Jandus Patents.—We are informed that, in addition to the Davy Construction Co., the Reason Manufacturing Co. have recently signed an agreement by which they become licensees of the Jandus Company.

Nernst Electric Lamp.—An agreement has been entered into by the Allgemeine Elektricitäts Gesellschaft, of Berlin, who are the owners of the Nernst patents, with the Nernst Electric Light, Ltd, of London, whereby the latter agrees to abandon for a number of years the manufacture of the Nernst lamp, and consents to procure from the A.E.G. all the lamps required for meeting the entire demand for Nernst lamps in those countries which are reserved to it.

Coronation Illuminations.—The elaborate and effective Canadian arch which is being erected across Whitehall, London, in connection with the Coronation procession is to be illuminated on the nights of June 26 and 27 with over 5,000 incandescent lamps, and the order for these lamps has been placed with the Electrical Co., 122-124, Charing Cross-road, London, W.C.

Fire Prevention.—In distributing a pamphlet entitled "Fire Service in Factories, Works, &c.," by Mr. Harold Sumner, the British Fire Prevention Committee call attention to the advantages of providing outside gas cocks to business premises. Gas is still used in a number of large works and factories in various parts of the country, and it is advised that while this system of lighting continues outside gas cocks should be provided, as the bursting and breaking of gas pipes in the course of a fire is a prolific cause of great damage to property.

"Armorduct" Conduit.—A new and useful list of "Armorduct" improved conduit for electric wiring has just been issued, and gives particulars and illustrations of the various parts that go to make up the "Armorduct" system.

Catalogues.—The Electric and Ordnance Accessories Co., Stellite Works, Cheston-road, Aston, Birmingham, have ready section C of their catalogue, dealing with main switches, &c. Copies of this list can be obtained by members of the trade post free. The list fully illustrates a variety of up-to-date switches.

A catalogue of single and multiphase alternating-current induction motors and single and multiphase transformers (list No. 4A) is issued by the Electrical Co., 122-124, Charing Cross-road, London, W.C. The list is well illustrated. Types K.D., L.K.D. and H.D. of three-phase induction motors are described with their several styles of rotors, and include a special type of motor for weaving looms. The single-phase motor described is the K.W., and the two-phase motor the K.Z. Brushholders and brushes for three-phase motors are included in the list, in which illustrations are also shown of three-phase and single-phase transformers.

The Premier Electric Lamp Co., 12, St. John's-lane, Liverpool, have ready a catalogue of low and high-voltage incandescent lamps, including higher candle-powers for street lighting and miniature lamps for decoration work. Copies of the list can be obtained on application.

A catalogue of electric traction supplies is issued by Messrs. Brecknell, Munro and Rogers, and include trolley standards, trolley heads, line ears, frogs, crossings, points, pole and bracket attachments, insulators, bondholders, car repairing tools, &c.

A new list of ceiling roses and wall sockets is issued by Messrs. Davies, Kent and Stewart, 17, Berners-street, London, W.

Electrical Transmission Co.—Mr. A. B. Rigby, manager of this company, writes:—

"We have received several communications from our friends with reference to an announcement appearing in your last issue concerning liquidation of the Electrical Transmission Co. (Ltd.). We wish to point out that Mr. Ernest Scott, of 2, Talbot-court, Gracechurch-street, E.C., purchased the business, patent rights, &c., of the limited company in December, 1900, and this purchase, of course, rendered it necessary that the limited company should be wound up. The business has since then been carried on under the title of the Electrical Transmission Co. The notices appearing are the usual formal notices connected with the winding-up of a limited company, and have no connection with the present concern."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 11 to 17, with the ports of destination:—

Africa—Alexandria, £22; Cape Town, £375; Durban, £1,311; *Argentina*—Buenos Ayres, £1,819. *Australasia*—Adelaide, £63; Auckland, £47; Christchurch, £84; Melbourne, £2,005; Perth, £90; Sydney, £2,479 (including £160 telegraph wire); Townsville, £528. *Ceylon*—Colombo, £201. *Channel Islands*, £131. *Chili*—Boca, £437; Coronel, £323. *Denmark*—Copenhagen £81 (telegraph wire). *Germany*—Hamburg, £225 (telegraph material). *Greece*—Piræus £53. *Holland*—Amsterdam, £50; Rotterdam, £160 (including £100 telegraph material). *Hong Kong*—£91 (including £48 telegraph material). *India*—Bombay, £730; Calcutta, £1,364 (including £111 telegraph wire). *North Atlantic*—£4,560 (telegraph cable). *Russia*—St. Petersburg, £500 (telegraph material). *Siam*—Bangkok, £25. *Spain*—Bilbao, £131. *Sweden*—Malmo, £236. *U.S.A.*—New York, £500. *West Indies*—St. Thomas, £7,857 (telegraph cable). Total £26,478, against £17,276 in the corresponding week last year (June 12 to 18).

COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Co. (Ltd.).

The seventh ordinary general meeting was held on Monday, Sir CHARLES RIVERS WILSON, G.C.M.G., C.B., presiding.

The SECRETARY (Mr. Charles H. Dade) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, in proposing to you the adoption of the report of the directors and the accounts for the year ended March 31 last, I am able to point to an improvement and an extension of business in almost every direction. The profits for the year were £203,269, against £113,598, and we are able, notwithstanding the much larger capital on which we have had to pay interest and dividends for the past year, not merely to maintain the dividend of 9 per cent., but to carry forward £27,438, while we brought into this year's accounts only £21,457. We have also made ample provision for our reserves, and we have applied over £23,000 to writing down the book value of our various assets. Turning to the balance-sheet, it will be seen that there is a considerable enlargement of figures all round. Capital actually paid up is £1,000,000 larger than last year. The reserve shows an increase of £121,184 (£459,705). Sundry creditors is £21,000 less. The assets side shows an aggregate increase of over £1,000,000, and the whole of the increase in the capital and in the reserve fund may be looked for in the items of contracts and undertakings and sundry debtors. The amount standing against contracts and undertakings is more than £400,000 less than last year, the sundry debtors are close upon £500,000 more than last year, and the amount standing to credit of investments is about £1,000,000 larger than last year. Under contracts and undertakings we include all the land, buildings, and works upon which this company has spent money, either for its own account or in anticipation of a sale to others. The reason the amount of the contracts and undertakings account was larger last year, while sundry debtors have increased, is, that during the past year we have been able to complete a large number of our pending arrangements with other companies for the sale of a number of these undertakings, and the purchase price in respect of them has either been paid or is due to us. In the course of the current year a very large proportion of the moneys due to us from other companies will be liquidated; in many cases we shall receive cash, but in some cases we shall receive shares or debentures in liquidation of the purchase price, and to the extent to which we receive shares and debentures in payment our investments will increase. The expenditure on works and undertakings on account of other companies is this year £26,725, against £350,375, and the expenditure on works and undertakings owned or leased by the company is only £99,988, against £236,643. The amount expended on schemes in course of development and on Acts of Parliament and other powers secured is £72,465, against £54,314. Altogether, the fact that the accounts for contracts and undertakings is so much less this year than last indicates the progressive character of the work we are doing, and shows that the schemes and undertakings which last year we had in hand have not become stagnant, but have developed into sound marketable assets. With regard to the item of investments, which shows an increase of about £1,000,000, with the exception of about £5,000, spread over 23 sundry investments, the whole of our large investments, amounting to over £2,000,000, are fully disclosed in the report. To one of these undertakings I ought to call special attention, although it is not an undertaking of any great magnitude, because it has been a cause of disappointment to us, and because it illustrates in a very forcible manner many of the difficulties we have to encounter. I refer to the Pontypridd and Rhondda Valley Tramways. We acquired this horse tramway, which has a mileage of a little over 3 miles, with the object of converting it to electric traction, and made application to the Light Railway Commissioners for powers. We have, however, been seriously opposed by the local authorities and by the railway company. It is, however, due to the opposition of the local authorities that we have not succeeded, and now the time is close upon us—I think it is August next year—when these authorities will have the right to purchase the undertaking under the Tramways Act, and it is probable we shall not obtain a price under that act which will fully compensate us for the expenses we have incurred in buying the undertaking, and in endeavouring to obtain an extension of tenure and electrical powers. We have before had disappointments in regard to new promotions of powers, but I do not remember that we have had in our experience a case exactly similar to this of Pontypridd, where we have been working several years a horse tramway, and have done everything that occurred to us with a view to improving the service, and have apparently been defeated at every stage. We are not, however, absolutely without hope of accomplishing something even yet, as the local authorities may see the wisdom of granting us a lease of the lines after having taken them over, as well as of the new lines which they have promoted as a result of the indications we have given them. I shall probably have something more to say about it next year, when the actual loss that we shall suffer will have been ascertained. It will not be a serious matter in amount, but there are several questions of principle involved, not only in regard to the general aspects of the business, but particularly in regard to the question of how the loss, if incurred, should be dealt with. In connection with our various undertakings the number of passengers carried in two years has increased from 55,000,000 to 97,000,000, and the traffic receipts

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from £315,000 per annum to £563,000. The total route mileage of the undertakings in which we are interested amounts to 465 miles, of which 296½ miles are at present working, while 168½ miles are authorised and are under construction or reconstruction for electric traction. In addition to the 465 miles, we may fairly add 85 miles in course of promotion, which would make a total of 550 miles. The scope of our operations extends from Perthshire in the north to the English Channel, and from Northumberland to the borders of Cornwall. Among the new schemes are the Metropolitan Electric Tramways. This is an important enterprise, and it is a scheme of large proportions. All the difficulties of its initiation have now been overcome, and we are on the point of carrying out what will be one of the largest electric tramway systems in the United Kingdom, embracing not merely the whole of the tramways in the north of London now leased by the London County Council to the North Metropolitan Tramways Co. (about 62 miles), but including also all the light railways which have been promoted in conjunction with the Middlesex and Hertfordshire County Councils, and extending from the boundaries of the County of London to Watford in the north-west, Barnet, Enfield and Cheshunt in the north, and Walthamstow in the east (about 66 miles), so that when the scheme is completed we shall control at least 130 miles of electric tramways ramifying the whole of the important area north of the City of London. We are, of course, engaged on many other schemes, about which I should like to speak to you, but time will not permit. There is, however, one enterprise which is becoming so large that it will form a very important proportion of our total investments, and that is the combination of electric tramways and light railways in South Staffordshire, Warwickshire and Worcestershire. We have bought up or obtained control of all the traction companies in the district. The total mileage of this network is 126 miles.

I mentioned on a former occasion that the board consider it desirable that we should have close association with some manufacturing works for the purpose of supplying our various undertakings with apparatus and for carrying out repairs and making replacements, and also for storing materials which are required for the daily operation of our undertakings. With this view, it will be remembered you authorised us to make a proposal to the shareholders of the Brush Electrical Engineering Co. to exchange shares in that company for shares in this company, and a large proportion of their shareholders have accepted this offer. We have also assisted the Brush Company with capital, and some of the directors of this company are now directors of that company. We think the policy of merging the interests of the two companies should be extended, and we propose that another offer be made of shares in this company in exchange for shares in the Brush Company upon equitable terms. This brings me to another matter referred to in the report—the absorption by this company of the Electrical Power Distribution Co. (Ltd.). That company was capitalised mainly by the British Electric Traction Co. and the Brush Company jointly, and is carrying on business on practically identical lines with that carried on by the British Electric Traction Co. It was originally formed independently of either company, for the purpose of doing work which did not at that time fall within the scope of either ourselves or the Brush Company—namely, to promote and carry out electric lighting and power schemes. Very soon after the formation of the Distribution Company we felt it was in our interests and in those of the Brush Company to support the Distribution Company, and to identify ourselves with it, because the Distribution Company was a large buyer of apparatus which could be supplied by the Brush Company, and many of its lighting and electrical power schemes could be worked very advantageously with our tramway and light railway schemes. In view of the close alliance of the three companies we have come to the conclusion that it will be more satisfactory that the Distribution Company should be merged in the British Electric Traction Co., and that its various subsidiary companies should be associated companies of the British Electric Traction Co. I should mention that our company and the Brush Company jointly hold very nearly the whole of the ordinary shares and exactly half of the preference shares of the Distribution Company.

With reference to the proposed increase of capital. The new business we are developing is of a distinctly more profitable character. We are not only increasing our traffic receipts, but they show a relative increase per route mile—that is, we are not merely taking more money because we have more miles of tramways, but we are taking more per mile than in previous years, and we are earning a larger net profit on a larger capital. The absorption of the Distribution Company will require about £200,000. Having nearly exhausted our present borrowing powers, we must make provision for the further development of the business. We, therefore, propose that our capital should be at once increased by £1,000,000 in ordinary and £1,000,000 in preference shares, and this will give power to issue £1,000,000 in debenture stock. This exactly doubles our existing capital. We have not thought it advisable to increase the dividend on the ordinary shares this year over 9 per cent., but we have set aside for special reserve £19,000, besides other reserves, as an act of prudence. As the dividend has not been increased, the directors think the shareholders should have the advantage of the new issue of shares. The price of the shares in the market is so low that no public issue could be made at the present moment except at a sacrifice of premium, and if shares have to be issued at a sacrifice, we think that it should be done in such a form that the advantage which the Company sacrifices should go to the shareholders. It is proposed that each shareholder should have one new share in respect of each 10 shares he now holds; and we are arranging to issue coupons for fractions of a share.

It is a matter of great satisfaction to the board that the superannuation fund and the friendly society have succeeded so well. The superannuation fund is for the benefit of the staff and the friendly society is for the benefit of the men, and both are in a thoroughly satisfactory and flourishing condition. The superannuation fund has now been joined by 30 of our associated companies, and the number of contributories have greatly increased in the past year. The total number of men employed by our companies is about 3,000, and already 1,255 have joined the friendly society, and 19 branches have been started. I have previously referred to a proposal for the establishment of a sinking fund on behalf of our associated companies. Some difficulties have presented themselves in formulating the scheme, which, however, we believe will be overcome shortly. I now move the adoption of the report and accounts, and the payment of the dividends therein referred to.

Mr. CROFT asked, with respect to the Brighton and Shoreham tramways, if there was any prospect of the difficulties which had been met with being overcome.

The CHAIRMAN: I am afraid the difficulties as to Brighton and Shoreham have rather increased than diminished.

A SHAREHOLDER asked if the offer to the Brush shareholders was intended to embrace the whole of the shareholders or not, and would the debenture-holders be included.

Mr. E. GARCKE said all the shareholders of the Brush Company would have the offer made to them, but it would not affect the debenture-holders.

Mr. BALDWIN called attention to a certain point in connection with the proposed absorption of the Electrical Power Distribution Co. When that company was established 200 deferred shares were given to gentlemen who were now on the board of the British Electric Traction Co. On the absorption of the Distribution Company it was proposed to pay those gentlemen £10,000, which he might take as a bonus that they would receive out of the promotion of the Electrical Power Distribution Co. He thought the shares in question should really have been held in trust by the directors for this company, and that the amount should not go to gentlemen who were members of the board.

The CHAIRMAN: It is the case that some of these gentlemen are directors of this company, but it was entirely in their own individual capacity, and irrespective of their connection with the British Electric Traction Co. that they some years ago established the Electrical Power Distribution Co. That being so, they obtained under the arrangements with that company these 200 shares, to which certain rights appertain.

Mr. BALDWIN said his point was that the Electrical Power Distribution Co. was promoted by the British Electric Traction Co. and not by the gentlemen in question in their private capacity.

The CHAIRMAN: It was without any knowledge on my part that they entered on that enterprise; they did it entirely in their private capacity The Electrical Power Distribution Co. was not promoted by this company.

Mr. BALDWIN said the auditors' report stated that premiums received on shares of the company were considered as part of the profits of the company, and certain commission went to some of the members of the board out of these premiums being taken as part of the profits. He wished to know what the amount of the commission was.

The CHAIRMAN: The commission is paid under contracts to which we are bound, and I do not think it is open to shareholders to go into a question of that sort, although I have nothing to hold back on the subject. The commission is a very reasonable one, and it is in accordance with contracts under which these services are given, and from which we cannot free ourselves. The shareholders know pretty well what those services are, and without those services the company would not be what it is now.

The resolution was then carried, as were resolutions increasing the capital of the company from £2,000,000 to £4,000,000 by the creation of 200,000 new shares of £10 each, 100,000 preference and 100,000 ordinary, the preference to be entitled to a cumulative preferential dividend not exceeding 6 per cent. per annum, as the board of directors may before issue determine. The retiring directors, Mr. C. Shirreff B. Hilton and the Hon. Sir Charles W. Fremantle, K.C.B., were re-elected, as were the auditors, and a vote of thanks to the chairman and directors terminated the proceedings.

In connection with the remarks of the chairman of the British Electric Traction Co. as to the exchange of that company's shares for those of the Brush Electrical Engineering Co., we understand that the shareholders of the latter have received an offer from the Traction Company for an exchange in the following proportions:—One fully-paid £10 ordinary share of the British Electric Traction Co. for 10 £2 fully-paid ordinary shares of the Brush Company. One fully-paid £10 preference share of the British Electric Traction Co. for six £2 fully-paid preference shares of the Brush Company.

Electrical Power Distribution Co. (Ltd.).

At the general meeting of this company on Monday, Mr. EMILE GARCKE presided, and said: We may, I presume, regard the presence of so few shareholders as a proof that the majority take the report and accounts for the past year as being satisfactory. I desire to take this opportunity of explaining to the shareholders the reasons for the proposed merging of the Electrical Power Distribution Co. into the British Electric Traction Co. About four years ago a group of four persons, including myself, agreed that there was scope for developing electric power for various uses in this country. At that time neither the British Electric Traction Co. nor the Brush Electrical Engineering Co. felt that the work of developing electric power supply was within their province, and it was, therefore, decided to form a separate company for the purpose. Neither the B.E.T. nor the Brush took any part in the inauguration of this company. The initial risks, responsibilities and services were undertaken by the four directors—Messrs. Garcke, Raworth, Sellon and Madgen—and we decided to accept for the responsibilities and for the several years' work that ensued 200 deferred (or founders') shares, for which we paid cash, but which were entitled to certain rights after a dividend had been paid upon the ordinary shares. Subsequently, however, it became necessary to appeal to the public for further capital, and the existence of these founders' shares was considered a bar to the raising of that additional capital. The four holders of these shares then agreed that the company should have at any time within 10 years the right to extinguish the special rights which the shares

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conferred on their holders for a payment in cash of £10,000. That was the position of affairs when the British Electric Traction Co. and the Brush Electrical Engineering Co. came along and decided to take a large interest in its further development. The Brush Company, as a manufacturing concern is, of course, desirous of obtaining orders for plant and apparatus, and it made an agreement with us by which it received preferential consideration in the placing of orders for plant. The British Electric Traction Co., on the other hand, became alive to the fact that the future course of electrical work would be in the direction of combining electric lighting with electric traction. The wisdom of establishing large generating stations for the distribution of current over large areas had not until that time been fully realised. One of the schemes which this company was developing, could, it was considered, be better worked in conjunction with a scheme which the British Electric Traction Co. was then promoting. There are other matters of a personal character. I am not one to discourage emulation between different companies or despise the beneficial effects of competition. When this spirit of emulation is actuating the same persons in different capacities, however, it ceases to be beneficial, and is inconvenient. In this particular case it was rather embarrassing to myself as managing director of the British Electric Traction Co. and chairman of the Electrical Power Distribution Co., to distinguish fairly and adequately between the respective interests of the shareholders in the two companies. Therefore, we came to the conclusion that the best course was to merge their interests and to combine. The terms of the proposed amalgamation have been differently regarded by the interested parties. Some shareholders in the British Electric Traction Co. thought too much was being paid to the Distribution Company, while, on the other hand, two shareholders of the Distribution Company protest, not very strongly, but still they protest, that the consideration which the British Electric Traction Co. offer is not good enough. Your shares cost you £11 each, both ordinary and preference, and you are asked to exchange your ordinary shares for British Electric Traction ordinary, standing to-day at £14, and to exchange your preference shares for British Electric Traction preference, standing at about £12. 10s. Prima facie these terms rather support the views of British Electric Traction shareholders, who think you are receiving too much, but if I had to address the British Electric Traction shareholders instead of yourselves, I could adduce many reasons why the bargain should be carried out, notwithstanding this prima facie view. But my duty is at this moment to you, and to disprove the assertion of one gentleman, who has protested that the directors have looked after themselves, but have not looked after the shareholders. The shareholders in this company, by this proposal, are put in the position of British Electric Traction shareholders, whose undertaking is an eminently successful one. It is open to each shareholder to accept that offer or to decline it. If it were not for the fact that the British Electric Traction Co. and the Brush Company hold a very large proportion of the capital of this company, it would probably have been much more difficult to convince the shareholders and the board of the British Electric Traction Co. that this particular arrangement is a fair and equitable one. If I could divest myself of my personal interest in the transaction I should be disposed to use pressure to induce the shareholders in this company to make the arrangement. I do not think it necessary to defend my colleagues and myself against the suggestion that this is a deal which is proposed in their interest. We do this work because we like it, and we have the fullest confidence in the results of the work that we have done, and if the arrangement were not made we should be perfectly content to remain with the rights to which we are entitled. As to our future prospects, we possess two Acts of Parliament, one covering an important industrial and manufacturing area in the county of Durham, and another for an important area in the north of London. In both districts the British Electric Traction Co. are promoting and carrying out important electric tramway schemes. Then we possess 17 electric lighting orders and three tramway and light railway orders, together with three other provisional orders which have received the sanction of the Board of Trade and now await Parliamentary confirmation. You will have seen criticisms that we are mere company promoters, but we can point to very important construction and engineering works which we have carried out in connection with orders, &c, in the short time we have been at work. We have erected eight generating stations, all working satisfactorily. They are small stations, but most of our undertakings have a capital of five figures. They are all self-supporting, and they all promise to be remunerative at an early date. It is the opinion of many electrical men that you can only generate and distribute electricity in large quantities at a remunerative rate. But the work which this company has done and is still doing demonstrates that, providing the work is carried out economically and the methods of administration are sound, even small stations can be made remunerative. Then we have carried out a tramway scheme at Weston-super-Mare, in combination with an electric lighting scheme, and have one or two other similar ventures in course of construction, so you will see we have been doing much the same work as the British Electric Traction Co., and it has become embarrassing to treat with the separate sets of shareholders in these various matters. Now, if these various enterprises were carried out by separate groups of men each group would make their profits upon their portion of the work, and each party would endeavour to make its profit at the expense of the other party. But we combine all the various functions, and if a profit can legitimately be made out of each department of work, this company is entitled to make that profit. Therefore the result, I think, of combining these various operations and carrying them out consistently is to the general advantage. If those of our shareholders who cannot see the fairness of the proposed terms, and cannot come in on that understanding, I suggest that it would be more consistent that they should find investments in departments of industry other than electricity.

Before the resolution for amalgamation was put, Mr. ANDREWS further asked if the Electrical Power Distribution Co. would cease to exist as a separate company, and if some of the shareholders did not agree would the company be still carried on with separate directors and under separate management?

Mr. GARCKE said they would have to be dealt with by the liquidator. The resolution was then carried.

ANGUS ELECTRIC LIGHT AND POWER CO. (LTD.)—The directors' report for the year to Dec. 31 states that the works at Montrose and Brechin were completed in July, 1901, and a satisfactory supply has been maintained in both towns. At the end of the year the equivalent of 2,066 8-c-p. lamps were connected in Montrose, and 2,790 in Brechin, and at present 2,672 additional lamps had been applied for in Montrose and 1,502 in Brechin, making 9,030 in the two towns. The result of the six months' working, after paying expenses, has been a net profit of £42. 4s. 5½d., which it is proposed to carry forward. The capital account for Montrose was £22,154. 2s. 6d., and for Brechin £18,904. 2s. 10d.; 12,513 units of current were generated in Montrose and 18,233 in Brechin. Public lamps used 3,407 in Montrose and 5,695 in Brechin, and private consumers 5,895 and 5,348 respectively. The public lamps in Montrose were 10 arcs and 38 incandescents, and in Brechin 101 incandescents.

CALCUTTA TRAMWAYS CO. (LTD.)—At a meeting on Friday last to approve the sub-division of the £10 shares into £5 shares, a question was asked as to the opening of further electrical sections of the company's lines. Mr. E. C. Morgan, who presided, said but for technical points raised by the Government a second section of their line would have been opened a month ago. This line passed the telegraph office, and the company had had to pay for the raising of the telegraph wires so that they went well over the tramway trolley lines. The Indian Government insisted that the tramway guard wires to prevent broken telegraph wires coming in contact, should be exceptionally strong, and this had caused some delay, but they had, the previous day, received a cablegram notifying that the line had now been passed, and traffic was now proceeding on this second electrical section. Further sections would be opened in quick succession, and he hoped the whole electrically-equipped line would be ready by the end of July. The section just opened was 4 miles in length.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—The report of the directors for the year to Dec. 31 shows a balance to credit of profit and loss for the year's working of £71,978, which, with £10,855. 19s. 3d. brought forward, makes £82,833. 19s. 3d. Interest absorbs £4,078. 3s. 3d., preference dividend £10,000, depreciation of plant, machinery and furniture £7,134, machinery renewal fund £3,000, leaving £58,621. 16s. It is proposed to pay a balance dividend on the ordinary shares at the rate of 10 per cent. per annum, making 10 per cent. (tax free) for the year (£15,000), a bonus of 5s. per share (£7,500), a special bonus of 5s. per share £7,500), and to carry forward £28,621 16s. The directors consider the results of the past year's operations have been most satisfactory, especially in view of increasing competition. The plant and buildings at Erith have been maintained in a thorough state of efficiency, and the total cost of upkeep charged against the year's revenue. A large sum has been spent during the year on extensions. An opportunity recently presented itself of obtaining a plot of land, consisting of about 16 acres, with a large frontage to the Thames, and this the directors acquired, but have not yet proceeded to develop it. It will prove of great advantage to the company by rounding off the property previously in their possession. The business transacted during the past year was once again in excess of that of all previous periods, and the factory is now fully employed.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—At the meeting on Friday last Mr. W. Chadburn said the balance at credit of profit and loss was £11,576, and after deductions for directors' remuneration and depreciation £8,765 was left for division. Interim dividends had been paid on both preference and ordinary shares, and the directors now recommended further dividends, making the full payment on the 6 per cent. preference, and 8 per cent. on the ordinary shares. The business was in a thoroughly sound condition. Orders were well maintained, and the outlook for the future was most promising. They had no doubtful debts. They had made a bad debt during the year but this was wiped off. Their reserve fund consisted of the £4,294 carried forward, and which was available either for dividend or for extensions. They had the cream of the trade in their particular line of business, and whatever orders passed them were those with which they could very well do without. Ironmongers might claim to set up telegraph installations on vessels; but what their company aimed at was to put in installations which would last as long as the vessel itself. In this policy they had been very successful. The report and accounts were adopted. A sum of £50 was voted to Mr. J. D. Lynch, the secretary, for valuable services rendered to the company.

MERTHYR ELECTRIC TRACTION AND LIGHTING CO. (LTD.)—Mr. E. Garcke presided at the meeting last week. He said the accounts dealt with the eight months to Dec. 31. The operations of the company had shown every hopeful sign of vitality, and the returns amply repaid the suspense of waiting for dividends. On the 3 miles of line which they had open they had carried 1,619,704 passengers, at an average fare of 1·41d. per head. Up to the close of the account there had been expended on capital account £86,850. Of this £29,927 was expended last year—£13,215 for machinery, £9,833 for mains, and £641 for accumulators. The gross receipts of the tramways since their opening had been £9,587, and electric current supplied for lighting, which supply commenced on July 22, had realised £2,104. There was available for distribution £11,772, and, after deducting expenses and interest, there was a net profit of £3,208. It was proposed to pay the cumulative preference dividend, absorbing £862, place £1,000 to reserve, and pay 5½ per cent. on the ordinary shares, leaving £145 to be carried forward.

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PERTH (W.A.) ELECTRIC TRAMWAYS (LTD.)—At the meeting last week Mr. E. Heasman, in congratulating the shareholders on the progress made by the undertaking, said that for the first three months of the 18-month period under review 7 miles of their lines were in operation; this was ultimately increased to 13 miles, making the average 11½. With the increasing prosperity of the city of Perth, the company's undertaking would continue to increase in value. Those portions of their line which were first brought into operation showed large increases in the earnings as compared with the previous 12 months. Working expenses were then slightly over 60 per cent., while for the first 21 weeks of 1902 this percentage had been reduced to 52·6 per cent., and as further sections of the lines were opened and the traffic increased, there would doubtless be a still further reduction. £102,110 had been spent on capital account during the 18 months, all represented by valuable revenue-earning assets. An order had recently been placed for additional cars for their service which were immediately needed for the increasing traffic. At June 30, 1900, there was a debit balance of £2,957, which was wiped out at Dec. 31., 1901, and at present there was available for distribution £4,397. It was proposed to pay the dividends which had accumulated on the 6 per cent. preference shares up to June 30, 1901. This would leave a balance forward of £1,125. In this way a dividend on the ordinary shares was brought nearer, and he hoped the time was not far distant when the ordinary shareholders would receive a proportion of the profits. Mr. A. H. P. Stoneham, who had recently visited Perth, said the company's system was an excellent one and was well conducted. Certain improvements were necessary, however. The car house required to be enlarged, and more cars would have to be provided. More suitable repairing shops and additional boiler power were necessary, but all this expenditure would be amply returned to them. The directors' report was adopted.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 15/16d. per oz. (June 19). Consols (2¾ per cent.) 96½—96⅝ for money, 96⅝—96¾ for account; 2½ per cent. 96½—97 (June 19). Consols Pay Day July 2; Stocks and Shares Continuation Days, June 21 and July 9; Ticket Days, June 23 and July 10; Pay Days, June 24 and July 11; Mining Share Carry-over Days, June 20 and July 7.

AFRICAN TELEGRAPH CO. (LTD.)—The coupons on this company's 4 per cent. mortgage debentures, due July 1, will be paid at Parr's Bank, Bartholomew-lane, London, E.C. The debenture register will be closed from 24th to 30th inst. inclusive.

CHARING CROSS, EUSTON AND HAMPSTEAD RAILWAY CO.—A special meeting was held on Wednesday, when a motion approving the act for incorporating the Edgware and Hampstead Railway Co. and for authorising the construction of railways, partly underground, from Edgware to Hampstead, was passed.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—The directors' report is issued for the year to May 31, 1902, and states that the gross profit was £32,247. 10s. 11d. After deducting expenses, interim preference and ordinary dividends, and providing for accrued preference dividend to May 31, there is a net balance of £20,470. 8s. 9d. It is proposed to carry £10,470. 8s. 9d. to contingencies account to strengthen the funds available for dealing with future business. The balance of £10,000 is to be devoted to the payment of the dividends and bonuses set out in our last issue.

GENERAL ELECTRIC CO. (1900), LTD.—The transfer books of the preference shares are closed from 16th to the 30th inst. inclusive, for the payment of the half-yearly dividend.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—An interim dividend of 5s. per share is announced.

HAVANA ELECTRIC RAILWAY CO.—Applications were invited last week to an issue of $7,500,000 5 per cent. consolidated mortgage 50-year gold bonds of $1,000 (part of a total authorised issue of $10,000,000). The price of issue was 98 per cent. The issue was made in London, New York and Montreal. The Havana Electric Railway Co. is incorporated under United States (New Jersey) law, and is formed to acquire, work and extend the undertaking of the Ferro Carril Urbano y Omnibus de Habana, established in 1876, and whose concession expires in 1958.

HENLEY-CALLENDER AMALGAMATION—Notice is given under date of June 14, that certain differences have arisen between the parties to this proposed amalgamation as to the terms of the proposed combine, which, in the view of the boards of directors of both companies, render it impracticable, at any rate for the present, and the negotiations have, therefore, by mutual consent, been treated as at an end.

KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION (LTD.)—The report for the period from Oct. 1, 1900, to Dec. 30, 1901, states that the contract with Messrs. J. G. White & Co. (Ltd.) for the erection of a complete electrical power transmission plant will soon be completed. The directors were enabled to supply power on May 1 to the Kalgoorlie Electric Tramway Co., which has contracted for a supply of current for 10 years. The tramway was opened on May 20. Further capital is necessary for subsidiary machinery, including rotary transformers, motors, hoists, pumps, &c., and the directors have created an issue of £50,000 6 per cent. debentures, of which a portion has been placed.

MUNICIPAL ISSUE.—The Newport (Mon.) Corporation have this week invited applications for £300,000 Corporation 3 per cent. redeemable stock, at £95 per cent., for electric tramways, electric lighting extensions, &c.

PEKING AND NORTH CHINA ELECTRICAL CORPORATION (LTD.)—This company, as announced in our last issue, has been formed with a capital of £100,000 in £1 shares. Subscriptions have been invited for £49,500 of these shares at par. The company takes over the concessions, &c., in China of the Siemens and Halske A. G., Messrs. H. Mandl & Co., and the Chinesische Elektricitäts Gesellschaft (m. b. H.), who have secured from the Chinese Government rights to establish electricity supply in Peking. The list closed yesterday (Thursday).

REUTER'S TELEGRAM CO. (LTD.)—At the meeting last week, Admiral Sir J. D. C. Hay, who presided, said the company had 108 special correspondents acting for them in South Africa in connection with the war, exclusive of their ordinary staff and local correspondents. He gave a graphic account of the extensive ramifications of Reuter's Company in all parts of the world, and of the outlay which so extensive a system involved. The directors' report and accounts were adopted.

STOCK EXCHANGE NOTICES.—The London Stock Exchange Committee has been asked to appoint a special settling day in 7,500 6 per cent. cumulative second preference £10 shares (£4 paid—£3 capital, £1 premium) of the *Bournemouth and Poole Electricity Supply Co. (Ltd.)*, and to allow the further issue of 10,000 6 per cent. cumulative preference £5, fully-paid, shares of the *British Insulated Wire Co. (Ltd.)*, and the further issue of 10,000 6 per cent. cumulative £10 preference shares of the *County of London and Brush Provincial Electric Lighting Co. (Ltd.)* to be quoted.

TELEGRAPH MANUFACTURING CO. (LTD.)—At a meeting of this company held on Monday a resolution for voluntary liquidation, consequent upon amalgamation with the British Insulated Wire Co., was approved.

THOMAS PARKER (LTD.)—The directors have resolved, subject to final audit, to declare a dividend of 10 per cent. for the year ended April 30.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	June 7	914	+ 165	1	914	+ 165
Ayr Corporation	„ 14	289	...	4	1,032	...
*Birmingham Tramways.	„ 14	4,649	+ 8	23	108,307	+28,823
*Blackburn Corporation..	„ 13	710	- 5	24	16,484	+ 2,187
Blackpool Corporation...	„ 12	603	- 144	11	6,914	- 788
Blackpool and Fleetwood	„ 14	471	- 82	24	7,845	- 580
Bolton Corporation	„ 15	1,470	+ 133	11	17,174	+ 477
Bradford Corporation ...	...	...	...	...	...	...
Brighton Corporation ...	„ 15	773	...	29	17,844	...
Brisbane Tramways.....	Apl. 30	2,238	+ 293	18	41,642	+ 4,719
*Bristol Trams & Carriage	June 13	4,235	- 269	23	97,659	+ 3,285
Burnley Corporation ...	„ 14	653	+ 251	‡11	7,561	+ 2,510
*Buenos Ayres & Belgrano	May 18	2,734	- 113	20	54,256	- 1,097
Calcutta Tramways Co...	June 14	R22,89)	+R1,174	24	R528,098	+R45,995
*Cardiff Corporation	„ 14	1,396	...	...	...	...
Carlisle Tramways Co....	„ 14	173	...	†24	3,398	- 14
Central London Railway	„ 14	7,000	+ 760	24	161,819	+13,044
City & South London Ry.	„ 15	2,953	+1,084	24	71,449	+24,217
Cork Elec. Tramways Co.	„ 12	585	+ 49	§23	10,193	+ 317
Devonport & Dist. Trams	„ 6	451	...	22½	9,000	...
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	„ 14	206	- 11	11	2,267	- 123
Dublin & Lucan Railway	„ 15	111	- 4	24	2,320	+ 62
Dublin Southern Dist....	„ 13	853	- 60	¶23	18,769	+ 3,630
Dublin United	„ 13	3,690	- 89	¶23	82,186	
Dudley—Stourbridge ...	„ 6	769	+ 168	22½	15,440	+ 2,259
*Dundee Corporation ...	„ 11	781	+ 68	...	...	...
East Ham Council	„ 14	387	...	51	18,851	...
Gateshead & Dist. Trams	„ 6	730	+ 277	22½	14,860	+ 1,251
Glasgow Corporation ...	„ 14	11,648	+ 228	2	23,830	+ 812
Greenock & Port Glasgow	„ 6	521	+ 316	22½	9,573	+ 5,455
Hartlepool Tramways ..	„ 6	257	+ 6	22½	4,787	+ 371
Hull Corporation	„ 14	1,716	+ 54	11	18,429	+ 212
Isle of Thanet Co.	„ 7	628	- 43	...	...	...
Kidderminster & Dist....	„ 6	129	+ 11	22½	2,398	+ 51
Leeds Corporation	„ 14	4,635	+ 374	11	57,228	+ 8,243
*Liverpool Corporation...	„ 7	10,492	+ 902	23	209,534	+15,820
Liverpool Overhead Rly.	„ 15	1,407	- 200	‡24	34,281	- 3,432
Manchester Corporation	„ 16	4,874	...	§53	118,075	...
Merthyr.....	„ 6	217	- 11	22½	4,410	- 668
Middleton.....	„ 6	297	...	10½	3,253	...
Newcastle-on-Tyne Corp	...	...	...	...	...	...
Oldham, Ashton & Hyde.	„ 6	559	- 24	22½	11,036	+ 85
Perth (W.A.) Elec. Trams	„ 13	978	+ 123	‡50	49,267	+15,411
Poole & Dist.....	„ 6	262	+ 2	22½	4,946	- 73
Portsmouth Corporation	„ 14	1,450	+ 797	...	...	...
Potteries	„ 6	1,518	+ 163	22½	31,643	+ 1,195
Salford Corporation ...	„ 16	2,486	+ 756	11	26,958	...
*Sheffield Corporation ..	„ 15	3,984	+ 401	24	90,944	+14,508
Southampton Corporat'n	„ 12	919	+ 73	23	19,346	+ 3,275
Southport Tramways ...	„ 6	303	+ 65	22½	4,469	+ 1,277
*S. Staffordshire Trams...	„ 6	828	+ 94	22½	16,936	+ 503
Sunderland Corporation.	...	...	...	...	...	...
Swansea Trams.....	„ 6	487	+ 68	22½	9,597	+ 827
Taunton Trams.....	„ 6	78	...	22½	1,306	...
Tynemouth & Dist.	„ 6	266	- 1	22½	4,816	+ 249
Wigan Corporation	„ 12	228	+ 16	11	2,236	+ 1,201
Wolverhampton District	„ 6	146	+ 96	22½	3,215	+ 2,069

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 11.	Price Wednesday, June 18.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 18	
						£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.						
100,000	1	...	Hl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½ ¼	½ ¼		...	..	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100 104	100 104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11 12	11 12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	103 106	103 106	6 5 2	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	8¾ 9¼	9 9¼	4 4 3	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8¾ 9¼	9 9½	3 13 8	March and September	9¼	...
[2],000	5	3 6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8½ 9¼	8½ 9½	3 3 2	...	9⅜	...
10,000	5	3/4½	Do (Nos. 20,001-30,000)	8½ 9¼	8½ 9½		...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105 107	105 107	3 14 11	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9 10	9 10	5 0 0	February and August	9½	9 1/16
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...	..	..	..
70,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	,, ,,	5⅝	5 1/16
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105 107	105 107	3 15 6	...	106¾	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936) xd	5 5½	5 5½	2 14 6	March	...	...
£40,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.) xd	110 113	108 111	4 1 1	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8 9	8 9	5 5 7	February and August	8⅜	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	11½ 12½	11½ 12½	4 16 0	January and July	12 1/16	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123 128	123 128	3 18 10	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103 106	103 106	4 6 0	...	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	7½ 8½	7½ 8½	4 14 2	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	13	12½
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	108 111	109 112	4 2 8	...	111	110½
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5¾ 6¼	5¾ 6¼	3 12 0	...	5¾	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6¼ 6¾	6¼ 6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...	...
£115,000	Stock	4%	Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104 107	104 107	3 14 11	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1½ 1¾	1½ 1¾	..	...	...	...
19,840	5	3/0	Do. 6 per Cent. Preference	4 4½	4 4½	6 13 4	...	..	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures xd	95 100	94 99	4 0 10	Mar., June, Sept., Dec.	96½	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16¾ 17½	16 17	3 16 6	April and October	16⅞	16½
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	111 115	111 115	3 18 2	June and December	...	...
£240,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	98 101	93 101	3 10 4	...	100½	99½
10,852	10	6/0	Notting Hill Electric Ordinary	14 15	14 15	4 0 0	March	14½	...
12,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	99 102	99 102	3 18 10	...	...	...
300,000	1	...	Rand Electric	1 1/16 1/16	1 1/16 1/16	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70 75	70 75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103 105	103 105	4 6 9	April and October	...	...
40,000	5	9 6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15¼	4 13 7	February and August	15½	15 7/8
30,000	5	3/6	Do. 7 per Cent. Preference	8¾ 9¼	8¾ 9¼	3 13 8	,, ,,	8⅞	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98 101	98 101	3 9 6	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1¾ 2¼	1¾ 2¼	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	...	...
65,000	5	..	South London Electric Supply Ordinary	3 3½	2¾ 3½	..	...	3	...
110,000	5	5 6	Westminster Electric Supply Ordinary	11 12	11 12	4 7 6	March and September	11⅝	11 1/16
28,141	5	1/3	Do. 5 per Cent. Cumulative Preference xd	3½ 4	3½ 4	...	...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4¼ 4½	4¼ 4⅜	4 8 11	April and October	4 1/16	4 1/16
£280,000	Stock	6%	Do. Permanent 6% Deb. Stock	127 132	127 132	4 12 7	...	...	...
20,000	10	...	Barcelona Tramways Ordinary xd	8½ 9½	8 9	3 6 8	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	8¾ 9⅜	8½ 9⅜	5 5 3	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95 100	95 100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½ 14½	13½ 14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams. Investment Ord.	3¾ 4	3¾ 4¼	...	...	3 1/32	...
75,000	5	2/6	Do. 5% Cum. Pref.	4¾ 5	4¾ 5	5 0 0	...	4 1/32	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	104 107	104 107	4 4 1	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106 108	106 08	3 14 1	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7 7½	7 7½	2 13 4	...	7⅞	...
20,000	10	5/0	Do. 5% Preference	9¾ 10¼	9¾ 10¼	4 17 6	May and November	...	..
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102⅝ 104⅞	102⅞ 104⅞	4 6 9	...	1 3½	103
100,000	10	6/0	British Electric Traction Ordinary	13⅜ 14⅛	13⅜ 14½	6 4 2	...	14⅛	13⅞
100,000	10	6/0	Do. 6% Cum. Pref.	12⅜ 13	12⅜ 13	4 12 4	February and August	12⅝	12 1/16
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126¾	124 1
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝ 1⅞	1⅝ 1⅞	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅞ 5¼	4⅞ 5¼	5 14 3	...	...	...
37,500	5	10/0	Do. "B"	4⅞ 5¼	5 5⅛	5 9 1	...	5 1/16	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	104 107	104 107	4 13 9	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 0	...	...	...
25,000	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	13½ 14½	14½ 15½	2 0 0	...	15¼	13⅞
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	108 110	108 110	4 3 1	...	...	...
480,000	1	1/2⅞	Cape Electric Tramways Shares	2⅝ 2⅞	2⅝ 2⅞	3 16 2	...	2⅛	...
£1,810,014	Stock	4%	Central London Ordinary Stock	103 106	104 107	3 15 1	June and December	106¼	101⅜
£494,993	Stock	4%	Do. 4% Preferred Stock	104 107	103 106	3 15 11	...	...	...
£494,993	Stock	4%	Do. Deferred Stock	100 103	100 103	3 17 10	...	102	...
£698,201	100	4%	Do. 4% Deb.	116 119	117 120	3 7 8	...	1 8	117
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5½	4¾ 5¼	4 10 11	...	5	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...	...
£1,330,000	Stock	2½%	City and South London Railway Con. Ordinary	71 74	71 74	2 14 1	February and August	71	...
37,500	10	1/0⅝	Do. Ordinary (Nos. 22,501 to 60,000)	...	...	...	,, ,,	...	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	..	...	...	...	...	..
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 15 5	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	126 129	127 130	3 18 2	...	...	...
£150,000	Stock	...	Do. (1901)	124 125	124 125	...	...	124½	124
£446,463	Stock	5%	Do. 4 per Cent. Perpetual Debenture	115 118	115 118	3 9 7	May and November	11 ¼	117
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛ 12⅛	11⅛ 12⅛	3 16 11	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14⅜ 15⅜	14⅜ 15⅜	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...	...
30,000	5	6,0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4¼ 4⅜	4¼ 4⅜	6 6 4	...	...	...
£75,000	Stock	40/8	Do. 5 per Cent. Debenture Stock (red.)	101 104	101 104	4 16 2	...	...	...
78,600	10	3,0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	...	8⅜	8 1/16
20,000	10	8%	†Imperial Tramways Ordinary	23 24	23 24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½ 14	13½ 14	4 5 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110 112	110 112	4 0 6	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½ 5	4½ 5	...	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4 13/16 4 15/16	4 13/16 4 15/16	3 0 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅜ 11	10⅜ 11	4 11 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98 99	98 99	4 0 10	January and July	...	...
[51,561	10	..	London United Trams 5% Cum. Pref. (£10 paid)	10¾ 11¼	1 ¾ 11¼	...	...	11⅛	10⅞
20,999	10	...	Do. (£5 paid)	5½ 6	5½ 6	...	...	5⅜	...
£655,341	Stock	...	Do. 4% 1st Mortgage Debenture Stock	106 108	106 108	...	...	108	...
£169,659	Stock	...	Do. Prov. Certs. (£50 paid)	55 57	55 57	...	...	...	...
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	115 119	115 119	4 5 7	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'r'l g 5% Mort. Debs. (1908)	104 106	104 106	4 14 9	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	104 106	104 106	4 6 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 13 4	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3 4	3 4	7 10 0	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96 100	96 100	5 0 0	...	...	...
£150,000	Stock	12/4	Perth (W.A.) Elec. Trams, Ltd, 1st Mort. Deb. Stck.	100 103	101 104	4 12 6	...	103½	103
23,334	10	8/0	Potteries Electric Traction Ordinary	9½ 10⅛	9 10	4 0 0	...	9	...
10,000	10	5 0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	107 110	107 110	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...	...	...	...
51,188	1	...	Do. 6% Preference (12/0 paid)	...	...	...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...	...	...	,, ,,	...	...
500,000	Stock	...	Do. 5% Debenture Stock (60% paid)	...	...	...	January and July	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 11.	Price Wednesday, June 18.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 18. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3½ 4½	3½ 4½	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70 80	70 80	...	...	...	...
£788,840	Stock	12/6	Anglo-American	44 47	44 47	5 19 5	Feb., May, Aug., Nov.	45½	...
£3,105,580	Stock	25/0	Do. Preferred	87 89	86 88	6 10 10	,, ,,	88	87
£3,105,580	Stock	2/0	Do. Deferred	⅝ 7½	6½ 7	1 8 7	,, ,,	6 15/16	6½
$13,333,300	$100	$12½	Commercial Cable Capital Stock	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	95 97	96 98	4 2 6	,, ,,	97½	96½
16,000	10	4/0	Cuba Submarine Ordinary	4½ 5½	4½ 5¼	7 5 6	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½ 13½	19½ 15½	7 8 2	,, ,,	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅝ 3½	2½ 3½	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8½ 9½	8½ 9½	5 5 3	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	98⅞ 102⅞	99⅞ 103⅛	4 7 8	January and July	...	...
60,710	20	3/0	Direct United States Cable	9½ 10½	9½ 10¼	6 3 10	Jan., Apr., July, Oct.	...	...
£101,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99 102	100 103	4 7 8	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200) (red.)	120 130	120 130	5 7 8	Jan., Apr., July, Oct.	124½	121
£1,955,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	87 89	87 90	3 18 3	,, ,,	89⅛	83½
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	107 111	107 111	3 12 2	May and November	110	108
300,000	10	6/6	Eastern Extension	12 13	12 13	5 7 8	Jan., Apr., July, Oct.	13⅝	12
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	108 113	108 113	3 11 4	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99 102	100 103	3 19 0	February and August	101¾	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	99% 102%	100% 103%	3 18 3	May and November	...	...
150,000	10	20/0	Great Northern of Copenhagen	25 27	25 27	5 11 1	January and July	...	...
£75,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos.	99 103	99 103	4 8 3	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	37 41	37 41	6 1 11	May and November	41	40
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100 104	100 104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99 102	99 102	3 18 7	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3½ 4½	3½ 4⅜	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	99 102	99 102	4 19 0	March and September	...	...
30,008	2½		West Coast of America	⅛ ⅜	⅛ ⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅛ ⅜	⅛ ⅜	...	May and November	...	...
34,563	10	£/0	Do. 6 per Cent. 1st Pref.	5½ 5¾	5½ 5¾	10 8 8	,, ,,	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅞ 4⅛	3⅞ 4⅛	...	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	101 104	101 104	4 16 8	January and July	...	...
207,930	10	3/0	Western Telegraph (late Br zili'n Submarine)	11½ 12½	11½ 12½	5 16 4	Mar., June, Oct., Dec.	11⅛	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102 105	102 105	4 15 3	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99 102	99 102	3 18 5	...	102	100½
			TELEPHONES.						
44,000	£5	5 0	Chili Telephone (fully paid)	3⅞ 4	3⅞ 4½	5 18 0	August	4 1/16	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6 2/6	1/6 2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½ ¾	½ ¾	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	,,	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95 99	95 99	6 1 3	...	...	...
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	3½ 3⅝	3½ 3⅝	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	53 57	53 57	7 17 11	...	54	...
15,000	£6	6/0	Do. 6 per Cent. Cumulative 1st Preference	12 14	12 14	4 5 9	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12 14	12 14	4 5 9	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞ 5⅛	4⅞ 5⅛	4 17 6	,, ,,	5 1/16	5
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	94 97	94 97	3 12 5	June and December	93	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	103 107	103 107	3 15 8	...	...	...
171,504	1	0/8⅝	Oriental	15/16 1 1/16	15/16 1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	4⅜ 5⅛	5 5⅛	6 7 3	July	...	...
40,000	5	2 6	Do. 5% Cumulative Pref.	4⅜ 5	4⅜ 5⅛	4 15 3	June and December	...	...
£179,947	Stock	5	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 8	June and December	...	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜ ½	⅜ ½	5 14 3	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛ ¼	⅛ ¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜ ½	⅜ ½	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7⅛ 8½	7⅛ 8½	5 17 8	July and February	...	...
70,000	5	3/0	Do. 6 per Cent. Preference	5½ 6	5½ 6	5 0 0	January and July	...	...
£250,000	Stock	50/3	Do. 4½% 1st Mort. Deb. Red.	101 104	102 105	4 7 5	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	5⅝ 6	5⅝ 6	5 0 0	...	...	...
105,731	2	...	Brush Electrical Engineering	1⅜ 1⅝	1⅜ 1⅝	...	March	1½	...
150,000	2	1/3½	Do. 6 per Cent. Pref. Non-Cum.	1⅝ 2¼	1⅝ 2¼	...	March and September	1⅝	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101 104	101 104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	95 100	95 100	4 10 0	January and July	...	...
20,000	5	10/0	Callender's Cable Construction Ord. xd	17 18	16 17	4 8 3	,, ,,	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅜ 6¼	5⅜ 6¼	4 0 0	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111 115	111 115	3 18 4	November and May	...	...
450,000	1	0 9⅜	Castner-Kellner Alkali Co. (fully paid)	1 1⅛	1 1⅛	4 16 0	...	1⅛	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	93 95	93 98	4 13 9	...	94	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	8 0 0	March	...	...
85,000	3	1/9⅜	Crompton and Co. (Nos. 1 to 54,000)	3 3½	3 3½	6 8 6	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103⅜ 108⅜	103⅜ 108⅜	4 12 8	,, ,,	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜ ⅝	⅜ ⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1½ 2⅛	1⅜ 2⅛	...	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	75 80	75 80	5 1 3	June and December	...	...
£5,500	5	2/6	Edmundson's Electricity Corporation Ord.	6¼ 6¾	6¼ 6¾	5 3 8	Half-yearly	6⅜	...
33,000	5	3/0	Do. 6% Cumulative Preference	5½ 6¼	5½ 6¼	4 16 0	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	108 111	108 111	4 2 0	...	...	...
112,100	2	1/2½	Electric Construction Co.	1½ 1¾	1½ 1¾	6 17 2	January and July	...	...
31,390	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2½ 3	2⅜ 3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 102	99 102	3 18 11	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾ 1¼	¾ 1¼	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	10 10⅜	10 10⅜	4 15 3	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98 101	98 101	3 19 3	...	...	...
35,000	5	10/0	Henley's Telegraph Works Ordinary	16½ 17½	16½ 17½	4 5 9	February and August	16⅜	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅜ 6	5⅜ 6	3 15 0	,, ,,	5 1/16	5½
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 115	111 115	3 18 3	,, ,,	...	...
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	,, ,,	2 3/16	2 ⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 102	99 102	3 18 5	March and September	101⅜	100½
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½ 16½	15½ 16½	6 1 8	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34 37	34 37	6 9 8	March and July	33	35
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 5	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	9½ 10½	...	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	...	4 8 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	...	...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	...	...	...	,, ,,	...	...
			FINANCIAL, INVESTMENT, &c.						
19,900	5	3 0	Electric and General Investment 6% Cum. Pref.	5⅛ 5⅜	5⅛ 5⅜	5 9 1	...	...	...
180,227	10	2/6	Globe Telegraph and Trust	8 9	8 9	5 16 8	Jan., Apr., July, Oct.	8⅜	8⅛
180,042	10	3/0	Do. 6 per Cent. Preference	12½ 13½	12½ 13½	4 8 11	,, ,,	13⅛	12½
11,339	8	4 0	Reuter's	7 8	6½ 7½	5 6 8	April and October	...	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110 120	110 120	5 0 0	,, ,,	112	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee have refused to quote these.

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NOTES.

As we go to press this week, earlier than usual in anticipation of the Coronation, the sad intelligence reaches us that HIS MAJESTY'S recent indisposition has taken an acute and most serious turn, necessitating immediate surgical operation. The loyal sympathy of all HIS MAJESTY'S subjects will be tendered to KING EDWARD on this lamentable crisis in his life, and all will fervently wish that he may be speedily and completely restored to health and strength. Long live the KING!

IN our Parliamentary columns this week we record a further stage in the London tramway schemes. The House of Lords in passing the second reading of the London County Council Bills, passed an instruction to its Committee to delete the clauses which refer to the tramways along the Embankment, and, as the House of Commons is hardly likely to go to the extent of re-inserting these clauses, it is probable that the Thames Embankment will be spared in its present condition for another year at least. The London United Tramways Co. has also been successful in passing the greater portion of its Bill through the House of Commons Committee stage, although three important amendments have been made in Committee. As announced in our last issue, the line over Hammersmith Bridge has not been allowed, and, in the final decision of the Committee, the line of tramway up to Wimbledon Common is thrown out on account of the local opposition to it, and the agreement with the Urban District Council of Barnes to extend the purchase period to 50 years has not been allowed, the period having been reduced by the Committee to 30 years. During the hearing of this Bill a welcome announcement was made to the effect that the London and South-Western Railway recognised the advantages of electric traction and would equip their suburban lines electrically—and possibly also their main lines at a future date.

A YOUTH who has been unconsciously imitating Mr. A. P. TROTTER'S performances on the bare 500-volt rail, but without the knowledge of how to take safe precautions, has just paid the penalty with his life. The boy, a lad of 13, who had been paddling in the "sea" at Southend, in the vicinity of the pier, climbed on to the pier, and stood with bare wet feet on the 500-volt tramway rail. Probably one foot was on the live rail while the other touched the track, for he fell dead, with severe burns about the body. This sad fatality serves to illustrate the fact, which Mr. TROTTER'S demonstrations were designed to emphasise, but which the public is very apt to overlook or misunderstand—viz., that when properly treated the 500-volt bare conductor is not a serious danger, but that when meddled with its possibilities of working evil are immense.

AN article by M. J. BORDELONGUE, in another column of this issue, puts forward a strong case for the partial abolition of the multiple telephone switchboard in the case of those large urban districts which are served by several exchanges. Taking Paris as an example, he points out that the number of calls received at one exchange for connection to a subscriber on the same exchange is a small percentage of the whole, varying, in fact, from 1·7 to 19 per cent. Hence, he recommends that in such cases the complete multiples should be done away with on the subscribers' sections of the switchboard, leaving only the local jacks and the multipled outgoing junction lines, and that the method of operating should be changed so that every call (no matter whether for a subscriber on the same exchange or on a distant exchange) is dealt with through an outgoing junction line. When considering M. BORDELONGUE'S estimate of the saving which will be effected by introducing this arrangement into the Paris system, it must be remembered that the present system of junction working in Paris does not compare in efficiency with the one in use in the larger towns in this country. Moreover, one or two items are omitted in his calculations, such as the extra amount of work necessary for the operators on the subscribers' board, and the extra number of junction lines which

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will have to be provided from the local to the incoming junction board of the same exchange. These will have to be multipled on all the subscribers' sections of the switchboard, and will add to the cost. As to the third wire which M. BORDELONGUE proposes to add to his junction lines for the automatic clearing signal, we think if he studies the matter further he will find that a suitable arrangement of bridging coils and earth connections is practicable and—at all events for inter-exchange junction lines of fairly great length—less expensive. Still, all things considered, it appears that, for the peculiar conditions in Paris, the proposed modification will be advantageous; in many other very large towns the traffic is so centralised that the proportion of outgoing junction calls from the central exchange is relatively small, but there may be other cases in which the multiple board is really the white elephant that M. BORDELONGUE's article suggests.

ON another page of this issue we give an abstract of an article by M. GIN, dealing with the temperature and efficiency of the electric furnace. The calculation of these data, as M. GIN himself admits, is a complicated problem, and we are not quite convinced that M. GIN has yet solved it. The temperature of the arc is so high that all gases and substances submitted to it are in a state of partial or complete dissociation, and physical constants which may be reliable for lower ranges of temperature, are likely to be rendered of little value for calculation when dealing with the conditions obtaining in the neighbourhood of the arc. In M. GIN's latest formula for calculating the temperature of an electric arc furnace, there are two physical constants, p and c, representing the resistance and specific heat of the gaseous or fluid medium lying between the two electrodes. We fail to see that reliable figures for these are available, and until a large amount of experimental work, dealing with the physical constants of gases at high temperatures, has been carried out, M. GIN's formula must remain of doubtful practical value.

Erratum.—In our report last week of the deputation from the Institution of Electrical Engineers to Mr. Gerald Balfour (p. 348), we mention Tuesday as the day upon which the deputation was received. This should, of course, read Wednesday.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Bolama	April 19, 1902
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Puerto Plata—Fort de France	May 31, 1902
Jeddah—Suakim	June 18, 1902
Mozambique—Majunga (Madagascar)	June 19, 1902

Colour Line in Virginia.—On May 1st last a law came into effect which enacted that certain street railway companies in the State of Virginia should separate the white from the coloured passengers, the portions of the cars in each case to be distinctly designated. No difference is to be made in the quality of the accommodation provided for each race, but all persons who shall refuse to take instructions as to the portions of the cars they shall occupy are to be considered guilty of misdemeanour, and upon conviction fined not less than $5, or more than $25.

Electrically-driven Grain Elevators.—Three large elevators for the handling of grain are in operation at West Superior, Wisconsin, the entire plant being controlled by the Great Northern Railway Co.; 62 motors, ranging in size from 7½ H.P. to 100 H.P., are used in the three buildings, and the motors run on a 400-volt three-phase circuit. Current at this pressure is generated by two units of 410kw. and 300kw. respectively, slow-speed Corliss engines being coupled directly to the alternators. Three-phase motors are used for all the work of the elevators, and in the majority of cases a rope drive is employed.

Lupus Cured by X-Rays.—A remarkable case of cure of lupus by means of the application of X-rays has occurred in Newcastle-on-Tyne. A woman who had suffered from the disease for over 30 years was operated upon at the hospital. For nearly 200 consecutive days she was subjected to exposures of 15 minutes' duration, and after inflammation of the tissues had set in a complete cure ensued. The woman's face is left practically free of scars, and for the first time for 30 years she has given up wearing a veil. During last year alone 20 lupus cases were treated and 15 of them resulted in successful cures.

Electric Sewage Pumping.—A new system of sewage disposal has recently been put into operation at Fond du Lac, Wisconsin, the chief feature of the plant being the employment of electro-motors for pumping purposes. The effluent is dealt with by two motors of 10 H.P. and 35 H.P. respectively, arranged in a vertical position over the pumps. The small motor deals with the entire discharge during periods of light flow, but when storms on the surface swell the sewers the rise in the pipes moves a float upwards and starts the second pump, which is equal to such rushes of water. The cost for current has worked out at $1.49 per day of 24 hours, and the pumping machinery and connections were $2,950.

Esprit de Corps.—A correspondent writing to us asks:—"Why do not you technical papers try to stop one abuse—viz., experts supporting opponents of the industry?" He complains of a well-known engineer who took a prominent part in the deputation to Mr. Gerald Balfour, "but appeared a day or so before against an electric tramway in the House of Commons, and apparently favours 'buses." Another prominent member of the deputation is charged with having "appeared on behalf of water and gas companies against electric tramways many times." He adds that "other members of the Council are as bad." Our correspondent, however, wishes his complaint to be published anonymously.

Gold Dredging by Electricity.—Gold dredges operated by electromotors are, according to the *Western Electrician*, doing much to reclaim the enormous wealth of gold lost by the methods of early placer mining. A gold dredging company has recently equipped a number of its dredges for driving by electricity, the power being obtained from adjacent long distance transmission lines, the voltage of which is reduced by transformers. Flexible cables convey the energy from three stations to the dredge, and the entire series of operations is then performed by induction motors ranging in capacity from 75 H.P. to 200 H.P. The dredges were formerly operated by steam, but considerable economy results from the use of electricity, especially as the plant can be kept working at night.

32,000-Volt Transmission in Indiana.—The Union Traction Co., Indiana, are, according to the *Street Railway Journal*, about to supply their 97 miles of inter-urban railway by 32,000-volt transmission lines from a generating station at Anderson. At present the system is operated over a 14,000-volt line, but the right of way for 75 miles of the new lines has been secured, the longest distance of transmission being 60 miles. Two transmission lines feed into a sub-station, which in turn supplies two others, and arrangements have been made for throwing over from one line to the other on the high-voltage lines. Glass insulators are employed on the line, and the scheme when completed will be a considerable advance on any power transmission plant, both for voltage and distance, yet erected in the east of the United States.

Defective Welding of Boiler Tubes.—According to the *Engineering News* Mr. D. Woodman recently made an interesting communication on this subject at a joint meeting of chemical societies at the Chemists' Club, New York. Two lots of boiler tubes, one of which had been satisfactory while the

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other had corroded to failure very rapidly, had been submitted to Mr. Woodman for analysis. He found the material practically identical in the two cases, it being a fair quality wrought-iron. The tubes were then tested to see if there might possibly be a difference in the welding, and to this end sections of each kind of tubes were laid in 10 per cent. sulphuric acid. Then it was found that while the good tubes were attacked uniformly all round, the line of the weld showing merely by its colour, the other tubes were eaten away on the line of the weld very rapidly and a deep slit was formed there. This indicated that the metal along the weld was porous and that the weld was therefore imperfect.

Funicular Electric Railways.—There are many cable-operated tramways in Switzerland, especially in the more frequented spots; but one of the most perfect examples, according to the *Engineering Magazine*, is situated at Vevey-Mont Pélerin. This line connects the city of Vevey with two villages, Chardonne and Beaumaroche, on the flank of Mont Pélerin, the length of the track being nearly a mile, and the difference in altitude of the two termini 1,364ft. The rolling stock consists of two cars, attached permanently to each end of the cable, so that one car in its descent pulls the other car up. The cable is driven by means of a 70 H.P continuous-current motor driving through belt and gearing, and the energy for this is supplied from two dynamos driven by gas engines. These are situated at the foot of the hill, and are fed with gas from a producing plant somewhat similar to the Dowson producer. At the upper station, where the motor is situated, a battery of accumulators has been laid down, and on occasions when the descending car is heavily loaded, compared with the one ascending, the motor is run as a dynamo and returns energy to the cells. At times of small load the battery receives its charge from the generators, though it also assists these when they are heavily loaded. With this arrangement the power plant is constantly run at its maximum efficiency. The working of the cars is entirely in the hands of a brakesman at the top of the incline. Since the opening of the line, an average of 13,000 passengers a month have been carried, and about 120 tons of merchandise, under a schedule of 20 trains a day. The financial results are said to be satisfactory.

An Electrolytic Nickel Extraction Process.—Nickel is a metal which is at present receiving much attention from inventors and capitalists, and any new process for extracting it from its ores, or for refining the crude metal is worthy of attention. The *Zeitschrift für Elektrochemie* of May 15th gives details of an electrolytic refining process patented by Ulke in America. This process is designed especially for treatment of the copper-nickel matte obtained by smelting the ores of the Sudbury district of Canada. This matte contains about 20 per cent. Ni, and a larger percentage of copper. It is cast into blocks of suitable form and is used as anode in a hot solution of copper sulphate with cathodes of sheet copper. Under these conditions both metals pass into solution at the anode, but only copper is deposited at the cathode. The electrolyte thus becomes richer in dissolved nickel and impoverished as regards its contents of copper, as the electrolysis proceeds. Portions are withdrawn from time to time, and fresh acid copper sulphate solution is added to replace that which is removed from the bath. The solutions of nickel sulphate containing copper as an impurity thus obtained, are treated with ammonia sulphate, and allowed to cool. A double sulphate salt of nickel and ammonium crystallises out. This is dissolved in water and electrolysed at a temperature of 40 or 50deg., after being made slightly alkaline with ammonia. Lead is used as anode material in this solution, and sheets of pure nickel are employed for the cathodes. The original article does not state whether the process is in actual use, but we believe that it is employed by the Orford Copper Co., of Newark, U.S.A. This company exhibited specimens of electrolytic nickel at the Glasgow (1901) Exhibition—testing 99·25 per cent. Ni with tensile strengths ranging from 100,000lb. to 160,000lb. per square inch.

Cutting Up Iron Tanks with an Electric Arc.—According to the *Railway Review*, an interesting use of the electric arc was recently made in the removal of four wrought-iron tanks in the Auditorium building Chicago. Each of these tanks was 12ft. high and 8ft. in diameter, and they were located on the 15th floor of the tower of the building, for the storage of water to operate the hydraulic elevator service. Some years ago steam apparatus was substituted for the hydraulic machinery to operate the elevators, and since that time the water tanks have not been in use. The tanks were placed in the tower at the time it was built, and an attempt to remove them in pieces by ordinary mechanical means was not successful. It was finally decided to cut up the tank shells into pieces of convenient size by means of an electric arc. With this process each tank was cut into eight pieces, of which six were in the cylindrical shell, and then each of these pieces was cut in half and the bottom piece cut loose from the base. The aggregate time of cutting up the first tank, the shell being ⅜in. thick, was seven hours. The apparatus for producing the arc was an anthracite carbon 1in. in diameter and 12in. long. One terminal of the circuit was attached to the tank and the other to the carbon, the latter being held in a suitable handle. The arc used was 2½in. to 3in. long, and the metal was melted to a white heat by the arc between the metal and the carbon. The arc would burn a hole straight through the shell in 4½sec., and cut the shell at the rate of 6in. per minute. On the average, each carbon, costing 25 cents, cut about 230 running feet of the tank. The energy supplied was from a 110-volt continuous current circuit, the pressure being reduced to 80 volts by chemical resistance.

Building Engine Foundations.—A recent number of *Power* has an article on this subject, in which the foundations of some high-speed engines are described as having been laid in weather when the thermometer hovered around zero. The plant in question had to be laid on soil which was not considered firm enough to carry the load, so that pile driving was resorted to, and the lower levels made up of concrete 8ft. thick. Heat was necessary for the water, to mix the concrete, and it was also found that, to prevent the materials freezing before ramming, a certain warmth had to be maintained. Four parallel lines of sewer pipes 16in. diameter were laid on the top of the ground, with a chimney at their ends, and through them the heat from wood burned in a brick furnace was passed. The concrete was rammed and laid on the top of those, the engine foundations being finally built on the surface of the whole, of coursed rubble limestone masonry, laid in cement mortar. One of the engines had been running a few days, when it was found to be moving on its foundation, and on examination the upper part of the concrete block was observed to be sliding around with the motion of the engine. The plant was shut down, and some three days spent in devising means for tying together the two layers of the foundation. Before work was commenced the order was passed along to run the engine for two days (or until it wrecked itself), as it was absolutely necessary that power be supplied. On starting up, the foundation was as solid as if made of one stone, as the cement mortar had not frozen dry, and when it thawed out it was like fresh mortar, and the three days rest had enabled the cement to set. The other units were not started until the foundations had thawed out and hardened again, so there was no trouble with them.

German Criticism of the Auer-von-Welsbach Secondary Cell.—This new form of secondary cell, in which lead and its peroxide are replaced by zinc amalgam and carbon in an electrolyte of zinc and cerium sulphates, is the subject of an appreciative notice in a recent issue of the *Zeitschrift für Elektrochemie*. After a detailed description of the cell construction, based on the English patent specification No. 21,566 of 1901, the writer remarks that the great surface offered by the carbon electrode is one of the chief advantages of the new cell, since it facilitates rapid charging of the cell without difficulties arising from polarisation. A further advantage is the fact that the components of the cell which undergo chemical change are in solution, either in water or in mercury, and all the defects of the usual type of lead cell, due to mechanical detachment of the lead during the chemical changes from its supports, are thus avoided. The capacity of the new cell is also stated to exceed four-fold that of the ordinary lead secondary cell, and this fact would seem to indicate that cerium forms both lower and higher oxides than

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those given in the patent specification. A recent research by Job (*Ann. de Chimie et de Phys.*, Vol. XX., 1900, p. 208), in fact, shows that both CeO_3 and CeO_4 are formed under certain conditions. The chief disadvantages of the new cell are the high E.M.F. necessary for charging, and the probable chemical and mechanical losses of the carbon electrode. The former defect is due to the diaphragm which divides the cell, and to the deep layer of badly-conducting electrolyte through which the current must travel. A further disadvantage is that arising from the slow action of the zinc amalgam on the electrolyte in a closed circuit, when the cell is fully charged. On this account the inventor recommends that discharge should always quickly follow charging, a regulation that will certainly limit the usefulness of the cerium cell, and hinder its application to many of the purposes for which the lead cell is now in general use.

The Electro-metallurgical Production of Ferro-manganese in France.—The *Zeitschrift für Elektrochemie* of May 15th contains a review of a French pamphlet, written by Gustav Gin, describing the Simon process for producing ferro-manganese in the electric furnace. The process consists in the electrolysis of a molten bath of calcium fluoride containing manganese dioxide in a state of solution, and resembles in principle the well-known methods of aluminium reduction. It is necessary that the temperature of the bath should be raised only slightly above that of manganese, which Heraeus has recently determined as about 1,325°C. If silicon and phosphorus should be present in the bath as impurities, they will combine with the fluorine as a result of secondary reactions and pass away as volatile products of the electrolysis. The electrical energy required to work this process is estimated to be 3,475kw.-hours per ton of ferro-manganese when raw material of the following composition is used in the bath:—6 Mn_3O_4, 6 SiO_2, 3 CaO, 0·6 Fe_3O_4. The reduction of the manganese oxide under certain conditions occurs partly by electrolysis and partly by chemical action of the carbon of the electrodes. The most favourable results are obtained when carbon is mixed with the manganese oxide before charging into the bath, and when the reduction is carried out with an E.M.F. of 80 volts per bath. The electrolysis alone only demands an E.M.F. of 7·5 volts. The ferro-manganese, obtained under these conditions has the following composition:—Mn 84·00, Fe 8·30, Si 0·20, C 7·10, P 0·10. The baths should be sufficiently large to absorb 150kw. The estimates for the factory which it is proposed to erect at Orlu, in the Pyrenees, are based upon an output of 20,000 tons per year. (This is probably a printer's error for 2,000.) The cost of production works out to £8. 3s. 6d. per ton, and compares favourably with the cost of producing the alloy by the ordinary blast-furnace procedure in localities where coal is mined on the spot. It may be explained that at Orlu, in the Pyrenees, electrical power derived from very cheaply-developed water power is available for the manufacture.

Petrol-Electric Automobiles.—The tests of alcohol automobiles organised by the French Minister of Agriculture took place on May 15th, 16th and 17th, and the *Industrie Electrique* describes two cars entered for these in which electrical machinery played an important auxiliary part. One, entered by M. Jenatzy, was of a type analogous to the Pieper vehicles—that is to say, with a single shunt dynamo working in conjunction with a secondary battery, so as to absorb the excess energy on the level and down hill, and to act as a motor driven from the cells to assist the petrol engine when going up hill and at high speeds. At the last moment, however, this car did not put in an appearance. The other car was a Krieger electric car of the well-known pattern developed by this constructor (having two motors suspended on the front axle), but with the addition of a 4·5 H.P. electrical generating set. This vehicle weighed 1,320kg. empty and 1,585kg. when loaded with two passengers, and included a storage battery of the new Phœnix type, weighing 400kg. and consisting of 44 cells with a capacity of 108 ampere-hours for a five hours' discharge. The only difference in the motors, gear and controller, as compared with an ordinary Krieger vehicle is that the gear ratio is 8·1, enabling speeds up to 45km. or 50km. per hour to be attained. The generating set is suspended at the back of the car, and is composed of a 4·5 H.P. de Dion motor, driving a four-pole shunt dynamo, the same type as the motors on the front axle, at 1,450 revs. per min. This dynamo supplies 2,000 to 2,100 watts at a variable difference of potential equal to that of the batteries (22 or 44 cells according to the grouping of the two sets). The generating set is running continuously, and would maintain the battery fully charged if the mean speed did not exceed 15km. per hour. In this case, the battery is charged very little on the level, and much during descents when, our contemporary says, the motors acting as dynamos add to what the generating set furnishes. Uphill, the battery is discharged and the additional power which it gives allows of a much greater speed than what the power of the generating set alone would furnish. Owing to the weight of the vehicle and the small power of the generating set, average speeds over 15km. per hour discharge the battery. For example, at an average speed of about 21km. per hour, the average discharge of the cells is 14 to 15 amperes, and if the battery is fully charged at the start, the distance that could be run without recharging would be 160km. to 180km. This distance may be increased by charging during stoppages en route The generating set consumes about 1 litre of carburetted alcohol per kilowatt hour furnished by the dynamo, and weighs (without its store of alcohol) only 160kg., or about 10 per cent. of the total weight of the vehicle.

Proposed Electric Power for Swiss Railways.—Herr L. Thormann, a Zurich engineer, published recently a study of the possibilities of substituting electricity for steam on Swiss railways, the absence of coal in that country having drawn attention to the great undeveloped water power. Herr Thormann proves that it is quite possible to raise sufficient water power to operate all the Swiss railways, but at the same time he shows that it is a mistake to believe that the expenses of the traffic would be thereby decreased to any considerable extent. The cost of the transformation and reconstruction would be heavy, and an amortisation of the invested capital would be impossible. The five principal Swiss railway lines demand about 30,000 H.P. a day. To guarantee this, 60,000 H.P. of high-pressure alternating current would be required, to which the necessary reserve would have to be added. The question whether the available water power of the country would be capable of supplying this power is answered in the affirmative. Herr Thormann, without taking into consideration the powerful waterfalls, names the following works, which are either in course of construction or design:—

Name of works.	H.P.	Name of works.	H.P.
Sihlwerk, near Einsiedeln ...	20,000	Montbovon (Vaud)	1,500
Laufenburg on the Rhine ...	10,000	Kander (Bernese Alps)	1,500
St. Maurice	5,000	Sense (Fribourg)	1,000
Wangen on the Aare	5,000	Gurtnellen	1,500
Beznau on the Aare	5,000	Göschenen	1,500
Wäggithal (Schwyz)	5,000	Ritomsee	8,000
Fribourg-Hauterive	4,000	Giornico	4,000
Rheinau	3,000	Marobbia	1,000
Hagneck, near Biel	2,000	Verzasca	1,000
Doubs, near Puntrut	2,000		
Vallorbe (Jura)	2,000	Total	86,000
Lungernsee (Unterwalden)...	2,000		

As this would be more than sufficient, the surplus could be used for industrial purposes. The cost of the establishment would be very great. The writer calculates it at 161,000,000f. ($31,073,000), viz., rolling stock, 40,000,000f. ($7,720,000); conducting cables and miscellaneous, 70,000,000f. ($13,510,000); and commutator stations, 51,000,000f. ($9,843,000). He shows, however, that although the direct saving would not be important, the country would profit enormously, as the commercial balance of Switzerland would become more favourable and the vast amount expended for coal would remain in the country. The general utilisation of water power throughout the country would also mean a valuable encouragement for other industries. The study of Herr Thormann has attracted much attention. That the project is no longer regarded as Utopian is proved by the meeting of electrical engineers referred to in *The Electrician*, Vol. XLVIII., p. 561, and also by the fact that the Oerlikon Co. has made an application to the Federal Government for a concession to establish a line of 20km. (12·4 miles) of electric standard-gauge railway for experimental purposes. According to a recent consular report, from which these notes are taken, there is no doubt that this concession will be granted.

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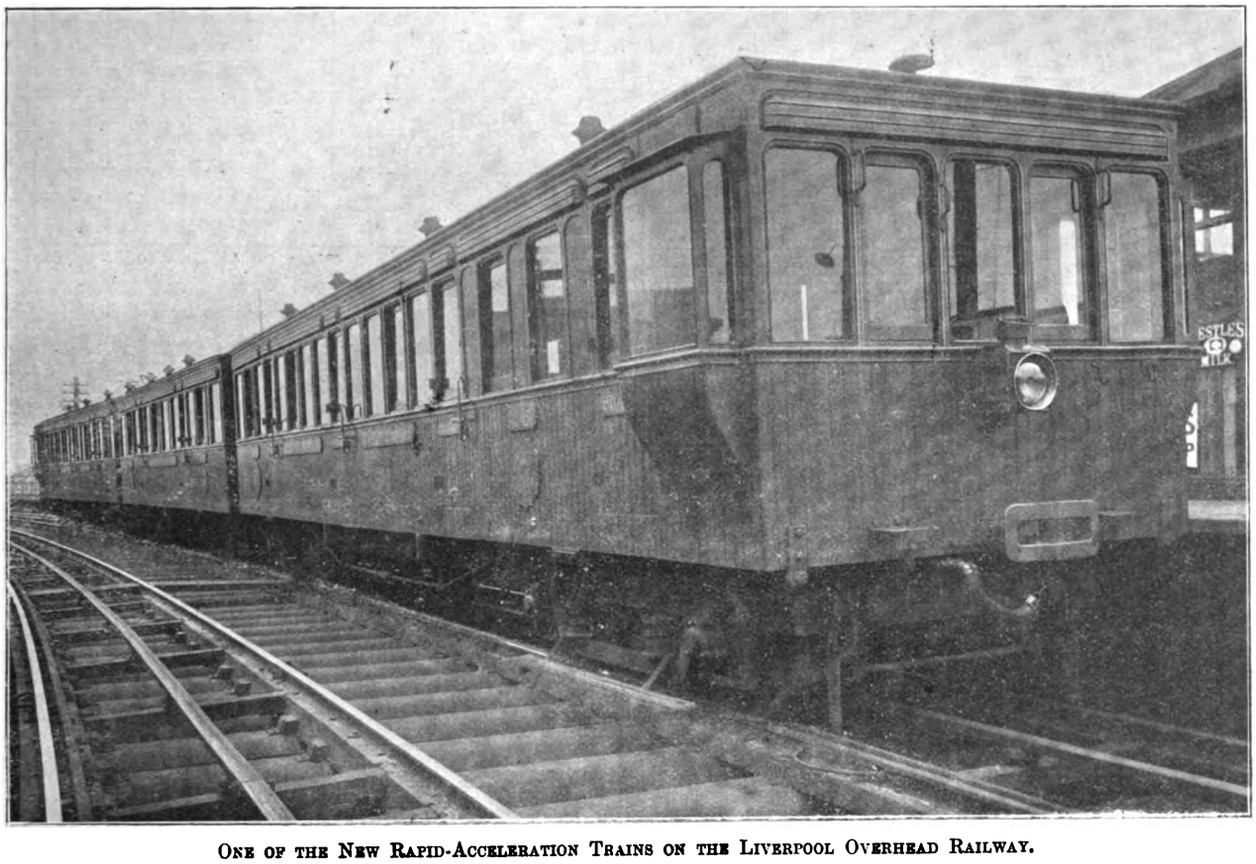
LIVERPOOL OVERHEAD ELECTRIC RAILWAY.

An interesting extension of plant on the Liverpool Overhead Railway, as showing how important is the question of increased acceleration on electric railways, is that being carried out by means of a new type of equipment supplied by Messrs. Dick, Kerr & Co. It will be remembered that the Liverpool Overhead Railway was the first elevated line in the world to be operated by electricity, and was equipped some 10 years ago. The total length of the line is a little over 6½ miles, with double track and a third-rail feed, and with a special rail return operated by 500 volts. The trains are made up of two or three carriages, the larger trains weighing about 55 tons. With the old equipment the entire distance was run in 32 minutes, including 16 stops, or practically at a scheduled speed of 12½ miles per hour. This requires a minimum of 14 trains running at five-minute intervals to cope with traffic.



One of the New Rapid-Acceleration Trains on the Liverpool Overhead Railway.

Some twelve months ago, however, it was decided to experiment with a new equipment in order to ascertain what acceleration could be obtained, and Messrs. Dick, Kerr & Co., entered into a guarantee to run the whole distance—including 16 stops of 12 seconds in 20·9 minutes; or, in other words, to improve the scheduled speed from 12½ to nearly 19 miles per hour. The weight of the train, including 154 passengers, was 55 tons. A most careful series of elaborate tests and trial runs were made by Mr. Cottrell, the engineer-in-chief of the Liverpool Railway, assisted by Mr. Mallock, and it was clearly demonstrated that the new train would make the journey easily under 20½ minutes. The accelerated curves obtained from these trials are shown in Fig. 1. From these it will be seen that the acceleration reached 4·2ft. per second, per second, or nearly 3 miles per hour per second, the average acceleration being well over 1 mile per hour per second, thus enabling the train to cover the 2,110ft. between the stations in little over one minute, including starting and stopping. This rapid acceleration is possible owing to the excellent commutation of the motors, which will not spark when carrying 300 or 400 amperes—*i.e.*, three or four times their normal current. During the acceleration of the train in the series position of the controller, each motor is carrying 300 amperes of current, as shown by the curves. The curves also show the perfect action of the brakes during the retardation of the train. The negative acceleration reached 4·75ft. per second per second recorded, which is probably near the practical limit in actual service. The diagrams of current in pressure at the motors are recorded and are of interest in determining the power consumption at different parts of the run.

The frequent stopping of trains running at high schedule speed will consume from 120 to 150 watts per ton-mile. If, however, the stops are far apart, the watts required are from 90 to 100 per ton-mile. In the experiments recorded the watts consumed were 137 per ton-mile, or about 6·35kw. per train-mile run. The results of the new accelerated service are shown in the following table. In consequence of the successful issue of these tests, the Liverpool Overhead Railway have instructed Messrs. Dick, Kerr & Co., to re-equip the whole of the rolling stock. Each of the new trains is to be fitted with four 100 H.P. railway motors, which are designed by Mr. S. H. Short and built at the works of the English Electric Manufacturing Co. at Preston.

Table Showing Results on the Liverpool Overhead Railway.

—	Old system.	Accelerated service.
Mean speed	12½ miles (20km.)	19½ miles (31km.).
Number of stops	16	16
Mean time at stations	11 seconds	11 seconds
Mean distance between stations	729yds. (666 metres)	729yds.
Watts per ton-mile	110	137
Acceleration	1·6ft. (0·44 metres) per sec. per sec.	3ft. (0·91 metres) per sec. per sec.
Retardation	3ft. (0·91 metres) per sec. per sec.	4·8ft. (1·26 metres) per sec. per sec.

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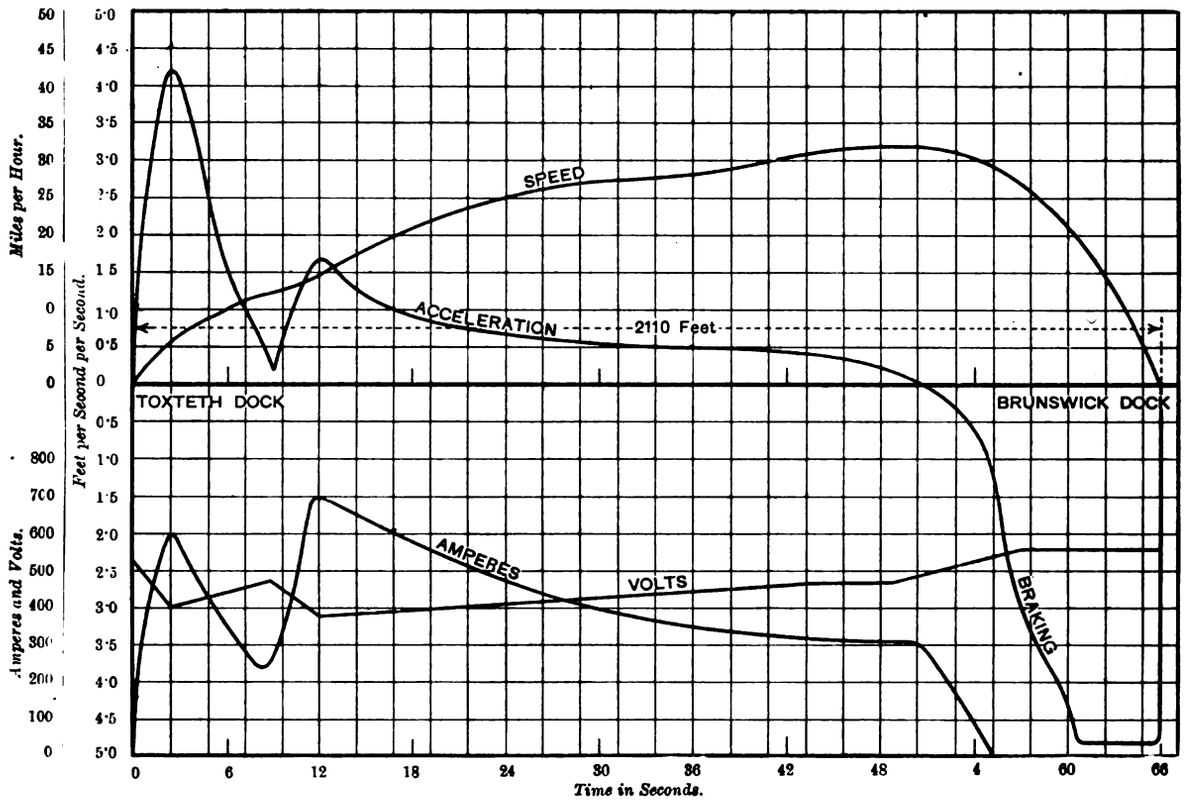
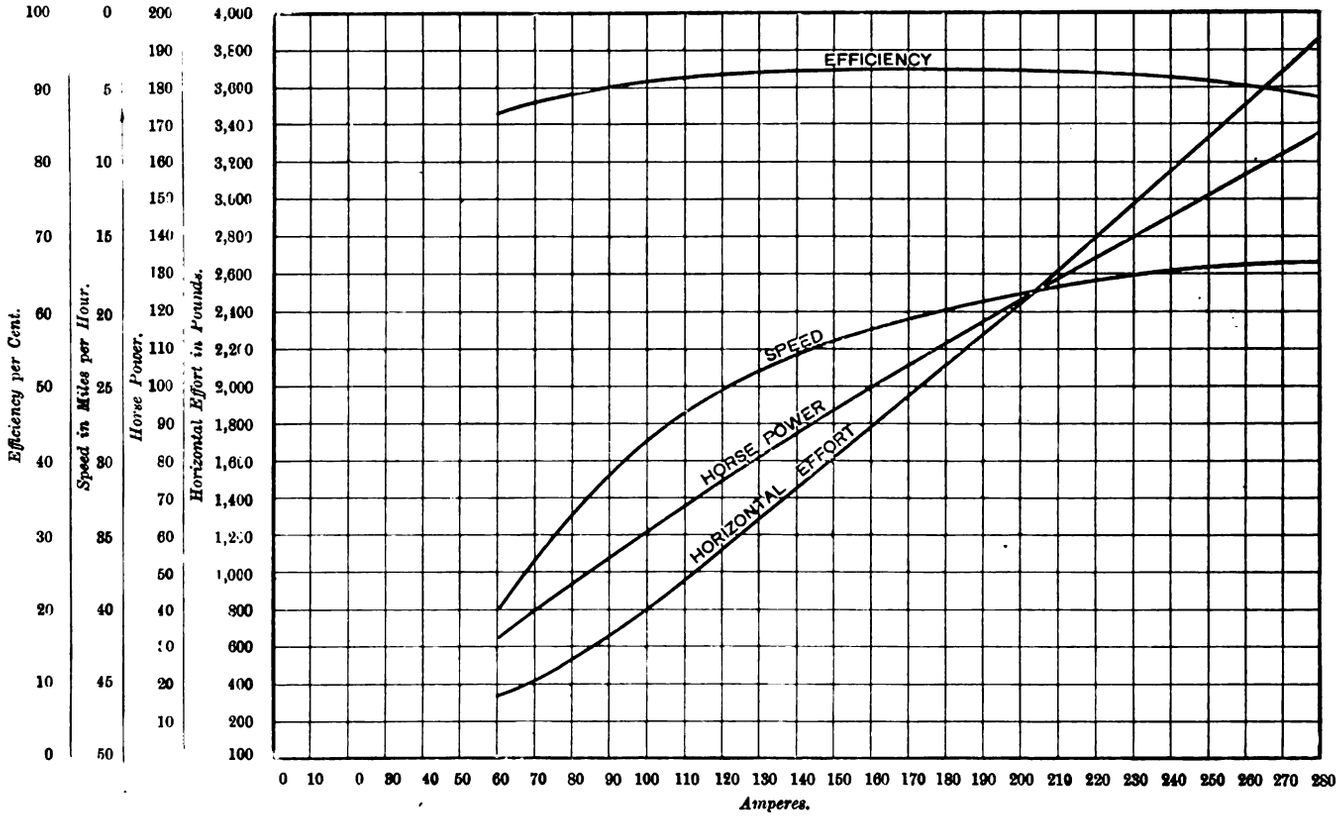


FIG. 1.—ACCELERATION CURVES.

Total weight of Train (2 motor cars and trailers), 55·52 tons.
Equipment, 2 100 H.P. motors per motor car.



Temperature Rise at End of One Hour delivering 100 H.P. at Armature Shaft:—Commutator Rise, 60°C.; Armature Rise, 40°C.; Field Rise, 60°C.; Bearings Rise, 15°C.; Air Temperature, 29°C.; Resistance at 20°C.—Field, 0·0792 ohms; Armature, 0·0603 ohms; Total Motor, 0·151 ohms.

FIG. 2.—CHARACTERISTIC CURVES OF 100 H.P. MOTOR BY BRAKE TEST. Wheel, 33in.; Gear Ratio, 2·79 to 1.

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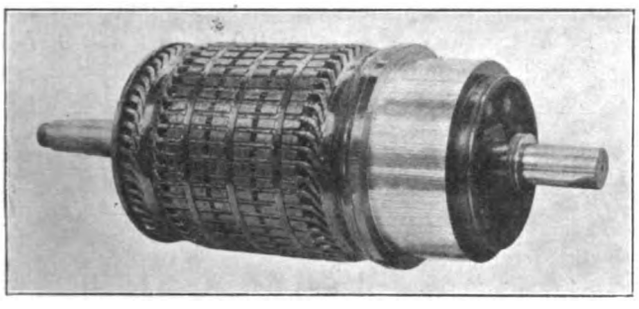
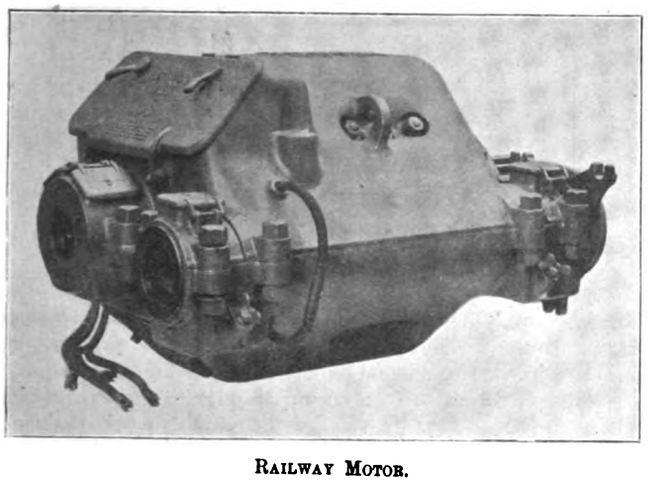
The performance of these motors is shown in the efficiency curves, Fig. 2, these having been made from actual measurements taken from one of the motors during the experimental run. The efficiency is unusually high, being practically 93 per cent. at the full load of 75kw. Their weight is 4,200lb., or only 42lb. per H.P., which is a point of considerable importance in keeping down the dead weight of the train.

The new motors in use on the Liverpool Overhead Railway are completely enclosed in a cast-steel shell, forming a fire and waterproof casing. This shell also serves to form the magnetic circuit of the fields and to support the armature and axle bearings. The only opening in the motor casing is over the commutator and brushes; this is, however, securely closed by a hinged lid fitted with fastenings. The motor frame is divided on the horizontal plane, the upper half being removable,



MOTOR ARMATURE.

leaving the lower half supported on the car axles and the nose suspension. In this way the armature and fields can be easily uncovered for inspection and repair without entirely dismantling the motor. This method of opening the motor is just the reverse of the tramcar motor, where the lower half of the frame is let down into a pit for inspection of the interior, which would not be practical with motors of such great size. The interior of the motor frame is provided with four laminated steel pole-pieces, each with its own field spool, held in place by large bolts passing through the outer shell. The field spools are made of copper ribbon, about 2in. wide, wound with



RAILWAY MOTOR.

asbestos and mica strip, between layers, and insulated outside with mica and asbestos combination boxes, held in position by means of heavy-braided tape. The complete coils are treated with a waterproofing insulated compound and thoroughly baked. The same number of turns of copper ribbon is put on each pole, so that a perfectly symmetrical field is produced, in which the armature revolves.

The armature is iron-clad, the copper bars with which it is wound being let into deep slots. Each coil in the armature is made with only one turn, and without joints, except at the commutator. The insulation of these coils is also composed largely of mica and asbestos, treated with a special insulating varnish, taped and baked. The coils are all alike and interchangeable, so that injured ones may be replaced with ease. Ample ventilation is provided for the interior of the armature core, and air ducts leading to the surface aid in keeping up a good circulation. The high grade steel from which these cores are made ensures low hysteresis losses, and the thorough insulating of the laminæ from each other prevents the formation of eddy currents. The commutator is very large and has many bars, rendering the commutation perfect, even with double the normal load on the motor. The brushes are in two sets at the top of the commutator, with two brushes in each set. No sliding contacts are permitted to carry current, each brush being fitted with a brass clamp which moves with it, and a flexible braided ribbon of copper, connecting it directly with the brush holder supports and main cables from the controllers.

The efficiency of the motor is well over 90 per cent., as shown by the characteristic curves of the machine. The temperature rise, after one hour's run at full load, is far below the standard of 75°C., being as follows:—

Commutator	55°C.
Armature	39°C.
Fields	57°C.
Pinion bearing	14°C.
Commutator bearing	9°C.

The bearings are all made of the best bronze, and provided with both oil and grease lubrication. Special provision is made to catch all the oil from the ends of the bearings, and to return it to the wells, so that it will not be dropping on the permanent way. The gears are of cast steel, with the teeth cut out of the solid casting. The pinion is of hammered machine steel. The gear housing is of malleable iron, made oil-tight.

The complete motor weighs as follows:—

Motor	3,945lb.
Gear	260lb.
Housing	140lb.
Links	40lb.
Key	2lb.
Total	4 387lb.

or, including gears, gear housing, &c., complete, only 48 8lb. per H.P. The motors are journalled at one end to the driving axle, and spring supported on the bogey frame at the other side. The method of suspension relieves the permanent way of severe shocks at the rear joints and cross-overs. The motors are carried on each of the two end cars of the train. The controlling mechanism is in many respects similar to the series-parallel method of control adopted by Dick, Kerr & Co. (Ltd.), and is fitted with a new blow-out device, which renders it perfectly proof against fire. It is interesting to observe what effect this improved equipment will have upon the service of the Liverpool Overhead Railway. The 12 trains of the new type will replace 14 of the old, and it is a matter of interest that these new trains will accommodate exactly the same number of passengers as the old ones.

With the previous equipment the trains ran 144 train-miles per hour, while in the new method they will run 216 train-miles per hour. There was a five-minute headway between the old trains, but under the new régime this will be reduced to 8½ minutes. In other words, the journey from one end of the line to the other will be made in two-thirds of the time taken on the old method, and, what is of supreme importance, the load on the power-station will be more uniform, and, as a consequence, the machinery will be running under more efficient conditions.

As a comparison, the following table is of interest as showing the scheduled speeds with the new Liverpool equipments and those obtaining on other lines:—

	Miles per hour, including stops.
Liverpool Overhead Railway	19
Manhattan Elevated „ (New York)	13½
Metropolitan „ „ (do.)	14·1
South Side „ „ (Chicago)	14·6
Lake Street „ „ (do.)	12½
City and South London	12½
Central London	14

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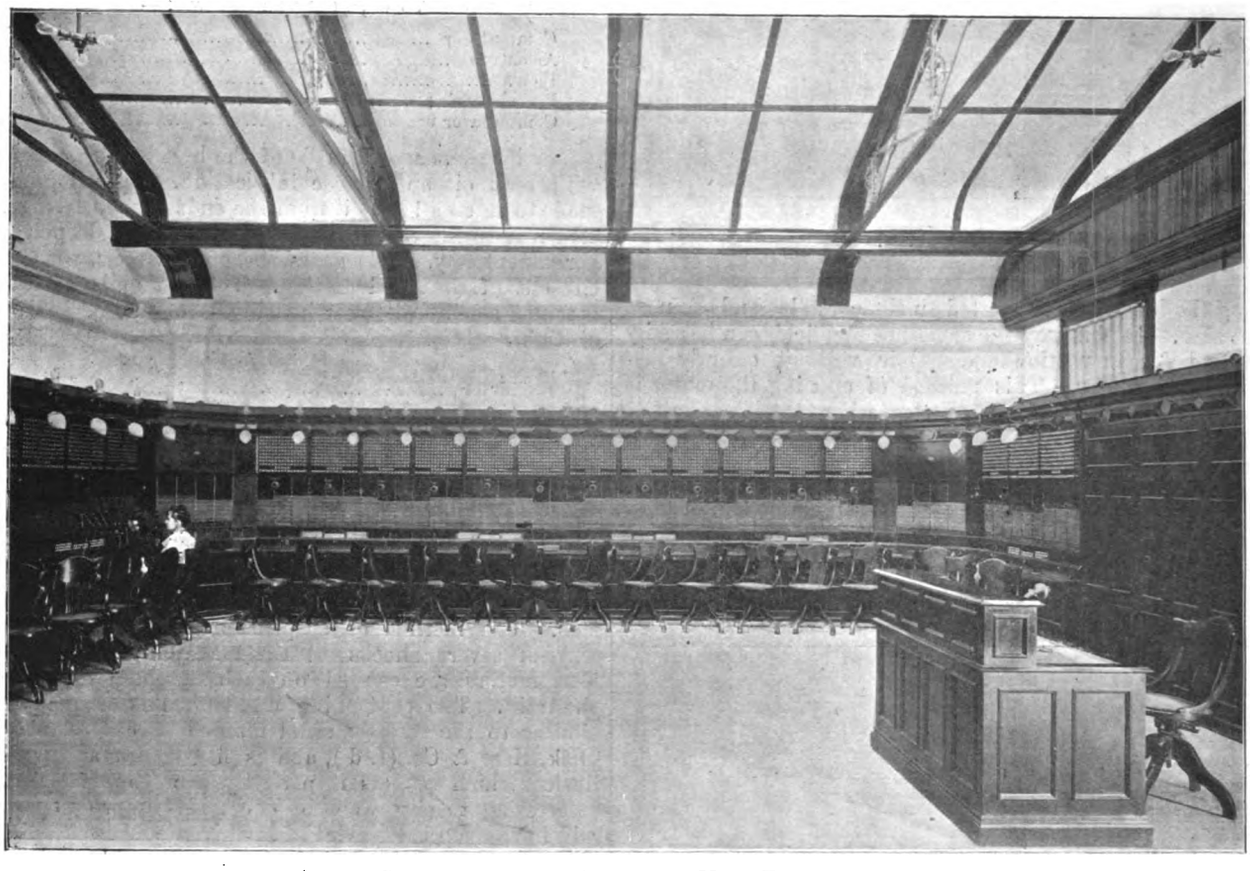
THE TELEPHONE SERVICE IN THE RIVER PLATE.

By the courtesy of Mr. E. M. Reiss, secretary of the United River Plate Telephone Co., we have had placed at our disposal a number of interesting photographs of the work carried out in connection with the recent considerable development of the company's telephone undertaking in Buenos Ayres, and other important cities of the River Plate. The original River Plate Company commenced operations as far back as 1882, and in 1886 the undertaking of the United Telephone Co. of the River Plate and the River Plate Telephone and Electric Light Co. were taken over and made one joint-stock concern.

In Buenos Ayres and its suburbs, the company serves a district with a population of nearly 1,000,000. The work of reconstructing the system in this city and placing the wires underground is being carried out entirely by the company's own staff under the supervision of Mr. J. E. Parker (manager of the company in the River Plate), Mr. R. S. Cuff (chief electrician), who planned and superintended the first part of the subway work, and Mr. C. W. Gwyther (engineer), who has continued the subway work and the cable work in connection therewith. Mr. F. W. Jones, managing director, makes periodical visits to Buenos Ayres to superintend the operations of the company, and in this way the London Board is in close touch with the important and rapidly increasing work in the River Plate. The photographs, of which there are altogether a very large number, have all been taken by Mr. Cuff.



Switchroom at the Avenida de Mayo Exchange.

The 204 and 306-pair cable, used in the conversion of the work which is now proceeding is of the Western Electric Co.'s make, and the same company has supplied the instruments and switchboards. The single conduits and iron pipes are of British manufacture, the multiple ducts being obtained from the United States. The principal exchange in Buenos Ayres is in the Avenida de Mayo, in a magnificent building owned by the company. The exchange is situated on the extensive top floor of the building, and ample room is available for extensions, which are constantly coming in. The old main exchange, which is now being entirely taken over by the new station, was at Calle San Martin.

Before proceeding to the internal arrangements of the Avenida switchroom, &c., it will probably be as well to give a short description of the underground cable system :—

The company's Avenida exchange has also a frontage on the next street, Rivadavia, and short tunnels connect the manholes in each street with the basement, at a depth of about 16ft. below the pavement. These manholes, in common with the most important ones on the main routes, are 10ft. square by about 8ft. in height, and have each 32 ducts, one set running in an easterly and the other in a westerly direction.

The 204-pair cables have conductors of 0·036in. diameter (No. 20 S.W.G.), and are used for junction lines, the 255 and 306-pair, with conductors of 0·028in. (No. 22 S.W.G.), being employed for the subscribers' circuits. At the nearest manhole to the distributing points these paper and air-space cables are jointed to special light-weight silk and cotton cables, lead-covered, which are taken up the buildings in wrought-iron pipes to boxes provided with carbon arresters and 6-ampere fuses, whence run pairs of vulcanised india-rubber leads to the short spans of aerial wire which connect with the subscribers' stations. This mode of distribution is rendered necessary by the continual removals of the subscribers, which are extremely frequent in this city.

On leaving the ducts at the exchange end, the cables from both routes are led along racks of channel iron, meeting near the centre of the basement passage, where they change their vertical arrangement for a horizontal one, running over an iron bridge to the foot of a steel tower (or vertical rack), which leads them to the horizontal side of the main distributing board on the fifth floor of the building, where they are soldered to the tabs of the test springs. These test springs are connected to the vertical side of the distributing frame by pairs of bridle wires soldered to the tabs of a pair of 6-ampere

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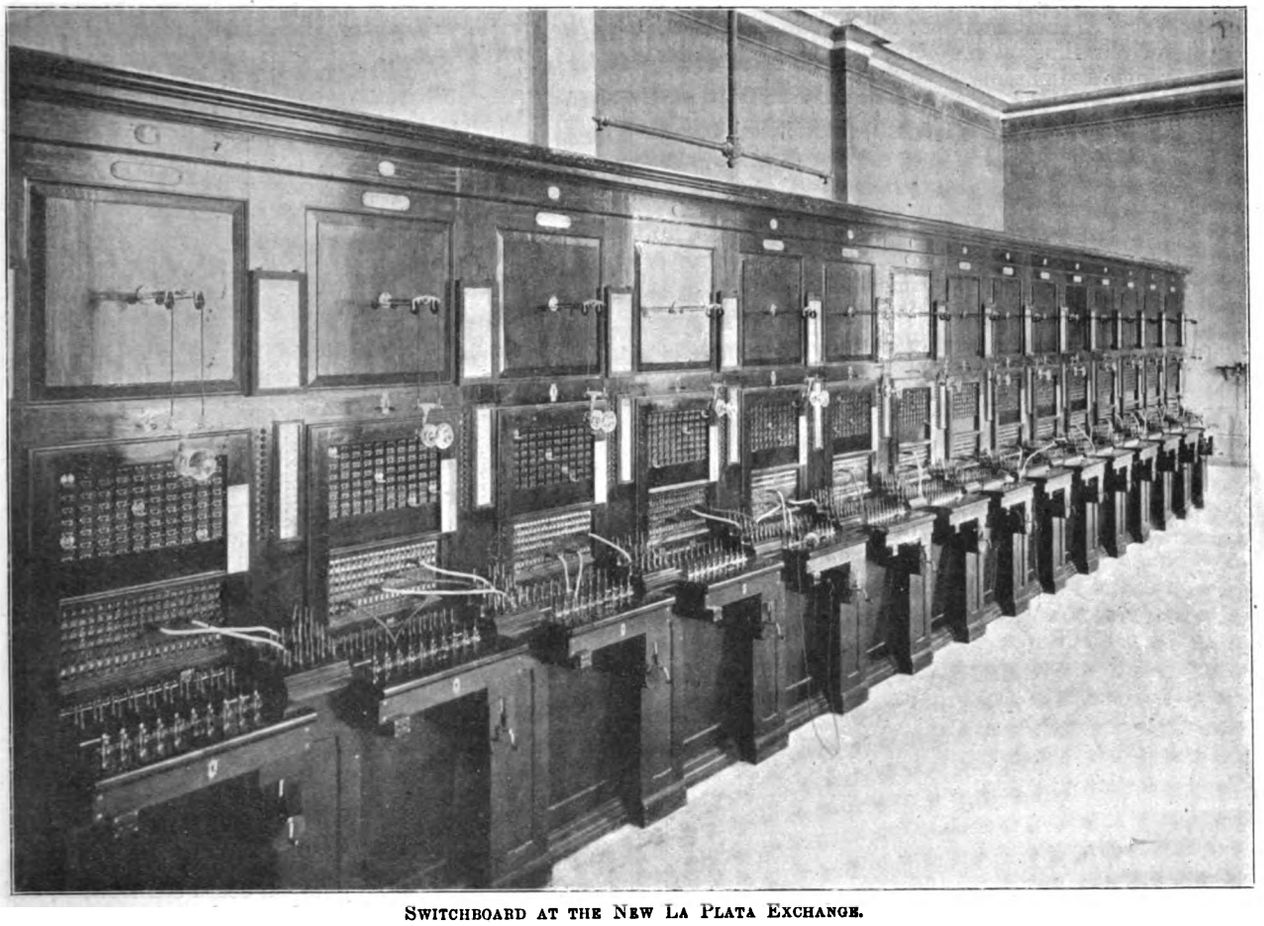
fuses, which in turn are fitted with carbon arresters and heating coils.

From the vertical side of distributing frame, 42-wire wool-

tions (all "branching" jacks), to the horizontal side of the intermediate distributing board, by triple bridle wires to the vertical side, and thence to the home section and line



SWITCHBOARD AT THE NEW LA PLATA EXCHANGE.

LA PLATA SWITCHBOARD IN OPERATION

overed cables are led along a troughing to the first trunk section of the multiple, which is fitted with series jacks, and hence run on as 68-wire cable through the subscribers' sec-

coil of the self-restoring indicator at the top of the switchboard.

The switchroom is a lofty, well-ventilated hall, about 47ft.

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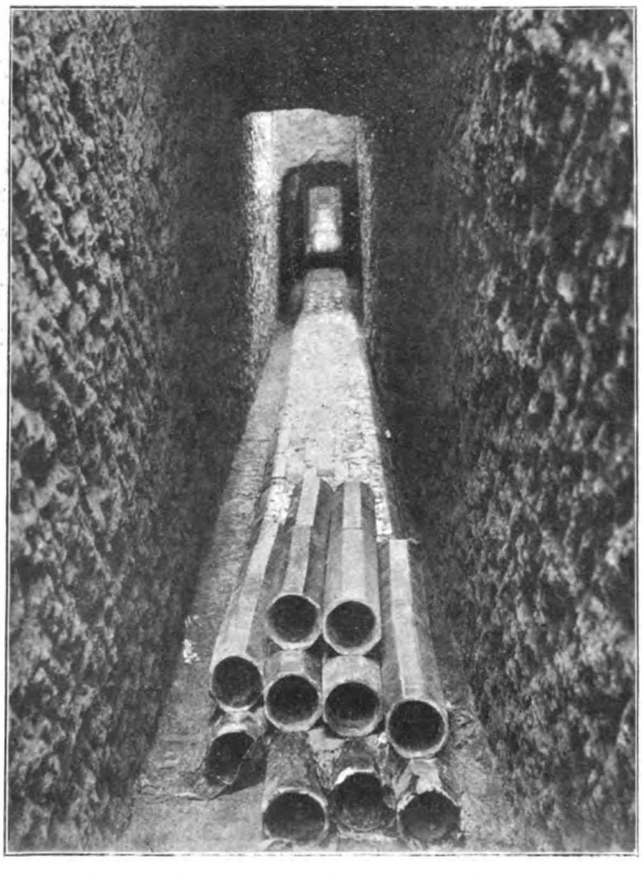
by 44ft. The roof is carried on ornamental steel principals; a glass louvre running almost the entire length admits ample light on the front of the board, whilst the back is lighted by five ordinary windows. Each operator's position is furnished with a 16 c.p. glow lamp, an incandescent gas burner being fitted to the same bracket in case of failure of the electric supply. One of our illustrations gives an excellent general view of the Avenida switchroom.

The switchboard, which is arranged round three sides of the room, is at present equipped for 5,040 subscribers' lines in addition to 150 incoming and 150 outgoing junction lines, and has an ultimate capacity of between 9,000 and 10,000. Each section, consisting of three operators' places, is fitted with 420 local jacks and 45 pairs of cords, though, to commence with, each position had but 100 lines connected up, this number being increased as the operators became more proficient. In the centre of each operator's position is a "pilot" lamp, actuated by a contact on the aluminium shutter of each drop



Line of Ducts between Viamonte and Cordoba.

(these drops being situated at the upper part of the board), and in the superintendent's desk is placed a lamp for each operator's position in parallel with the pilot lamp, immediately over the jack which communicates with her "set."

The outgoing junction lines are multipled round the room, and each is furnished with a lamp in every section of the board, the circuit being closed by a local relay, thus giving a visual engaged test when occupied in any section. The incoming junctions have jacks in the junction boards only, and end in single cords and plugs. The keyboard is fitted with additional ringing keys as well as the combined speaking and ringing key for each line, to enable the operator to ring the subscriber who originated the call, if necessary. Opposite each plug, besides the signal lamp, is a second lamp fitted with a red cap, which glows when its line is occupied in another position, and is thus serving, for the time being, as an out going junction. There is also a red "pilot" lamp in each operator's position to draw attention to the smaller lamp.

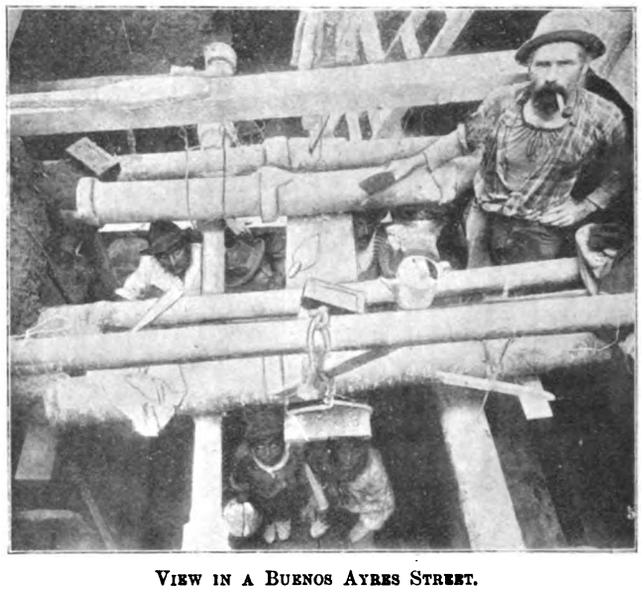
The power plant includes dynamotors for converting current, taken from the street mains at 220 volts, to 30 and 3 volts for the lamp and microphone batteries respectively, and also two ringing generators giving alternating current at 100 volts. All these motors, as well as the power board, which is fitted with the usual charging and discharging switches, ammeter and voltmeters, resistance lamps, &c., are situated on the fifth floor.

The diagrams opposite show the key-board connections of a subscriber's section, together with the complete circuit of a

Laying Multiple Ducts in Calle St. Martin between Paraguay and Charcas.

subscriber's line from the main distributing board to his indicator, and the incoming junction board connections, and both are so clear as to need no further explanations.

No difficulty is experienced in obtaining operators for the work, who are intelligent, but who require more skilled supervision than is the case at home. They are chiefly female, but a good number of male workers are employed.



View in a Buenos Ayres Street.

The exchange in the Avenida de Mayo is now in operation, and there are 24 exchanges aggregating 7,800 subscribers in connection with it. These are open day and night, and there are public call offices at all of the principal exchanges which are made much use of. In Buenos Ayres the subscription is, for business houses, about £15 per annum, three months'

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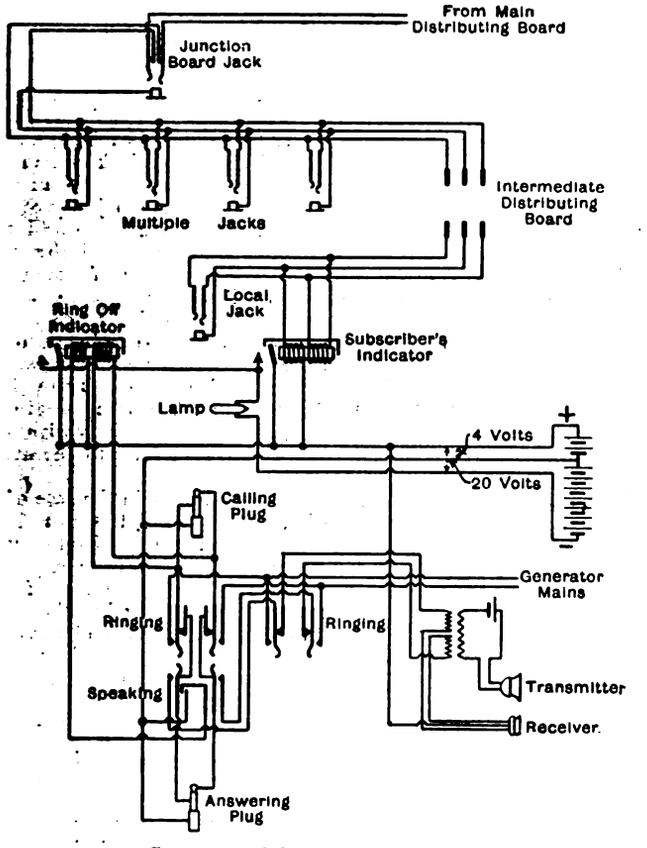
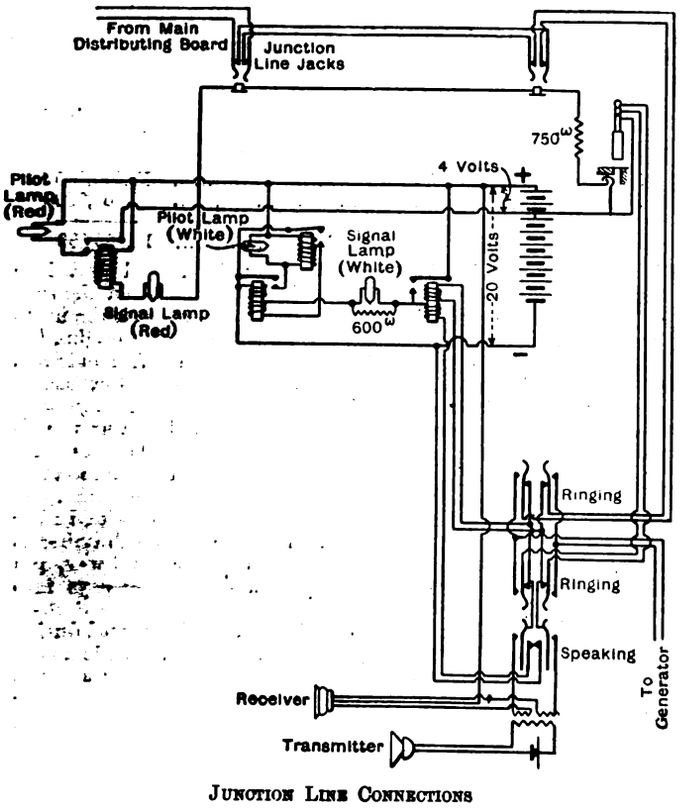
subscription being paid in advance. At Rosario, 200 miles distant from Buenos Ayres, and the second largest town in Argentina, the company has an exchange with 930 subscribers,



SUBSCRIBERS' BOARD CONNECTION



JUNCTION LINE CONNECTIONS

and it has recently acquired the business of the Provincial Telephone Co., with 15 exchanges and 750 subscribers, in the province of Buenos Ayres.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Zeeman Effect.—E. Riecke attempts to harmonise the values for e/m obtained from the Zeeman effect with that obtained from cathode rays more closely than has hitherto been possible. The fact that some spectrum lines are divided into triplets and others into more complicated structures, shows that the ratio cannot be the same for every mode of vibration. A simple dynamical reasoning gives, for the difference in the frequencies of the two extreme components of a triplet, the formula

$$n_2 - n_1 = \frac{1}{2\pi} \frac{e}{vm} H,$$

where v is the velocity of light. Zeeman applied this formula to the cadmium triplet, and found $e/m = 743 \times 10^{15}$ electrostatic units per gramme. Similar values may be obtained from the mercury lines. In the mercury spectrum, the first line of the second subordinate series is divided into nine components showing an equal interval of frequencies. Any pair of them gives the above value for e/m. This value differs from that obtained from cathode rays, which is $.559 \times 10^{15}$. But the author points out that the isolated mercury lines, which form true triplets, give the value $558{\cdot}5 \times 10^{15}$, and concludes that the same is the case for all true triplets, and that the cadmium triplet is not a triplet at all, but consists of six lines close together.

[E. RIECKE, *Physikal. Zeitschr.*, June 15, 1902.]

Energy of Ionisation.—J. Stark applies his theory of ionisation by ionic shock to the general question of the energy involved in ionisation, and the manner in which ionisation is carried on in gases, metals and electrolytes. The difference of potential which an electron must traverse in order to shatter a neutral atom and split an electron off it is 88 volts in hydrogen, 45 in nitrogen and 50 in oxygen. This indicates that the energy consumed in ionisation, or the "ionic energy," is less in hydrogen than in oxygen or nitrogen. This would explain why, in the electrolysis of HNO_3, the hydrogen should be electro-positive and the NO_3 electro-negative. A gas contains very few free electrons, whereas an electrolyte contains many, and a metal still more. Hence the difference of conductivities. The presence of a metal facilitates ionisation in gases by a process analogous to catalysis. Hence the "cathode fall of potential," which is a fundamental characteristic of metals. In metals generally the ionic energy is very small. Solution or immersion in a medium of high specific inductive capacity diminishes the ionic energy. The amount of the latter constitutes a valuable new property of matter.

[J. STARK, *Physikal. Zeitschr.*, June 15, 1902.]

Measurements of Electrical Dissipation at High Altitudes.—Since the International Commission for Scientific Ballooning at its Berlin Conference decided to recommend the measurement of atmospheric ionisation on a uniform plan by means of Elster and Geitel's apparatus, it is important to secure this apparatus in its best and most reliable form. R. Börnstein points out a source of error which must be avoided. He put up the apparatus in a room, connected the dissipation body, which was covered with black paper, with the aluminium leaves, and surrounded it with a guard cylinder of blackened brass. The leaves were kept at wide divergence by means of the positively charged dissipation body. This divergence suddenly disappeared when the slanting rays of an arc lamp fell from above upon the guard cylinder. It was found that the inside of the cylinder was the seat of photo-electric activity, under the influence of the ultra-violet light from the arc, but the outside also was active when the cylinder was connected to earth. Since no ultra-violet rays are contained in sunlight at low elevations, there is no risk of photo-electric errors there, but it is quite possible that ultra-violet light may be met with at 6,000 metres.

[R. BÖRNSTEIN *Physikal. Zeitschr.*, June, 15, 1902.]

E.

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Viscosity of Wires in a Magnetic Field.—A. Gray and A. Wood have studied the effect of a longitudinal magnetic field on the internal viscosity of wires of nickel and iron, as shown by the change of the rate of subsidence of torsional oscillations. The results are illustrated by diagrams showing the amplitude of successive swings. In iron and steel, the effect of a longitudinal magnetic field is to diminish the viscosity and the damping of the oscillations. In steel the effects are smaller than in iron, but no increase of field beyond 250 units appears to be effective in iron. Nickel shows a very curious behaviour. Fields below 156 units increase the viscosity, and bring about a rapid damping of the oscillations, whereas above that value they diminish the viscosity. Wire-drawing the nickel got rid of the reversal, and made the increase of viscosity general, even for the strongest fields. As regards the constitution of the magnetic metals, the authors believe that in the unmagnetised metal the elementary magnets have a perfectly orderly arrangement in closed chains, each of which may be composed of a large group of molecules of the substance. These molecules, when the substance is unmagnetised, form a closely coherent arrangement which is broken up into an entirely different collocation under the influence of an externally applied magnetic field. Thus, if the wire of the unmagnetised material perform torsional oscillations, the relative motions of the parts of the material will naturally be affected by the internal forces existing between the parts, and by the arrangement of the parts in more or less distinct chains or groups. It is reasonable to suppose that the effect of magnetisation being to entirely alter these internal magnetic forces, and to break up and re-arrange the groups of elementary magnets, will be also to alter considerably the internal friction shown by the material.

[Gray and Wood, *Proc. Roy. Soc.*, May 15, 1902.]

Formation of Ozone.—If oxygen is submitted to an electric discharge under increasing differences of potential, it is found that no ozone is produced until a certain electric force is reached. The amount of ozone then produced varies, as A. Chassy points out, directly as the square of the difference of potential between the electrodes. This law of squares does not hold good during the preliminary stages, when the exponent is much smaller than 2. The law comes suddenly into full force at a difference of potential of about 12,000 volts. What happens at lower voltages the author is not prepared to say, except that there is a point at which whatever resistance stands in the way of the aggregation of these oxygen atoms into a molecule of ozone is overcome. As regards the practical manufacture of ozone, he mentions that it is necessary to carry it on at a voltage 40 per cent. beyond that at which the ozone is first formed. It is useless to increase it still further, as after that the amount of ozone produced is in every case proportional to the electrical energy expended.

[A. Chassy, *Comptes Rendus*, June 2, 1902.]

Berlin Elevated Railway.—In a recent issue of the *Engineering News*, a description of this railway was given and some severe editorial comments made upon its construction. The rails used for the track have a weight of 51lb. per yard, and, in comparison with the practice adopted in America, this is considered too light for the traffic and the speed. American engineers have learned by a bitter experience the lesson of the value of heavy rails, and especially on roads operated by electric motive power. The heads and flanges of the rail have been halved at the joint to permit the webs of two rails to lap, and it is expected that a suspended joint will be maintained with a clear distance of 4ft. between the ties on either side. The difficulty of operation is thought to be further increased by the weight of the cars—26 tons—and the service of three-car trains at intervals of 2½ to 5 minutes. The note concludes with the remark that experience will determine the life of the ties and rails, laid in a manner almost directly opposed to American railway construction—and, we may add, quite as opposed to British practice.

THE NEW TELEPHONE SYSTEM IN PARIS.*

BY J. BORDELONGUE.

There is no doubt that the most suitable telephone system for a large town with a dense population is the employment of a single central exchange with a multiple switchboard. The question does not present itself in the same manner however, if the town is so large that the number of subscribers may possibly exceed the limit of the capacity of the multiples; or if the extent or configuration of the town is such that, to reduce the length of subscribers' lines, it is decided to erect several exchanges. If two or more exchanges exist on the same urban telephone system, the multiple jacks which are at the disposition of each operator at the subscribers' board can only be used for a small number of connections, since the majority of the calls are for connection to subscribers on another exchange and two operators must be employed to get these calls connected through. This state of affairs becomes worse as the number of exchanges serving an urban district increases. In Paris, for instance, where there are eight exchanges, the number of calls requiring two operators is much greater than those which can be effected by a single one. The actual figures for the number of calls which can be dealt with directly by the subscribers' operators at the eight exchanges are 19, 14, 17, 10, 9, 1·7, 12 and 9 per cent. respectively. These exchanges all have multiple boards whose capacity varies, and to these are added groups of in-coming junction lines to permit of intercommunication between the exchanges.

To fix our ideas, let us examine the actual costs in the case of an exchange for 10,000 subscribers—*i.e.*, 100 groups of 100 subscribers each. Up to the present, the exigencies of traffic require that for every 100 subscribers 50 groups of in-coming junction wires are required. It may be added that, owing to the increase of the number of subscribers in Paris, this ratio of one group of in-coming junction lines to two groups of subscribers is no longer accurate, and that the number of in-coming junction wires has had to be increased by about a fifth. However, we will use the figures cited, from which we get that 150 groups or 50 sections are required and 10,000 multiple jacks. The price of the switchboard is therefore as follows:—

	Fr.
100 operators' positions on the local switchboard (not including the multiple jacks) at 6,000fr.	600,000
50 operators' positions on the in-coming junction switchboard (not including the multiple jacks) at 4,000fr.	200,000
500,000 multiple jacks (10,000 for every three groups) at 2fr.	1,000,000
Total	Fr.1,800,000

In this we are neglecting "dummies."

If we take it that this capital is repaid in 10 years, it represents an annual sum of 180,000fr. Adding to this figure the cost of maintenance at 20,000fr. per year, we see that the annual cost of the switchboard is 200,000fr. To work 150 groups 300 operators are required, taking two per group, each working seven hours per day. The number of supervisors is 30—viz., one per 10 operators. The wages and salaries of this staff will be as follows:—

300 operators at 1,900 francs	Fr.570,000
30 supervisors, at 2,200 francs	66,000
Total	Fr.636,000

We will now consider the service effected under normal conditions—viz., with calls passing through two exchanges. When the subscriber calls, the subscriber's operator answers and receives the number required. This operator, whom we will call the originating operator, chooses an out-going junction line which is free and calls the operator at the in-coming junction board of the second exchange. The latter, who has 12 in-coming junction lines to attend to, answers as soon as she is free, and this, it may be observed, is a first cause of delay, if the operator is engaged at one of the other 11 lines. As soon as the in-coming junction operator has received the number of the subscriber required, she makes the engaged test of his line. If the line is engaged she informs the originating operator, who, in her turn, informs the calling subscriber. If the wanted subscriber is not engaged the junction operator calls him in the usual way, and when he answers, the two operators put their listening keys into the through position.

Thus, in general, the attention of both operators is engaged during the whole process of establishing communication. If, while awaiting the reply of the junction operator, the local operator answers another call, she may not be free when her colleague replies to her call. On the other hand, if she puts her listening key to the through position while the junction operator calls the wanted subscriber, it might happen that the connection is not made owing to the wanted subscriber not answering or the calling subscriber being tired of waiting and hanging up his telephone. Then the junction operator would have to ring the calling subscriber, but this would actuate the ring-off indicator at the local board and the conversation would be interrupted. The practice of hanging up their telephone as soon as

* Abstract from the *Journal Téléyraphique*.

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the demand for a subscriber is made is becoming very common among the 30,000 subscribers on the Paris system, although it is contrary to the instructions given them. The result is, that to avoid complaint from one or sometimes both subscribers, the originating operator has to see the call through and to ring the calling subscriber in order to put him through or to tell him that his correspondent does not answer.

A solution which forms part of the programme of the French telephone administration, and has been the object of preparatory measures in the more recent multiples, consists in the introduction of automatic calling and clearing signals being given when the subscriber takes off or replaces his receiver. But the complete realisation of this on a system as large as that of Paris will take some years. In addition to this improvement, it is intended to modify the arrangements so that whether a communication is to be effected between two subscribers on the same or different exchanges precisely the same series of operations is required from the local operator. The local operator has also to see the call through in every case, the junction operator having only to prolong the line of the wanted subscriber to the originating local board by means of a junction line. An important advantage in the modification will be the elimination of the multiple jacks on the subscribers' or local sections of the switchboard and of a certain number on the junction boards, and another will be a reduction of the number of junction line operators. The arrangement is as follows :—

The subscribers' board has a group of 100 local jacks per operator and, as already stated, no subscribers' multiple jacks. These boards can, therefore, be erected in any order, and, since they take up little room and are movable, they can be placed so as to utilise the space to best advantage. The out-going junction lines, which are multipled on the subscribers' sections in the usual manner, are not provided with visual signals, but the keyboard includes a certain number of call-wire keys provided with visual signals, which indicate to the local operator which junction-line operators are engaged.

The junction boards have multiple jacks, and each operator's position has 50 single cords serving 50 in-coming junction lines. These junction lines all have three wires, and the operation of connecting two subscribers is performed as follows :—As soon as the operator at the subscribers' board receives a demand for a number she depresses a call-wire key, which immediately puts her into communication with a *free* junction-line operator. She tells the latter operator the number demanded, and the junction operator makes the engaged test, and, if the subscriber is engaged, informs the originating operator of the fact. If the wanted subscriber is free, she inserts into his jack the plug of the single cord which she has employed for the engaged test, and tells the originating operator the number of the junction line to which that cord corresponds. The originating operator then sees the call through.

One ring-off indicator is connected on the line, and this is at the originating operator's board. When she observes the ring-off signal she removes the plugs, and a luminous signal appears automatically on the junction board, by means of the third wire of the junction line, and this indicates to the junction operator that the conversation is terminated and that she may break the connection. It is thus seen that the work of the junction-board operator will be considerably reduced, and that this will make it possible for her to serve a much greater number of lines than the 12 which are at present confided to one operator. Moreover, as the work is most simple and the junction operator has no communication with the subscribers, the less skilful or the more fatigued operators can be put in these positions.

It is possible to calculate approximately the cost of an exchange on this system for 10,000 subscribers. The cabinet work of the subscribers' boards will be on a smaller scale, as they have not to receive a complete multiple. There will be no change in the local jacks, indicators, nor in the elements of the subscribers' operators' keyboard common to all the lines (listening and ringing keys, ring-off indicators and the jacks of the out-going junction lines). Call-wire keys are added, but, on the other hand, the visual signals on the out-going junction lines are omitted. Under these conditions, therefore, the price of a group on the subscribers' board on the new system may be compared with that of the old system, less the multiple factor.

The old in-coming junction board, which included individual jacks and indicators, and plugs and cords, with their listening keys, ringing keys and ring-off indicators, will be simplified in the new system. All these will be replaced by 50 single cords and 50 luminous signals. The cost may be equivalent, but such a group will serve 50 instead of 12 lines, so that the 50 groups of 12 in-coming junction lines will now be replaced by 12 groups of 50. To avoid any miscalculation, let us suppose that one junction operator cannot serve 50 lines, but only 40, when the traffic is heaviest. Then 15 groups of in-coming junction lines would be required.

These 15 groups could only receive the 600 junction lines recognised as necessary up to the present for the 30,000 existing subscribers, and this calculation takes no account, so far, of the connections desired between two subscribers on the same exchange. An addition must be made therefore, as under the new system these calls also pass through the junction board. Five new groups—*i.e.*, 200 lines—will suffice for this, so that the total number of groups or operators' positions on the junction board will be 20.

The cost of the complete switchboard will, therefore, be as follows :—

	Fr.
100 operators' positions on the local switchboard (not including the multiple jacks) at 6,000fr.	600,000
20 operators' positions on the in-coming junction switchboard (not including the multiple jacks) at 4,000fr.	80,000
70,000 multiple jacks (10,000 for every three groups of the junction board) at 2fr.	140,000
Total	Fr.820,000

A comparison of this total of 820,000fr. with that of 1,800,000fr. previously indicated as the cost of the present multiple shows a saving of 980,000fr. in favour of the new system. Taking, as before, a repayment of capital in 10 years, the capital costs will be 82,000fr., and adding to this 10,000fr.* as the cost of maintenance per year, the total annual expenditure comes to 92,000fr. instead of 200,000fr.

It is only right to observe that the new system necessitates the use of junction lines with three wires instead of two, but on the other hand it entails great saving in the erection of the fixtures of the exchange. It is no longer necessary to have long and well-lighted rooms for the multiple switchboards, and all that is required is that the 15 groups constituting the in-coming junction board (which alone have complete multiples) should be erected in a line and be well lighted. The local sections may be disposed so as to utilise the space at disposal to the best possible purpose, and they may even be placed in different rooms. It has been recognised that a room of sufficient dimensions for a 10,000-subscriber switchboard of the old pattern could hold one of the new pattern designed for 15,000 subscribers.

The cost of working is also reduced, so far as the operating and supervising personnel is concerned. The new switchboard, with its 120 operators' positions, will require 240 operators and 24 supervisors, and the corresponding cost will be :—

240 operators at 1,900fr.	Fr.456,000
24 supervisors at 2,200fr.	52,800
Total	Fr.508,800

The saving in the yearly cost of working will, therefore, be 636,000fr.−508,800fr.=127,200fr. And the total annual saving in material and wages will be 114,200fr.+127,200fr.=241,200fr. per year. This only applies to a single exchange. It is easy to calculate what it would become when the system has been extended to the eight exchanges in Paris, and when these will be provided with switchboards working to their full capacity owing to the growing number of subscribers. Unfavourable conditions were purposely assumed by assuming that each junction operator could serve only 40 and not 50 lines. If experience shows that the latter figure is feasible, it will be found, on making due allowance in the above estimate, that the annual saving will be increased to 256,200fr. per year.

The proposal of this improvement and the idea of abolishing the multiple jack is due to M. Anizan, of the French telegraph administration. The figures given above apply to the "flat rate" system of charging employed in Paris, upon which no more than 100 subscribers can be dealt with by one operator. When the message rate is adopted, the average number of calls per subscriber per day will diminish, to judge by what has taken place on other networks. If we assume that it falls from 10 to 4, each operator at the local board will be able to attend to 250 instead of 100 subscribers, and each operator's position will, therefore, have to receive an addition of 150 local jacks. This alteration will be much more easily effected on boards which have no multiple jacks.

PROF. HOSPITALIER'S TELETACHYMETER.

This apparatus, described by Prof. Hospitalier at the last meeting of the Société Internationale des Electriciens in Paris, was devised by him for measuring the speed of his automobile. First, he thought of using a voltmeter and a magneto-generator, the voltage of which would be proportional to the speed. He felt discouraged by dimensions and weight of this apparatus. Charging and discharging a condenser would lead to great capacity, but for this condenser can be substituted the induction coil of a telephone set, connected as shown in the diagram on the next page.

A represents a commutator similar to the one used in Joubert's method for inscribing the wave shapes of alternating currents. Prof. Hospitalier realised this in the same form as in his commutator undograph. B is an accumulator battery or accumulator cell, which sends current impulses through the primary coil P through brushes *bc*. V is the voltmeter in which the secondary coil S is connected through

* Instead of 20,000fr. taken in the estimate for the old system. The difference is justified by the reduced number of parts which have to be maintained.

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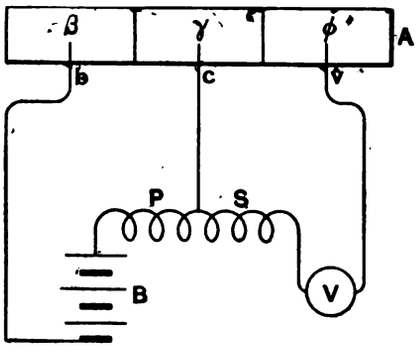
contacts *cv*. The revolving commutator is mounted on the shaft of which the speed is to be measured; contacts β, γ, ϕ are shaped and proportioned in such a way that the secondary circuit closes only after the initial period of primary current is passed and opens before the final period of the primary current, and the current impulses are repeated with a frequency sufficient for obtaining a steady voltmeter reading. This reading is proportional to the charging voltage and to



the speed of variation of the current, and thus for a given voltage it is proportional to the speed.

When using this apparatus on his gasoline automobile, Prof. Hospitalier charges the primary with the storage battery working the electric igniter. His voltmeter is graduated in kilometres per hour.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Pipes and Tubes: Their Construction and Jointing." By P. R. Björling. (London: Whittaker & Co.) 3s. 6d.

"A Practical Treatise on Modern Gas and Oil Engines." By Frederick Grover. 3rd Edition. (Manchester: Technical Publishing Co., Ltd.). 5s.

"The Thomson-Yates Laboratories Report." Edited by R. Boyce and C. S. Sherrington. Vol. IV. Part 2. (London: Longmans, Green & Co.) 20s.

"Programme of the City and Guilds of London Institute—Department of Technology. Session 1902-3." (London: Whittaker & Co.). 1s.

"Travaux du Congrès International de Physique: Paris, 1900." Edited by Ch.-Ed. Guillaume and L. Poincaré. Vol. IV. (Paris: Gauthier-Villars). 6fr.

"Discorso Pronunciato dal Prof. Riccardo Arnò in Occasione dell' Inaugurazione del Monumento a Galileo Ferraris in Livorno Piemonte." (Torino: Unione Tipografico).

"Anlasser und Regler für Elektrische Motoren und Generatoren.' By Rudolf Krause. (Berlin: Julius Springer). 4m.

"Catalogue of Scientific Papers (1800-1883)." Supplementary volume. Compiled by the Royal Society of London. Vol. XII. (London: C. J. Clay & Sons.)

ELECTRICITY WORKS ACCOUNTS.

Leeds Municipal Electric Supply Works.

A feature of the Leeds undertaking which complicates any comparison between it and the average municipal undertaking is the relatively small load-factor it possesses in conjunction with an output considerably above the average. Fortunately, for the purposes of criticism, the results attained are so uniformly and unmistakably excellent as to almost preclude the possibility of giving them too high praise. It will be remembered that as a natural and consistent result of the high prices which had to be paid for fuel and stores, the costs of 1900 were higher than in the preceding year. It is satisfactory to find from our analysis of last year's accounts that the old position has been more than regained.

With all the contributing items of expenditure at such low values as they are in our table it is impossible to single out any for special commendation. We have alluded to the difficulty of making comparisons with these results, but it seems safe to say that the total costs are quite 1d. per unit under the average of municipal undertakings of similar size and load-factor in 1900. On the other hand, the mean capital involved was materially higher than the average in its relation to the output. This latter position is, of course, an inevitable result of a comparatively low load-factor, and is much more than compensated for in the low working costs recorded.

Barnsley Municipal Electric Supply Works.

We heartily compliment the engineer of this undertaking on his results in the first two years of working. With an output of no more than 304,415 units sold, a load-factor of only 9·9 per cent., and an average total revenue of but 8·5d. per unit, there was a net profit of £159 for the year after payment of capital charges amounting to 6·21 per cent. on the mean capital expenditure.

We belive condensers are only this year being installed, so that considering the low value of the fuel charge (0·42d. per unit) it is evident that Mr. Baston has had a cheap fuel available. The excellence of the other items of works costs however serve to indicate the economical running of the works. Considering the low load-factor, the collective management and property charges at 0·7d. per unit cannot be taken exception to. The output shows a rise of 52 per cent. and the lamp connection of over 80 per cent.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 1900
Ayr (Municipal)	Oct. 11, 1901	Kens'gton & Knightsbr'(Co.)	Apr. 11, 1902
Barnsley (Municipal)	Jan. 17, 1902	Kingston-upon-Hull (Mun.)	July 18, 1900
Bath (Municipal)	April 20, 1900	Kingston-on-Thames (Mun.)	June 20, 1902
Bedford (Municipal)	Aug. 3, 1900	Lancaster (Municipal)	Feb. 15, 1901
Belfast (Municipal)	Oct. 18, 1901	Leeds (Municipal)	Oct. 11, 1901
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 26, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal)	Oct. 4, 1901	Leyton (Municipal)	Nov. 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Sept. 13, 1901
Bristol (Municipal)	Aug. 30, 1901	Morley (Municipal)	June 14, 1901
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	April 21, 1899	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	Aug. 9, 1901	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Nov. 29, 1901
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 16, 1901	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 28, 1900	Richmond (Company)	June 29, 1900
Croydon (Municipal)	Nov. 22, 1901	Salford (Municipal)	Jan. 24, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	Scarborough (Company)	Dec. 20, 1901
Derby (Municipal)	Jan. 26, 1900	St. Helens (Municipal)	Jan. 10, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dover (Company)	May 2, 1902	St. Pancras (Municipal)	July 5, 1901
Dundee (Municipal)	Dec. 6, 1901	Sheffield (Municipal)	Feb. 1, 1901
Eastbourne (Municipal)	Mar. 14, 1902	Shoreditch (Municipal)	Jan. 31, 1902
Edinburgh (Municipal)	Dec. 6, 1901	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Exeter (Municipal)	Aug. 5, 1898	South London (Company)	May 16, 1902
Folkestone (Company)	May 2, 1902	South Shields (Municipal)	Sept. 20, 1901
Glasgow (Municipal)	Sept. 27, 1901	Southampton (Municipal)	Feb. 8, 1901
Gloucester (Municipal)	Aug. 20, 1901	Southport (Municipal)	Jan. 17, 1902
Great Yarmouth (Mun.)	Dec. 13, 1901	Stafford (Municipal)	Aug. 16, 1901
Greenock (Municipal)	Aug. 30, 1901	Sunderland (Municipal)	Oct. 18, 1901
Guildford (Company)	Oct. 19, 1900	Taunton (Municipal)	June 16, 1899
Halifax (Municipal)	Dec. 27, 1901	Tunbridge Wells (Mun.)	Nov. 1, 1901
Hammersmith (Municipal)	Nov. 15, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hampstead (Municipal)	Nov. 22, 1901	Walsall (Municipal)	May 23, 1902
Hanley (Municipal)	Aug. 9, 1901	Wandsworth (Company)	May 9, 1902
Harrogate (Municipal)	Jan. 25, 1901	Westminster (Company)	April 4, 1902
Harrow (Company)	Dec. 21, 1900	Whitehaven (Municipal)	Feb. 8, 1901
Hast'gs & St. Leonards (Mun.)	July 12, 1901	Winchester (Company)	June 20, 1902
Hereford (Municipal)	Jan. 17, 1902	Windsor and Eton (Co.)	July 19, 1901
Hove (Company)	May 10, 1901	Woking (Company)	Dec. 22, 1899
Huddersfield (Municipal)	May 23, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Hull (Municipal)	Sept. 20, 1901	Woolwich (Company)	May 31, 1901
Isle of Wight Company)	Dec. 20, 1901	Worcester (Municipal)	April 18, 1902

REMARKS.

LEEDS.—*a* There is a "Reserve or Equalising Fund" with £7,894 at credit. *b* On rubber-covered mains £19,794, paper-covered £114,061. *c* Over-expended. *d* Returned law costs. *e* Land £30,748. *f* Less discounts. *g* There is a "Reserve and Equalising Fund" with £8,775 at credit. *h* India-rubber covered mains £19,046, paper-covered £176,976. *i* Inclusive of revenue from public lighting. *j* Engineers' department £1,749, clerical staff £949. *k* Insurance £201, loan expenses £225. *l* Costs incidental to change of pressure and system of supply, and of re-winding two alternators.

BARNSLEY.—*a* Over-expended. *b* Being proportion of engineer's salary. *c* Insurance. *d* On max. demand system (1-hour scale) or flat rate of 4d. per unit. *e* Includes public lighting. *f* Insurance. *g* After adding £149 revenue by "fittings."

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	LEEDS.		BARNSLEY.	
Undertaking Worked by	Leeds Corporation.		Barnsley Corporation.	
Date of Commencement of Supply	May, 1893.		February, 1900.	
System of Supply	Alternate-current transformer.		3-wire continuous-current.	
Chief Engineer	Harold Dickinson.		S. E. Bastow.	
YEAR ENDED	MAR. 25, **1901.**	MAR. 25, **1902.**	MAR. 31, **1901.**	MAR. 31, **1902.**
QUANTITIES—				
Units generated	—	—	245,750	—
„ **SOLD (TOTAL)**	2,520,414	3,055,165	200,112	304,415
„ sold to consumers	2,519,414	3,053,399	189,155	—
„ sold for public lighting, &c.	1,000	1,766	10,957	—
„ sold for traction	nil	nil	nil	nil
„ used on works	—	—	6,300	—
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	22·9	19·6	—	18
Actual maximum supply demanded	4,268 kilowatts	3,110 kilowatts	245 kilowatts	350 kilowatts
Load factor	6·75%	11·2%	9·3%	9·93%
Number of public lamps	1 arc	6 arc	19 arc 38 (16 c.p.) glow	27 arc 76 glow
Number of consumers	1,829	2,451	206	280
Connections to mains in 8-c.p. lamps at end of year	132,283	195,000	12,279	22,183
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	4,020	5,940	325	760
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	— / —	£28,115 / £86·5	£48,500 / £63·8
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	— / —	— / —	28,115 / 86·5	48,500 / 63·8
RECEIVED (TOTAL)	£217,420 / £54·1	£491,425 / £82·7	26,115 / 80·3	— / —
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	217,420 / 54·1	491,425 / 82·7	26,115 / 80·3	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	— / —	2,000 / 6·15	4,537 / 5·97
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	2,000 / 6·15	4,537 / 5·97
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	12,949[a] / 3·22	22,472[g] / 3·78	2,932 / 9·02	— / —
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	368,098 / 91·6	505,029 / 85·1	33,715 / 104	43,463 / 57·2
Lands and buildings	76,350[e] / 19·0	122,622[e] / 20·6	— / —	— / —
Plant	154,787 / 38·5	179,946 / 30·3	— / —	— / —
Mains	133,856[b] / 33·3	196,022[h] / 33·0	— / —	— / —
Miscellaneous	3,105 / 0·773	6,440 / 1·08	— / —	— / —
BALANCE OF CAPITAL ACCOUNT	−150,678[c] / −37·5	−13,604[c] / −2·29	−7,600[a] / −23·4	— / —
REVENUE—	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.
TOTAL	£43,669 / 4·160d.	£45,332 / 3·560d.	£3,665 / 4·400d.	£4,481 / 3·533d.
Revenue from supply	42,297[i] / 4·030d.	45,295[i] / 3·557d.	3,654[e] / 4·385d.	4,481[e] / 3·533d.
„ meters, &c.	1,328 / 0·126d.	38 / 0·003d.	— / —	— / —
„ public lighting	— / —	— / —	— / —	— / —
„ supply for traction	nil / —	nil / —	nil / —	nil / —
„ miscellaneous sources	45[d] / 0·004d.	— / —	11 / 0·013d.	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£13,769 / 1·311d.	£13,256 / 1·041d.	£1,480 / 1·775d.	£2,074 / 1·635d.
TOTAL WORKS COSTS	9,351 / 0·891d.	7,918 / 0·622d.	1,180 / 1·415d.	1,185 / 0·934d.
Generation of electricity	*8,406 / 0·801d.*	*7,067 / 0·555d.*	*1,179 / 1·414d.*	*1,166 / 0·919d.*
Fuel (including cartage, &c.)	4,727 / 0·450d.	3,457 / 0·272d.	664 / 0·796d.	537 / 0·423d.
Oil, waste, water, stores	402 / 0·038d.	476 / 0·037d.	102 / 0·122d.	102 / 0·080d.
Wages at station	2,447 / 0·233d.	2,280 / 0·179d.	373 / 0·447d.	403 / 0·318d.
Repairs and maintenance at station	830 / 0·079d.	855 / 0·067d.	40 / 0·048d.	124 / 0·098d.
Distribution of electricity	*945 / 0·090d.*	*851 / 0·067d.*	*1 / 0·001d.*	*19 / 0·015d.*
Wages, &c.	416 / 0·040d.	554 / 0·044d.	1 / 0·001d.	19 / 0·015d.
Repairs, renewals of mains, &c.	529 / 0·050d.	297 / 0·023d.		
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	4,418 / 0·421d.	5,339 / 0·419d.	300 / 0·360d.	889 / 0·701d.
Ne rents	*2 / —*	*1 / —*	*36 / 0·043d.*	*346 / 0·273d.*
Rates and taxes	*1,356 / 0·129d.*	*1,810 / 0·142d.*	nil / —	
Management	*3,060 / 0·291d.*	*3,528 / 0·277d.*	*264 / 0·317d.*	*543 / 0·428d.*
Salaries	2,485 / 0·237d.	2,698[j] / 0·212d.	168[b] / 0·202d.	319 / 0·252d.
Stationery, &c.	128 / 0·012d.	152 / 0·012d.	50 / 0·060d.	39 / 0·031d.
Establishment charges	247 / 0·024d.	251 / 0·020d.	33 / 0·040d.	168 / 0·132d.
Law charges &c.	200[f] / 0·019d.	427[k] / 0·034d.	13[c] / 0·016d.	17[f] / 0·013d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£29,900 / 8·85%	£32,076 / 7·35%	£2,184 / 8·30%	£2,407 / 6·24%
Sum carried to Depreciation Fund	— / —	1,764[l] / 0·402%	— / —	— / —
Sum carried to Reserve Fund	7,633 / 2·26%	9,135 / 2·09%	1,457 / 5·54%	2,397 / 6·21%
Net interest on loans (incl. Debenture charges)	15,385 / 4·55%	18,018 / 4·13%	72 / 2·73%	
Net profit for the year	6,882 / 2·04%	3,170 / 0·726%	8 / 0·030%	159[g] / 0·412%
BALANCE FROM LAST ACCOUNT	— / —	— / —	nil / —	8 / 0·021%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	6,882 / 2·04%	3,170 / 0·726%	8 / 0·030%	169[g] / 0·438%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	31·5%	29·3%	40·4%	46·3%
Expenditure per mean kilowatt capacity	£3. 18s. 0d.	£2. 13s. 3d.	—	£3. 16s. 7d.
REVENUE PER MEAN KILOWATT CAPACITY	**£12. 7s. 5d.**	**£9. 2s. 0d.**	—	**£8. 5s. 5d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	7s. 4d.	5s. 6d.	—	5s. 2½d.
Price charged for lighting, per unit	4½d. to 5d.[f]	4d. less 5% discount	7d. to 3d.	7d. to 2d.[d]
Price charged for power, per unit	2d. less 5% discount	1½d. to 2d. less 5% disc.	1½d.	1½d.
Price charged for public lighting	4d. per unit	1½d.	7d. to 2d.	7d. to 2d.[d]
Receipts per unit for private supply	4·03d.	3·56d.	4·38d.	3·53d.
„ „ public lighting	—	—	—	—
„ „ traction				

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LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS. By F. C. RAPHAEL. *New Edition in preparation.*

THE DEPUTATION TO MR. GERALD BALFOUR.

In our last issue we reported at length the speeches made by members of the deputation of the Institution of Electrical Engineers, who desired to impress on Mr. GERALD BALFOUR the necessity of revising the existing law of electric lighting and traction, and the reply which the President of the Board of Trade made to them. In heading this deputation, Mr. SWINBURNE has had no easy task for what has been practically the first official duty of his presidentship, and he acquitted himself of it with excellent tact and discretion. No one could have stated more clearly the main object of the deputation, an object which should be dear to all electrical engineers alike, whether they are connected with the section of the industry owned by municipal authorities or with private electrical enterprise. Anything tending to cramp the electrical industry, and to place difficulties in the way of its proper growth and development is inimical to its true interests. An industry based on scientific progress, on research and experiment, should be allowed the very greatest latitude; pioneers should be encouraged, not discouraged, and new enterprises should be relieved of all unnecessary trammels. But the very opposite is the case. When electric supply works or electric tramways are to be built, consideration has to be had of the fact that the owners will have to part with them at "old iron" prices to the local authorities in a certain number of years; and, moreover, before sanction can be obtained to erect the works, the local authority's consent is essential, and without it the scheme falls to the ground. The procuring of this consent may not appear to be a difficult matter at first sight, when it is considered that, in view of the purchase clause, the local authority will benefit ultimately; but this is not so in fact. The local authority whose consent is to be obtained is sometimes an owner of gasworks. Frequently it desires to own its electricity works from the outset, and, being engaged in spending money on other improvements at the moment, it opposes any company seeking electric lighting or tramway powers so as to keep the door open for itself. Again, should a power company threaten to be in a position to supply electrical energy at a cheaper rate than the existing electricity works of a local authority, the latter will oppose powers being granted to the company for its district. In the case of tramway schemes exorbitant demands for road-widening and improvements are often insisted on, and even sums of money are asked as a price of the local authority's consent; and, finally, as the local authority is a prospective owner of the electricity works and tramways, it considers itself entitled to make terms, even if it can state no other ground for opposition. In short, as Mr. SWINBURNE points out in a letter to Monday's *Times* (in which he is less restrained and more outspoken than he was in his calm and logical argument before Mr. GERALD BALFOUR)—"the one accident of our using roads and the other

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accident of the surfaces being controlled by local authorities give the local authorities power to buy us up at scrap value, to prevent traction schemes of public benefit, to prevent their ratepayers buying energy from power companies, and to treat the whole industry as the plaything of misapplied socialism."

Other speakers who followed Mr. SWINBURNE were not so careful or so diplomatic. It is doubtless essential that the Board of Trade's technical regulations should be maintained "up to date" to keep pace with the constantly fresh electrical engineering developments; but it would have been better for the more important issue involved if all the members of the deputation had confined themselved to pressing on Mr. GERALD BALFOUR the necessity of new and direct legislation, and of the appointment of a Royal Commission to inquire into the matter and to recommend the precise measures which are required. Naturally, a body of engineers, some of whom have grievances against the Board of Trade Regulations, found themselves subjected to an immense temptation to enlarge on the subject when they had the president of the department, so to speak, in their clutches; but it would have been better to have resisted it. When, finally, Mr. PATCHELL endeavoured to interest Mr. GERALD BALFOUR in such deep technical matters as the earthing of the neutral point of a three-phase system, and the conundrum whether an extra high-pressure cable is a high-pressure cable (a conundrum, by the way, whose solution we gave in our columns more than two years ago), Mr. SWINBURNE was wise in calling him to order. It was too late, however; for Mr. BALFOUR immediately seized the opportunity to take this point, which is by far the easier to remedy, as if it was the more pressing one, and to evade giving any expression of opinion as to the question of general legislation.

We are thankful to him for his promise to consider the Institution's representations as to alterations in the existing Board of Trade Regulations, but we have a right to ask for more than this. Lord CROSS's Select Committee of the two Houses of Parliament reported, four years ago, that in their opinion the Electric Lighting Act of 1888 should be amended so as to give local authorities merely a *locus standi* to oppose the granting of a provisional order, instead of their having, as now, practically a right of absolute veto. This Committee had not electric traction matters under its consideration, but naturally the same thing applies. A Bill based on the recommendations of Lord CROSS's Committee, and, therefore, not applying to traction undertakings, is, it appears, among the crowded-out measures this session, as well as a Light Railways Bill, which would, presumably, make the provisional Light Railways Act a permanent measure and officially recognise tramways as light railways; but this is cold comfort. Government Bills brought forward at the end of the session, and in a half-hearted manner, are not infrequently dropped if there are signs of opposition; and if this is to happen this session, it may occur next session and the session after. A warning has also been sounded by the general tendency and result of the debate on "Standing Order 22" in the House of Commons on May 15th (see *The Electrician*, May 23, p. 184). The votes of private members on any measure threatening to curtail the power of local authorities are apt to be recorded in the "Noes" lobby, for the town council party are useful friends to have in a Parliamentary election. Doubtless it is for this reason that the deputation from the Institution of Electrical Engineers was insistent on the advisability of a Royal Commission being appointed. A Royal Commission is occasionally the shelf on which a difficult question is reposed for a convenient period when the Government is busy with other matters; but it is more often a reliable and forcible means of framing good legislative measures. A short delay, and then a thorough revision in the law of electric lighting, power supply and traction will be far better than abortive attempts at half measures, such as the debate on Mr. CHAPLIN'S motion to amend the standing order above referred to. We may fitly conclude by quoting the last paragraph in Mr. SWINBURNE'S letter to Monday's *Times*:—"What we want is not a couple of Bills promoted by the Board of Trade, brought on some day, but a full and impartial inquiry into the whole effect of legislation on the electrical industry in the country. Such an inquiry ought to be outside the influence of the local authorities, and it ought to have sufficient weight to guide Parliament. A Royal Commission seems most likely to be efficient."

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

Practical Radiography. A Handbook for Physicians, Surgeons and Other Users of X-rays. By A. W. ISENTHAL, F.R.P.S., and H. SNOWDON WARD, F.R.P.S. 3rd edition. (London: The Photogram Limited.) 1902.

The authors have evidently set out with the excellent intention of speaking their minds plainly, for they tell us in the introductory remarks that not only is the present edition of their book "much larger," but also that it is "more important than the others." If, however, we skip through the "Historical Review," and wink at the definite statement, "This ether is capable of vibrating at widely different frequencies, thus producing the phenomena of heat, light, photochemical action, electricity, magnetism, gravitation, &c.," and if, without daring to contemplate what the "&c." can refer to, we excuse the pun on page 10, we have one of the most complete and useful books on X-ray practice that exists to-day in the English language. The first chapter is headed "Sources of Electric Energy," and there we find a good deal of space devoted to a clear exposition of various primary and secondary batteries, direct and alternating current supply from street mains, the Wimshurst machine and even thermal methods of obtaining electricity direct from heat. All this is particularly well illustrated. The section, too, which deals with induction coils and interrupters is full of practical detail, and here, as before, the illustrations are of a high order. It is satisfactory to have the elementary function of the interrupter explained and so fully discussed at a time when much is being said and written upon that useful adjunct. Scarcely a month passes without the announcement of a new way of suddenly breaking the primary circuit of an induction coil, and so numerous are the methods already suggested that the task of conscientiously choosing typical examples for the purpose of the book cannot have been a light one. Although Mr. Mackenzie Davidson's mercury "break" is not included in the authors' list, enough is said to enable the novice to recognise the principle involved, and to see the advantage or otherwise of that particular device in special cases.

The X-ray tube itself comes in for a share of criticism, and the various types of bulbs designed and used by different workers are for the most part carefully described and illustrated. We take exception, however, to Figs. 46 and 47, as being likely to give an erroneous impression to a beginner.

A distinct feature of the book is certainly the excellent account of the numerous "accessories," and every radiographer will welcome the suggestions respecting the best manner of setting up what apparatus is essential for conducting X-ray work upon an extensive scale. The rest of the book deals with the actual operation of taking radiographs, considers in some detail the efficiency of photographic plates by various makers, and includes well-illustrated accounts of the best "localisation" methods, stereoscopy and the function of X-rays in medical diagnosis. We venture to think that the theoretical side of the question might well have been omitted

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from a book of this character—in the first place, because it is scarcely possible to deal adequately with the matter in a few pages; and secondly, because of the danger of misrepresentation, so often apparent where theoretical considerations receive incomplete treatment. "Practical Radiography" contains many well-executed plates, and cannot fail to be a welcome addition to the literature of the subject.

An Elementary Book on Electricity and Magnetism and their Applications. By DUGALD C. JACKSON, C.E., and JOHN PRICE JACKSON, M.E. 1902. (New York: The Macmillan Company; London: Macmillan & Co.) 7s. 6d.

This little work, though necessarily following the lines of elementary text-books on electricity and magnetism, is certainly of a more original form than the majority of these. It is clearly written, and, as the authors points out in their preface, they write on the principle that "good teaching requires the overthrow of the traditional academic order and abstract presentation in elementary instruction in physical science, and the substitution therefor of a rational presentation of applied science." The rational order of instruction here set out is one which follows very nearly in the same sequence as the order of discoveries and industrial applications.

Each chapter is concluded with an exhaustive list of questions referring to pretty nearly everything that has been stated or described in that chapter, and which cannot fail to be useful to the student, to prove whether he has really assimilated what he has just read. The illustrations are good, and many of them new, which is at least a relief to the eye that sees the same old blocks doing duty in elementary text-book after elementary text-book. The book is well up to date, dealing with the later applications of electricity such as enclosed arc lamps, electric refining of metals, smelting and welding, heating and cooking by electricity, cathode and X-rays, electromagnetic waves and wireless telegraphy. E. C. R.

Theoretical Elements of Electrical Engineering. By C. P STEINMETZ. (New York: *Electrical World and Engineer.*)

The main difficulty in teaching pure mathematics is to make the subject interesting to the student, and this difficulty is more marked if the education of the student is by text-book rather than by lecture or personal tuition. Applied mathematics is different to pure mathematics in this respect, however. Not only is there a wealth of illustration to borrow from, but each process in the reasoning can be made clear to the student as a definite step towards a particular goal of practical application. To a text-book on the theoretical elements of electrical engineering this should particularly apply, for electrical engineering is the branch of applied mathematics which is the most interesting, owing to the immediate utilitarian aspect all its problems assume. Notwithstanding this, Mr. Steinmetz's book is dull. His theory is, needless to say, sound, and his choice of problems is possibly correct; but the work, nevertheless, is dull and tedious reading rather than inciting interest.

In his preface Mr. Steinmetz mentions that the first part of the volume originated from a series of university lectures which he once promised to deliver, and truly it is particularly this part which reads as dry notes serviceable to the lecturer, but devoid of the particular flavouring which the lecturer himself would have added subsequently to make them palatable to the student. This first part is devoted to "General Theory."

The second part of the volume is almost independent of the first part. It is a series of monographs concerning alternating and continuous-current dynamos, motors and converters, the alternating part of which is more or less supplementary to the author's highly mathematical work "Alternating-Current Phenomena" in the same series. Each section is a series of theoretical notes about the particular class of machine with which it deals, the four main sections into which it is divided being "Synchronous Machines," "Commutating Machines," "Synchronous Converters," and "Induction Machines." The style in which these notes are written makes them just fall short of being interesting as a talk about the various machines, and as the book cannot be regarded as a treatise on the design or application of electrical machinery either, we fear that it will not appeal to a large number of readers.

Konstruktionstafeln für den Dynamobau. Part I. Gleichstrom-Maschinen. Part II. Wechselstrom-Maschinen, Umformer, Motoren und Transformatoren. By Prof. E. ARNOLD. (Stuttgart: Ferdinand Enke. 1902).

This is an age of learning by pictures, and the two large portfolios of drawings, of which the title has been given above, are undeniably in full keeping with the spirit of the age. Most readers of technical literature and all who are engaged in the advanced work of electrical design, are familiar with the writings of Prof. Arnold on the subject of dynamos, both continuous-current and alternating. These writings are appropriately supplemented by the present set of plates, being the fourth edition of the continuous-current series and the second edition of the alternating series. Both are admirably adapted to meet the needs of a lecturer at a technical college who wishes to illustrate to his students the practical construction and method of manufacture of all kinds of modern electrical machinery. If the critic must find some objection, it can only be that it requires a special book-case to provide a permanent home for a volume 20in. by 16in. Seriously speaking, it may be questioned whether any branch of technical science other than electrical engineering is so lavishly supplied with working drawings of all classes of apparatus, such as are contained in the present portfolios or in Mr. Kapp's "Dynamo Construction," with which they challenge comparison. The explanation of this wealth of illustration must be sought in the fact that the latest development of applied science has had brought to bear on it a system of technical education far more highly organised than any of its predecessors. The generosity of the leading electrical firms has laid bare to the world almost the arcana of the designer's art, and the learner may be excused if at times he is inclined to ask himself, Can anything more be wanted besides such complete working drawings? Perhaps, indeed, there is nothing more, save the bearing on it all of the weighty question of £. s. d.

In the first series of 60 plates are to be found drawings of continuous-current dynamos of all sizes, of crane motors, and of tramway motors, with additional details of bearings, brush-holders, magnet-frames, slide rails, and insulating couplings. Among the makers whose machines are laid under contribution occur the well-known names of Siemens and Halske, the Allgemeine Elektricitäts Gesellschaft, the Oerlikon Co., Lahmeyer, Kolben, Alioth, &c. The bulk of the manufactories represented are German, and all are Continental.

The second series of 60 plates is similarly concerned with alternators, alternate-current motors and transformers, with details of exciter arrangements, pole-construction, &c., while to the names of makers must especially be added that of Brown, Boveri & Co. America is directly represented by a 1,500kw. two-phase generator of the Westinghouse Company, and by a single-phase motor of the Wagner Mfg. Co., of St. Louis. Britain is entirely absent in both cases, yet, in spite of the honoured names of our great pioneers, it must be sorrowfully allowed that the absence is not strikingly conspicuous. It is interesting to observe that while 35 plates are devoted to three-phase apparatus, five plates suffice for single-phase alternators and one for single-phase motors.

The letterpress is confined to a complete table of the leading dimensions and constants of the machines illustrated. Comparison of the dimensions by the light of the usual formula, which makes the output per revolution per minute proportional to the length of the armature core and to the square of its diameter, reveals surprising discrepancies, even in the case of machines somewhat similar in type and output; but it would be going too far afield if the interest of the subject were to lead us into any discussion as to the causes of such discrepancies.

Geleislose Elektrische Bahn mit Oberleitung. By THOMAS MARCHER. (Halle: C. O. Lehmann.) 1902. 1·80m.

A study of the title page of this pamphlet encourages the unmerited suspicion that it is a joke. First, the author's name is almost too appropriate for the exponent of a new system of automobile, and then an endeavour to translate the first three words of the title page involved us in serious difficulties. At the first attempt we evolved "rail-less electric railway,"

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and trying to improve on this, "electric way without rails." We must, therefore, give up attempts at literal translation in this case, and explain that the pamphlet describes what has been done in the way of electrically propelled cars running on ordinary roads and taking their current from a trolley-wire. This new branch of the electrical industry, as the author is pleased to term it, comes very near to being nothing more than a fad, but those who are interested in it will find all there is to say in its favour in this 35-page pamphlet.

THE TEMPERATURE AND EFFICIENCY OF THE ELECTRIC FURNACE.

In 1898, M. Gin, of Paris, published a formula for determining the temperature of an electric furnace, based on the supposition that the arc was struck in an atmosphere non-conducting and not subject to dissociation.* The temperature changes in this case were assumed to be adiabatic in character. In the May issue of the *Elektrochemische Zeitschrift* M. Gin gives a series of formulæ, which represent the temperature changes and efficiency of the furnace, when the atmosphere or medium surrounding the electrodes between which the arc is struck is a conductor. If l and s represent the length and diameter of this separating atmosphere or medium, p equal its resistance, and c its specific heat, based on unit volume, then the amount of energy converted into heat in unit of time is RI^2, and the corresponding amount of liberated heat is

$$\frac{1}{A}\left(\frac{l}{s}\right)^2 pls.$$

When the arc is surrounded by a compound which permits no heat to pass, the equation becomes

$$\frac{1}{A}\left(\frac{l}{s}\right)^2 pls = clst.$$

From this it follows that the temperature of the arc in the material will increase as the square of the current density, and this equation applies whether the medium separating the electrodes be in the gaseous or fluid condition.

The calculation of the temperature of an electric furnace working on the resistance principle is a complicated problem, but, assuming certain data, it can be approximately ascertained.

Expressing in gramme calories the following values for the unit weights of the bodies submitted to the action of the current :—

C_s = The mean specific heat in solid state
C = The latent heat of fusion.
C_1 = The mean specific heat in fluid state.
C_r = The heat absorbed as a result of the chemical changes.

And taking, further, the following :—

P = The weight of substance passed through the furnace in unit of time, when this is in full work.
$T_f T_r$ = The fusion temperature and the temperature at which the reaction occurs.
Σ = The total superficial area of the exterior of the furnace, from which radiation occurs, then

$$EJ = 1{\cdot}16[P(C_s T_f + C_f + C_1(T_r - T_f) + C_r) + K\Sigma S T_r].$$

From this equation T_r can be calculated with approximate correctness.

The formula can be simplified by omitting $C_s T_f$ and by substituting $K-$ for $K\Sigma S$, a characteristic constant of all work with the one type of furnace. The equation then becomes

$$EJ = 1{\cdot}16\,[P(C_f + C_r + C_1(T_r - T_f)) + KT_r],$$

and the effective work of the furnace is represented by

$$\frac{P[C_f + C_r + C_1(T_r - T_f)]}{P[C_f + C_r + C_1(T_r - T_f)] + KT_r}.$$

This last formula shows that the efficiency of the furnace as a heating agent diminishes as the reaction temperature falls, and increases with the increase of the values for C_f and C_r, that is, with the increase in the amount of heat absorbed by the physical and chemical changes in the substances operated on.

* See *Comptes Rendus*, 126, p. 236.

THE CASTELLI COHERER.

Since 1898 the Italian naval authorities have carried out a series of experiments in wireless telegraphy with a view to test the practicability of the system as a means of communication between the semaphore stations of the kingdom. These experiments, of which some account is given by A. Banti, in *L'Elettricista* for May last, were based on the Marconi system, and the results obtained were somewhat disappointing until Capt. Bonomo, to whom the later experiments had been entrusted, tried telephonic reception in combination with a self-decohering coherer invented by Paolo Castelli, an assistant semaphorist. Telephones had already been used experimentally by Popoff, Ducretet and others, but no one had made use of a suitable coherer such as that of Castelli. Coherers, as is well known, are formed in various ways, the most noteworthy

Fig. 1

Fig. 2

Fig. 3

being the so-called powder coherers, which may be made, for example, with silver electrodes and granules of carbon or silver, or silver and nickel (Fig. 1). When these tubes are used it is necessary to tap them for each wave received, in order to "decohere" them and thus render them capable of receiving another signal. But tubes or coherers having iron or carbon electrodes with a drop of mercury between them (Fig. 2) not only have a high degree of sensitiveness, but have the advantage of decohering completely immediately the action of the electric waves ceases. The tube proposed by Castelli (Fig. 3) consisted of two carbon electrodes enclosing two drops of mercury separated by a small iron cylinder. This tube is self-decohering. When it is used in conjunction with a telephone the receiving apparatus of a station becomes extremely simple (Fig. 4). In practice the receiving arrangements devised by Capt. Bonomo takes a somewhat more complete form (Fig. 5), but it is essentially much simpler than previous arrangements.

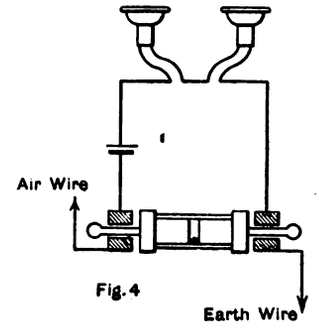

Fig. 4

In practice it ensures regularity and rapidity of communication to much greater distances. It was possible to establish a system of signalling between Palmaria and Leghorn with a transmitter giving only 4mm. sparks, whilst telegrams were exchanged between Portoferraio lighthouse and Leghorn, Gorgona and Palmaria, the maximum distance being 148km. For a good tube, carefully adjusted, the E.M.F. of the cell should be from 1 to 1·5 volts. The hygrometric state of the atmosphere has an appreciably injurious effect on tubes which are not perfectly closed. In the mercury tubes the self-decoherence is more or less perfect according to the purity and freedom from amalgam of the mercury used, to the dryness and cleanliness of the interior of the tube, and to the smallness of

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the drops of mercury. The most suitable diameters of the drops are comprised between the extreme limits of 1·5mm. and 3mm. Drops less than 1·5mm. in diameter give insensitive tubes; those greater than 3mm. diminish the completeness of the decoherence. The diameters of the tubes must be proportional to the drops of mercury used; in general they are 3mm. in internal and 5mm. to 8mm. in external diameter. These tubes must be regulated by the telegraphist on duty, and they lose after a certain time their good qualities, but the telegraphist can dismount the tube, clean it, and put in fresh mercury, taking all the necessary precautions for obtaining absolute cleanliness.

It was chiefly due to the use of the Castelli tube that it was found possible to effect communication with precision and clearness between a station installed at Teialone (Maddalena), and another at the semaphore station of Monte Argentaria, a

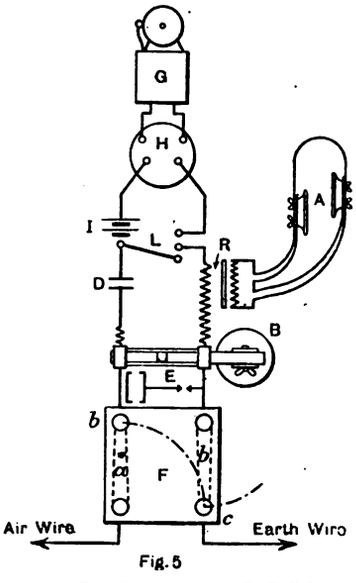

Fig. 5

G, Bell. A, Telephones. L, Bell Switch.
H, Relay. B, Induction Coil. E, Lightning Protector.

distance of 200km. (124·3 miles). After these trials the experiments were discontinued, and the two stations were dismantled. The new Castelli coherer in an improved form is stated to have been used by Marconi in his first attempts to signal across the Atlantic.

THE PROGRESS OF ELECTRIC SPACE TELEGRAPHY.*

BY G. MARCONI.

Wireless telegraphy, or telegraphy through space without connecting wires, is a subject which at present is probably attracting more world-wide attention than any other practical development of modern electrical engineering. That it should be possible to actuate an instrument from a distance of hundreds or thousands of miles and oblige it at will to reproduce audible or visible signals through the effects of electrical oscillations transmitted to it without the aid of any continuous artificial conductor, strikes the minds of most people as being an achievement both wonderful and mysterious. If we examine the subject closely we may, however, come to the conclusion that, although telegraphy through space is certainly wonderful, as are likewise all natural and physical phenomena, yet it is certainly in no way more wonderful than the transmission of telegrams along an ordinary telegraph wire. The light and heat waves of the sun and stars travel to us through millions of miles of space, and sound also reaches our ears without requiring any artificial conductor. Is it not, therefore, wonderful that man should have devised means by which he is enabled to confine electricity conveying messages or power to a wire and cause the effect which we call an electric current to follow all the turns and convolutions which may exist in the wire?

We find that the first systems of telegraphy used by mankind were truly wireless. A bonfire built on a hill by a band of aboriginal Indians conveyed a signal wirelessly by etheric waves—in this case light waves—to Indians on another hill, perhaps miles distant. Even to-day there are innumerable systems of what may truly be called wireless telegraphy in practical use. A red light at a railway crossing conveys a signal by waves through the ether to the eye of the engine driver. The red light is the transmitter, the eye the receiver.

The method of space telegraphy of which I intend speaking to-night is founded on a comparatively new way of controlling and detecting certain kinds of etheric waves, much slower in rate of vibration than light waves, called Hertzian waves, after the scientist who first demonstrated their existence. The mathematical and experimental proof by Clerk Maxwell and Heinrich Hertz of the identity of light and electricity, and the knowledge of how to produce and detect certain previously unknown ether waves, made possible this new method of communication. I think I am right in saying that the importance of the discoveries of Maxwell and Hertz was realised by very few, and even, perhaps, so recently as a year ago a great number of scientific men would have hardly foreseen the advances which have been made in so brief a time in the art of space telegraphy.

The time allowed for this discourse does not permit me to describe all the various steps which have made possible the results recently obtained nor to describe the work of the numerous workers who have contributed to the advance of the subject, but I hope it may be of interest if I describe the various problems which have lately been solved, and the very interesting developments which have taken place in my own work during the last few months. I shall first briefly describe my system as used in my early experiments six years ago, and afterwards endeavour to explain the various improvements and modifications which have since been introduced into it.

The transmitter consists of a modified form of Hertzian oscillator, the main feature of which is in having one sphere of the spark discharger earthed and the other connected to an elevated capacity area or to a comparatively vertical wire. The two spheres are also connected to the ends of the secondary winding of an induction coil or transformer. When the key is pressed the current of the battery is allowed to actuate the spark coil, which charges the spheres and the vertical wire, which, when discharging, causes a rapid succession of sparks to pass across the spark-gap. The sudden release caused by the spark discharge of the electrical strain or displacement created along certain lines of electric force through space by the charged wire causes some of the electrical energy to be thrown off in the form of a displacement wave in the ether, and, as a consequence, the vertical wire becomes a radiator of electric waves. In this connection it is interesting to remember that Lord Kelvin showed mathematically more than 40 years ago the precise conditions under which such a discharge as we are considering would be oscillatory. It is easy to understand how, by pressing the key for longer or shorter intervals, it is possible to emit a long or short succession of impulses or waves which, when they influence a suitable receiver, reproduce on it a long or short effect, according to their duration, in this way reproducing the Morse or other signals transmitted from the sending station.

The receiver consists of a coherer (on the nature of which I hope to make a few further remarks later) placed in a circuit containing a local cell and a sensitive telegraph relay actuating another circuit, which works a trembler or decoherer and a recording instrument. In its normal condition the resistance of the coherer is infinite, or at least very great, and the current of the battery cannot pass through it to actuate the instruments, but when influenced by electric waves the coherer becomes a comparatively good conductor, its resistance falling to between 100 and 500 ohms. This allows the current from the local cell to actuate the relay, which in turn causes another stronger current to work the recording instrument and also the tapper or decoherer, which is so arranged as to tap or shake the coherer, and in this way restore its sensitiveness. The practical result is that the circuit of the recording instrument is closed for a time equal to that during which the key is pressed at the transmitting station, and in this way it is possible to obtain a graphic, acoustic or optical reproduction of the movements of the key at the sending station. One end of the tube, or coherer, is connected to earth and the other to an insulated conductor, preferably terminating in a capacity area similar in every respect to the one employed at the transmitting station.

I noticed that by employing similar vertical rods at both stations, it was possible to detect the effects of electric waves, and in that way convey the intelligible alphabetical signals over distances far greater than had previously been believed possible, and by means of similar arrangements distances of transmission up to about 100 miles were obtained.

It was soon, however, realised that so long as it was possible to work only two installations within what I may call their sphere of influence, a very important limit to the practical utilisation of the system was imposed. Without some practical method of tuning the stations it would have been impossible to work a number in the vicinity of each other at the same time without interference caused by the mixing of messages. The new methods of connection which I adopted in 1898—*i.e.*, connecting the receiving vertical wire or aerial directly to earth instead of to the coherer, and by the introduction of a proper form of oscillation transformer in conjunction with a condenser so as to form a resonator tuned to respond best to

* Lecture delivered before the Royal Institution, June 13th.

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waves given out by a given length of aerial wire—were important steps in the right direction. I referred at length to this improvement in the discourse which I had the honour to deliver at this table on February 2, 1900. I had, however, realised at the time that one great difficulty in the way of achieving the desired effects was caused by the action of the transmitting wire. A straight rod in which electrical oscillations are set up forms, as is well known, a very good radiator of electrical waves. In all what we call good radiators electrical oscillations set up by the ordinary spark-discharge method cease or are damped out very rapidly, not necessarily by resistance, but by electrical radiation removing the energy in the form of electric waves.

It is a well-known fact that when one of two tuning forks having the same period of vibration is set in motion, waves will form in the air, and the other tuning fork, if in suitable proximity, will immediately begin to vibrate in unison with the first. In the same way a violin player, sounding a note on his instrument, will find a response from a certain wire in a piano near by, that particular wire, out of all the wires of the piano, happening to be the only one which has a period of vibration identical with that of the musical note sounded by the violinist. Tuning forks and violins, of course, have to do with air waves and wireless telegraphy with ether waves, but the action in both cases is similar. It is very important to take into consideration the one essential condition which must be obtained in order that a well-marked tuning or electrical resonance may take place. Electrical resonance, like mechanical resonance, essentially depends upon the accumulated effect of a large number of small impulses properly timed. Tuning can only be obtained if a sufficient number of these timed electrical impulses reach the receiver. As Prof. Fleming so graphically puts it in one of his lectures on electrical oscillations, to "set a pendulum in vibration by puffs of air we must not only time the puffs properly, but keep on puffing for a considerable period." It is, therefore, clear that a dead-beat radiator—*i.e.*, one that does not give a train or succession of electrical oscillations—is not suitable for tuned or syntonic space telegraphy.

As I pointed out before, a transmitter consisting of a vertical wire discharging through a spark-gap is not a persistent oscillator. Its electrical capacity is comparatively so small and its capability of radiating waves so great that the oscillations which take place in it must be considerably damped. In this case receivers or resonators of a considerably different period or pitch will respond and be affected by it.

Early in 1900 I obtained very good results with another arrangement in which the radiating and resonating conductors each take the form of two concentric cylinders, the internal cylinder being earthed. By using zinc cylinders only 7 metres high and 1·5 metres in diameter good signals could easily be obtained between St. Catherine's Point, Isle of Wight, and Poole, over a distance of 30 miles, these signals not being interfered with or read by other wireless telegraph installations worked by my assistants or by the Admiralty in the immediate vicinity. The capacity of the transmitter due to the internal conductor is so large that the energy set in motion by the spark discharge cannot all radiate in one or two oscillations, but forms a train of slowly-damped oscillations, which is just what is required. A simple vertical wire may be compared with an empty teapot, which, after being heated, would cool very rapidly, and the concentric cylinder system with the same teapot filled with hot water, which would take a very much longer time to cool. In the receiver the closely adjacent cylinders which give it large electrical capacity cause it to be a resonator possessing a very decided period of its own, and it becomes no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray ether waves which are sometimes caused by atmospheric disturbances, and which occasionally prove troublesome during the summer.

Another successful system of tuning or syntonising the apparatus was the outcome of a series of experiments carried out with the discharge of condenser or Leyden jar circuits. I tried by means of associating with the radiating wire, or capacity, a condenser circuit, which is known to be a persistent oscillator, to set up the required number of oscillations in the radiator. An arrangement consisting of a circuit containing a condenser and a spark-gap constitutes a very persistent oscillator. Prof. Lodge has shown us how, by placing it near another similar circuit it is possible to demonstrate interesting effects of resonance by the experiment usually referred to as that of Lodge's syntonic jars. But, as Lodge points out, "a closed circuit such as this is a feeble radiator and a feeble absorber, so that it is not adapted for action at a distance." I very much doubt if it would be possible to affect an ordinary receiver even at a few hundred yards. It is, however, interesting to notice how easy it is to cause the energy contained in the circuit of this arrangement to radiate into space. It is sufficient to place near one of its sides a straight metal rod or good electrical radiator, the only other condition necessary for long-distance transmission being that the period of oscillation of the wire or rod should be equal to that of the nearly closed circuit. Stronger effects of radiation are obtained if the radiating conductor is partly bent round the circuit containing the condenser (so as to resemble the circuits of a transformer).

My first trials with this system were not successful, in consequence of the fact that I had not recognised the necessity of attempting to tune to the same period of electrical oscillations (or octaves) the two electrical circuits of the transmitting arrangement (these circuits being the circuit consisting of the condenser and primary of the transformer and the aerial or radiating conductor and secondary of the transformer). Unless this condition is fulfilled, the different periods of the two conductors create oscillations of a different frequency and phase in each circuit, with the result that the effects obtained are feeble and unsatisfactory on a tuned receiver. The syntonised transmitter is shown in Fig. 1. The period of oscillation

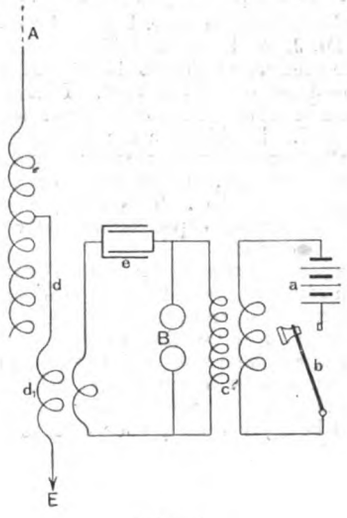

Fig. 1.

of the vertical conductor A can be increased by introducing turns of wire, or decreased by diminishing their number, or by introducing a condenser in series with it. The condenser in the primary circuit is constructed in such a manner as to render it possible to vary its electrical capacity.

The receiving station arrangements are shown in Fig. 2. Here we have a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer or detector. In order to make the tuning more marked, I place an adjustable condenser across the coherer in Fig. 3. Now, in order to obtain best results, it is necessary that the free period of electrical

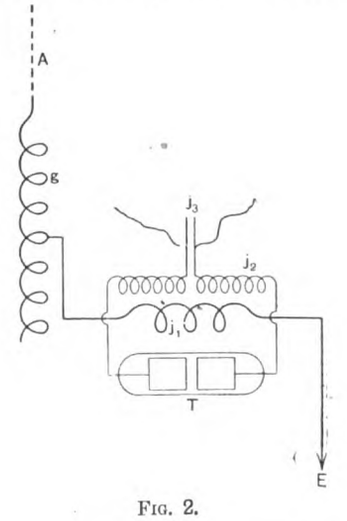

Fig. 2.

oscillation of the vertical wire primary of transformer and earth connection should be in electrical resonance with the second circuit of the transformer, which includes the condenser. I stated that in order to make the tuning more marked a condenser is placed across the coherer. This condenser increases the capacity of the secondary resonating circuit of the transformer, and in the case of a large series of comparatively feeble but properly timed electrical oscillations being received, the effect of the same is summed up until the E.M.F. at the terminals of the coherer is sufficient to break down its insulation and cause a signal to be recorded. In order that the two systems, transmitter and receiver, should be in tune it is necessary (if we assume the resistance to be very small or neligible) that the product of the capacity and inductance in all four circuits should be equal.

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It is easy to understand that if we have several stations, each tuned to a different period of electrical vibration, and of which the corresponding inductance and capacity at the transmitting station are known, it will not be diffcult to transmit to any one of them, without danger of the message being picked up by the other stations for which it is not intended. But better than this we can connect to the same vertical sending wire, through connections of different inductance, several differently tuned transmitters, and to the receiving vertical wire a number of corresponding receivers. Different messages can be sent by each transmitter connected to the same radiating wire simultaneously and received equally simultaneously by the vertical wire connected to differently tuned receivers. This result, which I believe was quited novel at the time, I showed to several friends of mine including Dr. J. A. Fleming, F.R.S., nearly two years ago. Dr. Fleming made mention of the results he had seen in a letter to the London *Times* dated October 4, 1900. I have further noticed that the tuning can be further improved by the combination of the two systems described. In this case the cylinders are connected to the secondary of the transmitting transformer, and the receiver to a properly-tuned induction coil, and all circuits must be tuned to the same period as already described. This arrangement is going to be further tested in long-distance experiments shortly to be undertaken between England and Canada.

The syntonic systems have not been applied generally to ships, as it has always been considered an advantage that each ship should be able, especially in case of distress, to call up any other ship or ships which may happen to be at the time within the range of its transmitter, but in the case of land stations the syntonic method has been applied in several instances where necessity demanded it. Thus at the testing stations which maintain communication between St. Catherine's, Isle of Wight, and Poole, in Dorset, when electric waves of a certain

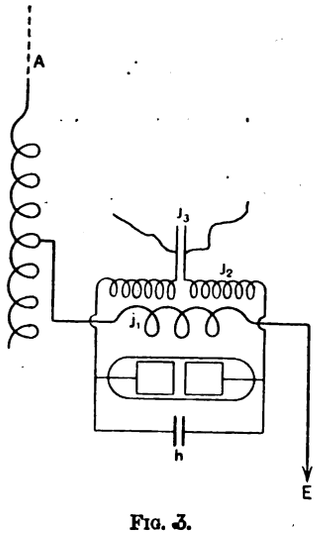

FIG. 3.

frequency are used, no interference whatever can be caused by the working of the Admiraity installations in the vicinity. The long-distance station at Poldhu, Cornwall, is able to transmit signals decipherable on a tuned receiver on a ship at over 1,000 miles distance, whilst the Lloyd's wireless station at the Lizard, only 7 miles away, is not affected by the powerful waves radiated from Poldhu if tuned to a different frequency.

I am not at all prepared to say that under no possible circumstances could a wireless message transmitted between syntonic instruments be tapped or interfered with, but I wish to point out that it is now possible to work a considerable number of wireless telegraph stations simultaneously in the vicinity of each other without the messages suffering from any interference. Of course, if a powerful transmitter, giving off waves of different frequencies, is actuated near one of the receiving stations it may prevent the reception of messages, but the ordinary systems of communication through wires may be likewise affected. Prof. O. J. Lodge, in a report of his experiments in magnetic space telegraphy, mentions that he was able to interfere with the working of the ordinary wire telephone system in the city of Liverpool. Sir W. H. Preece has also published results which go to show that it is possible to pick up at a distance on another circuit the conversation which may be passing through a telephone wire. About two years ago, at Cape Town, it was found impossible to work the cables landing there during certain hours when the electric tramways of the town were running, and the matter became subsequently the subject of litigation between the companies concerned. Prof. Fleming, who has witnessed the working of a great number of syntonic wireless telegraph stations, was sufficiently impressed by what he saw to make the following statement in his Cantor lectures on "Electrical Oscillations and Electric Waves," delivered before the Society of Arts in December, 1900 :—"The objections as to interference of stations which imperfectly-informed persons are in the habit of raising with regard to Mr. Marconi's system of wireless telegraphy, as a matter of fact no longer exist."

I shall now say a few words on the subject of the detector of the electric waves, called sometimes "the electric eye," which consists of that essential part of the receiving apparatus especially affected by the electrical oscillations. In all wireless telegraph apparatus used up to quite a recent date, a detector, now called a coherer, has been employed. This detector is based on discoveries and observations made by S. A. Varley, Prof. Hughes, Colzecchi, Onesti, and especially Prof. Branly. Prof. O. J. Lodge has made large use of this apparatus, which he firs named "coherer," in the very numerous experiments and studies he has carried out on the effects produced by Hertzian waves. The form of coherer I have found most trustworthy and reliable for long-distance work consists of a small glass tube about 4cm. long, into which two metal pole-pieces are tightly fitted. They are separated from each other by a small gap, which is partly filled with a mixture of nickel and silver filings. Provided such a coherer is properly constructed, and the tapper and relay in good adjustment, it proves to be quite reliable when within the range of the transmitting station. Experiments with syntonic systems have, however, shown that certain kinds of coherers can be far more advantageously employed than others. One apparently all-important condition is that the resistance of the coherer in its sensitive state, or after being tapped, should appear to be infinite when measured with an E.M.F. of about 1 volt. If the tapping does not entirely do away with the conductivity of the filings very poor results are obtained, which can be explained as follows. According to the systems I have described, electrical syntony between the transmitter and receiver is dependent on the proper electrical resonance of the various circuits of the transformers used in the receivers. The condenser and secondary of the transformer must not be partially short-circuited by the coherer, otherwise the oscillations cannot mount up or sum up their effect, as is essential in order to produce the difference of potential at the ends of the coherer necessary for breaking down its resistance ; but the electrical oscillations will leak across the conductive coherer without causing it to record any signal. Of course, the condenser is short-circuited when the filings cohere under the influence of the received oscillations ; but in this case the signal is already recorded, and the tapper at once restores the coherer to its non-conducting condition, and in this way restores its sensitiveness.

By using coherers containing very fine filings the necessary condition of non-conductivity when in a sensitive state is obtained. Coherers have lately been tried which will work to a certain extent satisfactorily without the necessity of employing any tapper or decoherer in connection with them. Nearly all are dependent on the use of a carbon microphonic contact or contacts which possess the curious quality of partially re-acquiring spontaneously their high resistance condition after the effect of the electrical oscillations has ceased. This enables one to obtain a far greater speed of reception than is possible by means of a mechanically-tapped coherer, the inertia of the relay and tapper which are used in connection with it being necessarily sluggish in their action. In all these self-decohering coherers a telephone which is affected by the variations of the electric current, caused by the changes in conductivity of the coherer is used in place of the recording instrument. It has not yet been found possible, so far as I am aware, to actuate a recording instrument or a relay by means of a self-restoring coherer. The late Prof. Hughes was the first, I believe, to experiment with and receive signals on one of these coherers associated with a telephone. His experiments were carried out as early as 1879, and I regret that this pioneer work of his is not more generally known. Other self-restoring coherers were proposed by Profs. Tommasina, Popoff, and others, but one which has given good results when syntonic effects were not aimed at was (according to official information communicated to me) designed by the technical personnel of the Italian navy. This coherer, at the request of the Italian Government, I tested during numerous experiments. It consists of a glass tube containing plugs of carbon or iron with between them a globule of mercury. Lieutenant Solari, who brought me this coherer, asked me to call it the "Italian Navy Coherer." Recently, however, a technical Paper gave out that a signalman in the Italian navy was the inventor of the improved coherer, and I was at once accused in certain quarters of suppressing the alleged inventor's name. I therefore wrote to the Italian Minister of Marine, Admiral Morin, asking him to make an authoritative statement, to which I could refer in the course of this address, of the views of the Italian Admiralty on the matter. The head of the Italian navy was good enough to reply to me by a letter, dated the 4th inst., in which he makes the following statement, which I have translated from the original Italian :—"The coherer has been with good reason baptised with the name of 'Italian Navy Coherer,' as it must be considered fruit of the work of various individuals in the Royal Navy and not that of one." These non-tapped coherers have not been found to be sufficiently reliable for regular or commercial work. They have a way of cohering permanently when subjected to the action of strong electrical waves or atmospheric

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electrical disturbances, and have also an unpleasant tendency towards suspending action in the middle of a message. The fact that their electrical resistance is low and always varying, when in a sensitive state, causes them to be unsatisfactory for the reasons I have already enumerated when worked in connection with my system of syntonic wireless telegraphy.

These coherers are, however, useful if employed for temporary tests in which the complete accuracy of messages is not all-important, and when the attainment of syntonic effects is not aimed at. They are especially useful when using receiving vertical wires supported by kites or balloons, the variations of the height of the wires (and, therefore, of their capacity) caused by the wind making it extremely difficult to obtain good results on a syntonic receiver.

Coherers have long been considered as constituting almost the essential basis of electric space telegraphy, and although many other detectors of electric waves existed, none of them possessed a sensitiveness which even approached that of a coherer, and most of them were also unsuitable for the reception of telegraphic messages. With a view to producing a receiver which could be worked at a much higher speed than a coherer, I was fortunate enough to succeed in constructing a magnetic detector of electric waves, based on a principle essentially different from that of the coherer, and which I think leaves all coherers far behind in speed, facility of adjustment and efficiency when worked in tuned circuits. This detector, which I had the honour of describing in detail before the Royal Society yesterday, possesses I believe a sensitiveness which surpasses that of the best coherers. The magnetisation and demagnetisation of steel needles by the effect of electrical oscillations has long been known and was noted especially by Prof. T. Henry, Aloria, Lord Rayleigh and others. Mr. E. Rutherford also has described a magnetic detector of electric waves based on the partial demagnetisation of a small core composed of fine steel needles previously magnetised to saturation. By means of a magnetometer Mr. Rutherford succeeded in 1895 in tracing the effects of his electrical radiator up to a distance of three-quarters of a mile across Cambridge. But Mr. Rutherford's arrangement is not suitable for the reception of telegraphic messages in consequence of the fact that a careful process of remagnetisation, which requires some time to effect, is necessary in order to restore its sensitiveness after the receipt of each impulse. Mr. Rutherford's arrangement is also considerably less sensitive than a coherer.

The detector which I am about to describe is, in my opinion, based upon the decrease of magnetic hysterisis, which takes place in iron when under certain conditions it is exposed to the effect of high frequency oscillations or Hertzian waves. As employed by me, it has been constructed in the following manner:—On a core of thin iron or steel, but preferably hard drawn iron, are wound one or two layers of thin insulated copper wire. Over this winding insulating material is placed, and over this, again, another longer winding of thin copper wire contained in a narrow bobbin. The ends of the winding nearest the iron core are connected, one to earth and the other to an elevated conductor, or they may be connected to the secondary of a suitable receiving transformer or intensifying coil, such as are employed for syntonic wireless telegraphy. The ends of the other winding are connected to the terminals of a telephone or other suitable receiving instrument. Near the ends of the core, or in close proximity to it, is placed a horseshoe magnet, which, by a clock-work arrangement, is so moved or revolved as to cause a slow and constant change or successive reversals in the magnetisation of the piece of iron. I have noticed that if electrical oscillations of suitable period be sent from a transmitter, rapid changes are effected in the magnetisation of the iron wires, and these changes necessarily cause induced currents in the windings, which in their turn reproduce on the telephone with great clearness and distinctness the telegraphic signals which may be sent from the transmitting station. Should the magnet be removed or its movement stopped, the receiver ceases to be perceptibly affected by the electric waves even when these are generated at very short distances from the radiator.

I have had occasion to notice that the signals audible in the telephone are weakest when the poles of the rotating magnet have just passed the core, and are increasing their distance from it, whilst they are strongest when the magnet's poles are approaching the core. Good results have also been obtained by keeping the magnet fixed, and using an endless iron rope or core of thin wires revolving on pulleys (worked by clockwork), which cause the iron to travel through the copper wire windings, in proximity to, preferably, two horse-shoe magnets with their poles close to the windings, care being taken that their poles of the same sign are adjacent. This detector has been successfully employed for some time in the reception of wireless telegraphic messages between St. Catherine's Point, Isle of Wight, and the North Haven, Poole, over a distance of 30 miles, also between Poldhu, in Cornwall, and Poole, in Dorset, over a distance of 152 miles, of which 109 are over sea and 43 over high land.

It would, no doubt, be possible to obtain signals by causing the iron core to act directly on a telephone diaphragm, and in this case the secondary winding could be omitted. This detector, as I have already stated, appears to be more sensitive and reliable than a coherer, nor does it require any of the adjustments or precautions which are necessarily for the good working of the latter. It possesses a uniform and constant resistance, and, as it will work with a much lower E.M.F., the secondaries of the tuning transformers can be made to possess much less inductance, their period of oscillation being regulated by a condenser in circuit with them, which condenser may be much larger (in consequence of the smaller inductance of the circuit) than those used for the same period of oscillation in a coherer circuit, with the result that the receiving circuits can be tuned much more accurately to a particular radiator of fairly persistent electric waves. As a call, a coherer in circuit, with a relay working a bell, can always be used, and if it is found possible to make the magnetic detector record on a registering instrument (as to the possibility of which the results of recent tests have left little doubt in my mind), it may be found possible to receive wireless telegraph messages at a speed of several hundred words a minute. At present, by means of this detector, it is possible to read about 30 words per minute.

The considerations which led me to the construction of the above-described detector are the following:—It is a well-known fact that, after any change has taken place in the magnetic force acting on a piece of iron, some time elapses before the corresponding change in the magnetic state of the iron is complete. If the applied magnetic force be caused to effect a cyclic variation, the corresponding induced magnetic variation in the iron will lag behind the changes in the applied force. To this tendency to lag behind Prof. Ewing has given the name of magnetic hysteresis. It has been shown also by Profs. Gerosa, Finzi and others, that the effect of alternating currents or high-frequency electrical oscillations acting upon iron is to reduce considerably the effects of magnetic hysteresis, causing the metal to respond readily to any influence which may tend to alter its magnetic condition. The effect of electrical oscillations probably is to bring about a momentary release of the molecules of iron from the constraint in which they are ordinarily held, diminishing their retentiveness and consequently decreasing the lag in the magnetic variation taking place in the iron. I therefore anticipated that the group of electrical waves emitted by each spark of a Hertzian radiator would, if caused to act upon a piece of iron which is being subjected at the same time to a slowly varying magnetic force, produce sudden variations in its magnetic hysteresis, which would cause others of a sudden or jerky nature in its magnetic condition. In other words, the magnetisation of the iron, instead of slowly following the variations of the magnetic force applied, gives a sort of jump each time it is affected by the electric waves emitted by each spark of the radiator. These jerks in the magnetic condition of the iron would, I thought, cause induced currents in a coil of wire of strength sufficient to allow the signals transmitted to be detected intelligibly on a telephone, or perhaps even read on a mirror galvanometer. The results obtained go to confirm my belief that this detector can be advantageously substituted for the coherer for the purposes of long-distance space telegraphy.

During the last few years the developments in the practical applications of my system have been exceedingly rapid. Time does not allow me to give you an account of the many cases in which it has proved its usefulness, but it may be sufficient if I mention that Lloyd's have adopted the system exclusively for use at their stations at home and abroad for a period of 14 years, and that no less than 17 liners plying across the Atlantic carry permanent installations. In more than one case recorded in the daily papers the system has been of service to vessels in distress, especially in the English Channel. No less than 40 land stations (most of which are controlled by the corporation of Lloyd's) are being equipped with the system in Great Britain and Europe, and over 40 vessels in H.M. Navy carry installations. The adoption of my system in the Royal Navy has brought about a certain slight change of appearance in the rig of the ships. Some naval officers believe that this change improves the ships' appearance; others think the contrary.

The Italian Admiralty after experimenting for some time with the self-decohering coherers to which I have referred before, have informed me officially, by a letter dated May 24th last, of its decision to equip their war vessels with the same apparatus as has been successfully employed on the transatlantic liners. On these liners commercial use is made of the system for the convenience of passengers, and as an illustration of its commercial workableness I might mention that lately the "Campania" and "Lucania" of the Cunard line have been collecting as much as £60 each trip in receipts derived from passengers' wireless messages.

Nearly two years ago the facility with which communication was possible over distances of nearly 200 miles, and the improvements in syntonic methods introduced, together with the ascertained fact of the non-interference of the curvature of the earth, led me to decide to recommend the construction of a large power station in Cornwall and another one at Cape Cod, Mass., U.S.A., in order to test whether, by the employment of much greater power, it might not be possible to transmit messages across the Atlantic, and establish a transoceanic commercial communication which the monopoly of the Postmaster-General will not apparently permit between two stations if both are situated in Great Britain. An unfortunate accident to the masts at Cape Cod seemed likely to postpone the experiments for

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several months, when I came to the conclusion that whilst the necessary repairs there were being carried out I would use a purely temporary installation in Newfoundland for the purpose of a transatlantic experiment, from which I might, at any rate, be able to judge how far the arrangements in Cornwall had been conducted on right lines. Before describing the results it may be useful if I give a brief description of the nature of the apparatus used at the transmitting and receiving stations.

The transmitter at Poldhu was similar in principle to the syntonic one I have already described, but the elevated conductor at the transmitting station was much larger, and the potential to which it was charged very much in excess of any that had previously been employed, the amount of energy to be used in this transmitting station having been approximately determined by me prior to its erection. The transmitting elevated conductor consisted of 50 almost vertical naked copper wires, suspended at the top by a horizontal wire stretched between two poles, each 48 metres high, and placed 60 metres apart. These wires were separated from each other by a space of about 1 metre at the top, and, after converging together, were all connected to the transmitting instruments at the bottom. The potential to which these conductors were charged during transmission was sufficient to cause sparking between the top of the said wires and an earthed conductor across a space of 30cm. of air. The general engineering arrangements of the electric power station erected at Poldhu for the execution of these plans and for creating the electric waves of the frequency which I desired to use were made by Dr. J. A. Fleming, F.R.S., who also devised many of the details of the appliances for producing and controlling the electric oscillations. These, together with devices introduced by me, and my special system of syntonisation of inductive circuits, have provided an electric wave-generating plant more powerful than any hitherto constructed. Mr. R. N. Vyvyan and Mr. W. S. Entwistle have also greatly assisted me in the experiments carried out with the very high tension electrical apparatus employed.

The first experiments were carried out in Newfoundland last December, and every assistance and encouragement was given me by the Newfoundland Government. As it was impossible at that time of the year to set up a permanent installation with poles, I carried out experiments with receivers joined to a vertical wire about 400ft. long, elevated by a kite. This gave a very great deal of trouble, as in consequence of the variations of the wind constant variations in the electrical capacity of the wire were caused. My assistants in Cornwall had received instructions to send a succession of "S's," followed by a short message at a certain pre-arranged speed, every 10 minutes, alternating with five minutes rest during certain hours every day. Owing to the constant variations in the capacity of the aerial wire it was soon found out that an ordinary syntonic receiver was not suitable, although a number of doubtful signals were at one time recorded. I, therefore, tried various microphonic self-restoring coherers placed in the secondary circuit of a transformer, the signals being read on a telephone. With several of these coherers, signals were distinctly and accurately received, and only at the pre-arranged times, in many cases a succession of "S's" being heard distinctly although, probably in consequence of the weakness of the signals and the unreliabily of the detector, no actual message could be deciphered. The coherers which gave the signals were one containing loose carbon filings, another, designed by myself, containing a mixture of carbon dust and cobalt filings, and thirdly, the "Italian Navy Coherer," containing a globule of mercury between two plugs. For the good results obtained I was very much indebted to two of my assistants, Mr. G. S. Kemp and Mr. P. W. Paget, who gave me very efficient aid during the tests, which the extremely severe weather prevailing in December in Newfoundland made exceedingly difficult to carry out.

The result of these tests was sufficient to convince myself and my assistants that, with permanent stations at both sides of the Atlantic, and by the employment of a little more power, messages could be sent across the ocean with the same facility as across much shorter distances. The experiments could not be continued or extended in consequence of the action which the cable company, which claims all telegraphic rights in Newfoundland, saw fit to take at the time. Having received a most generous invitation from the Government of the Dominion of Canada to continue my operations in the Dominion, it was thought undesirable to continue the experiments in Newfoundland, where I should have probably been landed into litigation with the telegraph company. I am glad to say that the Canadian Government, on the initiation of Sir Wilfrid Laurier and Mr. Fielding, has shown itself most enterprising in the matter, and not only encouraged the erection of a large station in Nova Scotia, but actually granted a subsidy of £16,000 towards the erection of this transatlantic station, the object of which is to communicate with England from the coast of Nova Scotia. It is anticipated that the Canadian station will be ready for further tests very shortly. Another station for the same purpose is being erected on the United States coast.

Towards the end of February of this year I thought it desirable to test how far the messages transmitted by the powerful station at Poldhu could be detected on board a ship. The ship selected was the "Philadelphia," of the American line. The receiving aerial conductor was fixed to the mast, the top of which was about 60 metres above sea level. As the elevated conductor was fixed, and not floating about with a kite, as in the case of the Newfoundland experiments, very good results were obtained on an ordinary syntonic receiver, similar to those I have already described, and the signals were all recorded on tape by the ordinary Morse recorder. Readable messages on tape were received up to a distance of 1,551 miles from Cornwall, and indications were received as far as 2,099 miles. Most of the messages were received in the presence of the captain or the chief officer of the ship, who were good enough to sign the tapes. I have some of these tapes here, in a frame, and they can be examined at the conclusion of my discourse. It is curious to observe that signals could not be received at over 900 miles by any of the self-restoring coherers. The reason for this lies probably in the fact that the tuned receiver, when connected to a fixed aerial is more efficient. Another result of considerable scientific interest was that at distances of over 700 miles the signals transmitted during the day failed entirely, while those sent at night remained, as I have stated, quite strong up to 1,551 miles, and were even decipherable up to a distance of 2,099 miles. This result, which I had the honour of describing before the Royal Society yesterday afternoon, may be due to the dis-electrification of the very highly charged transmitting elevated conductor operated by the influence of daylight.

I regret time does not permit me to give you the views which have been expressed with reference to this phenomenon. I do not think, however, that the effect of daylight will be to confine the working of transatlantic wireless telegraphy to the hours of darkness, as sufficient sending energy can be used during day-time, at the transmitting station, to make up for the loss of range of the signals, and therefore this business of communicating across the Atlantic will not be one of those works of darkness with which some people connected with cable companies would seem disposed to class it. It is, however, probable that had I known of this effect of light at the time of the Newfoundland experiments, and had tried receiving at night-time, the results would have been much better than those that were obtained.

The day is rapidly approaching when ships will be able to be in touch and communication with the shore across all oceans, and the quiet and isolation from the outside world which it is still possible to enjoy on board ship will, I fear, soon be things of the past. However great may be the importance of wireless telegraphy to ships and shipping, I believe it will be of even greater importance to the world if found workable and applicable over such great distances as those which divide Great Britain from her colonies and from America. Any of those who have lived in the colonies will easily appreciate what a hardship it is to have to wait, perhaps, four or five weeks before receiving an answer to a letter sent home. The cable rates are at present prohibitive to a vast majority of people. May it not, perhaps, be for wireless telegraphy to supply the want?

I apologise for having kept you so long, but I cannot help reading you, in conclusion, a short extract from a leading article in the London *Times* of Saturday, December 21, 1901, published at the time of the Newfoundland experiments. And I do so because it expresses in language of admirable clearness the sentiments with which I myself regard this subject:—"It would probably be difficult to exaggerate the good effect of wireless telegraphy if, as Mr. Marconi and Mr. Edison evidently believe, and as the Anglo-American Company evidently fear, it can at no distant time be developed into a commercial success. The expense of telegraphy to distant countries is at present prohibitory to vast numbers of people, and even those who use it do so only in respect of matters of great urgency, or in which large money interests are at stake. The reason of the high charges must be sought, of course, in the enormous costliness of the plant, both in its original construction and in its maintenance and repair. A system of aerial telegraphy which would not require an expensive plant, and through which, therefore, messages might be sent at moderate rates, would soon become a potent agent in cementing those ties between Great Britain and the colonies which other recent events have done so much to strengthen and even to create. A system of comparatively cheap telegraphs would do for the British Empire very much what was done by the penny post for the United Kingdom. The pathetic story of Rowland Hill, whose efforts to establish cheap postage originated in the sympathy he felt for a poor girl in a Cumberland village, who was unable to pay the sum demanded for a letter from her brother in a distant county, relates an event which in principle may be repeated to-day in many parts of the world. A cheap telegraph service would unite families, however scattered, would keep the dispersed members in close and constant touch with the old home, and would cement friendships between our own people and the colonial nations, besides forging another link in the ties which bind this country to the United States."

Röntgen Society.—The annual general meeting of the Röntgen Society will be held at 20, Hanover-square on Thursday, July 3, at 8:30 p.m. The election of officers for the ensuing year will take place at this meeting.

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THE HEWITT MERCURY VAPOUR LAMP.

Dr. Max. v. Recklinghausen publishes an interesting article on this lamp in the *Elektrotechnische Zeitschrift* of June 5th. After a summary of the results of previous experiments with mercury vapour lamps, the author describes Mr. Hewitt's lamp and discusses its properties. A description of the lamp and other references to it appeared in *The Electrician*, Vol. XVII., pp. 50, 934 and 946, and Vol. XLVIII., p. 743. Dr. v. Recklinghausen points out that the voltage of the lamp is proportional to its length, and inversely proportional to its diameter (not to its sectional area), other things being equal. The voltage does not vary to any important extent with the current within the region of good efficiency, and within these limits one can vary the current 50 or even 100 per cent. without altering the pressure more than a few per cent. (see Figs. 1 and 3). In this the Hewitt lamp resembles an arc lamp. The efficiency of the lamp at 3 amperes and 60 volts is 0·5 watts per candle. On

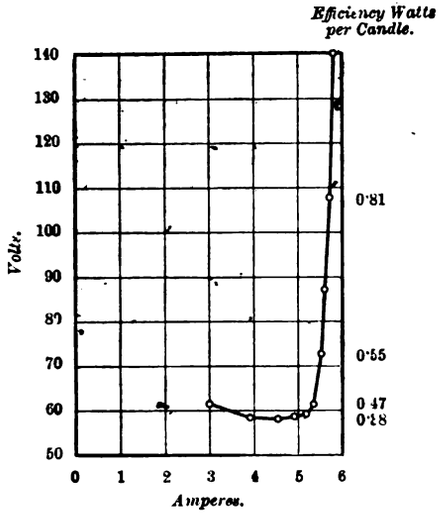
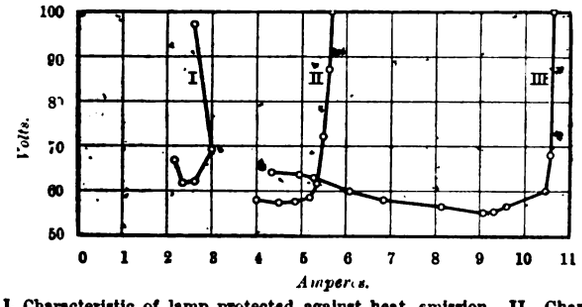


FIG. 1.—Typical Characteristic of a Lamp.

increasing the current the pressure drops only slightly and rises again, and the efficiency on the flat part of the curve is about 0·38 watts per candle. Above 5 amperes the voltage rises rapidly and the efficiency diminishes. In order to maintain the lamp at the end of the nearly horizontal part of the curve just before it begins to rise, a steadying resistance is employed absorbing usually from 5 to 20 per cent. of the voltage, but it is stated that by suitable alterations in the construction of the lamp this has been reduced to ½ per cent. The most important factor, which Hewitt was the first to recognise properly, is the relation between the density of the gas and its conductivity, as the resistance is a function of the density (or temperature) of the gas. Experiments have shown that for each lamp there is a temperature at which the conductivity is a maximum. The temperature of the lamp, and, therefore, its conductivity—and,



I. Characteristic of lamp protected against heat emission. II. Characteristic of same lamp at temperature of the room. III. Characteristic of same lamp exposed to a cold wind in the open air and without external cyclinder or lantern.

FIG. 2.—Influence of External Temperature on the Characteristic.

therefore, the current passing—depends on the heat emitted, which, in its turn, depends on the external temperature. The temperature for best conductivity is also that for highest efficiency, and the object of the cooling chamber is to maintain the temperature and density of the gas constant. It is necessary to protect the lamp from changes of temperature by a cylindrical mantle of glass or a lantern which retains the heat given off by the lamp. Dr. Recklinghausen shows the influence of the change of temperature by an interesting curve connecting volts and current. When the current is increased, the volts do not immediately increase, but only do so gradually as the temperature assumes its steady value again. This is shown by the dotted lines in Fig. 5. Besides the external temperature and the dimensions of the gas tube and of the cooling chamber which determines the density of the gas, the resistance of the lamp also depends on the resistance of the electrodes (which absorbs some 13 volts). It is stated in the article that the electrical characteristic curve of the Hewitt lamp, and its candle-power, can be pre-determined just as well as with a carbon filament lamp, and that the life is as least as good.

The lamp will not light by itself, and the seat of this initial resistance appears to be in the negative electrode. The lamp lights up

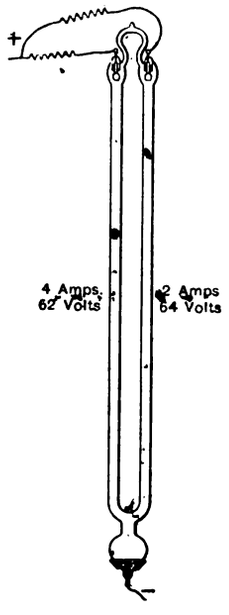


FIG. 3.—Showing extremely Small Difference in the Pressure, in spite of a Large Difference in the Current through the two similarly sized arms of a Lamp.

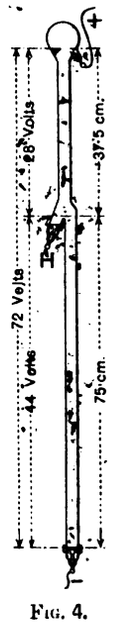


FIG. 4.

easier when it is hot than when it is cold, but this objection to lighting up seems to become great again when the lamp has been burning some time and its temperature is again the same as that of the room. On the other hand, a long rest enormously increases the initial resistance. A convenient method of lighting is to give an impulse of high potential, whose effect is extraordinarily increased by the metallic coating outside the negative electrode, and connected to the positive pole. As soon as this momentary high potential has broken down the resistance of the negative electrode the ordinary strong current can pass through the tube. The author has noticed that in some cases a definite number of successive impulses are necessary in order to start the lamp. One method of producing the high potential

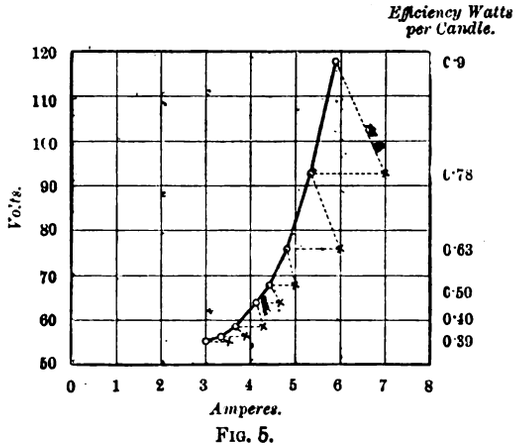


FIG. 5.

for lighting up is to include an electromagnet in series with the positive terminal of the lamp and momentarily short-circuit the lamp through a small resistance. A large current then flows through the electromagnet, and on breaking this short-circuit a wave of high potential is produced in the coil.

The above description of the lamp and its properties applies only to continuous-current lamps. Owing to this effect of initial resistance, it requires 5,000 volts alternating to maintain 2 amperes through a lamp which will take the same current at 100 volts continuous.

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A pretty experiment to show the effect of this starting resistance is illustrated in Fig. 4. The tube is provided with an auxiliary mercury electrode H, and tests with a Weston voltmeter show that the fall of pressure in the two halves of the tube is 28 and 72 volts respectively. On short-circuiting H, with the negative electrode at the bottom, one would expect the lower half of the tube to be darkened. But this does not happen until the initial resistance residing in the electrode H is overcome by an impulse of high potential. Before the resistance at H is broken down, only a small current passes through it, just sufficient to actuate the voltmeter.

In suitably shaped lamps, it is possible to observe a distinct migration of mercury from the positive to the negative electrode. As large condensing chambers prevent this, the author thinks that it is probably due to the different temperatures at the two poles. This may also be the cause of an effect noticeable if a suitably-constructed lamp is operated in the open air on a cold day—viz., that during the first seconds the column of gas only gives light at a point directly over the positive electrode. The author points out that this is due to the Hewitt lamp generating more heat at the positive electrode than at the negative. At the point of the negative electrode at which the current leaves it, there is a bright spot which moves backwards and forwards on the surface of the mercury, and makes a funnel-shaped indentation in the mercury often several millimetres deep. The motion of this spot may be prevented by making the platinum leading-in wire project above the surface of the mercury. The luminous column of gas begins about 2cm. over the electrode.

The article concludes with some interesting remarks as to efficiency and colour. In particular cases the efficiency may be so low as $\frac{1}{3}$ watt per candle without and about 0·4 watt per candle with steadying resistance. The red rays, which are absent in the spectrum of the light, cannot, of course, be supplied by red glasses or reflectors, but good results have, it is said, been obtained with reflectors and transparent textile material coloured with matter which fluoresces with a red colour when exposed to the mercury light. A pretty experiment is to look at the mercury vapour lamp through ruby glass, when the glowing column of gas will hardly be perceptible. If, however, the fluorescent silk or other material is brought near the lamp, it appears as if the silk itself was producing a bright fiery red light. Some red rays are observable if the lamp is forced, but this has evidently to do with the high temperature then employed. Finally, the mercury lamp is highly active chemically, much more than an arc lamp taking the same watts. Photographic enlargements were made with about one-thirtieth the number of watts in a Hewitt lamp as were required in an arc for the same exposure. One reason of this is that the former lamp can be brought much nearer to the plates. On the other hand, the author asserts that it is his own experience and that of others that the light from the Hewitt lamp is less tiring to the eyes than other methods of illumination, partly, it is true, on account of the diffused source (about 3 c.p. per square centimetre, which is double that of an Auer mantle), but mainly on account of the wave-length.

CORRESPONDENCE.

INDUCTION MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I would be greatly obliged if you would publish the following remarks in answer to a letter from Mr. A. C. Eborall, printed in your issue of June 20th. I have confined myself strictly to a correction of statements of a technical nature, ignoring those of a more personal character, as I cannot see that the public can derive much benefit from these.

1. Mr. Eborall states in his last Paper read before the Manchester Section of the Institute of Electrical Engineers, on March 25, 1899, as follows:—"It will, therefore, be readily understood, from what has been said above, that the successful operation of a larger 'power' distribution scheme would be impossible if large motors of this type were used indiscriminately; even if there was *no lighting work*, the effect of the starting of such motors would be detrimental to the proper performance of other motors connected to the system. For this reason it is 'absolutely necessary' that *all* induction motors of any size should be fitted with slip rings, and be operated (at starting) with rotor resistances. In the author's opinion, *all* motors above 5 B.H.P. having to start against load should be so fitted; if they are not required to start against load, permanently short-circuited rotors can be used for motors up to 8 B.H.P. inclusive." In view of the above, I fail to understand the meaning of the first paragraph of Mr. Eborall's letter. I cannot but repeat that such a statement seems entirely unwarranted, and is very apt to mislead readers less familiar with this subject, the reason for this opinion being given in detail in my Paper.

2. Mr. Eborall seems entirely misinformed as to the systems used in American towns. There are certainly as many representative towns worked entirely on the A.C. system in the States as on the Continent. I only mention a few like Denver, Salt Lake City, St. Louis and San Francisco, which have used for many years the system claimed by Mr. Eborall exclusively for Continental towns like Bockenheim, Strasburg, &c.

3. Mr. Eborall seems under the impression that I intended to bring out the compensators, or whatever he may wish to call them, as something entirely new, which, of course, was not at all my intention. I only followed his example in contributing to the discussion on this interesting subject by giving my views based on experience obtained equally on the Continent and in America. Since Mr. Eborall, in his frequent publications, has persistently ignored this piece of apparatus, which I have seen used successfully in hundreds of cases, I thought it only fair to point out its advantages at some length.

4. Mr. Eborall considers the design of the 7½ H.P. motor, the figures of which are given in my Paper, not too good when compared with those obtained with most "Continental" motors. In the first place, this motor on which the tests mentioned were taken, is by one of the best known Continental makers. Secondly, the writer does not believe that there are any motors of this size on the market for which better all-round constants can be actually "proved."

5. Mr. Eborall endeavours to compare the two types of motors when starting with one-third of full load torque. He claims, in italics, that, by using my own figures, a squirrel-cage motor when started with a compensator against one-third full-load torque, will take a current equal to 2½ times full-load current with a power-factor of 0·2. Now, I have shown at great length, to those unfamiliar with such apparatus, that a squirrel-cage motor with a compensator starting under these conditions—*i.e.*, one-third full-load torque—will take 1¼ full-load current, and I fail to see how Mr. Eborall arives at figures 100 per cent. in excess of those I have given. Even the great difference in power-factor emphasised so strongly by Mr. Eborall—*i.e.*, about 0·8 as against 0·2—merely means that the value of the lagging current introduced is 60 per cent. in the former case, as against 94 per cent. in the latter.

6. Mr. Eborall calls it an absurdity to consider a starting-box with a contact handle to be moved carefully when starting, heavy conductors between slip rings, brushes, brush-holder, polar winding, perhaps short circuiting and brush-lifting devices, as "complications, which are liable to cause trouble when compared with a simple squirrel-cage motor."

7. Mr. Eborall states that in general he is in agreement with all I have said, a fact which I acknowledge with great satisfaction. In return, I must confess that I am also one of the "very few" in this country, who believe that properly designed three-phase systems are bound to come, and that, therefore, the experience gained, not "only" on the Continent, but all over the world, should be utilised to get to a clear understanding of what is best suited to fill the conditions over here. It was this belief which induced the writer to publish his notes on "Induction Motors."—Yours, &c.,

Rugby, June 21. H. S. MEYER.

PARLIAMENTARY INTELLIGENCE.

LONDON COUNTY COUNCIL TRAMWAYS AND SUBWAYS.

In the House of Lords, on Monday, on the motion for the second reading of the London County Council (Subways and Tramways) Bill,

Lord NEWTON said that among the opponents to the subway which was to emerge on the Embankment from the north and join up with a tramway along the Embankment to Westminster (see *The Electrician*, April 25, p. 27) were the local authority of Westminster, the Royal College of Physicians and Surgeons, who had their examination hall near the terminus, and the Metropolitan District Railway. The tramways at present under the control of the London County Council did not seem to be in a particularly flourishing condition, and he was unable to discover any financial justification for the proposed subway. He held that it would be more

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practical to make a connection between the north and south of the river by means of a tube under the Thames than to adopt such a circuitous route as was proposed. The fact that no omnibuses were to be found along the Embankment showed sufficiently that further means of communication was not required there. In addition to this, however, he objected to the piecemeal character of the bill, which would evidently be followed by proposals to cross the bridges. If the County Council desired to carry out a far-reaching scheme, let them show exactly what they intended, so that their plan could be discussed on its merits. He moved that it should be an instruction to the Committee to which the bill might be referred that they should strike out the power to construct any tramway south of the Strand.

Lord RIBBLESDALE, the Chairman of the Committee in question, objected to this instruction on the grounds that the very matters covered by it were exactly those which a committee should consider. A tube under the river would cost £500,000 per mile, and would link up with nothing.

The Earl of Mayo and the Duke of Rutland supported the instruction.

The EARL of MORLEY, Chairman of Committees, said an instruction to a Private Bill Committee was almost entirely unknown in that House, and such procedure was highly inconvenient. If their lordships did not approve of the Committee's conclusions, there would be an opportunity to revise them on third reading.

The LORD CHANCELLOR disagreed with the Chairman of Committees. Instructions were occasionally given to Committees on private bills. He regarded the Embankment as one of the most magnificent things of its kind in Europe, and its use in the way now proposed was to be deprecated.

Lord TWEEDMOUTH maintained that the Embankment was constructed for the convenience of the public as a whole, and not for a small section of it, and the working of a tramway along it would not in any way interfere with the conduct of the light traffic which at present used that thoroughfare.

The House divided, and the figures were: For the instruction, 77; against, 32; majority, 45.

The London County Council (Tramways and Improvements) Bill was then read a second time.

Lord NEWTON moved that it be an instruction to the Committee to omit tramway No. 7—viz., that running from Waterloo to Westminster in conjunction with the subway contained in the previous bill.

This instruction was agreed to.

LONDON UNITED TRAMWAYS BILL.

The House of Commons Committee, which has this bill under consideration, resumed last Friday.

Mr. CHARLES OWENS, general manager of the London and South-Western Railway Co., was further cross-examined by Mr. FITZGERALD, K.C., for the promoters. He doubted whether the London United Tramways had carried over 3,000,000 passengers in one year from Hounslow to London. The railway traffic between Hounslow and Waterloo would not be a tenth of that, so that the tramways, if they carried that number of passengers, must have created the traffic. The railway company's accountant told him that there had been a decrease of traffic on the South-Western stations between Hounslow and Waterloo since the construction of the tramways. He based his opposition on the ascertained local receipts, which showed a decrease of 64 per cent. on the Shepherds Bush to Hounslow section. No doubt the competition of the tramways was accentuated by the opening of the tube line. The total mileage of the London and South-Western Company was nearly 900 miles, and last year the company carried 63¾ million passengers, the dividend on their ordinary stock being 5¾ per cent. That stock stood at a premium of 78, being the highest of any stock in the market.

So that you do not appear *in formâ pauperis?*—No; and I do not want to get into that condition.

The CHAIRMAN: I do not think the return on the money has any bearing on the case.

This closed the evidence for the London and South-Western Railway Co.

Mr. PEMBER, K.C., then addressed the Committee on the petition of the London and South-Western Railway Co. He said that when tramways were drawn by horses a great deal was to be said for the contention that tramways and railways would not compete; but in the last year or two electric traction had suddenly come to be used, and now the London and South-Western Railway Co. could speak, not from mere anticipation of danger but from actual loss incurred, and therefore their opposition ought to be attentively considered. Mr. Owen's figures were very substantial, and if that gentleman put the loss from the lines proposed, judging by the two lines already constructed, at £10,000 per annum, surely the matter was serious, and the Committee ought to consider whether, in the interests of the public, it was necessary to inflict it. Until necessity was shown—until the working class areas in other parts of London were filled in with working class populations—he asked the Committee not to sanction tramways, the avowed intention of which was to make such suburbs as Richmond, Barnes, Mortlake and Wimbledon working class localities. The company, so far, had only constructed 16 of the 62 miles of lines authorised. Why should they not construct the greater portion of the remaining 46 lines before asking Parliament to give them 16 miles more? Why not wait and make sure of the necessity of further lines before granting powers with regard to more? The action of the promoters was a little analogous to land-grabbing. He could not help thinking that the multiplication of these applications to Parliament, and the already small relation at present between the lines constructed and the lines authorised, was due to the fact that the promoters wanted to keep out of the district any possible intruder. Moreover, the bills promoted by joint stock companies were not under the control of Parliament as to their capital in the same way as railway and many of the other companies, and, therefore, Parliament ought to be a little careful in sanctioning *ad libitum* the capital of such companies. No doubt the various local authorities were delighted to find somebody coming into their districts desiring to do something which they could not do without their consent. The company was bleedable and the local authorities bled it. That might be all very well, but Parliament ought to have regard, when considering the consents of these local authorities, to the road improvements which the company had agreed to make. These improvements were bribes or baits to the local authorities to induce them to give their consent. Electricity was now very rapidly being utilised on railways. The Metropolitan and the Metropolitan District Companies systems were being electrified, and in connection with that the argument was being urged that electrification should be extended to a number of the great London railway companies. It was a great question as to whether the whole of the line from London to Brighton would not be electrified. That matter was occupying the attention of the Brighton Company's directors at the present time; and he believed a large amount of electrification is under the consideration of the directors of the London and South-Western Railway Co. How far that would be carried out he could not, of course, say. That it would be carried in the suburban districts was certain. There was a scheme for the electrification of the South-Western Railway as far as Richmond, no doubt in order to project the rolling stock of the Metropolitan District Company in the direction of Richmond, and probably there would be electrification of the railway to Wimbledon. Both these schemes would be carried out shortly. The electrification of the railways might be said to cut both ways. No doubt it would give future possibilities of running an even greater number of lighter trains, which in the aggregate would largely increase the railway accommodation. It might be said that if the railways were electrified they would have a better chance of competing with the tramways. That might be so, but the real question was—"Is there any necessity for competition?" The better the existing accommodation the less need there was to divide the traffic with a tramway. To halve the profit was a great discouragement to existing companies to spend large sums of money on rolling stock. He did not put forward a claim of vested interest on behalf of the railway companies, but considering the enormous expenditure of the railway companies on the acquisition of land, their enormous terminal expense (in a great measure rendered necessary by the increase of suburban traffic), the expenses imposed on them by Parliament, the Board of Trade, and other Government departments, and the heavy local rates, he held that the total was enormously larger than the expenses of tramway promoters, even including the amount exacted from them by local councils for widenings and street improvements. Only a case of public necessity could justify the present invasion of railway rights, and such a case had not been established.

Mr. J. D. FITZGERALD then replied on the whole case. He said the whole of the promoters' lines were in competition with one railway or another, though mainly they competed with the London and South-Western Railway Co. If the objection of competition were to prevail there would be no suburban tramways in London, because it was impossible to construct a tramway anywhere without competing with a railway. The effect of that competition was perfectly well known. The whole of our railway system had been built up by competition, and the London and South-Western Railway Co., as well as other companies, had been actively engaged in promoting lines which would compete the one with the other. The tramway company carried an enormous amount of traffic which they had created for themselves by the very facilities they had provided—a traffic embracing millions of passengers in the course of the year, a traffic which the South-Western Railway never had and never could have dealt with. The Joint Committee of last year contemplated that where the tube railways ended the surface tramways should begin, and that was the very thing the promoters were doing. Proceeding to discuss the agreement with the Barnes Council under which that body had agreed to extend the period at the end of which they might purchase the lines from 21 to 50 years, he said the Legislature had, in effect, repealed for practical purposes the provisions of the Tramways Act of 1870. The Legislature has discovered that that act was a mistake, and, accordingly, they passed the Light Railways Act of 1896, under which most of the tramways were now being authorised, and under which there was no term of purchase at all.

The CHAIRMAN asked if counsel could give a precedent in which the period within which the council could not exercise the option to purchase approached 50 years.

Mr. FITZGERALD said under the Light Railways Act there were no purchase powers at all. In the case of the Cavehill and Whitewell Company, tramways were authorised in perpetuity in the hands of the promoters.

The CHAIRMAN (after consulting in private with his colleagues) announced that the Committee were prepared to sanction the whole of the lines except that portion which it was proposed to make on Wimbledon Hill, above Mansell-road, Mansell-road being situate at the foot of the hill. The period at the end of which the Barnes Council might purchase their portion of the undertaking would be reduced from 50 to 30 years.

It was stated that this decision would not affect the decisions at which the Committee had earlier arrived.

On Tuesday the Committee considered the clauses of the bill.

After some discussion a provision was inserted for the protection of children attending Holy Trinity schools, Merton-road, Wimbledon, to the effect that the trams should pass the schools between the hours of nine in the morning and five in the afternoon at a pace not exceeding 4 miles an hour.

In connection with certain cases where the promoters may have to touch the property of petitioners, a clause had been agreed to by the promoters, providing that they should, if required, acquire the whole of such property, instead of only such part as might actually be affected. An attempt was now made on behalf of a number of property owners, who had not petitioned against the bill, to obtain an extension of the clause in their favour, in the event of their property being in any way affected. Discussion took place and eventually the Committee rejected the proposition.

The remaining clauses having been adjusted the bill was ordered to be reported to the House for third reading.

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KNOTTINGLEY TRAMWAY EXTENSION.

The Select Committee of the House of Lords engaged in considering the Local Government Provisional Orders Tramway Bill resumed their investigations on Monday, Lord Newton presiding. The object of the Bill is to confirm certain provisional orders relating to tramways, amongst the number one empowering the West Riding Tramways Co. to make a tramway extension 2¾ miles long from Pontefract to Knottingley.

In opening the case for the promoters, Mr. ACKWORTH declared that the railway service in Pontefract and neighbourhood was very unsatisfactory. The through traffic left little if anything to be desired, and it was served by a large number of well-timed and quick trains, but the local service was bad. He denied that the proposed tramway would prove injurious to the railway, maintaining on the other hand, that it would be of service to it by taking passengers to and from the stations. He pointed out that the tramway scheme had the support of the West Riding County Council, the Corporation of Pontefract, the Knottingley Urban District Council, and the Pontefract Rural District Council.

Evidence was then called in support of the bill.

Mr. LITTLER, K.C., on behalf of the Lancashire and Yorkshire Railway, was proceeding to cross-examine one of the witnesses as to the utility of the proposed tramway for the conveyance of goods, when

Mr. ACKWORTH objected, on the ground that there was no reference to freight in the railway company's petition.

After some conversation,

The CHAIRMAN said it was absurd to suppose that a little tramway, 2¾ miles long, would interfere with the goods traffic of a railway like the Lancashire and Yorkshire. The question was not raised in the petition, and as it was obviously an afterthought, the Committee would decline to go into the question.

Mr. LITTLER said the railway company could not confine its case to the question of passenger competition alone. He would therefore withdraw from the inquiry.

The preamble was then declared proven after formal evidence from the engineer as to the practicability of the scheme.

The bill will be reported for third reading.

OTHER ELECTRICAL BILLS.

In the House of Lords on Thursday last week the following bills were read a second time:—Liverpool Corporation, City and Brixton Railway, Manchester Corporation (general powers), Eastbourne Corporation, Whitechapel and Bow Railway and London, Tilbury and Southend Railway.

In addition to the two London County Council tramway bills mentioned elsewhere, the following bills were read a third time in the House of Lords on Monday:—Mexborough and Swinton Tramways, Saddleworth and Springhead Tramways, Hastings Tramways and South Wales Electrical Power. The following were then read a third time and passed:—Piccadilly-City Railway; North-East London Railway; London United Electric Railways; Great Northern and Strand Railway; Brompton and Piccadilly Circus Railway (new lines, &c.); Great Northern and City Railway; Charing Cross, Euston and Hampstead Railway (Nos. 1 and 3); Charing Cross, Euston and Hampstead Railway (No. 2); North-West London Railway and Baker Street and Waterloo Railway Bills.

In the House of Commons on Monday, the following bills were read a second time:—Central London Railway, North Staffordshire Tramways and the Rossendale Valley Tramways.

The Rhondda Urban District Council Tramways Bill, which has already passed the House of Lords (see *The Electrician*, Vol. XLVIII., pp. 786 and 825) has been before a Committee of the House of Commons during the past few days. So far the chief opposition has been at the instance of the Taff Vale Railway Co., by reason of competition, and several religious sects who object to the trams being run on Sundays The bill is roceeding

On Friday the Metropolitan Railway Bill came before the Committee of the House of Commons as an unopposed measure. Amongst other things it proposes to authorise the execution of further works, the acquisition of additional land for the enlargement and improvement of Baker-street station, the erection of a generating station, and the electrical working of the undertaking, and other undertakings in which they are jointly interested with other companies. The bill was for a long time on the list as an opposed bill, but all opposition has now been withdrawn, and it was reported for third reading.

The bill to confirm a provisional order of the Local Government Board empowering the Pontypridd Urban District Council to complete a tramway scheme, sanctioned last year, came before a Select Committee of the House of Lords, presided over by Lord Newton, on Friday in last week. The order was opposed chiefly by the Taff Vale Railway Co. on the ground of competition. The cost of the whole scheme when completed, it was pointed out, would be £45,000, the tramway being 1¾ miles in length. For the Taff Vale Company, it was argued that the bill was unique, inasmuch as it left with the Local Government Board the decision as to the character of the line; and it was also declared that the traffic would not justify its construction, as the Taff Vale Railway did not carry five passengers a day between Treforest and Pontypridd, though they ran 22 trains a day. In the result, the Chairman declared the preamble of the bil proven.

VALUATION OF MACHINERY IN SCOTLAND.

In the House of Commons last week, in answer to a question by Mr. RENSHAW as to whether the decision of the Valuation Appeal Court, on March 15, 1902, in the case of the Assessor for Dundee *v.* Carmichael & Co., altered the practice which has prevailed in Scotland since 1854 with regard to the valuation of machinery fixed or attached to any lands or heritages,

The SOLICITOR-GENERAL FOR SCOTLAND replied that it did, and he regretted that there should have been a disturbance of the practical view which had been acted upon in Scotland for many years. At the same time, although he could not undertake to introduce legislation for restoring the old practice, any such measure would have the sympathy of the Government.

THE GENERAL ELECTRIC CO.'S FIRE.

Mr. RITCHIE, in the House of Commons on Thursday last week, replying to Mr. TENNANT, said the Home Office had no *locus* in reference to the inquest on the victims of this fire, but the coroner had been informed that an inspector of the department would attend if he so desired.

LEGAL INTELLIGENCE.

Berrenberg Electric Lamp Syndicate (Ltd.) v. Lowdon.

This case came before Mr. Justice Bruce and a common jury in the King's Bench Division on Friday last, and was brought to recover £49. 15s., balance of sum alleged to be due for electric lamps sold and delivered. Defendant pleaded that the terms of dealing were not those as alleged by plaintiffs, and, alternatively, that the lamps sold were sold with a warranty, and that the lamps were not in accordance with such warranty. Defendant claimed, therefore, to set-off against plaintiffs' claim, and counterclaimed damages for breach of warranty.

Mr. WILLS, for plaintiffs, said the plaintiff company entered into negotiations with defendant about October, 1900, for his becoming an agent for the sale of their goods. Defendant asked to have the sole agency in London or some district, but it was ultimately arranged that he, having some customers of his own for lamps, should purchase them from plaintiffs upon certain terms, a sliding scale as to price being arranged. Between October, 1900, and January, 1901, deliveries were made on orders given by defendant amounting to £59. 12s., on account of which only a small sum had been paid, and against which there were one or two credits, making plaintiffs' claim altogether £49. 15s. During the period of these deliveries defendant made a few complaints with regard to the lamps supplied, but that was a thing which always happened in regard to such a business. When lamps were returned on the ground that they did not burn properly plaintiffs supplied fresh ones. By January, 1901, defendant had paid nothing in respect of the lamps he had had, and accordingly a demand was made for £53. 0s. 8d., the amount due. Defendant then made some complaint about the lamps supplied, and said he was not able to pay the money. It was agreed that if defendant paid £5 down, and undertook to pay £20 more by the end of June, there should be an end to all questions between the parties. Defendant paid the £5, but never paid the £20, and, therefore, the arrangement came to an end. Plaintiffs claimed to have the full amount sued for.

Mr. JOHN HOWARD, agent-general for Nova Scotia, managing director of plaintiff company from 1898 to early in 1901, said defendant was never appointed agent to the company. Defendant was to act as buyer not as agent. During the time defendant was supplied with lamps he made certain complaints about their efficiency, and there were complaints from other people besides defendant. Some of the lamps supplied to defendant were wrongly marked "100 voltage." That was a pure mistake.

Mr. T. A. ROSE, who was manager of the Berrenberg Syndicate, said the ordinary price of the lamps was about 11½d. each to the trade. They sold about 54,000 of the lamps for £550, or about 2½d. each. The Berrenberg pump was working all right when he was there. The 54,000 lamps were sold at that low price because they were inefficient. Sometimes the pump was inefficient, and sometimes worked all right. Defendant complained to him that he was losing his customers by reason of the lamp being bad, but he did not specify any customer. In every make of electric glow lamps you expected at least 2 to 3 per cent. of inefficient lamps. Some makes ranged up to 10 per cent. or even more. The average price of an English made lamp was between 9d. and 10d., whereas foreign made lamps ranged from 4d. upwards .

Mr. E. P. WILSON, the receiver for the debenture-holders, said he sold the 54,000 lamps for £550, but without any guarantee . He sold the plan and machinery for £6,250 . He carried on the busines sfor eight months in order to try and sell as a going concern. Defendant had offered £10 in ettlement

His LORDSHIP suggested at this stage that the parties should endeavour to come to terms, but after discussion the parties could not agree.

Mr. KNIGHT, for the defence, said the complaints made by defendant were many, persistent and serious. The defence was that the lamps were so inefficient as to be worth nothing. Out o f£69 worth of goods supplied by plaintiffs to defendant, £31 worth had not been paid for by his customers. Defendant could not sue them because he had guaranteed that the lamps were reliable, and they had proved otherwise. On this head defendant counterclaimed for £31. 12s. 3d., and also for a further £15. 16s. 1d., the discount or profit he would have made if the goods had been all right. Defendant then made a general claim for damages by reason of the loss of his customers.

Mr. LOWDON having given evidence in support of his case,

The jury found for plaintiffs on the claim for £24 and for defendant on the counterclaim for £15, and judgment was entered accordingly, with costs on the High Court scale.

Isaacson v. New Grand Theatres (Ltd.).

At Westminster (London) County Court, on Friday last, Judge Woodfal and a jury again heard the claim by the parents of a young electrical engineer named Isaacson for damages for the loss of their son. Mr. Horton Smith, K.C., in this Court had held that deceased was not a workman within th

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meaning of the Employers' Liability Act or the Workmen's Compensation Act, but was a highly-skilled electrician. He took the case from the jury and non-suited the plaintiffs. Various applications and hearings came both before the High Court and at Westminster, and the whole matter now came on as a new trial.

Mr. MINTON-SENHAUSE, for defendants, took preliminary objection to the case being proceeded with on the ground that this was an action under the Employers' Liability Act, and a claim under the Workmen's Compensation Act was pending. Mr. Horton Smith had found that the electrical installation works at the theatre was not a factory, and that decision was appealed against. The same judge also refused to assess compensation under the Workmen's Compensation Act, and that was appealed against. He (counsel) contended there could not be two actions pending at the same time with regard to the same matter.

His HONOUR over-ruled the objection on the ground that the case was sent back to be begun *de novo*.

Mr. MOYSES, for plaintiffs, said plaintiffs sought damages for the loss of their only son, who met his death, as was alleged, through a defect in the plant at the theatre where he was employed as an electrical engineer.

Mr. F. WM. RAYNER, A.I.E.E., said he was superintendent of the electrical affairs at all the company's theatres. Mr. Isaacson was engaged as a practical man with a view to avoiding sending to any outside contractor to do repairs. There was no engineer's shop at the theatre, but there were the necessary tools for repairs.

Mr. J. OWNER, an inspector of factories, said the sump was in a dangerous position, and the cover was an improper arrangement. Since this accident occurred such works as these had been included in the Factory Acts.

Mr. MINTON-SENHAUSE submitted deceased was not a workman, that there was no evidence of defect or negligence, and that there was, consequently, no case to go to the jury.

His HONOUR held that no negligence was proved, and there was no case to go to the jury. He therefore non-suited the plaintiffs. It was a painful duty, but he could come to no other decision.

Mr. MOYSES having asked for leave to appeal, made formal application under the Workmen's Compensation Act. The application was adjourned

West India and Panama Telegraph Co. (Ltd.) v. Cuba Submarine Telegraph Co. (Ltd).

In the House of Lords, on Monday, this case came up on appeal from an order of the Court of Appeal affirming, with some variations, a judgment of Mr. Justice Farwell (fully reported in our issues of May 25, 1900, March 15 and 22 and June 14, 1901), and at the conclusion of the arguments of counsel,

Lord MACHNAGHTEN (presiding), in moving that the appeal be dismissed, said the whole question turned upon the agreement made in January, 1870, but before calling attention to the language of that agreement it was necessary to recall the circumstances under which that agreement was made. In 1869 there was a land line connecting Santiago and Havana, and at that time the Government of Cuba was not very strong, for the island seemed to have been in a state of perpetual disaffection or insurrection, and no reliance could be placed on the line for the transmission of messages beyond it. There was also in existence in 1869 an American company called the International Ocean Telegraph Co., which had a line from Lake City to Key West and thence to Havana, and it was in contemplation by this company to extend its business so as to gather all the traffic of the West Indian islands. Apparently, in consequence of the difficulty of telegraphic transmission over the island of Cuba, this company thought it better to promote another company—which was done by the establishment of the West India and Panama Telegraph Co.—which was to take off its hands communication between Cuba and the West Indian islands. That company in its turn found it desirable to form another company to carry on telegraphic communication by sea from Santiago to Havana. The International was the parent of the Panama Company and the Panama Company or Cuba Company, and these three companies were bound together by the strongest ties of mutual interest. Each company entered into an agreement with each of the other two companies, and the agreement between the Panama and Cuba companies was the one with which their lordships had to deal. The substantial question depended upon the meaning of one expression which occurred in several clauses, but the point was as to the clauses providing that the Cuba Company would hand over and forward by the West India Company all telegraphic messages received by or sent through the lines of the Cuba Company for any other parts of the world with which the West India Company might be in telegraphic communication. Now, what was the meaning of that phrase "telegraphic communication." He thought their lordships might adopt the view taken by the Court of Appeal. He should say that a company was in telegraphic communication with every place with which there was interchange of telegraphic messages, to which it could send messages, and from which it could receive messages. That was the view the Court of Appeal took of the matter. In his opinion, the Court of Appeal was right in giving that extended meaning to the expression, and that any other meaning would be contrary to the ordinary plain meaning of the phrase. There had been an argument that the Cuba Company was a mere local enterprise, but the real object of this agreement was to secure for these three companies the benefit of messages sent to New York and forwarded to London. The respondents had expressed themselves satisfied with the order of the Court of Appeal, and, therefore, it was not necessary to deal with it, but he desired to guard himself from being understood to say that the companies meant to bind themselves not to enter into any agreement without the consent of the other.

Lords Brampton, Robertson and Lindley concurred, and the appeal was accordingly dismissed with costs.

Hiram Maxim Lamp Co. (Ltd.) v. Wardlow and Others.

On Friday Mr. Justice Farwell heard an application for the holding over of the hearing of this action.

Mr. JENKINS, K.C., said the action was brought by the company against certain persons who were directors of the company for an injunction to restrain defendants from making a certain call. The directors of the Hiram Maxim Lamp Co. (continued counsel) had refused to allow plaintiffs' nominees access to the board meeting or to interfere in any way with the business of the company. He urged that the plaintiffs had a good cause of action against the directors, who refused to give up a list of shareholders, and plaintiffs were, consequently, afraid that the affairs of the company were not being properly conducted.

His LORDSHIP, having reviewed the course of the litigation between the parties, refused the application.

Alleged Trespass.

At Darlington County Court, on June 18, Messrs. Cox-Walkers were sued by the agent of the Rev. W. Eckersley, for £12. 19s. 10d., as damages for trespass. An injunction was also sought. It appeared that defendants hold a contract under Darlington Corporation for the maintenance of the fire telephone system, and in 1894 fixed a bracket on property owned by plaintiff. An action for damages was entered, but was settled by defendants paying the sum claimed. By accident the trespass was repeated, and defendants, on becoming acquainted of this, removed the bracket, but declined to pay damages.

For defendants, it was stated that there had been no damage, and that when the wires were subsequently fixed, they were only near one part of plaintiff's premises, and that leave for wires to cross property they did not touch was seldom asked for.

Judge TEMPLAR said defendants had not been given an opportunity of doing what any ordinary person would do. Permission to affix wires was, however, necessary, and defendants were liable to actions of this kind. Few people would bring them, but when they were brought the penalty must be paid. As defendants had not acted contumaciously in the face of the Court he would not grant an injunction, and as it was a case of mere inadvertence, only moderate damages (£1 and costs) would be given.

Improper Fencing and Guarding.

At Margate three summonses, under the Gas Works Clauses Act, 1847, for improperly fencing, guarding, and lighting electric light trenches, issued by the Broadstairs and St. Peter's Urban Council against the Isle of Thanet Electric Tramways and Lighting Co. (Ltd.) were heard at Margate on Monday. The trenches had been excavated for the purpose of laying electric light cables.

For the defence it was contended that the trenches had been sufficiently guarded and lighted, and that this was borne out by the fact that no one had fallen into them, and no complaints had been made respecting them.

The Bench convicted, and imposed a fine of 40s. in each case, with 12s. Court fees and £2. 2s. solicitors' fees.

Re London and Provincial Electric Construction Co. (Ltd).

On Tuesday, the petition of Mr. J. W. Vickers to wind up this company was dismissed without costs, as the petitioner's claim against the company having been settled.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Derby Technical Education committee require an assistant lecturer and demonstrator in physics and electrical engineering for the Municipal Technical College. Forms of application, to be returned by July 10, from the principal. See advertisement.

Manchester Tramways committee require three foremen linesmen. Applications to Chairman, 55, Piccadilly, Manchester, by 1 p.m. July 5. See advertisement.

Hornsey Local committee of Middlesex County Council, require a teacher of electric lighting and electric wiring. Applications to Mr. B. S. Gott, Guildhall, Westminster, by July 12. See advertisement.

Edinburgh Corporation require an assistant to the superintendent of mains. Applications to resident electrical engineer (Mr. F. A. Newington), Dewar-place, Edinburgh, by July 7. See advertisement.

The Council of the Metropolitan Borough of Southwark (London) require a charge engineer. Applications to town clerk (Mr. J. A. Johnson), Town Hall, Walworth-road, S.E., by 4 p.m. July 2. See advertisement.

The Stepney (London) Guardians require an engineer for their Childrens' Homes at Stifford, Essex. Applications to the clerk (Mr. S A. Lewis), Guardians' offices, Barnes-street, Ratcliff, E., by July 23. See advertisement.

Swindon Corporation require an electrical engineer and tramways manager. An advertisement contains further particulars. Applications to the town clerk (Mr. Robert Hilton) by July 9.

Three telegraph linesmen are required by the Government of Northern Nigeria for eight months. Applications to Crown Agents

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for the Colonies, Downing-street, London, S.W., by July 7. See advertisement.

The Indian Telegraph Department invite applications for five assistant superintendentships in the telegraph department of the Government of India. Applications to secretary, Judicial and Public Department, India Office, Whitehall, London, S.W., by June 30.

London County Council require an electrical distribution engineer for their tramway department. Applications by 10 a.m. of July 14.

The Council of University College, Bristol, require a demonstrator in engineering. Applications by July 4 to Mr. J. Rafter, registrar and secretary.

A demonstrator in electrical engineering is required for University College, Nottingham. Applications to secretary by June 30.

The position of principal of the Wandsworth Technical Institute is vacant. Applications to hon. sec., 4, Galveston-road, London, S.W., by June 30.

An assistant master in engineering and mathematics is wanted for Birmingham Municipal Technical School. Salary £125. Applications by June 30.

Mr. G. H. Barnby Holmes, pupil of the city electrical engineer (Mr. C. A. Midgley), has been appointed junior assistant engineer at York electricity works, and Mr. F. B. Walker, of Bradford, has been appointed chief clerk of the Corporation's electric lighting department.

Mr. H. W. Henderson, of Hull, has been appointed shift engineer at the Cork Electric Tramways and Lighting Co.'s station.

Acts of Parliament.—On Monday the Royal Assent was given to the following acts:—

Electric Lighting Orders Confirmation (Nos. 2, 3 and 4).	Manchester and Liverpool Electric Express Railway.
Brighton and Rottingdean Seashore Electric Tramroad.	Cornwall Electric Power.
Derbyshire and Nottinghamshire Electric Power.	Middlesex County Council Tramways.
Newcastle-upon-Tyne Electric Supply Co.'s Act.	Gloucestershire Electric Power.
Manchester Corporation Tramways.	Scarborough Tramways.
	Preston Corporation.
	Birkenhead Corporation.
	Erdington Tramways.

Beckenham.—A committee is considering the advisability of promoting a bill to authorise the construction of electric tramways, and to obtain further powers respecting the electricity undertaking.

Carnarvon.—Mr. Assheton Smith has applied to the Gwyrfai Rural Council for support in connection with his application for a provisional order authorising the erection of electricity works for the supply of electricity for the Dinorwic Quarries and in the parishes of Llanddeiniolen and Llanfairisgaer and a portion of Llanberis. A committee of local representatives of each of the parishes has been appointed to consider and report upon the matter.

Chichester.—Acting on the recommendation of the Electric Lighting committee the City Council have decided to transfer their provisional order to the County of Sussex Electrical Power Distribution Co, which undertakes to repay the cost of obtaining the order, and to take steps, within 12 months, to establish electricity supply. The right of purchase has been reserved by the Council at the end of 14 or any subsequent period of seven years, and current is to be supplied at 3d. per unit for public lighting, or £15 per annum per arc lamp burning till 11 p.m., with £2 additional if fitted with two incandescent lamps to burn from 11 p.m. till dawn.

Dundee.—The treasurer made his annual statement last week, when it was announced that the current year's revenue, including the balance forward, was estimated at £25,914. 15s. 9d., and the expenditure at £25,667. 10s., showing a surplus of £247. 5s. 9d. The revenue was made up as follows:—Balance from 1902, £217. 11s. 9d.; sale of electricity for private lighting, £15,967. 4s.; motors, £600; public lamps, £1,005; tramways, £8,125; and the expenditure:—Generation of energy, £9,720; distribution, £975; public lighting, £370; rents, rates, taxes, &c., £2,650; management, £1,352. 10s.; interest, £5,000; sinking fund, £2,800; contingent fund, £2,800. They had 782 consumers at the end of the year, compared with 617 last year, and the total units sold were 1,860,881, against 1,041,800. The area of lighting now consisted of the whole city. The only change they proposed to make in the price of current was the reduction of ½d. per unit for power. He proposed that the price of electrical energy to ordinary consumers, otherwise than by agreement and for motive power, per quarter should be as follows:—For any amount up to 20 units 6s. 8d.; for each unit above 20 units, 4d.; and that all consumers who consume above 10,000 units be charged 3d. per unit above 10,000, subject to 5 per cent. discount for monthly accounts. The public lamps are to be charged at £15 each for those burning the whole night, and £7. 10s. each for those burning part of the night, net. Electrical energy for motive power will be charged for as follows:—60 units or under per quarter a minimum of 7s. 6d., above 60 units per quarter 1½d. per unit if taken through separate meter, but if not taken through separate meter the ordinary rate of 4d. per unit, subject to 5 per cent. discount. The rate for tramways will be such as has been agreed on between the two departments. The accounts and estimates were approved.

Ealing.—The accounts of the electric lighting department for the year ended March 31 have been issued, and show total expenditure of £116,311. 4s. 5d., an increase of £8,361. 2s. 1d. for the year. The receipts from the sale of current amounted to £10,603. 11s., and with meter rental (£431. 19s. 6d.), public lighting revenue (£3,547. 6s. 2d.) and miscellaneous items the total amounted to £14,741. 3s. Generation, distribution and management expenses, &c., came to £8,183. 7s. 6d., leaving a gross profit of £6,557. 16s. Interest absorbed £3,333. 3s. 9d., £2,704 was required for sinking fund instalment, and after providing £100 for bad debts, the net profit for the year amounted to £421. 10s. 11d., against a loss of £512. 4s. last year. The number of units sold to private consumers was 453,387, and 252,399 units were supplied for public lighting. The equivalent number of 8 c.p. lamps connected was 45,448, representing 991 consumers. The average price obtained was 5·6d. per unit, and the percentage of gross profit to capital was 5·63. There are 72 public arc lamps, and the equivalent of 1,113 8 c.p. incandescents for public lighting.

Ebbw Vale.—The Ebbw Vale Company have offered to supply electric current for public lighting at 2d. per unit, provided a minimum of 50,000 units per annum is required.

Falmouth.—Crompton & Co. have submitted proposals for obtaining a provisional order for erecting electricity works in the town, and their representative (Mr. Purvis) has been asked to meet the General Purposes committee to discuss details.

Finchley.—An inquiry was held last week into the application of the Council to borrow £35,000 for the erection of electricity works. Technical particulars were supplied by the electrical engineer (Mr. E. Calvert) who said that the district was a large one, and was rapidly developing. Gas was expensive, and at the outset the Council would be able to supply electric current cheaper than gas. The three-wire continuous-current system of distribution, with a terminal pressure of 250 volts, had been decided upon. Circulars had been sent out in 1900, and he calculated that the probable initial requirements would be equal to 14,506 8 c.p. lamps. Since the receipt of the replies the number of buildings had increased, and there was reason to believe that many of the new residents would be prepared to adopt electric lighting. The summary of the cost of the scheme was as follows:—Buildings £8,000, machinery and apparatus £10,600, mains, &c., £14,150, sundries £2,250, a total of £35,000. The station had been so designed as to admit of extensions to the generating plant if necessary. Replying to Mr. Sydney Morse (for the North Metropolitan Electrical Power Distribution Co.), Mr. Calvert said he thought a municipal undertaking was more likely to pay than one run by a company. Evidence was also given by the surveyor (Mr. F. Smythe) and by the chairman of the Council (Councillor B. Todd, J.P.). Mr. Todd had no objection to taking electricity in bulk from an independent company if it were in the public interest to do so. Mr. Morse said that his clients would supply electricity at an average price of 3¾d. per unit, and he asked the inspector not to make his report until the Council and ratepayers had had an opportunity of seeing whether they were prepared to make an arrangement on that basis or not, but Mr. Todd replied that they had decided that a municipal scheme would be preferable. There was also opposition by some ratepayers.

Forthcoming Books.—There will shortly be published, with the approval of the Eastern Telegraph and its Associated Companies, a "Social Code," compiled by Mr. R. Atkinson, of Salisbury House, London, E.C. The lines on which the work is being prepared will render it of great assistance as a means of communication between colonists and their friends at home. The simplicity of arrangement and the large number of everyday phrases which the book will contain, make it peculiarly adaptable to the requirements of colonists, travellers and members of the public services. Inquiries or information about domestic or personal matters may be cabled at the least possible expense. One advantage of this particular compilation lies in the fact that the Eastern and Associated Telegraph Companies have arranged to keep copies for public convenience at home and foreign stations. The volume will be of convenient size for the pocket, it will contain more than 10,000 carefully-selected phrases of daily use (with spaces for additional matter to be filled in), and the published price will be 5s.

Great Yarmouth.—The electric tramways were opened for traffic on Thursday last.

Hanley.—The electric lighting accounts for the year ended Dec. 31 last show that the capital expenditure at that date amounted to £79,882. 4s. 8d., an increase of £6,552. 1s. 6d. for the year. The receipts from the sale of current for private lighting were £10,545. 8s. 1d., and for public lighting £1,960, making, with meter rental (£302. 17s.) and receipts from sale and repairs of other apparatus (£57. 17s. 9d.) a total of £12,866. 2s. 10d. The annual expenses were £8,513. 19s. 10d., leaving £4,352. 3s. to meet interest

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(£2,156. 6s. 1d.) and sinking fund (£2,148. 4s. 5d.) The net profit was, therefore, £47. 12s. 6d., which has been carried forward. 825,127 units were generated, 151,051 were supplied to public lamps, 546,551 to private consumers, and 23,714 used on works. The total number of 8 c.p. lamps connected was 46,300.

Huddersfield.—The Local Government Board have declined to sanction the borrowing of £516. 12s. 8d. for defraying the costs of obtaining the electric lighting orders of 1890 and 1896, and have excluded this sum from the amount sanctioned in April last. The sum has been charged to capital account, and has now been transferred to depreciation and contingencies account.

Intercommunication Telephones.—The General Electric Co. have ready illustrated sheets of particulars of the "Combat" (common battery) patent intercommunication system, specially designed for small suites of offices, warehouses, private residences, &c. The "Combat" system is claimed to be the simplest on the market, as the selection of line and the operation of ringing is effected by one and the same movement—the insertion of a loose plug.

Leeds.—The electric tramway between Moortown and Roundhay has been opened for traffic.

Light Railways.—The Highways committee of the London County Council are opposing the application of the Crystal Palace Light Railway and Tramways Co. for the construction of a light railway from Lordship-lane to the Crystal Palace.

The Board of Trade have, after modification, confirmed the Orpington, Cudham and Tatsfield Light Railway Order, 1902.

The Swansea and District Light Railway order has been confirmed by the Board of Trade.

The Colne and Trawden Light Railways (Capital Powers Amendment) Order has been submitted to the Board of Trade for confirmation. Objections by July 8.

Liverpool-St. Helens Tramway.—The tramway between Liverpool and St. Helens is now open for traffic, a full service being given on Wednesday.

The Liverpool Corporation have extended the city tramways from the present terminus at Old Swan to the City boundary at Knotty Ash, where the Lancashire Light Railways Co.'s line—the Liverpool and Prescot Light Railway—commences and continues to the boundary of Prescot, where it forms a junction with the existing tramways of St. Helens, which go through Prescot, Rainhill and Eccleston Park to St. Helens, and then on to Haydock. The Liverpool and Prescot Light Railway Order was granted by the Board of Trade in March, 1899, and the line has been fully constructed and equipped for some months, but, owing to the connection with the city tramway service being incomplete, it has not been opened for public traffic. The Light Railway is nearly 3½ miles in length, and is of the tramway type, and is to be worked on the overhead trolley system. The Lancashire Light Railways Co. is one of the companies controlled by the South Lancashire Electric Traction and Power Co. (Ltd.), who also control the South Lancashire Tramways Co., to whom, by the South Lancashire Tramways Acts of 1900 and 1901, powers were given for the construction of over 105 miles of tramways in the districts between St. Helens, Manchester, Bolton and Warrington. Nearly 20 miles of these tramways will be completed in six or seven weeks' time, also a large generating station at Atherton.

London County Council.—At Tuesday's meeting it was decided to loan Bermondsey £28,016 and Islington £8,630 for electricity supply.

Tramways.—The Highways committee reported on suggested new tramway proposals to be brought before the next session of Parliament. Their proposals include the construction of new tramways of a total length of about 11½ miles on the north side of the Thames, at an estimated cost, for the construction of the tramways, the paving of the tramway tracks, the provision of cars and car sheds, and other works in connection with the tramways, of about £529,850, and for street widenings of about £64,416; while, on the south side, the total length of tramway is about 22 miles, and the cost of the construction of the tramways and other works in connection therewith is estimated at about £945,700, and of the necessary street widenings at about £198,891. The committee propose that those of the new lines which will be ultimately connected with the Council's (northern) tramways (leased until Midsummer, 1910, to the North Metropolitan Tramways Co.), shall be constructed for horse-traction, unless, before the time shall arrive for their construction, effect shall have been given to the provisions in the company's lease relating to the reconstruction for electric traction of the leased tramways, or the parts of them immediately adjacent to, and to be worked in connection with, the new tramways. The estimates provide, however, for rails of sufficient weight to permit of the running of electric cars. Those of the new lines which will be ultimately connected with the London County Council tramways, on which, being at first detached from either of the Council's tramways undertakings, could be worked independently, they propose shall be constructed for electric traction.

The consideration of the report was adjourned.

Thames Embankment Tramways.—Some discussion took place over the action of the House of Lords in striking out the Thames Embankment tramway scheme. Mr. Benn said the position was that they could carry the tramway underground to the Strand, but could not get to the surface. Dr. Collins suggested that those members of the Council who were also members of the House of Commons should move in the House that the House disagree with the Lords' instructions. Mr. Benn thought this a good suggestion, and promised to see if it could be carried out.

Lowestoft.—The Council have given formal notice of intention to apply for a provisional order for supplying electric current in the rural parishes of Ellough, North Cove, Weston and Worlingham.

Mendomsley.—The Parish Council have accepted the terms of the Consett Iron Co. for supplying electric current to about 30 public lamps.

Municipal Telephony.—The Telephones sub-committee of Manchester Corporation has resolved to proceed with the application to the Postmaster-General for a licence to establish a municipal telephone service for Manchester, Salford, and Stockport.

Northfleet.—The Urban Council, by 10 votes to 1, have decided to invite offers for a transfer of their provisional electric lighting order.

Ottawa.—The Municipal Council recently invited offers for the installation of a municipal telephone service, with exchange and apparatus for 4,000 subscribers. We learn that no tender of practical value was received, and the Council will, therefore, invite proposals for a modified scheme.

Russia.—The Helios Company has secured a contract for the generating plant and electrical equipment of an electric tramway to be constructed at Vladicaucas, S. Russia, by La Société des Tramways et Eclairage Electriques de Vladicaucase.

Sleaford.—The Council have decided to provide an electric motor for pumping at the sewage farm.

South Shields.—The Electric Light committee have received a communication from the South Shields Gas Co. calling the attention of the Corporation to sec. 20 of the Electric Lighting Act, 1882, in the hope that they would abandon the idea of supplying, free of cost, electric current for lighting to certain persons during May, June and July. The Gas company are advised to take proceedings for an injunction if the Corporation determine to carry out this offer. A reply to this letter has been made that the action of the Corporation in offering electric energy free of charge during the three months to consumers whose premises were wired during those months has been regulated by a desire to relieve the pressure upon the department in connecting up new consumers which usually takes place in the beginning of the autumn. As those consumers would enter into an agreement to take current until Sept. 30, 1903, there would be no loss to the undertaking; but, on the contrary, the proposal would be of considerable advantage and benefit to it, and was consequently in the interests of ratepayers. With regard to sec. 20 of the Electric Lighting Act, 1882, the Electrical committee were unable to see in what way they are showing any undue preference, as all new consumers who were prepared to conform to the terms of the Corporation would be put on the same footing.

Sudbury.—Owing to margin of borrowing powers being insufficient, the Town Council's application for sanction to a loan of £12,000 for electric lighting has been refused.

Taunton.—The official inauguration of the extensions to the electricity works took place on Monday. Taunton claims to be the first town in the United Kingdom to have adopted public electric lighting. The present additions to the plant and mains have cost about £18,000, bringing the capacity of the station up to 1,600 H.P. The electric light undertaking has altogether cost about £62,000. The work has been carried out under the supervision of Mr. E. Manville, consulting engineer.

Tunbridge Wells.—At present there is the equivalent of 43,378 8 c.p. lamps connected, against 35,260 last year. The receipts for the past year amounted to £11,314 and the profit was £446. 5s. 6d.

War Relief Fund.—We learn that the handsome sum of £508 has been contributed to the War Relief Fund for soldiers' and sailors' wives and families by the Chelmsford employés of Crompton & Co., by means of weekly penny subscriptions.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week*]

TENDERS INVITED.

Teddington Urban District Council invite offers from persons and companies willing to take over the Teddington provisional order, 1901, and to submit a scheme for the electric lighting of the district. An advertisement contains some further particulars, and tenders have to be sent to the clerk to the Council, Mr. G. H. Salmons, Elmfield House, Teddington, S.W., by July 12.

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The Visiting committee of *Devon* County Asylum, Exminster, invite tenders for wiring alterations and additions, 2,000 lamps, booster dynamo and motors, switchboard, replacing of battery of 120 700-ampere-hour cells, &c. Plans, &c., may be inspected and specifications obtained of the consulting engineers (Messrs. O'Gorman and Cozens-Hardy), 82, Victoria-street, Westminster. Tenders to the clerk to the County Council (Mr. H. Michelmore), The Castle, Exeter, by noon July 23. An advertisement contains further particulars.

Chester Corporation invite tenders for permanent way construction, bonds, overhead equipment and cars. Further particulars are given in an advertisement. Drawings and specifications may be inspected after 23rd inst. at the Town Hall, on application to the city surveyor (Mr. I. M Jones) or to the city electrical engineer (Mr. F. Thursfield), from either of whom specifications and forms of tender may be obtained. Tenders to the town clerk (Mr. Samuel Smith) by 10 a.m. July 7.

Chester Corporation also invite tenders for accumulators and reversible battery booster. Specifications from the city electrical engineer, Mr. F. Thursfield. Tenders by July 7. See advertisement.

London County Council invite tenders for 50 double-deck electric tramcars, complete with trucks, controllers, motors, ploughs, &c., a 25-ton electric and three 10-ton hand-power overhead travelling cranes to lift 10 tons each; also for trench work, concreting, bricklaying, repaving, &c., in connection with laying of stoneware cable ducts for southern tramways. Tenders by July 15.

London County Council require tenders for steam, exhaust and other piping, valves, &c. Tenders by July 8.

Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board require tenders for three 500kw. steam-driven, direct-coupled, three-phase alternator sets; three 50kw. ditto continuous-current exciters, &c.; and permanent way (including copper bonding and conduits for cables). Tenders to the clerk, Town Hall, Stalybridge, by July 7.

Falkirk Corporation invite tenders for steam, exhaust, drain and other pumps, feed pump, tank, &c.; balancing transformers and motor generators; storage batteries; switchboard and connections; arc and incandescent lamps and fittings; cable work and travelling crane. Tenders to town clerk by noon July 14.

Epsom District Council invite tenders for a semi-marine bry-back boiler, with fittings, &c.; ejector condensers, circulating pumps and pipework; spray cooling ponds; steam feed and drain pipes, &c.; and a 150kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, &c. Tenders to clerk by noon July 18.

Nuneaton and Chilvers Coton Electricity committee invite tenders for private lighting cables (paper) and public lighting cables (rubber), joint boxes and compounds; also 20 arc lamp columns with incandescent brackets, complete with lamps, cutouts, switches, resistances and accessories. Tenders to chairman by June 30.

Gillingham Urban District Council invite tenders for water-tube boilers, steam and exhaust piping, condenser, cooling tower, three high-speed engines, 250kw. tri-phase alternators, switchboard, underground cables, arc lamps, crane and well. Tenders to clerk by 3 p.m. July 17.

Ipswich Corporation invite tenders for engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains and road work, permanent way construction of tramways, and arc lamps. Tenders by noon July 5.

Wrexham Town Council invite tenders for a water-tube boiler and superheater, a 300kw. steam alternator and additions to switchboard. Firms wishing to tender should communicate with Mr. W. H. Trentham, 39, Victoria-street, London, S.W.

Romford Urban District Council are open to receive offers for the construction and maintenance of electricity supply works. Offers to clerk by noon June 30.

West Ham Borough Council require 50 double-deck electric tramcars, complete with electrical equipment. Tenders to town clerk by 4 p.m. July 8.

Lowestoft Corporation invite tenders for rails, fish-plates and bolts and permanent way construction for their electric tramways. Tenders to town clerk by 5 p.m. July 12.

Sunderland Tramways committee require tenders for permanent way and overhead equipment and cables. Tenders to chairman by July 9.

Newcastle-on-Tyne Guardians invite tenders for lighting three relief offices. Tenders by noon July 11 to Mr. J. W. Gibson, 127, Pilgrim-street, Newcastle-on-Tyne.

Newcastle-upon-Tyne Corporation invite tenders for 2,000 tons of tramway rails, fish-plates, &c. Tenders to Chairman Tramways committee by noon July 10.

Bexley District Council invite tenders for points and crossings and boilers. Tenders by July 7.

Cheltenham Guardians invite tenders for providing inter-communication telephones at the workhouse. Tenders by 5 p.m. July 2.

Willington Quay and Howdon Industrial Society invite tenders for electrical plant. Tenders by July 14.

Manchester Electricity committee invite tenders for 12 months supply of stores. Tenders by July 1.

Manchester Electricity committee invite tenders for high and low-pressure piping. Tenders by July 3.

Tenders are invited for electric lighting installation at the *Edinburgh* free library extension buildings. Tenders to town clerk by July 7.

The *Norwegian* State Telegraph Department invite tenders until noon of July 7 for telephone cable and for Leclanché battery glass.

TENDERS RECEIVED AND ACCEPTED.

The London County Council have received eight tenders for an electric light installation at the Battersea fire station, ranging from £107. 10s. to £225; seven tenders for Camberwell station, ranging from £94 10s. to £195; eight tenders for Battersea river station, varying from £85. 10s. to £198; and eight tenders for the Battersea Park-road sub-station, varying from £35. 19s. to £90. 10s. The lowest tender (that of Cramer & Co.) was accepted in each case.

Bray District Council have accepted the following tenders:—
Chamberlain and Hookham, meters.
Brush Company, transformers.
General Electric Co., batteries, voltmeter and balances.
Reason Manufacturing Co., demand indicators.

Brighton Town Council have accepted the tender of Bolckow, Vaughan & Co. for 300 tons of steel girder rails, 12 tons of fish-plates, and 20 tons of sleepers at £2,611. 10s.; and that of Askham Bros. and Wilson (Ltd.) for points, crossings, drain boxes and other sundries at £1,117. 19s. 11d.

Barton (Lancs.) Board of Guardians have accepted the tender of Messrs. Browett, Lindley & Co. for a steam dynamo for £591; and that of Messrs. Collier & Co. for lamps and wiring.

The Liverpool Overhead Railway Co. have placed an order with the St. Helens Cable Co. for 8 miles of 37/14 dialite bitumen cable.

Cleckheaton District Council have accepted the tender of the Lancashire Dynamo and Motor Co. for five electric motors.

Greenock Corporation have accepted the tender of the Indiarubber Company, Silvertown, for the supply and erection of a 300kw. steam dynamo, with steam and exhaust piping, for £3,160.

Seven tenders, varying in amount from £291 to £327. 18s. 2d., were received for the electric lighting of the Wakefield Technical and Art Schools, and the lowest, that of Mr. George Hood, of Dewsbury, has been provisionally accepted.

BUSINESS NOTICE.

Messrs. F. F. Bennett, A. Ward-Thomas and J. W. Donaldson (trading as Bennett and Ward-Thomas), electrical engineers, Winter's-buildings, St. Ann's-street, Manchester, have dissolved partnership. Debts by Messrs. A. Ward-Thomas and J. W. Donaldson, who continue.

BANKRUPTCIES AND LIQUIDATIONS.

David Roberts, electrical and motor engineer, 30, Macklin-street (formerly of 3 and 5, Whiston-street), Derby, has been adjudicated bankrupt.

The Telephonic Bell-Push Syndicate (Ltd.) is to be wound up voluntarily, and Mr. H. A. Wilson, 39A, Lombard-street, London, E.C., has been appointed liquidator.

Plant, &c., for Sale.—Particulars of some electric lighting plant, which is for sale about the end of June, are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Burton-upon-Trent Gas and Electric Light committee will shortly have for sale three Lancashire boilers, particulars of which are set out in an advertisement. Further information from the manager and engineer (Mr. F. L. Ramsden), Gas and Electric Light Works, Burton-upon-Trent.

The Metropolitan Electric Supply Co. (Ltd.), 16, Stratford-place, London, W., have two Brown's patent steam feed-water heaters for sale. The plant can be viewed by appointment. See advertisement.

Telegraph Stores Sale.—Tenders are invited for the purchase of about 40 tons of gutta percha, a quantity of copper, lead, and other metals, covered wire, tools, glow-lamp tops, &c. Forms of tender, &c., from the Controller of Stores, G.P.O. (West), E.C. Tenders by 10 a.m. July 16. See advertisement.

Slot Meters.—The Rochdale Electric Co. have received an order for 1,000 slot meters from the Northern Counties Electricity Supply Co. The order, claimed to be the largest ever placed for a prepayment meter, follows one for 500 meters given by the same company this year.

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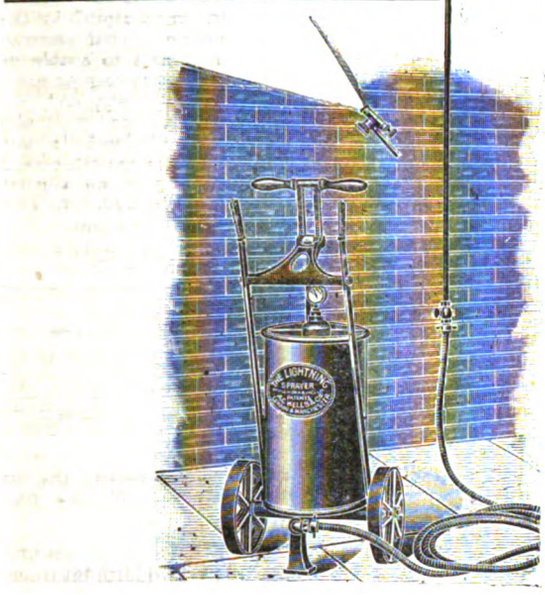
Lime-washing.—The importance of lime-washing on works and factory premises, in order to ensure cleanliness and to conform to the conditions laid down by the authorities, lends interest to the introduction on the market by Messrs. A. C. Wells & Co., 102-104, Midland-road, St. Pancras, London, of the "Lightning" lime and colour washer, which, we understand, is being largely adopted for use in electric car sheds and similar buildings. The apparatus is simple in use, and the directions for mixing the wash and cleaning the machine after use show that



a labourer, with a little supervision, will easily acquire the use of the apparatus and wash over a large area in a short time. There are other uses to which this useful device can be put. The illustration shows the apparatus fitted for work. No outside power is required, and lime, whiting and cold-water paint can be applied at a speed of from 8 to 10 sq. yds. per min. It is claimed that one coat with the machine on rough surfaces is equal to two applied with the brush.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 18 to 24, with the ports of destination :—

Africa—Alexandria, £328 (telegraph material); Cape Town, £389; Durban, £1,915; Lourenco Marques, £113 (telegraph material); Port Elizabeth, £66. *Australasia*—Adelaide, £117 (including £54 telegraph cable); Fremantle, £248 (including £189 telegraph wire); Melbourne, £1,320 (telegraph wire); Sydney, £545; Wellington, £60. *Ceylon*—Colombo, £451 (telegraph material). *China*—Shanghai, £279 (including £9 telegraph apparatus). *France*—Boulogne, £140. *Germany*—Hamburg, £169. *Gibraltar*, £15. *Holland*—Amsterdam, £49. *Hong Kong*, £291. *India*—Calcutta, £786. *Japan*—Nagasaki, £312; Yokohama, £438. *Sweden*—Stockholm, £333. Total £8,364 against £10,295 in the corresponding week last year (June 19 to 25

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

April 10, 1902.

8,315. E. M. Chapman. "Mec." electric coupling (for table decorations).
8,323. E. Townshend. Birmingham. Electric fittings.
8,334. M. J. L. Weston. Liverpool. Regulation of arc lamps. (A. de Puydt, Belgium.)
8,337. J. E. Smith. Manchester. Shade holder.
8,338. J. E. Smith. Switch for incandescent lighting.
8,339 and 8,340. J. E. Smith. Incandescent electric lighting and electric call bells.
8,341. J. E Smith. Manchester. Connecting lamps to dry batteries.
8,347. A. Beasley and H. H. Habrison. Electrical time recorder.
8,389. A. Tuerk. Electric clock-winding mechanism.*
8,396. T. E. Devonshire. Troughs and conduits.

April 11, 1902.

8,414. J. Oliver. Bristol. Lamp-holders.
8,441. A. Eckstein and A. Brooker. Manchester. Combined magneto-bell and indicator.
8,456. F. Bryan and A. H. Bayley. Electric ignition.
8,484. H. Schmitt. Multiplex telegraphy.
8,486. P. M. Justice. Electric telegraphic printing machines. (Rowland Telegraphic Co., U.S.)*
8,487. P. M. Justice. Transmitting devices for telegraphic apparatus. (Rowland Telegraphic Co., U.S.)*
8,488. P. M. Justice. Producing synchronous motion. (Rowland Telegraphic Co., U.S.)*
8,503. C. W. Atkinson. Electrical measuring instruments.

April 12, 1902.

8,520. G. H. Baillie. Converting electric currents.
8,549. H. H. Berry, P. T. W. Simon and E. Skinner. Electric switch fuses.
8,550. W. Toothill. Lancashire. Water-power valve.
8,557 and 8,558. British Thomson-Houston Co. Electric motor control systems. (J. B Linn, U.S.)*
8,566. J. N. Maskelyne, Jun. Wireless telegraphy.
8,577. Siemens Bros. & Co., C. Rodgers and W. Parker. Carbon commutator brushes.
8,583. R. Haddan. Pincers for electricians. (Bergmann Elektricitäts-werke A.G., Germany.)*
8,592. F. H. Hadfield. Secondary batteries.
8,596. L. P. Stark. Rails for electric railways and tramways.

April 14, 1902.

8,616. J. P. Tierney and J. Malone. Dublin. Moving points of an electric tramway or railway electrically.
8,629. H. Craven and J. R. Garner. Manchester. Trolley heads.
8,630. E. T. Whitelow. Manchester. Insulating lapping for electric wires.
8,643. F. H. Nalder and Nalder Bros. and Thompson. Damping the oscillations of electrical measuring instruments.*
8,645. W. P. Miles. Automatic regulation of the flow of electricity, &c.
8,651. L. Barlow and J. Young. Conduits.
8,653. E. McIntyre. Shade holder.*
8,667. Siemens Bros. & Co. Regulating pressure of alternating-current dynamos. (Siemens and Halske A.G., Germany.)*
8,670. T. L. Carbone. Arc lamps.*

April 15, 1902.

8,717. W. Fairburn-Hart. Leeds. Electric lamps. (General Electric Co., U.S.)*
8,747. Siemens Bros. & Co. Locking devices of electrical blocking apparatus for railways. (Siemens and Halske A.G., Germany).*
8,748. Siemens Bros. & Co. Securing and adjusting the active laminated rings of electrical machines. (Siemens and Halske A.G., Germany).*
8,784. H. H. Lake. Rail bonds. (E. G. Thomas, U.S.).*
8,788. L. Andrews. Alternate current measuring instruments.
8,789. L Andrews. Electrical distributing systems.
8,794. W. A. McCallum. Mechanism for recessing trolley wires.*
8,796. H. C. Froelich and E. P. Baird. Liverpool. Controlling devices.
8,809. J. J. Ghegan and E. J. Griswold. Circuit controllers.*

April 16, 1902.

8,824. T. Gregson. Manchester. Suspending overhead wires.
8,843. H. L. Wiedemeyer. Disinfecting by electric light irradiation.*
8,858. H. W. Hellmann. Electrical ignition.
8,863. A. Brook. Electric light for medical purposes.
8,866. H. Brooker, W. H. Goss and J. Lea. Waltham Cross. Wireles telegraphy.
8,872. S. Bach. Liverpool. Switches.*
8,878. W. Rutherford. Protecting devices for overhead electric traction systems. (J. Roberts, Natal.)
8,884. G. W. Johnson. Arc lamps. (Voltohm Elektrizitätsgesellschaft A.G., Germany.)
8,892. H. H. Lake. Electrically-wound clocks. (Aktiebolaget Svenska Elektriska Urfabriken, Sweden.)*

April 17, 1902.

8,969. H. J. Haddan. Dynamo-electric generators. (H. L. Peck, U.S.)*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

4,305. Derbyshire. Tidal motors for generating electricity.
6,757. Barnard and Stedman. Electric fire alarm.
8,280. Fortun and Semprun. Accumulators.
8,629. Wilson. Safety device for overhead conductors.
8,943. Baily. Measuring magnetic properties of material.
10,587. Sperryn and Wood. Lamp-holders.
10,747. Gardner, Gardner and Gardner. Electric ignition plugs.
11,071. Gray. Electrical connections.
11,703. Grundy. Electrical distribution boards.
11,838. Justice ("Long Arm" System Co.). Regulators, motors operating air or fluid compressors.
12,456. Lister. Trolleys.
13,568. Tommasi. Plates for accumulators. (Date applied for Jan. 17 1901.)
14,579. Lake (Tesla). Transmission of electrical energy.
14,670. Howard. Electric circuits.
15,509. British Thomson-Houston Co. (Linn). Controllers
16,042. Imray (Hartmann and Braun). Quantity meter
19,462. Ducrétet. Electromagnets.

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COMPANIES' MEETINGS AND REPORTS.

W. T. Henley's Telegraph Works Co. (Ltd.).

The 23rd ordinary general meeting was held on Friday, under the presidency of Mr. SYDNEY GEDGE.

The SECRETARY (Mr. A. E. Salmon) read the notice convening the meeting.

The CHAIRMAN then said: With respect to the balance-sheet, there is little to call your special attention. The capital remains where it was, both ordinary and share capital. There is power to have £200,000 of each, but the actual amount issued of each is £175,000. That we may before very long have to increase each capital to the £200,000 is possible, because our business and other exigencies of the trade may not improbably render it desirable that we should add to our works. The mortgage debenture stock remains in the balance-sheet at £50,000, because it is kept alive for special reasons, but you are aware that £1,000 a year is being paid off, and at the present date the amount is really reduced by £2,000. You will see from the comparison of the moneys owing to us and the moneys we owe that, considering the large extent of our business, both are very reasonable—that our debtors pay up very rapidly and that we ourselves pay our debts even more rapidly. The reserve under the cable repairing contract with respect to the Bahamas and Florida cable continues to increase, and now amounts to £7,215. 6s. 10d. and it has not had to be drawn upon in the past year. Besides that we have been for some time receiving on that account £350 a year, which goes to form part of our profits. The net profit for 1901 was £57,449. 13s. 3d., which is a little more than that of last year. We bring forward £24,000, and the result is that the Directors are able to ask you to confirm their declaration of a dividend for the whole year of 20 per cent. We really have nothing more to say with respect to the operations of the past year. There is a paragraph in the report to which I may now refer. This says: "The negotiations for the amalgamation of the Company with Messrs. Callender's Cable and Construction Co. (Ltd.), are still proceeding." That was true at the date of the report, the 10th of this month, but you are already aware that they are not now proceeding, but have come to, I may say, an untimely end. You will naturally wish to know something about the matter, but I am inclined to think the least said about it the better. The Directors were of opinion, and still are of opinion, that an amalgamation between two such companies as ours and Callender's is likely to prove to the benefit and advantage of both, provided only that it can be arranged upon fair and proper terms, and those terms must relate to two things—first, there must be an agreement as to the right mode of ascertaining the amount in the new company to be given to each of the old ones. You will understand easily that an amalgamation of this kind could not take place by means of the absorption of either company by the other, but that it was necessary to form a new company which should combine both, to each of which companies, therefore, must be allotted a certain interest in that new company, and the first thing we had to take care of was that Henley's Company received in proportion to Callender's Company a right amount of that interest. In order to do that the value of what the two companies had to sell, or the comparative value of what they had to part with, to the new company had to be taken on a right basis. As to what was the right basis, the Directors of the two companies were unable on some points to come to an agreement. The next thing that had to be considered was that the arrangements for the working of the new company, partly set forth in the Articles of Association and partly left to the new Board, must be such as to ensure as far as possible the harmonious working without friction of the two concerns thus brought together. I am sorry to say that on that point also the Directors failed to see eye-to-eye with each other on certain points, and I think there was sufficient in that ground as well as in the first why the amalgamation should not be proceeded with. I am glad, however, to say that the negotiations were conducted in the most friendly way, and that they were broken off in the most friendly way; the door was shut, not slammed. This draft circular was agreed on between the committees of the two Boards who had to come to a final decision on the matter, and who parted as friends. I now move the adoption of the report and balance-sheet.

The MANAGING DIRECTOR (Mr. George Sutton) seconded the resolution, and said: I want the shareholders to be assured that these accounts, notwithstanding that we thought that an amalgamation with Messrs. Callender's was going to happen, have been made up in exactly the same manner as they have been in preceding years, and that the stocks (a very important item in the accounts, which, if taken improperly, directly affect the profits) have been taken on the same low standard as in previous years—a standard actually lower than the market price in very many cases—as that has been considered by the Board a proper and wise policy for the Company to pursue. No departure has been made from that procedure. Then, again, with respect to the accounts. One of the largest items of stock we have to carry is, of course, copper. It will be known to many of you that in the latter part of last year a considerable fall took place in the copper market. The large stock we carried at the end of the year was written down to the market price, and involved the Company in a considerable loss in last year's accounts; but that has gone into last year's accounts, and this year is free of that loss. It is a loss that must occur sometimes in a manufacturing company. The industrial crisis in Germany has played havoc with part of our business. Cables have been sold abroad and to some extent here in England by Germans at prices which, to English manufacturers, are quite unremunerative, and to that extent, particularly abroad, we have suffered in our profits. Notwithstanding that, the balance-sheet shows you that our profits are larger than hitherto, proving that what we lose in one way we gain in another—by extension of business in new directions and by growth of business in old. The American competition has also affected us to some extent, but not as regards prices. The growth of our business and the fact that our profit is larger than the previous year (our turnover, I think, is about the same) shows that our actual output of goods has been considerably larger because of the ruling prices of raw material being much lower than in 1900. Therefore, to do the same turnover we had to manufacture a larger quantity of goods. The increase in our business has made a great alteration in our works. I do not want to frighten you with respect to an increase of capital. Mr. Gedge has said something about our wanting capital, but my view is that we shall not want any more capital in the immediate future, although we have to spend money on capital account. The cash reserves of the company are sufficiently large to enable us in the near future, at any rate to put up the new machinery we must have, and which we are going to put down immediately, and the new buildings that are necessary, and it may be that we must also acquire new land. The extent of our property at Woolwich is only a few acres, and we require a great deal of yard room for the recent development of our business. Underground cables take up a great deal of space, and we have not the room at Woolwich. It is a question for the Board to consider in the immediate future as to whether they should construct new works, and whether they should be in be in the neighbourhood of London or some other part of the kingdom. I can assure you that, as far as I can see, there will be no immediate asking for new capital. We shall not want any new capital this year. In connection with our business you have to bear in mind that the best assurance you have for the future success of this Company is that the men who are conducting it are the same men who have brought it up to its present condition as one of the leading houses in this country in cable manufacturing, and that they have been augmented, by the growth of the Company's business, by new men of ability and experience.

The motion was carried unanimously, as was a resolution approving the dividend. Mr. Sydney Gedge was then re-elected a Director, and the auditors were re-appointed. A hearty vote of thanks to the Chairman Directors and staff terminated the proceedings.

Deutsch-Atlantische Telegraphen Gesellschaft.

In the report of the directors of this company for 1901, which covers the first completed year of the working of the company's cable, the directors state that the increase in traffic has been very satisfactory. In 1898 when the traffic with America was very heavy, the whole of the German American traffic in both directions was estimated at about 2,800,000 words, whilst the traffic over the company's cable last year exceeded that figure, although several interruptions of the cable occurred. These interruptions in the aggregate totalled for the year 29 days, the repairs, except in one case (when the interruption was caused by an English cable-ship working in the neighbourhood of the company's cable), were effected by the company's c.s. "Von Podbielski." The position of the company's cable on the coast of Holland close by the Hoaks lightship, in a neighbourhood where vessels anchor to enter the Zuyder Zee at favourable times, causes the cable to be caught and damaged by the dragging of anchors in bad weather, and the directors, therefore, propose to remove the cable from this dangerous place, and make a detour of about 50 nautical miles. Repeated interruptions have also occurred near Start Point on the English coast, due, the directors consider, to the fact that too light a type of cable was chosen for this position. The repairs which were effected here include the replacing of these lighter lengths by a heavier type of cable. Experiments made during the year with special types of controlling instruments to ensure perfect service have been successful, and a system of direct transmission between Emden and New York has also proved successful and advantageous to the company's operations. The staff are gradually becoming accustomed to the new apparatus, and only experience is now required to make the system of direct transmission free from error, interruption or delay. It is expected that the new system will effect economy of working and the saving of travelling and other expenses. In 1901 agencies of the company were established in Hamburg, Denmark and Sweden. It is the experience of the directors that a sure and regular working of their system cannot be permanently obtained for traffic between Germany and America with a single cable, and even brief interruptions of the service are very detrimental to the company's interests. Therefore, negotiations had been opened with the German Post Office authorities to form a basis of agreement for the laying of a second cable for traffic between Germany and North America in order to provide accommodation for the growing traffic. These negotiations have, so far, resulted in an agreement with the German Government authorities, and in a new cable-working contract. By the agreement the concession owned by the company dated May 28, 1889, is prolonged to Dec. 31, 1944. The laying of a second cable is also provided for in two sections, the first from Borkum to Horta (Azores) which is to be working by Dec. 31, 1903, and the second between Horta and New York to be working by Dec 31, 1904, the entire cable to be in operation by Jan. 1, 1905, otherwise the supplemental concession to be null and void. The German Government pays to the company for the right of using the two cables for the year 1904 750,000m. (provided the first section of the second cable is working before Jan. 1, 1904); from Jan. 1. 1905, to Dec. 31, 1944, the annual payment is to be 1,710,000m. provided the second cable is working prior to Jan. 1, 1905. This payment is to be reduced in 1905 by 90,000m., in 1905 by 60,000m, and in 1907 by 30,000m. From the date of working of the Borkum-Azores section of the cable the Government has the right to a proportion of 16pf. per word on all fully-paid traffic between Germany and transitting Germany on the one side, and North America and beyond on the other. The surplus of the receipts for the first 3,750,000 fully-paid words (at 1m. per word) belongs to the company to cover expenses and all other charges on ordinary traffic, and beyond

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that number of words the German Government receives an additional share of 50pf. per word until 7,170 fully-paid words are cabled in any one year, when this special 50pf proportion of the receipts for the Government terminates. The German Government has also the right to this special proportion of 50pf. per word on traffic exceeding 3,750,000 fully-paid words during the time when only the Emden–Azores section of the cable is working, during which time the cable of the Commercial Cable Co. (Azores–Canso–New York) takes part of the German–Azores–New York traffic, the proportion due to the Commercial Company being deducted from the Government's special proportion of 50pf. per word. If a higher rate than 1m. per word is fixed for other than ordinary telegrams, the Government's share of 16pf. and 50pf. respectively per word is to be raised accordingly; and if the rate is reduced below 1m. (in consequence of a general reduction of tariffs) a proportional reduction in the Government share is to be made. In such cases the 3,750,000 and 7,170,000 words respectively will be considered as realised as soon as the receipts amount to 3,750,000m. and 7,170,000m. on fully-paid traffic. In the event of interruption in the working of the cable the company has the right to claim indemnity during the period of interruption, but must forward telegrams at its own expense in such way and by such route as the German postal authorities shall deem best. If the company is unable to supply an alternative route during interruption, or if the German authorities consider the route selected unsuitable for the necessities of the traffic, another route may be provided and the Government's payments will continue to be made to the company; but the company must refund to the Government the costs of such diversion of traffic, provided the annual amount for which the company is so liable does not exceed 1,710,000m. Under the agreement the manufacture of the second cable referred to is placed with the Norddeutsche See-Kabelwerke, of Nordenham, which concern undertakes to establish and lay the two sections within the stipulated time at a cost, for delivery in working condition, transport and laying, of 20,084,000m. (£1,004,200), bringing up the cost of the new cable to rather over 21,000,000m. (£1,050,000), including a sum to be provided for interest. This is a somewhat heavier charge than the cost of the company's first cable as several modifications are being made in the construction of their second cable, including a thicker sheathing for 351 nautical miles, an addition in length of 56 nautical miles and a heavier core throughout to increase speed of working. It is proposed to issue 4 per cent. stock of the nominal amount of 20,000,000m., for which purpose the German Government guarantees as interest and amortisation an annual sum of 1,010,470m. The Government guarantee is to be vested in a trustee, with whom an additional sum of 400,000m. is to be placed in 1904. The agreement further provides for certain modifications of the company's articles of association under which all agreements between the company and other telegraph undertakings with regard to the routine of telegrams, tariffs, connections with other lines, and similar management points; also all agreements with other Governments must be presented for the German postal authorities' approval before conclusion. The directors conclude by stating that the annual indemnity of 1,710,000m. (of which 1,010,470m. is to be deducted for guarantee of interest and amortisation of the bonds) will enable the company to provide both for expenses of repairs to the second cable and the increased cost of working the two cables. It is also anticipated that the traffic of the first 3,750,000 fully-paid words over the company's cables will provide a satisfactory income on the share capital.

ANGUS ELECTRIC LIGHT AND POWER CO. (LTD.)—At the meeting last week the chairman (Dr. Stone) said the result of the past six months' working, making their first complete year, after paying expenses, had been a net profit of £42. As a general rule, companies counted upon a loss for the first year, and sometimes for two, and in cases where corporations took up electric lighting there was invariably a loss the first year, so that it seemed their operations had been carried out in a satisfactory manner. No doubt as soon as the public found the benefit from these motors the number would increase very much. Lighting applications were coming in freely, and the number of lamps applied for and the number connected were both in excess of the estimate

BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)—The directors' report states that during the year 60 new installations have been connected, while the number of lamps added were equal to 1,571 8 c.p. The gross receipts from sale of current showed an increase of £270 over last year. After writing off £90. 8s. 11d. as depreciation, £75 from preliminary expenses, and £50 from special legal expenses, and placing £67. 16s. 8d. to reserve, the balance is £767. 2s. 8d. Of this sum £275 has been absorbed in payment of interim dividend at rate of 5½ per cent. per annum on the cumulative preference shares, leaving £492. 2s. 8d., which the directors recommend shall be appropriated in payment of dividend at rate of 5½ per cent. per annum on the cumulative preference shares for the past half-year, and in payment of dividend at rate of 2 per cent. per annum for the year on the ordinary shares, leaving £38. 12s. 6d. to be carried forward.

EDMUNDSON'S ELECTRICITY CORPORATION (LTD.)—In the directors' report for the year to March 31 it is stated that, including £2,201. 19s. 1d. from last year, the net profit, after payment of interest, is £30,962. 13s. 9d., or, with premiums on new issues (£6,807. 6s. 4d.), £37,770. 0s. 1d. After deducting preference dividend (£6,701. 4s. 8d.) and interim dividend at rate of 5 per cent. per annum on ordinary shares (£4,437. 10s.), there remains £26,631. 5s. 5d., which the directors recommend should be appropriated to a final ordinary dividend at rate of 9 per cent. per annum (making 7 per cent. for the year and absorbing £7,987. 10s.) on the 35,500 shares issued prior to October, 1901; a dividend at rate of 7 per cent. on the ordinary shares issued in October, 1901 (£889. 11s. 8d.); and a deferred share dividend of 7 per cent. (£1,575). £10,000 is to be added to reserve, and £6,179. 3s. 9d. is carried forward. Since the last report a central station at Newport, Isle of Wight, has been opened, and powers have been obtained for electric lighting at Ryde, Cowes and Ilfracombe. The terms upon which the undertaking of the Woolwich (District) Electric Light Co., Ltd. (in which Edmundson's Electricity Corporation has a considerable interest), has been sold to Woolwich Corporation allow of a return of upwards of £2 a share to the shareholders of that company. The sale is to be completed during 1902. During the year 10,000 preference shares, 10,000 ordinary shares and £40,000 debenture stock have been issued.

GENERAL ELECTRIC POWER CO. (S. AFRICA.)—An adjourned meeting was recently held at Johannesburg. The directors' report stated that the nominal capital remained at £200,000 in £1 shares, with 13s. 6d. called up. At the commencement of the war the electric power plant was taken over by the Government of the late South African Republic, who ran it to light the township of Germiston, and to supply power to certain mines which were being worked by them. Upon the British occupation the plant was handed over by the Boers in good condition, and was run satisfactorily from then onwards. Mr. R. G. Fricker, in moving the adoption of the report and accounts, said the last statutory meeting was held on March 30, 1899. During the first nine months of 1899 the company increased its output by 41 per cent. over the previous year, but the war necessitated shutting down the mines, which were the company's principal customers. So far the profit on the actual working had been inconsiderable, as the company had been run primarily to supply power at the cheapest possible rate to its shareholders, who entirely consisted of mining companies, and to whom the price of current had been reduced as the business increased. Since the works were handed back to their rightful owners by the Boers they had been working more or less successfully. Their uncalled capital was £65,000.

GREENWOOD AND BATLEY (LTD.)—The report of the directors for the year ended March 31 states that, after providing for interest and management expenses, and making provision for doubtful accounts, the profit amounts to £31,667. 13s. 5d. £7,500 is written off for depreciation, £10,000 added to reserve, and dividends recommended for year to March 31 of 7 per cent. on the cumulative preference and 5 per cent. on the ordinary shares (absorbing £15,615. 13s. 3d.), leaving £3,026. 4s. 1d. to be carried forward. Steady progress continues to be made with the De Laval steam turbines for electric generation and other purposes. The works of the English De Laval Steam Turbine Co., adjoining Albion Works, are completed, the plant is installed, and the manufacture of turbines is now being carried on. The directors anticipate a steady increase in sales in this important branch of their engineering business.

KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION (LTD.)—At the meeting on Monday the chairman (Mr. R. W. Wallace, K.C.) said the period covered by the accounts was 15 months. Of the liabilities on uncompleted contracts (£61,514), £55,000 was under the general contract and £4,255 for tramway machinery. They had undertaken to supply power for working the Kalgoorlie tramways, and for that purpose it was necessary to put in additional plant, which was not included in the original contract. The tramway is working satisfactorily. They had decided to issue debentures for £50,000, and of that amount the contractors (Messrs. J. G. White & Co.) had agreed to take up £10,000. The local board in Australia had been dissolved, as they found it was difficult to work with two boards, and had therefore appointed an efficient manager to carry out the board's instructions in Australia. According to contract their work was to be completed in July next, but they had already completed a large amount of the work, and were able to supply current to the tramways, which started on May 20.

LISBON ELECTRIC TRAMWAYS (LTD.)—The directors' report for year ended Dec. 31 states that the conversion of the Lisbon tramways from animal to electric traction was continued during the year, and by the end of 1901 more than half of the lines were in operation electrically. The total length of route in operation at end of December was 24,304 metres, representing 47,724 metres of single track. Working by animal traction showed a loss, even under best conditions, and the numerous interruptions, due to construction, added to this loss considerably. The speedy conversion of the system became, therefore, a factor of paramount importance to the prosperity of the enterprise, and the rapid progress made during the year is mainly due to the untiring efforts of the general manager and chief resident engineer officer (Mr. W. B. Rommel), and the staff of the construction company. The earnings, which up to the introduction of electric traction had been steadily falling off, immediately increased, and the results of each new service opened to the public have been equally satisfactory.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The report of the directors for the year ended March 31 states that the gross receipts (in sterling) in the River Plate were £114,841. 5s. 8d., against £109,540. 13s. 4d. for the previous year, and the working expenses in London and River Plate £60,345. 2s. 8d. After deducting interest and interim preference and ordinary dividends, and adding transfer fees and interest on investments, there is a profit of £33,405. 18s. 3d., added to £6,058. 16s. 9d. from previous year, making £39,464. 15s. After transferring £20,000 to reserve (making this £75,000), the directors recommend a final ordinary dividend of 4½ per cent., making 7 per cent. for the year. £6,414. 15s. is carried forward.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The directors' report for the year ended Dec. 31 last states that the revenue amounted to £75,554. 4s. 6d. £20,673. 17s. 2d. is charged for ordinary expenses, and £17,720. 12s. 9d. for expenditure relating to repairs of cables, &c. £94. 19s. 7d. is taken for income tax, leaving (with £322. 1s. brought forward) £37,386. 16s. £7,508. 6s. 8d. is absorbed in debenture interest, and £16,566. 13s. 4d. for sinking fund, leaving £13,311. 16s., and the directors propose to place £13,000 to general reserve, and to carry £311. 16s. forward. The revenue

includes a further sum of £12,000 in respect of subsidy due from the French Government, but which has not been paid. This arrear now amounts to £80,415. The negotiations with the French Government, however, in regard to the purchase of certain of the company's cables have been successfully concluded, and the first instalment of £112,000 on account of the purchase has been received.

WEST AUSTRALIAN GOLD FIELDS (LTD.)—At the meeting on Tuesday the chairman (Lord Castletown) said they were interested in the Kalgoorlie Tramways, the Kalgoorlie Electric Power and Lighting Corporation and the Kettle River Power Co., and he thought that in those undertakings they had valuable properties. Mr. Stoneham said that they anticipated great profits from the Kalgoorlie tramways. They knew approximately what the tramways would bring in, because they had careful reports made by the advisers of the Perth electric tramways. The Kalgoorlie tramways had created a record. They began to build on Jan. 20, and on May 20 they ran the first five cars.

NEW COMPANIES, STATUTORY RETURNS, &c.

ENGLISH AND GENERAL TRAMWAYS CO. (LTD.)—Reg. June 19, capital £5,500 in 5,000 ordinary shares of £1 each and 10,000 deferred shares of 1s. each, to acquire, construct or have an interest in tramways or railways, and to equip, maintain and work the same by electricity or other power. Mr. P. J. Brenchley, Mortlake-road, Ilford, is the first secretary.

FARRALL INCANDESCENT ELECTRIC LIGHT SYNDICATE (LTD.)—Reg. June 17, capital £10,000 in £1 shares, to adopt an agreement with T. D. Farrall and to carry on the business of electricians, engineers, generators and suppliers of electricity, manufacturers of and dealers in electrical apparatus, &c. The subscribers are: E. C. Macmillan (550 shares), T. D. Farrall, electrical engineer (750 shares), C. F. Lewns, N. B. Falconer, J. B. Gemmell, F. G. Soper, T. D. Farrall, jun., electrical engineer (each with 100 shares). Reg. office: 22, Chancery-lane, W.C.

JAMES PROCTOR (LTD.)—Reg. June 12, capital of £10,000 in £5 shares, to acquire the business carried on at Burnley by Mr. J. Proctor, and to carry on business as mechanical and electrical engineers, brass founders, boiler and tool makers, machinists, &c. Reg. office, Hammerton-street Ironworks, Burnley.

KILMALCOLM ELECTRIC LIGHTING CO. (LTD.)—Reg. in Edinburgh June 12, capital £10,000 in £1 shares, to carry on in Kilmalcolm or elsewhere the business of electrical engineers, electricians, engineers and contractors, suppliers of electricity manufacturers of electrical apparatus, &c. The first directors are R. Barr, T. H. Barr, J. Fullarton, Dr. J. Parker, W. F. Salmon, W. A. Sloan and W. B. Stirrat. Reg. office. 116, Hope-street, Glasgow.

MOTOR MANUFACTURING CO. (LTD.)—Reg. June 12, capital £80,000 in 5s. shares, to adopt an agreement with the Motor Manufacturing Co. (Ltd.), to acquire patents, concessions, &c., and to carry on the business of motor, cycle, vehicle, boat, launch, flying machine and carriage builders and dealers, electricians, engineers, machinists, suppliers of electricity for motive power, traction, light and heat, &c. Reg. office: 47, Holborn Viaduct, E.C.

NEW CENTURY (FOREIGN) ARC LIGHT CO. (LTD.)—Reg. June 17, capital £10,000 in £1 shares, to carry on business of an electric light company in all branches, to construct and instal cables, wires, accumulators, lamps and works, to generate and supply electricity, to manufacture machinery and apparatus, &c. Reg. office: 28, Victoria-street, S.W.

THORNTON AND ATKINSON (LTD.)—Reg. June 9, capital £3,000 in £1 shares, to take over the business of engineers carried on by Messrs. H. and A. R. Thornton, and the business carried on by Messrs. J. N. Atkinson and E. C. Harris as the Bradford General Electrical Co. The subscribers are: H. Thornton, engineer, W. Beanland, A. F. Mossey, J. N. Atkinson, engineer, E. C. Harris, electrical engineer, R. Thornton, engineer, A. E. Rhodes, architect. The first directors are H. Thornton, A. R. Thornton and J. N. Atkinson. Reg. office: Providence Foundry, Cleckheaton.

HOVE ELECTRIC LIGHTING CO. (LTD.)—According to the return to March 26 the capital is £100,000 in 20,000 shares of £5 each, of which 12,745 have been taken up. £5 per share has been called up on 12,000, and £3 per share on 745 shares and £62,232 has been received, in addition to £336 paid in advance of calls. Mortgages and charges, £25,000.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—The annual return to March 10 gives the capital as £25,000 in 5,000 shares of £5 each, of which 3,000 have been taken up. £15,000 has been received. Mortgages and charges, £5,000. 549 shares have been allotted since date of above return.

NORWICH ELECTRICITY CO. (LTD.)—In the return to April 29 the capital is given as £100,000 in 10,000 shares of £10 each, of which 8,750 have been taken up. £87,500 has been received. Mortgages and charges, £36,400.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 7/16d. per oz. (June 26). Consols (2¾ per cent.) 96—96⅛ for money, 96—96⅛ for account; 2½ per cent. 96½—97 (June 26). Consols Pay Day July 2; Stocks and Shares Continuation Days, July 9 and 28; Ticket Days, July 10 and 29; Pay Days, July 11 and 30; Mining Share Carry-over Days, July 8 and 25.

CAPE ELECTRIC TRAMWAYS (LTD.)—An interim dividend of 6 per cent., tax free, has been declared payable July 1.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of the 6 per cent. cumulative preference shares will be closed from July 2 to 16 inclusive.

METROPOLITAN DISTRICT RAILWAY CO.—Messrs. A. L. Stride and Charles Spofford have been elected on the board of this company.

OKONITE LIMITED—A private meeting of debenture-holders was held on Monday to appoint new trustees. These are to be nominated by Mr. W. Holmes (solicitor to the company).

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—The directors state that the transfer of the Parliamentary powers obtained by the company in 1900, and of the various contracts entered into by it, to the South Wales Electrical Power Distribution Co. has been effected. This transaction has resulted in a profit to the company of £31,508. 10s. The directors have decided to pay an interim dividend for the period to 30th inst. at the rate of 10 per cent. per annum, payable 30th inst.

THOMAS PARKER (LTD.)—The annual report of the directors states that, after writing off various depreciations, the balance standing to credit of profit and loss account is £9,049. 9s. 9d., out of which a dividend is proposed at the rate of 10 per cent. per annum (less tax), requiring £7,060. 7s. 2d., the balance (£1,987. 2s. 7d.) is carried forward.

WESTERN TELEGRAPH CO. (LTD.)—The coupons of this company's second issue of 5 per cent. debentures, due 30th inst., will be paid at Parr's Bank, Bartholomew-lane, London, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	...	...	...	...	...	...
Ayr Corporation	June 21	290	...	5	1,372	...
*Birmingham Tramways.	„ 21	5,013	+ 476	24	113,320	+ 29,299
*Blackburn Corporation..	„ 20	817	+ 181	25	17,302	+ 2,371
Blackpool Corporation...	„ 19	661	− 114	12	7,576	− 902
Blackpool and Fleetwood	„ 21	470	− 122	25	8,315	− 701
Bolton Corporation	„ 22	1,546	+ 234	12	18,720	+ 712
Bradford Corporation	...	...	...	...	...	...
Brighton Corporation ...	„ 22	824	...	30	18,669	...
Brisbane Tramways.....	May 7	2,572	+ 479	19	44,214	+ 5,198
*Bristol Trams & Carriage	June 20	4,457	+ 81	24	102,116	+ 3,366
Burnley Corporation ...	„ 21	656	+ 265	‡12	8,217	+ 2,775
*Buenos Ayres & Belgrano	...	...	...	...	...	...
Calcutta Tramways Co...	„ 21	R25,753	+ R6,055	25	R553,851	+ R52,050
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co....	„ 21	176	+ 8	†25	3,574	+ 22
Central London Railway	„ 21	7,577	+ 1,314	25	169,396	+ 14,358
City & South London Ry.	„ 22	3,017	+ 1,110	25	74,465	+ 25,326
Cork Elec. Tramways Co.	„ 19	569	+ 53	§24	10,767	+ 376
Devonport & Dist. Trams	„ 13	413	...	23½	9,414	...
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	„ 21	225	...	12	2,492	− 123
Dublin & Lucan Railway	„ 22	111	− 1	25	2,432	+ 63
Dublin Southern Dist....	„ 20	819	− 111	¶24	19,598	+ 3,345
Dublin United	„ 20	3,594	− 240	¶24	85,780	
Dudley—Stourbridge ...	„ 13	664	− 3	23½	16,104	+ 2,257
*Dundee Corporation ...	„ 20	753	+ 85	...	...	...
East Ham Council	...	...	...	...	...	...
Gateshead & Dist. Trams	„ 13	745	+ 244	23½	15,604	+ 1,498
Glasgow Corporation ...	„ 21	11,637	− 261	3	35,467	+ 551
Greenock & Port Glasgow	„ 13	564	+ 335	23½	10,136	+ 5,791
Hartlepool Tramways ..	„ 13	250	+ 4	23½	5,037	+ 375
Hull Corporation	„ 21	1,720	+ 86	12	20,149	+ 293
Isle of Thanet Co.	„ 14	575	− 136	...	...	...
Kidderminster & Dist....	„ 13	105	− 31	23½	2,503	+ 20
Leeds Corporation	„ 21	4,850	+ 415	12	62,478	+ 8,998
*Liverpool Corporation...	...	...	...	...	...	...
Liverpool Overhead Rly.	„ 22	1,517	− 55	‡25	35,798	− 3,487
Manchester Corporation	„ 21	5,049	+ 4,168	§54	123,124	...
Merthyr.....	„ 13	200	− 22	23½	4,610	− 690
Middleton	„ 13	243	...	11½	3,496	...
Newcastle-on-Tyne Corp	„ 14	2,579	...	...	...	...
	„ 21	2,669				
Oldham, Ashton & Hyde.	„ 13	502	15	23½	11,538	+ 100
Perth (W.A.) Elec. Trams	...	...	...	...	...	...
Poole & Dist.....	„ 13	245	− 26	23½	5,191	− 93
Portsmouth Corporation	„ 21	1,573	+ 870	...	...	...
Potteries	„ 13	1,450	+ 6	23½	33,093	+ 1,201
Salford Corporation ...	„ 23	2,642	+ 858	12	29,600	...
*Sheffield Corporation ...	„ 22	4,257	+ 689	25	95,201	+ 15,197
Southampton Corporat'n	...	...	...	...	...	...
Southport Tramways ...	„ 13	256	+ 102	23½	4,725	+ 1,380
*S. Staffordshire Trams...	„ 13	724	− 37	23½	17,710	+ 466
Sunderland Corporation.	„ 22	1,137	+ 76	12	13,018	+ 1,069
Swansea Trams.....	„ 13	450	+ 18	23½	10,047	+ 845
Taunton Trams.....	„ 13	56	...	23½	1,361	...
Tynemouth & Dist.	„ 13	259	+ 11	23½	5,075	+ 261
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 13	133	+ 78	23½	3,348	+ 2,147

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 18.		Price Tuesday, June 24.		Rate per Cent. Yielded.	Dividend Due.	Business Done During 6 Days Ending June 24	
										Highest	Lowest
			ELECTRICITY SUPPLY.					£ s. d.			
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½	½	½	½	...	...	..	..
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100	104	100	104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11	12	11	12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.) d	103	106	101	104	4 6 7	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9	⅝	9	9⅜	4 4 3	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9⅝	3 13 8	March and September	...	...
40,000	5	3 6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8¼	9½	8½	9½	3 3 2	...	...	...
40,000	5	3/4½	Do (Nos. 20,001-30,000)	8½	9	8½	9⅛	...	...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	107	105	107	3 15 2	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	10	9	10	5 0 0	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	..	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	5⅝	5½	5⅝	3 18 3	,, ,,	...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red. xd	105	107	105	107	3 14 9	...	107⅜	105⅜
44,426	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5	5½	5	5½	2 14 6	March	...	...
£110,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	108	111	108	111	4 1 1	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8	9	8	9	5 5 7	February and August	8⅛	8⅛
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref. xd	11½	12½	11½	12½	4 16 0	January and July	12½	...
£400,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.) xd	123	128	121	126	4 0 8	June and December	12⅝	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.) xd	103	106	101	104	4 6 7	...	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	7½	8½	7½	8½	4 14 2	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12	13	12	13	4 12 4	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.) xd	109	112	107	110	4 1 10	...	...	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5¾	6½	5¾	6½	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,600	5	5/0	Kensington and Knightsbridge Ordinary	10	11	10	11	4 10 11	...	10⅞	...
10,000	5	6½	Do. 6 per Cent. 1st Pref.	6½	6¾	6½	6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104	107	104	107	3 14 11	...	...	...
£ 11,000	3	...	London Electric Supply Ordinary	1½	1⅝	1½	1⅝	...	...	...	...
42,840	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	...	...
£ 50,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	94	99	94	99	4 0 10	Mar., June, Sept., Dec.	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16	17	16	17	3 16 6	April and October	16 11/16	16½
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage xd	111	115	109	113	3 19 8	June and December	...	...
£240,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.) xd	93	101	97	100	3 10 0	...	...	...
10,566	10	6/0	Notting Hill Electric Ordinary	14	15	14	15	4 0 0	March	...	...
19,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	99	102	99	102	3 18 10	...	...	...
300,000	1	...	Rand Electric	1⅜	1⅝	1⅜	1⅝	...	...	...	...
£115,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,000	100	4½	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 6 9	April and October	...	...
50,000	5	9 6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	...	...
10,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.) xd	98	101	97	100	3 10 0	...	...	...
13,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅞	2⅛	1⅞	2⅛	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
66,000	5	...	South London Electric Supply Ordinary	2¾	3¼	2¾	3¼	...	...	...	...
110,000	5	5 6	Westminster Electric Supply Ordinary	11	12	11	12	4 7 6	March and September	11 1/16	11 3/16
28,141	5	1/3	Do. 5 per Cent. Cumulative Preference	3½	4	3½	4	...	...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4½	4⅝	4½	4⅝	4 8 11	April and October	...	...
£234,000	Stock	6%	Do. Permanent 6% Deb. Stock xd	127	132	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	8	9	8	9	3 6 8	...	8⅛	8 1/16
10,000	10	5/0	Do. 5% Cumulative Preference xd	8½	9⅛	8⅛	9⅛	5 5 3	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½	14½	13½	14¼	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3¾	4¼	3⅞	4⅛	...	...	4	...
75,000	5	2/6	Do. 5% Cum. Pref.	4½	5	4⅝	5	5 0 0	...	4 1/16	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs. xd	104	107	102	105	4 5 9	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21	22	21	22	3 13 4	February and August	...	...
25,000	10	5%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
100,000	Stock	4%	Do. 4 per Cent. Debentures	106	08	106	108	3 14 1	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7½	7	7⅛	2 13 4	...	...	...
50,000	10	5/0	Do. 5% Preference	9⅝	10⅛	9⅝	10⅛	4 17 6	May and November	...	...
£270,000	40	4%	Do. 4½% 1st Mort. Debs.	102⅝	104⅝	102⅝	104⅝	4 6 9	...	...	...
100,000	10	12	British Electric Traction Ordinary xd & rights	13½	14½	12	13	6 18 6	...	14	12⅝
100,000	10	6/	Do. 6% Cum. Pref. ex rights	12½	13	11⅞	12⅛	4 18 0	February and August	12⅝	11⅝
£1,000,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	126	124
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝	1⅞	1⅝	1⅞	...	...	1⅞	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅜	⅛	4⅜	5⅛	5 14 3	...	...	...
27,500	5	10/0	Do. "B"	5	5⅛	5	5⅛	5 9 1	...	...	...
£ 20,000	Stock	5%	Do. 5 per Cent. Debentures xd	104	107	102	105	4 15 3	...	106	105⅛
£ 20,000	Stock	5%	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd. xd	97	100	95	98	5 2 0	...	...	...
35,000	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	14½	15½	...		2 0 0	...	...	...
£200,000	100	4½%	Do. 4½ 1st Deb. Stock (Red) xd	103	110	106	108	4 3 7	...	...	...
480,000	1	1/2⅞	Cape Electric Tramways Shares	2⅝	2⅝	2⅝	2⅝	3 16 2	...	...	...
£1,560,014	Stock	4%	Central London Ordinary Stock	104	107	104	107	3 15 1	June and December	106⅛	105⅝
£494,093	Stock	4%	Do. 4% Preferred Stock	103	106	105	108	3 14 1	...	106	...
£494,993	Stock	4%	Do. Deferred Stock	100	103	100	103	3 17 10	...	...	...
£698,201	100	4%	Do. 4% Deb.	117	120	117	120	3 7 8	...	...	...
40,000	5	2 6	City of Birmingham Trams. Co. 5% Cum. Pref.	4⅜	⅛	4⅜	⅛	4 10 11	...	4⅜	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	2½	City and South London Railway Con. Ordinary	71	74	71	74	2 14 1	February and August	72⅜	71
37,500	10	1/0	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	...		...		...		...	...
£100,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	133	128	133	3 15 5	,, ,,	125	124
£200,000	Stock	5%	Do. (1896)	127	130	128	131	3 17 8	...	...	...
£150,000	Stock	...	Do. (1901)	121	125	122	126	...	...	125½	124⅜
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	...	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛	12⅛	11⅛	12⅛	3 16 11	...	...	...
59,887	10	6/0	Do. 6 per Cent. Preference	14½	15⅝	14⅝	15⅝	3 17 5	...	...	...
£330,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	86	89	86	89	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½	4⅝	4½	4⅝	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.) xd	101	104	99	102	4 18 0	...	...	...
78,000	10	8/0	Great Northern and City Railwy Pref. Ord. (4%)	8	9	8	9	3 6 8	...	...	...
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	14	13½	14	4 5 8	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110	112	110	112	4 0 6	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½	5	4½	5	...	...	...	...
57,500	10	1%	Liverpool Overhead Railway Ordinary	4 1/16	4 1/16	4 1/16	4 1/16	3 0 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅛	11	10⅛	11	4 11 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	98	99	99	101	4 0 0	January and July	...	...
[51,201	10	5/0	London United Trams 5% Cum. Pref. (£10 paid) xd	10¾	11½	10½	11	4 10 11	...	...	...
30,999	10	2/8	Do. (£5 paid) xd	5½	6	5½	6	...	...	...	...
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock xd	106	108	104	106	3 15 6	...	108	...
£169,656	Stock	18/0	Do. Prov. Certs. (£50 paid) xd	55	57	54	56	...	...	...	...
£3,500,000	£1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	115	119	115	119	4 5 7	...	...	...
£80,000	100	5%	Montreal Str't R'lw'y St'r'l'g 6% Mort. Debs. (1908)	104	106	104	106	4 14 9	...	...	...
£140,000	100	6½%	Do. Sterling 4½% Debentures (1922)	104	106	104	106	4 6 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
40,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3	4	7 10 0	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	96	100	96	100	5 0 0	...	...	...
[£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk. xd	101	104	99	102	4 18 0	...	...	...
23,334	10	8/0	Potteries Electric Traction Ordinary	9	10	9	10	4 0 0	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	107	110	107	110	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...		...		...	...	...	...
51,188	1	...	Do. 6% Preference (12/0 paid)	...		...		...	April and October	...	...
50,000	1	...	Do. 7% Preference (fully paid)	...		...		...	...	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 18.	Price Tuesday, June 24.	Rate per Cent. Yielded.	Dividend Due.	Business Done During 6 Days Ending June 24. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£82,800	100	4 %	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	101 104	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3½ 4½	3½ 4½	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70 80	70 80	...	...	...	...
£7,8,840	Stock	12/6	Anglo-American	44 47	44 47	5 19 5	Feb., May, Aug., Nov.	45½	44½
£3,105,580	Stock	25/0	Do. Preferred	86 88	87 89	6 10 0	" "	89	87½
£3,105,580	Stock	2/0	Do. Deferred	6½ 7	6½ 7	1 8 7	" "	6½	...
$13,333,300	$'00	$1½	Commercial Cable Capital Stock xd	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock xd	94 96	94 96	4 3 4	" "	97½	96½
16,000	10	4/0	Cuba Submarine Ordinary	4½ 5½	4½ 5½	7 5 6	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½ 13½	12½ 13½	7 8 2	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2½ 3½	2½ 3½	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8½ 9½	8½ 9½	5 5 3	" "	...	...
£80,000	50	4½%	Do. 4½ per Cent. Debentures	91% 103%	94% 103%	4 7 8	January and July	...	...
60,710	20	3/0	Direct United States Cable	9½ 10½	9½ 10½	6 3 10	Jan., Apr., July, Oct.	...	...
£101,800	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	100 103	100 103	4 7 8	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,300] (red.)	120 130	120 130	5 7 8	Jan., Apr., July, Oct.	124	121
£1,955,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	87 90	88 91	3 17 8	" "	91	89½
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	107 111	107 111	3 12 2	May and November	109	...
300,000	10	6/6	Eastern Extension	12 13	12 13	5 7 8	Jan., Apr., July, Oct.	12½	12⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	103 113	108 113	3 11 4	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100 103	100 103	3 19 0	February and August	...	...
£300,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100% 103%	100% 104%	3 18 3	May and November	102	...
150,000	10	20 0	Great Northern of Copenhagen	25 27	25 27	5 11 1	January and July	...	...
£75,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos	99 103	100 103	4 8 8	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,300] (red.	37 41	37 41	6 1 11	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100 104	100 104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99 102	99 102	3 18 7	June and December	...	...
15,000	10	..	*West African Telegraph Shares	3½ 4½	3½ 4½	...	...	3½	...
£139,300	100	5%	Do. 5% Debentures (red.)	99 102	100 103	4 18 5	March and September	...	...
30,000	½	..	West Coast of America	½ ⅝	½ ⅝	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	99 102	99 102	3 18 5	January and July	...	...
88,321	10	...	West India and Panama	⅜ ½	⅜ ½	...	May and November	...	...
24,563	10	0/0	Do. 6 per Cent. 1st Pref.	5½ 5½	5½ 5½	10 8 8	" "	...	...
4,669	10	..	Do. 6 per Cent. 2nd Preference	3½ 4½	3½ 4½	" "	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	101 104	101 104	4 16 8	January and July	...	...
207,920	10	3/0	Western Telegraph (late Brazilian Submarine) xd	11½ 12½	11½ 12½	5 16 4	Mar., June, Oct., Dec.	12½	13
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1886)	102 105	102 105	4 15 3	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.) xd	99 102	97 100	4 0 0	...	...	...
			TELEPHONES.						
44,000	£5	5 0	Chili Telephone (fully paid)	½ ¾	½ ¾	5 18 0	August	...	...
234,850	10/0	8%	Consolidated Telephone Con. and Manfg.	1/6 2/6	1/6 2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½ ¾	½ ¾	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95 99	95 99	6 1 3	...	97½	...
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	3½ 3¾	3½ 3¾	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	53 57	53 57	7 17 11	...	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12 14	12 14	4 5 9	February and August	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12 14	12 14	4 5 9	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4½ 5½	4½ 5½	4 17 6	" "	...	...
£3,000,000	Stock	2½%	* Do. Debenture Stock 3½ per Cent. (red.) xd	94 97	93 96	3 12 11	June and December	97½	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.) xd	103 107	102 106	3 15 6	...	...	...
171,504	1	0/2½	Oriental	1/16 1/16	1/16 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	5 5½	5 5½	6 7 3	July	...	...
40,000	5	2 6	Do. 5% Cumulative Pref. xd	4½ 5½	4½ 5	4 15 3	June and December	...	...
£ 79,947	Stock	5	* Do. 5 per Cent. Debenture Stock (red.) xd	103 106	101 104	4 16 2	June and December	...	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	8d.	Alliance Electrical Co. 5% Cum. Pref.	⅜ ½	⅜ ½	5 14 8	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛ ¼	⅛ ¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜ ½	⅜ ½	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7½ 8½	7½ 8½	5 17 8	July and February	...	...
70,000	5	2/0	Do. 6 per Cent. Preference	5½ 6	5½ 6	5 0 0	January and July	...	...
£250,000	Stock	4 %	Do. 4½% 1st Mort. Deb. Red. xd	102 105	101 103	4 7 7	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	5½ 6	5½ 6½	4 18 0	...	6	6½
105,731	2	..	Brush Electrical Engineering	1½ 1⅝	1½ 1⅝	...	March	...	...
150,000	2	1/3½	Do. 6 per Cent. Pref. Non-Cum.	1⅝ 2½	1⅝ 2½	...	March and September	2	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101 104	101 104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock xd	95 100	94 99	4 10 10	January and July	...	...
80,000	5	10/0	Callender's Cable Construction Ord.	16 17	16 17	4 8 3	" "	...	...
40,000	5	4/0	Do. 5 per Cent. Cumulative Preference xd	5½ 6½	5½ 6	5 0 0	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.) xd	111 115	107 113	3 19 8	November and May	1 2	...
450,000	1	0.9½	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	4 16 0	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	93 98	93 98	4 13 9	...	97	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary xd	¾ 1	¾ 1	8 0 0	March	...	...
55,000	3	1 9½	Crompton and Co. (Nos. 1 to 54,000)	3 3½	3 3½	6 8 6	January and July	3½	3½
£100,000	100	8%	* Do. 5 per Cent. First Mortgage Deb. (red.)	103% 108%	103% 108%	4 12 8	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜ ½	⅜ ½	...	February and August	...	...
17,189	5	...	Do. (£5 paid)	1½ 2½	1½ 2½	" "	" "	...	...
£344,028	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.) xd	75 80	73 77	5 3 11	June and December	...	...
35,500	5	2.6	Edmundson's Electricity Corporation Ord.	6½ 6¾	6½ 6¾	5 3 3	Half-yearly	...	...
30,000	5	3/0	Do. 6% Cumulative Preference	5½ 6½	5½ 6½	4 16 0	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	108 111	108 111	4 2 0	...	...	...
112,100	2	1/2½	Electric Construction Co.	1½ 1¾	1½ 1¾	6 17 2	January and July	...	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2½ 3	2½ 3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 103	99 102	3 18 11	January and July	...	...
122,585	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾ 1½	¾ 1½	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref. xd	10 10½	10 10½	4 15 3	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98 101	98 101	3 19 3	...	...	...
35,000	5	5 0	Henley's Telegraph Works Ordinary xd	16½ 17½	16 17	4 8 3	February and August	17	16½
35,000	5	4 3	Do. 4½ per Cent. Preference	5½ 6	5½ 6	3 15 0	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 115	111 115	3 18 3	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works xd	21 22	21 22	4 10 11	" "	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 102	1 0 103	3 18 5	March and September	101½	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½ 16½	15½ 16½	6 1 8	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34 37	34 37	6 9 8	March and July	34	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 16 5	January and July	...	...
25,000	5	8 0	Do. Manufacturing Ordinary	...	9½ 10½	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	...	5½ 6	4 3 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	...	...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	...	...	...	" "	...	...
			FINANCIAL, INVESTMENT, &c.						
19,980	5	3 0	Electric and General Investment 6% Cum. Pref.	5½ 5¾	5½ 5¾	5 9 1	...	...	...
180,337	10	2/6	Globe Telegraph and Trust	8 9	8 9	5 16 8	Jan., Apr., July, Oct.	8¾	8⅞
180,043	10	3/0	Do. 6 per Cent. Preference	12½ 13½	12½ 13½	4 8 11	" "	13½	12⅞
11,688	8	4/0	Reuter's	6½ 7½	7 8	5 6 8	April and October	...	...
3,203	£100 Cert.	6%	Submarine Cables Trust	110 120	110 120	5 0 0	" "	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

IT is characteristic of the KING'S generous mind that, notwithstanding the deplorable illness which has rendered necessary a postponement of his coronation, HIS MAJESTY has resolved that his subjects shall suffer no inconvenience or loss which it is within HIS MAJESTY'S power to prevent. In full accord with this nobility of spirit are his command for the celebration of all treats for the poor and needy, and his undelayed publication of the Coronation honours. To have postponed either of these would have caused heart-burnings; and these HIS MAJESTY, with kindly forethought, has sought to avoid.

THE personal history of the Kings of England might, to a large extent, be expressed merely by writing down a list of those whom each King has delighted to honour. The present list of Coronation honours is no exception; it proves King EDWARD to be a monarch of liberal mind and cultivated taste, a broad and sympathetic thinker and student of his time. This is not the place for the altogether agreeable task of analysing the KING'S list, except in so far as it comes within the domain of science. And into that domain it certainly does extend in right royal manner. We have to record the appointment of two scientific peers, Lords KELVIN and LISTER, to HIS MAJESTY'S Privy Council; the creation of a new Order of Merit numbering no less than three scientific peers, Lords RAYLEIGH, KELVIN and LISTER, among its first members; besides the creation of a large number of scientific baronets and knights. Among these last, it is our great pleasure to tender congratulations to Sir OLIVER LODGE, Sir ARTHUR RÜCKER, Sir JOHN THORNYCROFT, Sir WILLIAM RAMSAY and Sir WILLIAM MATHER.

THE Seventh Annual Convention of the Incorporated Municipal Electrical Association was opened in London on Wednesday, and there is every prospect that the meeting will be successful and bear good fruit. Those meetings which have been held previously in London have always attracted more members and elicited better Papers and discussions than have the meetings in provincial towns, and it is to be hoped that the practice will be continued of arranging a large proportion of the annual gatherings of the "Municipals" in the metropolis.

A FEATURE of the opening day was the relatively small attendance of electricity committee-men. This is probably to be accounted for in part by the strictly technical character of the Papers which were on the programme, and in part by the counter-attraction furnished by the Royal review of Indian troops in close proximity to the Institution of Mechanical Engineers' building, where the meeting was held. A considerable number of Chairmen of Electricity Committees are in town, however, to take part in the Convention, and the proportion of leading municipal electrical engineers is great, so that the informal chats and comparison of personal experiences to which Mr. RIDER rightly attaches so much importance in his presidential address will not be lacking.

THE level of excellence in this year's Convention was evident from the first, for Mr. RIDER'S presidential address was among the best and most appropriate we have heard. It dealt mainly with electric traction matters, to which Mr. RIDER has naturally devoted his entire attention since his assumption of the post of electrical engineer to the London County Council Tramways Department, and the subject of combined electric lighting and tramway undertakings. In this latter he had long practical experience, both as regards design, construction and working, at Plymouth. His opinions, therefore, command respect and careful consideration. Tramway engineers may be surprised, however, to read his warm recommendations of the combination of electric lighting and traction undertakings now that he has no longer a lighting load to trouble him. Undoubtedly

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the addition of tramways to an existing electric lighting system is in every way desirable, owing to the economies effected by the improvement of the load-factor; but the converse is also true: that the addition of a peaky load curve to a broader tramway curve will undoubtedly increase the cost of generation per unit. Experience has shown that when the same authority has to supply both lighting and tramways there is an economy in combining the two undertakings; but to give a fairer idea of the nature of this economy Mr. RIDER should have prepared, in addition to his figures for the financial results of two electric lighting stations, one with and the other without a tramway load, a third set of figures showing the result of running tramways without lighting.

MR. RIDER'S attitude towards the "æsthetic" objections to the overhead trolley system is entirely to be commended. There are a few cases, but indeed very few, in which these objections can be advanced against the overhead trolley wire. The question of cost must usually be paramount, and Mr. RIDER'S three exceptional reasons which justify the adoption of a conduit system need not be added to. With regard to the question of cost, however, it should be pointed out that the three figures he gives are for single track in every case. For both the surface contact and the conduit systems the cost is practically double for double track; but the cost of the overhead line would be far less than double if an additional track were added, as the two trolley wires requisite for single track would do equally well for double track.

A DEPUTATION of Municipal Engineers and Chairmen of Tramway Committees appeared on Wednesday before Sir FRANCIS HOPWOOD and Sir HERBERT JEKYLL, of the Board of Trade, in order to complain of certain of the Board's tramway regulations. The chief grievance was with regard to the speed limit of 10 miles an hour and the use of indicators for checking the speed. The deputation, however, was assured that the Board of Trade "were considering the matter," so there was nothing left for them but to wait and see what result this consideration would effect. As regards red tail-lights, to which some members of the deputation objected, the Board does not appear to be able to allow of the substitution of other colours, as it is "pledged to the Home Office not to vary that requirement." But there is nothing to prevent route-indicator colours being used in conjunction with the red lamps. On the whole, the deputation, which did not attempt reform on any broad basis, does not seem to have attained much success, even on a narrow basis.

Record Railway Speed.—A train on the Burlington and Missouri Railroad consisting of nine cars and hauled by a 10-wheeled engine with 6ft. driving wheels, is reported to have covered 14·8 miles in nine minutes, which is at the rate of 98·66 miles per hour.

Electricity in India.—Bombay, with a population of 750,000, is, up to the present time, without electric light, and its trams are worked by horses. Other parts of the country are also behindhand in this respect, and there are unlimited opportunities for electrical engineers to develop the industry in this vast, and by no means overcrowded, field of labour.

The First Locomotive.—There is now being exhibited by Tangyes Limited, at 35, Queen Victoria-street, London, an historical relic of the greatest interest and importance—no less than the first locomotive ever made and run in England. It was invented and constructed by William Murdock, the well-known assistant to James Watt, who, second only in importance to Watt himself, invented numerous devices in connection with steam engines.

Telephony in China town.—An article in *Telephony* of Chicago, dealing with the Chinese telephone system in San Francisco, contains the interesting statement that with only 260 subscribers the subscription is but $2.50 per month, and calls outside Chinatown are charged extra at 5 cents each. A hundred additional connections are to be made almost immediately. There are five sections on the switchboard, and the operators speak both English and Chinese.

Fire at the Royal Institution.—The Royal Institution was the scene of an alarming fire on Tuesday night. Some experiments were being conducted with chemicals in the Davy-Faraday Research Laboratory when an outbreak of fire occurred, and in a couple of minutes the room was in flames. The firemen from Great Marlborough-street and Scotland Yard were hastily called up, and appliances set to work so rapidly that the fire was prevented from spreading beyond the laboratory. This portion of the Institution was, however, seriously damaged.

A Curiosity of French Law.—It appears that a French law, still in force, prohibits any person, being in possession of a trade secret, from divulging that secret to a foreigner under a penalty of two to five years' imprisonment and a fine of 500fr. to 20,000fr. The offender is also deprived of all civil rights and kept under police surveillance for five to ten years after his release. A lighter punishment is inflicted in the event of a communication being made to a Frenchman resident in France, but the maximum is enforced in the case of a State secret. The proprietor of a factory has the exclusive right to all discoveries and inventions made within his field of work.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Bolama	April 19, 1902 ...	—
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Puerto Plata—Fort de France	May 31, 1902 ...	June 30, 1902
Jeddah—Suakim	June 18, 1902 ...	—
Mozambique—Majunga (Madagascar)	June 19, 1902 ...	—

Wireless Telegraphy.—Mr. Edward P. Thompson brings forward the curious theory, in the *Electrical World and Engineer* of New York, that long-distance wireless telegraphy is not accomplished by Hertzian waves, but by means of oscillatory currents conducted by intervening lakes, rivers, or, in fact, anything that offers a comparatively easy path. He further states that the waves would be 16 miles above the receiving station with the sending station 1,500 miles distant, and, therefore, could not affect the coherer. The aerial wires, in the absence of waves, are a necessity in that they act as a capacity by which the oscillatory earth current is conducted through the coherer.

Fatalities on American Railways.—No less than 86,277 persons were killed and 469,027 injured on the railways of the United States during the last 18 years. According to the *Engineering News* of New York, three-fourths of the fatalities were neither employés nor passengers, but of those those who were injured, nearly all were on goods trains service, and the old system of coupling was responsible for most of them. In 1893 a law was passed requiring all goods trains to be fitted with automatic couplings and air brakes, and since that time the fatalities to servants engaged on this work have decreased by about 35 per cent. per annum, and the injuries by 52 per cent. The use of the automatic couplings and air brakes has also made it possible to effect great economy in working.

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Illumination of the Fleet.—The *Engineer*, referring to the Naval Review, says:—

The illuminations at this review will be far superior to those usual. They run for three nights, and on the Thursday and Saturday search-lights will for part of the time replace the lamps that suggest set pieces at Crystal Palace fireworks. These search-light displays will be extremely magnificent, and it is a matter of congratulation to whoever is responsible that the spectacular effect of search-lights on steam is to be used. The plan of colouring the lights is, perhaps, a little too suggestive of pantomime, but it will be very "pretty." Artistically, the lights had better have been left natural—for search-lights make their own colours. Still, the artificial colours will, no doubt, prove a boon to the Royal Academy artists who may elect to paint it for next year. Nature's colours with search-lights are not to be found in any paint box. The best view of the search-light display will be had by taking steamer round the fleet; the ordinary illuminations, on the other hand, will be distinctly better watched from the shore. Of the foreign ships the "Pobieda," "Montcalm," and "Illinois" will be the most interesting to inspect.

Fothergill Prize.—The Council of the Society of Arts offer the Fothergill prize of £50 and a silver medal for a Paper on "Existing Laws, Bye-Laws and Regulations relating to Protection from Fire, with Criticisms and Suggestions." The Paper should consist of about 8,000 to 10,000 words, and be written with a view to its being read and discussed at an ordinary meeting of the society. Papers submitted for the prize must be sent to the secretary on or before October 1, 1902. Each Paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto. The judges will be appointed by the Council. The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if, in the opinion of the judges, no Paper deserving the full award is sent in.

Automatic Transformer Switches.—The *Elektrotechnische Zeitschrift* of June 12th and 19th contains a long article by Herr J. Schmidt, assistant engineer at the Nuremberg electricity works, descriptive of the various applications of the automatic transformer switch made by Messrs. Schuckert & Co. This switch, which was described in detail in *The Electrician*, Vol. XLVII., pp. 862-3, has proved itself of considerable service on the network at Nuremberg for switching out the primary circuits of transformers as soon as the secondary circuit is open and switching in again as soon as it is closed. Hitherto, however, its main application has been in the case of single transformers or small sub-stations from which motors were actuated, but it is stated that a slight modification of the original apparatus is now to be tried in connection with lighting transformers and sub-stations.

High-Tension Transmission in America.—A new power station has just been completed by the Missouri River Power Co. at Canyon Ferry, and is described in the *Electrical World and Engineer* of New York. A dam about 480ft. long has been thrown across the river, and it is estimated that about 10,000 H.P. will be obtained, the head being 30ft. The plant originally consisted of four 750kw. 550-volt two-phase Westinghouse generators and two 90kw. exciters. The current from these generators was raised from 550 to 10,000 volts by oil-cooled transformers and then transmitted to places 20 and 14 miles distant. Six machines have now been added similar to those already put down, but are three-phase instead of two-phase. To make the plant uniform, the four two-phase machines have been converted to three-phase. Current at 50,000 volts is transmitted to a sub-station 65 miles distant by overhead conductors.

Niagara.—The outlet tunnel of the Niagara Power Co. was recently inspected for the first time since the completion of the works in 1894. This tunnel, with its new extension, is 7,436·5ft. long, and measures 21ft. in height by 18ft. 10in. wide. It is lined with brick, from four to eight rings being used, according to the character of the rock. The velocity of the water flowing through it is, we believe, 25ft. per second; yet, in spite of this unusual speed, the inspection proved the condition of the work to be absolutely sound. Notice was given to all the company's customers, who take on the aggregate 50,000 H.P., that the works would be shut down for some hours, and those who were compelled to run at night had to make arrangements for a supply of power from other sources. The water was shut off from 1:30 a.m. to 7 a.m. on a Sunday morning, during which time the bulkhead between the tunnel and the new extension was removed.

Conversazione of the Institution of Electrical Engineers.—The annual gathering, which took place at the Natural History Museum on the 1st inst., was of especial interest to electrical engineers, and particularly to members of the Institution. Not only were the members themselves present in great force, but there were, in addition, the foreign delegates to the Tramways and Light Railways Congress, and the members of the Municipal Electrical Association, who are now holding their seventh annual convention in London. The President and Mrs. Swinburne, surrounded by members of the Council, received guests from 9 to 10:30 p.m. The various galleries of the Museum were thrown open, and even this additional space proved none too large. A ladies' band gave selections of music in one of the galleries, while the string band of the Royal Engineers performed, as usual, in the main hall. Precisely at 11 p.m. the two bands played the National Anthem, and the vast crowd joined heartily in singing it; at the conclusion three cheers were given. Some Bremer lamps were used, with good effect, for lighting the hall in which the reception was held.

A Combined Waterworks and Electrical Generating Plant.—At St. Louis (Mo.), U.S.A., the electrical plant is an adjunct of the waterworks plant, and furnishes current for a municipal tramway and for lighting several buildings belonging to the water department. Three generators are employed—viz., a 100kw. railway generator, a 100kw. alternator and a 20kw. alternator. The first two of these are steam-driven, but the latter, which is employed for light loads, is connected to a Pelton impulse water-wheel running at 1,200 revs. per min., receiving its water from the delivery side of the main pumping engine. The reason for this is that the efficiency of a large pumping engine is high, while that of so small a steam engine as 20kw. would be comparatively low. In fact, it is stated in the *Engineering News* of New York that, as the result of tests, the 20kw. generator in question is operated with a total steam consumption of about 30lb. per electrical horse-power-hour. The principal advantage, however, in this method of driving is the low first cost, as a Pelton wheel costs less both in capital expenditure and maintenance than an independent steam engine of the same size.

The Edison Storage Battery.—*Electricity* of New York states that, referring to the Edison storage battery, Mr. John R. Williams, second vice-president of the Electric Storage Battery Co., is reported as saying: "So far as I am aware the Edison battery to-day is in the same experimental state as it was two years ago; that is, nothing of practical or commercial importance has yet been evolved." When his attention was called to Mr. Edison's claim that the value of his battery was proved by the running of an automobile over 62 miles of good and bad roads in New Jersey, Mr. Williams said that was not remarkable, and that the oxide battery of his company, in practical use for a number of years, has run an automobile from Camden to Atlantic City and back on one charge. "Many automobiles," said Mr. Williams, "are in almost daily service, equipped with our oxide battery, capable of running 70 miles over average roads. I am informed that Mr. Edison proposes to make a test of the durability of his battery by a series of trips aggregating 5,000 miles, but a battery that will do no more than this is scarcely of any commercial value. Batteries of the Electric Storage Battery Co. are still in daily use after running over 10,000 miles, and sets of our standard cells have frequently made from 16,000 to 20,000 miles."

The Hoepfner Processes for the Electrolytic Production of Nickel and Zinc.—For some time past there has been proceeding in the columns of the *Zeitschrift für Elektrochemie*, a somewhat acrimonious discussion relating to the practical value of the various electro-metallurgical processes worked out by the late Dr. C. Hoepfner, of Frankfurt, whose death was recorded in this paper some 18 months ago. Our readers may be aware that the Hoepfner processes are in operation at Winnington Cheshire, at Papenburg in Germany, and at Hruschau in Austria, but exact figures for the production of zinc and nickel at any of these works always have been difficult to obtain. Dr. L. Hoepfner has taken up the defence of

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his brother's reputation as an inventor, and in a letter of April 24th he states that at Papenburg in the year 1901, 150 tons of electrolytic nickel were produced by the Hoepfner process, while the plant has since been enlarged, and is now producing 800kg. of nickel per day. These figures are official. At Brunner Mond's Winnington Works the Hoepfner zinc extraction process is in operation. Up to April 30, 1901, 1,663 tons of zinc are stated to have been produced, with 5,000 tons bleach as a by-product; and the present daily output at these works is reported to be 3 tons zinc and 9 tons bleach. Dr. L. Hoepfner does not state whether these figures are also official, but presumably they have been obtained by application to the Winnington firm.

A 25,000-volt Continuous-current Dynamo.—A short article in *L'Industrie Electrique* of June 10th states that M. Thury, who, for many years, has been active in developing a high-pressure continuous-current system of power distribution by means of dynamos in series, has finally succeeded in constructing a continuous-current generator which will produce 25,000 volts directly at its brushes. In the dynamo in question the armature is stationary and the revolving part is a two-polar field magnet which is separately excited. The armature has 48 coils, each wound as a gramme ring with 500 turns of 0·2 sq. mm. wire, the armature resistance being 700 ohms. The slots are 28mm. deep and 18mm. wide, and the bore of the armature is 590mm. The external diameter of the armature cores is 1,000mm., and the width of the armature 300mm. The machine will generate 1 ampere at 23,000 volts. The most interesting part of the machine is, of course, the commutator, the sections of which are separated by air insulation. As the pressure between the commutator segments may be as high as 750 volts momentarily, means of avoiding sparking are essential. An air blast to blow out the sparks is produced by a fan mounted on the main shaft of the machine and connected by pipes to the region which is below the brushes. By this arrangement the blast is stronger the faster the speed of the machine—*i.e.*, the higher the pressure. In addition to this, condensers are connected between adjacent sections. There are 96 commutator segments, so that the difference of potential between each is 500 volts. It is found that the air-blast is only needed when the current exceeds 0·3 ampere. The current is collected by brushes which rotate with the field magnets and are connected to two highly insulated slip rings.

The Theory of Calcium Carbide Formation.—The *Zeitschrift für Elektrochemie* of May 29th contains an interesting abstract of a recent Paper by Rothmund, relating to the temperature at which calcium carbide is formed. The author first points out that two factors control the course of chemical change—namely, chemical affinity, and the resistant forces which operate to retard the effects of this chemical affinity. The reciprocal of the latter gives the reaction velocity. Increase of temperature can accelerate chemical change, by influencing in the contrary direction both these forces. The increase of the reaction velocity by heat is in most cases approximately the same, and amounts to $x \times 2{\cdot}5$ for each increase of 10°C. The chemical affinity, in the case of exothermic reactions (as for example the burning of coal) is greatest at low temperatures, in spite of the fact that coal at the normal temperature is apparently in the passive state as regards oxygen. In those cases in which exothermic reactions are favourably influenced by increased temperature the effect is, therefore, solely the result of an improvement in the reaction velocity. The formation of calcium carbide is an endothermic reaction, and increase of temperature may in this case effect the reaction in both ways. The author has proved experimentally that a temperature of 1,620°C. is the lowest at which carbide can be formed. Below this temperature, in the presence of carbon monoxide, the action can be reversed, and the carbide already formed can be split up into its constituent elements—carbon and lime. In the same issue of the *Zeitschrift für Elektrochemie* an account is also given of experiments which W. Borchers has been carrying out relating to the same subject. A graphite crucible was filled with alternate layers of wood charcoal, and lime, the charcoal in excess, and was heated by a stream of enriched air blown into the crucible by magnesite nozzles. This air contained 35 and 50 per cent. oxygen, and was previously heated by passing through a metallic coil encircling the upper part of the crucible. The temperatures which can be obtained under these conditions can be calculated by the aid of well-known physical data, and are as follows:—

With pure oxygen .....3,100°C.	With 35 per cent. oxygen...1,800°C.
„ 50 per cent. oxygen ...2,200°C.	„ air ....1,260°C.

The temperatures are probably slightly higher when carbon dioxide is produced in addition to carbon monoxide. Experiments with this crucible showed that no carbide could be obtained under 50 to 60 per cent. oxygen in the air current—*i.e.*, that a temperature of approximately 2,000°C. was requisite to produce crystalline carbide. The results of the researches by V. Rothmund and by Borchers show that while theory demands a temperature of only 1,620°C. for carbide formation, in practice at least 2,000°C. is necessary in order to produce carbide in quantity.

The German Electrical Association.—At the tenth annual general meeting of the Verband Deutscher Elektrotechniker, held in Düsseldorf from June 12th to 15th, an important announcement was made by the president as to the future and objects of the Association. The Verband was originally founded in 1892 mainly for the purpose of furthering the "economic interests" of the German electrical engineering industry, without, however, neglecting technical matters. It appears that the economic interests, or, let us say, the commercial aims and objects of the association, have been allowed to fall gradually into the background, although the technical objects of the Association have been fulfilled in an efficient manner far exceeding what was expected by the founders. After lengthy consideration, the executive of the Association has come to the conclusion that it would be to the interest of all parties that the purely business side should now only be approached by the Association in an informatory manner, and the Verband Deutscher Elektrotechniker will now become purely a technical institution, while the business interests will be watched over by a new society, the "Verein zur Wahrung gemeinsamer Wirthschaftsinteressen der Deutschen Elektrotechnik" (Institution for the Protection of the Common Economic Interests of German Electrotechnics). Continuing, the president referred to the industrial depression in Germany, and suggested what he thought were the three causes of it; First, the running of electricity supply and tramway undertakings by manufacturing firms; secondly, the depression of prices, for which new firms were mostly responsible; and thirdly, the inadequate commercial training of engineers. In connection with the latter he emphasised the necessity of instituting political-economical courses at the technical schools. The reception of the reports of the various committees then took place The low-pressure safety regulations have been revised and the committee are hoping to complete and publish those for higher pressures in the autumn. The regulations for the specification, rating and testing of electrical machines, adopted tentatively last year, have now been formally accepted, an appendix having been added in the form of certain recommendations as to frequency, speed, number of poles, variation in pressure and similar matters. The recommendations of the hysteresis committee, adopted tentatively last year, have not yet been made absolute. Although the committee reports that good experience has been had with the apparatus recommended for the measurement of hysteresis, it adds that a new apparatus has been designed which it would like to test before coming to a definite conclusion. Another committee has prepared a specification for tests of installation material, which has been adopted provisionally for a year; and, finally, the earth current and patents committees have not finished their deliberations. As in previous years, the time left for the reading and discussion of Papers was far too small, in spite of the fact that proofs of several of them were sent out beforehand to those who might contribute to the discussion, and these Papers were read in abstract only. This fact was particularly regrettable as the Papers were above the average merit. It has now been decided for future meetings to fix the date for authors to send in their Papers earlier, so that proofs of all the Papers may be circulated first.

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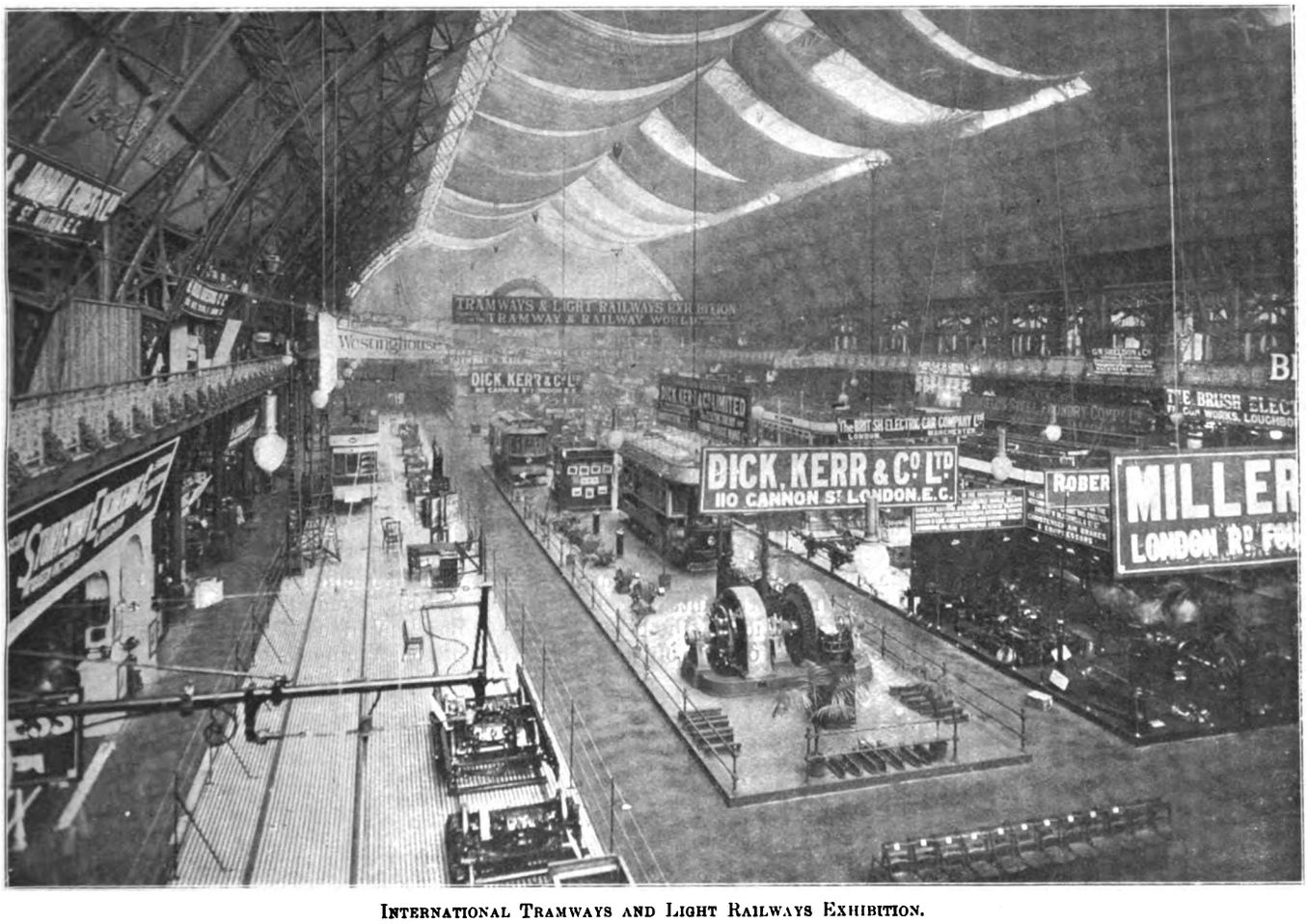
THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

On Monday the second International Tramways and Light Railways Exhibition was opened at the Agricultural Hall, London, N. The opening ceremony was performed by Mr. Gerald Balfour, President of the Board of Trade, and some account of this function will be found in our leading article this week. It is two years since a similar exhibition was opened in London, and so greatly has the electric tramway industry extended in the interval that there are now no less than twice as many exhibits as on the previons occasion, while many of these are, of course, of far greater importance and magnitude. Probably the most attractive single item in the exhibition is the handsome tramcar built for the London County Council by Messrs. Dick, Kerr & Co. This car is the first of a batch of 100 cars now being built for the Council's tramways in South London, at a cost of £740 per car. As shown in the illustration, it is double-decked and open vestibuled, while the equipment and fittings are of the most substantial and artistic description. Following are the principal dimensions:—

	Ft.	in.
Length of body over corner posts	21	0
Do. over platforms	32	0
Do. overall	33	6
Width over body	6	9
Do. roof	7	1
Clear height inside at centre	6	9
Overall height from rail	13	0
Do. to crown of roof	9	10
Gauge	4	8½

Seating capacity: 28 inside, 38 outside—total 66.

This car, built for the conduit lines in South London, bears considerable resemblance to what is known as the "Preston" type, with Bellamy reversed stairway, which has been supplied by Messrs. Dick, Kerr & Co. to many of the tramways of this country. The frame of the car is so arranged as to accommodate on each side two large fixed windows in the centre, and four end windows arranged to lower. Above the windows is a line of narrow, ornamental pivoted sashes, provided for ventilation. At each end of the car are provided route-indicator boxes with revolving linen screens. A feature of the interior of the car is a glazed partition dividing the seats on each side. The interior woodwork is of quartered oak, the end doors sliding in the usual way, and fitted with the necessary handles, catches, &c. The car is mounted on maximum traction bogies of the Brill type, each bogie carrying one motor. The electrical equipments are in most respects similar to those usually supplied by Messrs. Dick, Kerr & Co., the notable features connected with the motor being its high efficiency and freedom from sparking of the commutator under all conditions of load.



International Tramways and Light Railways Exhibition.

A companion exhibit is the single-deck combination vestibule car, which, since its introduction by the Electric Railway and Tramway Carriage Works some years ago, has found considerable favour amongst a large number of municipalities and electric tramway companies. The car exhibited has been built to the order of the Sunderland Corporation. The main feature in the design of the car is the provision of both outside and inside seats upon a single deck, giving also ample room for passengers alighting from or boarding the car, and consequently reducing the time necessary at the stopping places. The car is built to accommodate 34 passengers, 16 inside and 18 outside, and has an overall length of 30ft. 10in. over the buffer irons, and a width of 6ft. over the side sills. The truck is of the 21E Brill type of standard design, with 6ft. wheel base and 30in. wheels. The under frames are of oak, in combination with steel sole bars, and ensure a

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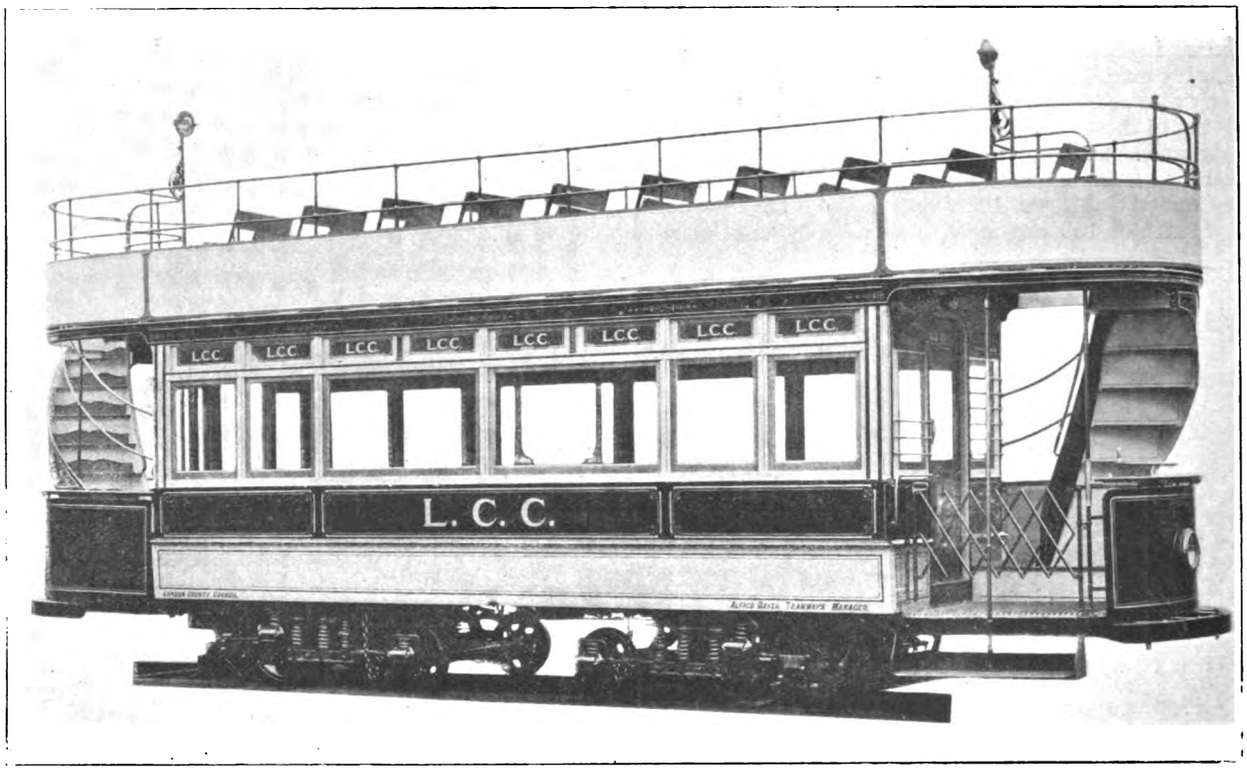
maximum of strength with minimum weight. The platform frame, which is an important factor in this class of car, is formed by continuing the side frames to the necessary length. The car is of the "vestibule" type, offering complete protection from the wind and weather. The vestibules are furnished with balance blinds and windows, one on each end,



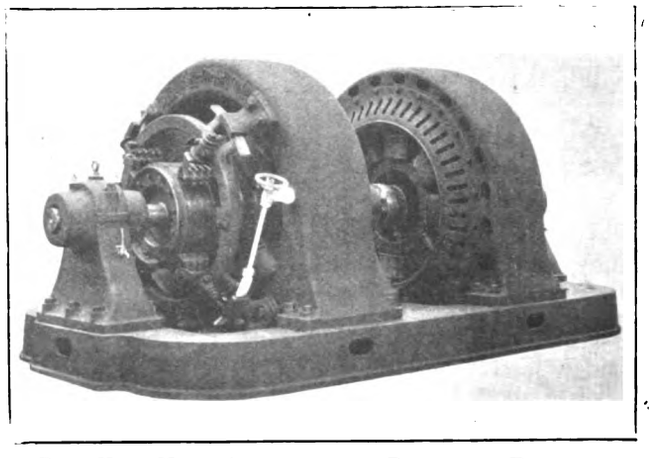
THE FIRST L.C.C. ELECTRIC TRAMCAR.

constructed to drop if required. In order to ensure the safety of the passengers riding on the open portion of the car, the near side of the front platform and the off side of the rear platform are panelled in, the panelling being surmounted with wrought-iron scroll work, the remaining portion of the platform being closed with a folding gate. On the off side of the front platform and the near side of the after platform are folding gates. The whole of the open portion occupied by the passengers is adequately protected from the weather by storm blinds. The equipment comprises two No. 26A motors and standard DE1 form B controller.

DICK, KERR RIGID TRUCK VESTIBULE CAR.

We should mention that Messrs. Dick, Kerr & Co. are making a combined exhibit in conjunction with the English Electric Manufacturing Co. and the Electric Railway and Tramway Carriage Works, of Preston. On their spacious stand is also shown a motor-alternator for the Portsmouth tramways. The combination consists of a direct-current shunt-wound motor direct coupled to an eight-pole three-phase alternating-current generator, the two machines being carried on the same bed-plate. The output of the generating side is 200kw. when supplying current at 5,500 volts and running at 375 revs. per min. and 25 cycles per sec. The motor is a four-pole shunt-wound machine running at 550 volts.

The exhibits on this stand also include a number of standard traction motors. Various sizes of motors are exhibited, but the method of construction is practically the same. The



DICK, KERR MOTOR-ALTERNATOR FOR PORTSMOUTH TRAMWAYS.

motor frame, consisting of two bowl-shaped castings, is divided horizontally, and so arranged that the bottom half may be lowered out so as to permit inspection of the interior of the motor without removing the armature. On the motor frame are four salient poles built up of laminated sheet-steel punchings, each pole being divided by a gap into sections, thereby adding considerably to the cool running of the machines. The field coils are all alike, and inter-

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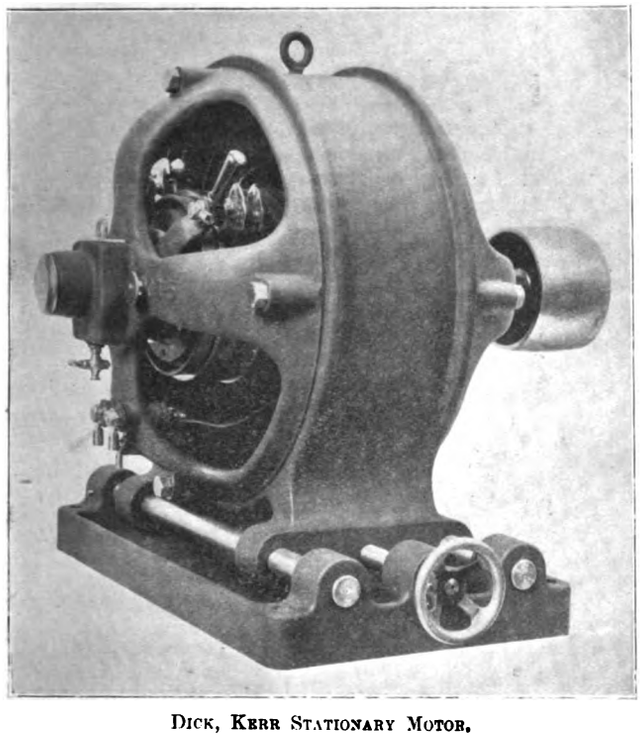
changeable. The armature is of the slot type, being built up of laminated punchings ; the armature coils are former wound and interchangeable. The aim of the designers has been to provide a machine which will run economically and sparklessly under all conditions of load, and experience has shown that these expectations have been more than realised. A 100 H.P. motor of this type was illustrated on page 875 of our issue last week, in connection with the new equipment for the Liverpool Overhead Railway.

Adjoining the stand just described is the large and imposing stand of the British Westinghouse Electric and Manufacturing Co. This stand extends the entire length of the main hall, and includes a completely-equipped working trolley line, with a car fitted with the Newell magnetic brake. Our readers are already familiar with this ingenious and effective brake ; we will, therefore, only briefly describe this part of the exhibit. The brake proper comprises : (1) A double track-shoe of peculiar construction, combined with a powerful electro-magnet, which, when energised by current produced by the car motors acting as generators, is strongly attracted to and grips the rail by magnetic force ; (2) brake heads and shoes of the ordinary type, acting directly on the wheels, and consti-



DICK, KERR STATIONARY MOTOR.

tuting a wheel brake of maximum power and efficiency ; (3) sundry castings and forgings for simultaneously transmitting the downward pull and resultant drag of the magnetic track-brake into lateral pressure upon the wheels. The combination of these three elements in duplicate, together with the necessary tie-rods and attachments, constitutes a single-truck brake equipment, designed for application to a four-wheel or single-truck tramcar ; a double-truck equipment, being the equivalent of two single-truck equipments as above described, is required for an eight-wheel or double-truck tramcar. In addition to the truck equipment a complete brake includes brake controller attachments for use when the motor controllers are not provided with braking points, and a diverter or rheostat, for dissipating the heat generated by any excess of current over and above that required to operate the brake when the heaters are not in service. The tramcar, which travels on a track over 300ft. long, is similar to those supplied by the British Westinghouse Electric and Manufacturing Co. for the Tyneside Electric Tramways. Visitors are allowed to ride on the car, and to inspect its construction and equipment. It is fitted with four motors, all controlled simultaneously from the one main lever of the driver's controller, the same lever also serving to regulate the brakes. Adjoining the stand is a 112 H.P. Westinghouse gas engine driving a generator, which supplies power to the car. The exhibit includes other specimens of Westinghouse manufactures, including motors of various types and the new Westinghouse-Bremer arc lamp.

The exhibit of the British Thomson-Houston Co. includes the latest type of electric traction apparatus for operating light railways, tube railways and tramways. Most of the apparatus shown is similar to that used on numbers of light railways and tramways equipped on the Thomson-Houston system in various parts of the United Kingdom and abroad. The car exhibited is a double-deck car, built by Messrs. G. F. Milnes & Co., of Hadley, Salop, and is mounted on two Brill maximum traction bogie trucks, having 30in. diameter driving wheels, and 20in. diameter small wheels, with 4ft. wheel-base, and 4ft. 8½in. gauge. Several different types of B.T.H. traction motors are shown, all of the ironclad type of construction, suitable for narrow and standard gauges. The ratings of the motors are as follows :—

GE 58,	with 4 turn armature	.....	37 B.H.P.
GE 54,	do. 3	ditto	..... 30 do.
GE 60,	do. 4	ditto	..... 27 do.
GE 66,	do. 1	ditto	..... 125 do.
GE 67,	do. 3	ditto	..... 40 do.

An exhibit of the British Thomson-Houston master control system is shown in operation, the only difference being, that owing to limited space, and for the purpose of a clearer demonstration, the motors shown in operation are the CE type instead of traction motors. This system is intended for use on lines dealing with heavy passenger traffic, and where it is necessary to have a rapid and frequent service of trains with a high rate of acceleration. Further, where trains must be capable of operation in either direction and from either end, so that time and space required for the shunting of a locomotive at crowded termini can be avoided, the above system is ideal. After a thorough investigation of the merits of different systems, the Great Northern and City Railway Co. have decided to equip their trains with this system. Two trains equipped with this system are now in operation on the Central London Railway. This system has also been adopted by the Manhattan Elevated Railway of New York. The "master control system" consists in general of two parts : first, a number of electrically-operated switches, called "contactors," constituting the series-parallel motor controller which effect the different combinations of the motors, and vary the starting resistance in circuit with them, and an electrically-operated reverse switch ; second, two master controllers, one located at each end of each motor car, which operate the motor controlling switches and reverse switch. A cable connected to each master controller, and to the electrically-operated switches, runs the entire length of the train, whether the cars are motor or trailer cars, with suitable couplers for connecting the cars. The synchronous action of the motor controllers on all the cars with the movement of the master controller handle, ensures similar resistance connections and motor combinations on all the cars at all times. The position of the master controller handle indicates to the operator the exact position of the motor controllers on all of the cars, the proper number of points being provided on the cap-plate. The rate of movement of the motor controllers, and, consequently, the amount of current taken by all of the motors is, therefore, under his immediate control, and the motorman is able, at will, instantly to utilise the full power of the motors in either direction in an emergency. In case the power circuit is momentarily interrupted, for any reason, the system of control provides for the immediate restoration of the motor and resistance connections which were, in effect, immediately preceding such interruptions, being equivalent in this respect to the ordinary hand controller. All current for the operation of the motor controllers on each of the different cars passes through the single master controller under the immediate control of the motorman. The interruption of current to the motors in the off position of the motor controller is ensured by providing three separate electrically-operated switches connected in series, any one of which has capacity to open the circuits. If the train should break in two, the current would automatically and instantly be cut off from the

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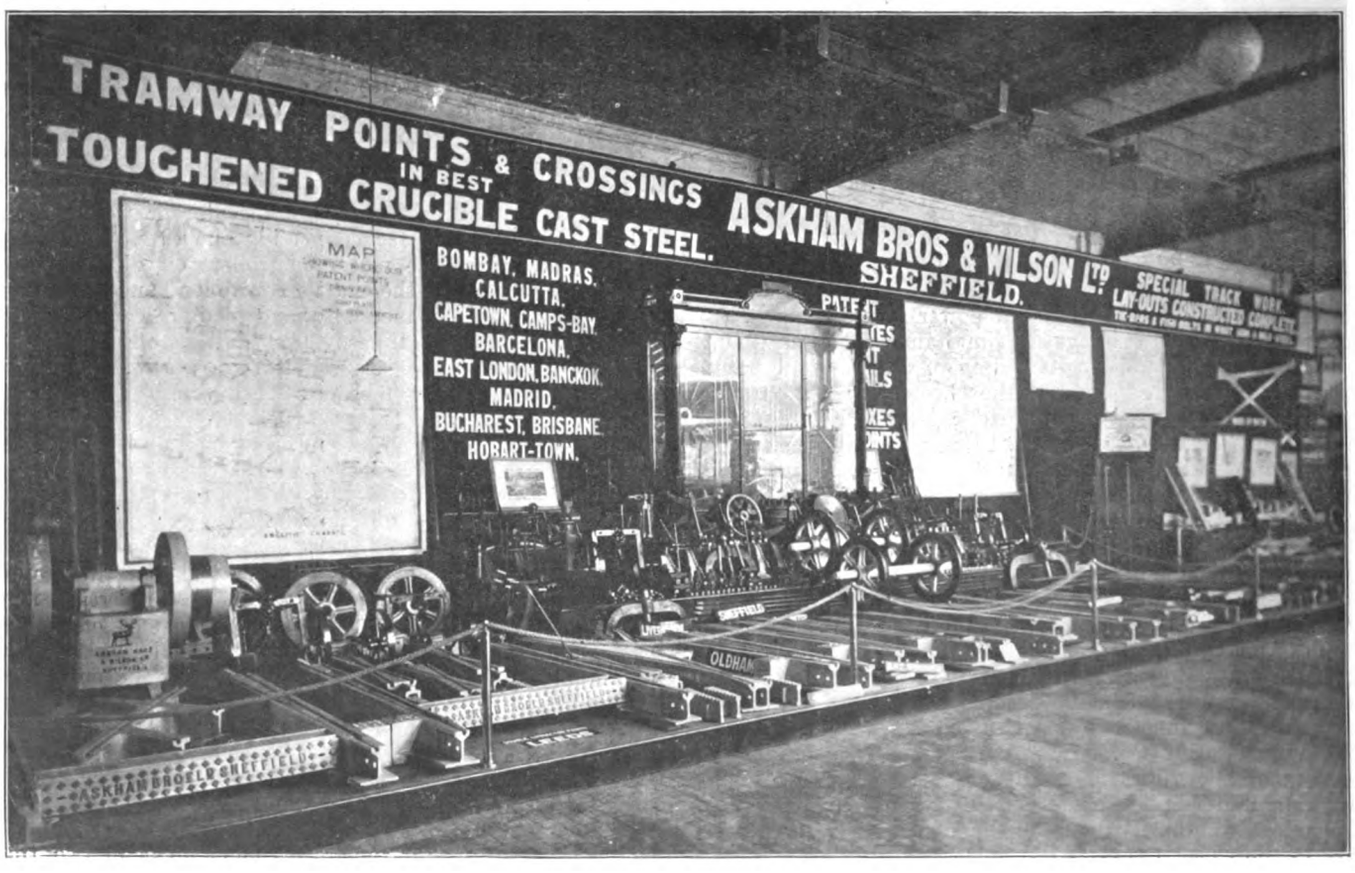
PART OF THE BRITISH THOMSON-HOUSTON CO.'S STAND.



MESSRS. ASKHAM BROS. & WILSON'S STAND.

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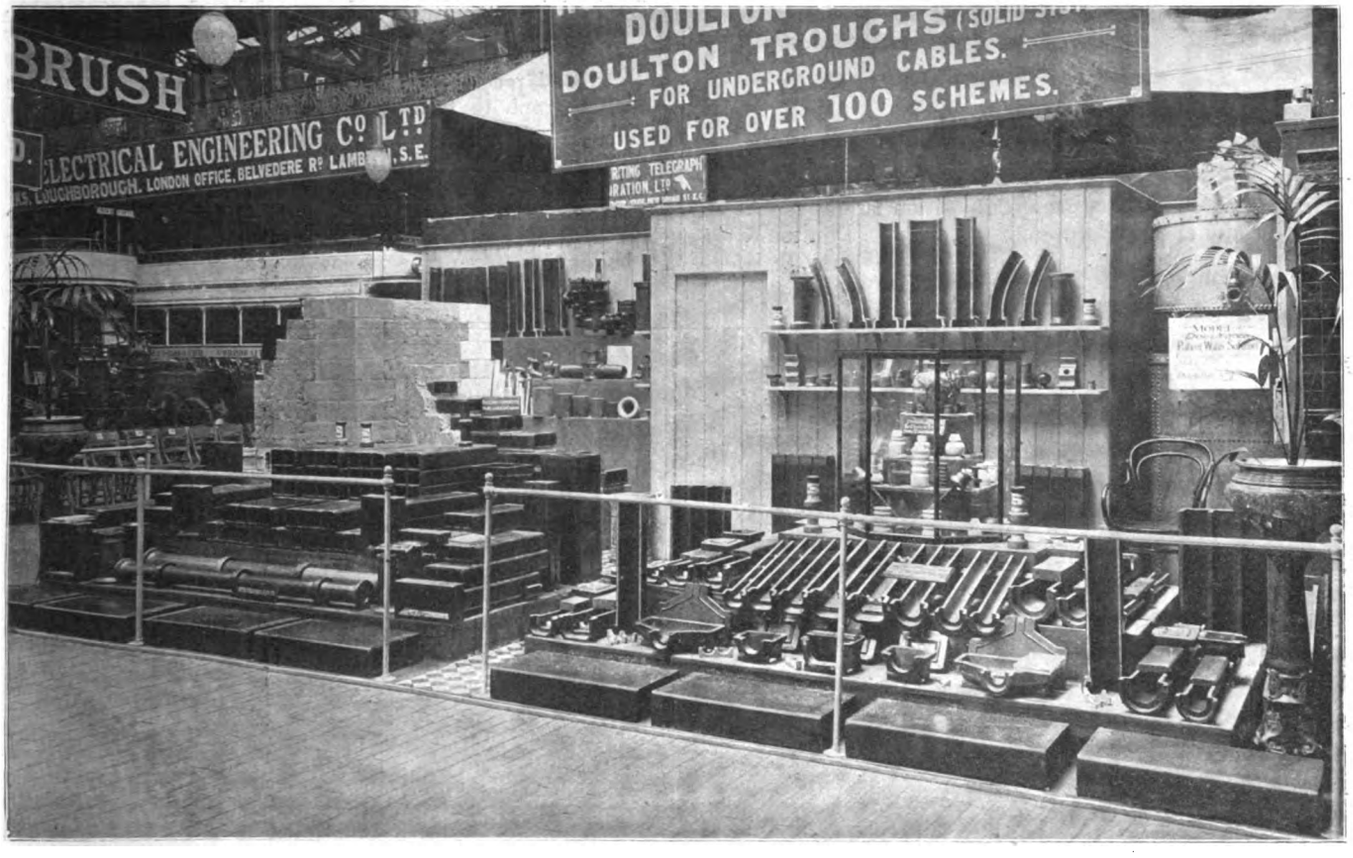
motors on that part of the train not under the control of the motorman, while his ability to control the front part of the train would not be affected. When the master controller is thrown off, both "positive" and "negative" connections are cut off from the operating coils of the motor control switches, and none of the train wires or any of the wires in the train line cables are "alive." For reversing the motors the master controller is provided with a separate reversing handle, and a mechanical interlocking device prevents this reversing handle from being thrown unless the main handle is in the off position. Moving this reverse handle either back or forward makes connections for throwing an electrically-operated reverse switch, called the "reverser," to either "forward" or "reverse" position. The reverser is electrically interlocked, so that it cannot be thrown when the motors are taking current. The operating circuit is so arranged that, unless the reverse switch is thrown for the direction of car movement indicated by the master controller reverse handle, it will be impossible to operate the contactors and get current through the motors on that particular car. A cutout switch is provided on each car, so that in an emergency all of the contactors on that car may be disconnected from the control circuit. The control operating current, per car, at 550-volt line potential, is about 2·5 amperes for an equipment for two 160 H.P. or four 80 H.P. motors. The total weight of control apparatus for this equipment is approximately 2,200lbs.

This stand includes a large number of other electric traction fittings and plant, &c., but owing to the pressure on our space we must defer detailed reference to these until a later issue.

At the stand of Messrs. Askham Bros. and Wilson, near the main entrance, are exhibited a number of details of the utmost importance to the tramway engineer—viz., track rails, joints, points, crossings, tie bars, wheels, &c. One of our illustrations is from a photograph of this stand, which should certainly be carefully inspected by every engineer and tramway manager visiting the exhibition. Special attention may be called to the spring points, which are of the automatic type, and are made in best toughened crucible cast steel, and are fitted with special hard-forged steel non-breakable tongues. They are of 80ft., 100ft., 150ft., 200ft. radii., as supplied to Liverpool, Manchester, Nottingham, Halifax, Leeds, &c. Straight points are exhibited as supplied to the British Electric Traction Co. (Ltd.) and to Dublin, Liverpool, London United, Bristol, Sheffield, Bradford, Leeds, Birmingham, Hull, Middlesbrough, Oldham, Birkenhead and other towns, as shown by a large displayed map.

Dealing also with important elements of tramway construction is the adjoining stand of Messrs. Doulton & Co., in which art and utilitarianism keep close company. The Doulton conduit naturally attracts the engineer's first attention. By an exceptionally clear arrangement, as shown in our illustrations, the designers of this stand have made it intelligible even to the lay mind how these conduits are laid.

The Doulton conduit has been adopted in connection with more than 100 important schemes of electric lighting and traction at home and abroad. Many thousands of miles of duct have been laid, and after experience in actual operation extending over 10 years, the annual production is now numbered in millions of feet of duct. It is manufactured of hard-burnt glazed stoneware, which possesses great strength and toughness, is a non-conductor of electricity, is unaffected by heat, and is thoroughly proof against chemical action due to acids and gas found in the ground. For building in concrete, the Doulton conduit, owing to its rectangular section, is more suitable than any other type of conduit. The blocks of stoneware are bedded in Portland cement mortar upon a foundation of concrete, and the trench at the sides of the conduits and above them is filled in with concrete; thus forming a substantial and permanent structure, the depreciation of which may be regarded as nil. As there is no projection at the joints, the minimum of space is occupied, and economy is effected in the amount of concrete required. The operation is simple and expeditious, and accurate alignment of the ducts is readily secured. It has been found a convenient plan to adopt a three-way or four-way conduit



MESSRS. DOULTON & CO.'S STAND.

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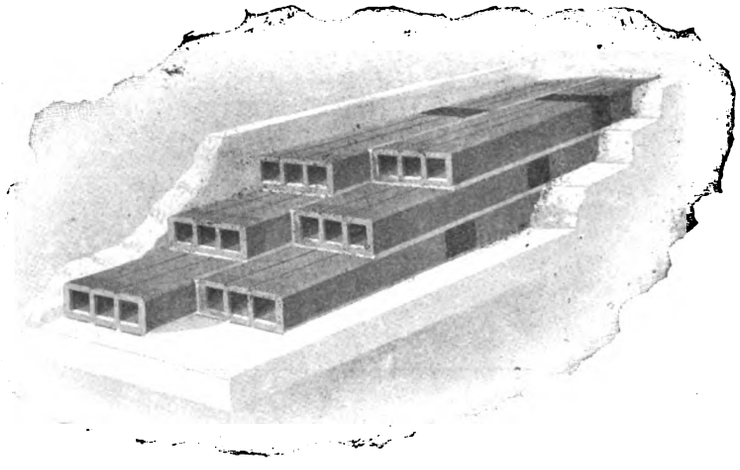
as a unit, and to build up multiples to the number required. Examples are also shown of the Doulton troughing (solid system) for underground electric cables. This troughing is of strong hard-burnt glazed stoneware. Its cost compares with that of wood, and is a fraction only of the cost of cast iron. It is supplied in 2ft. lengths, with socket joints. The



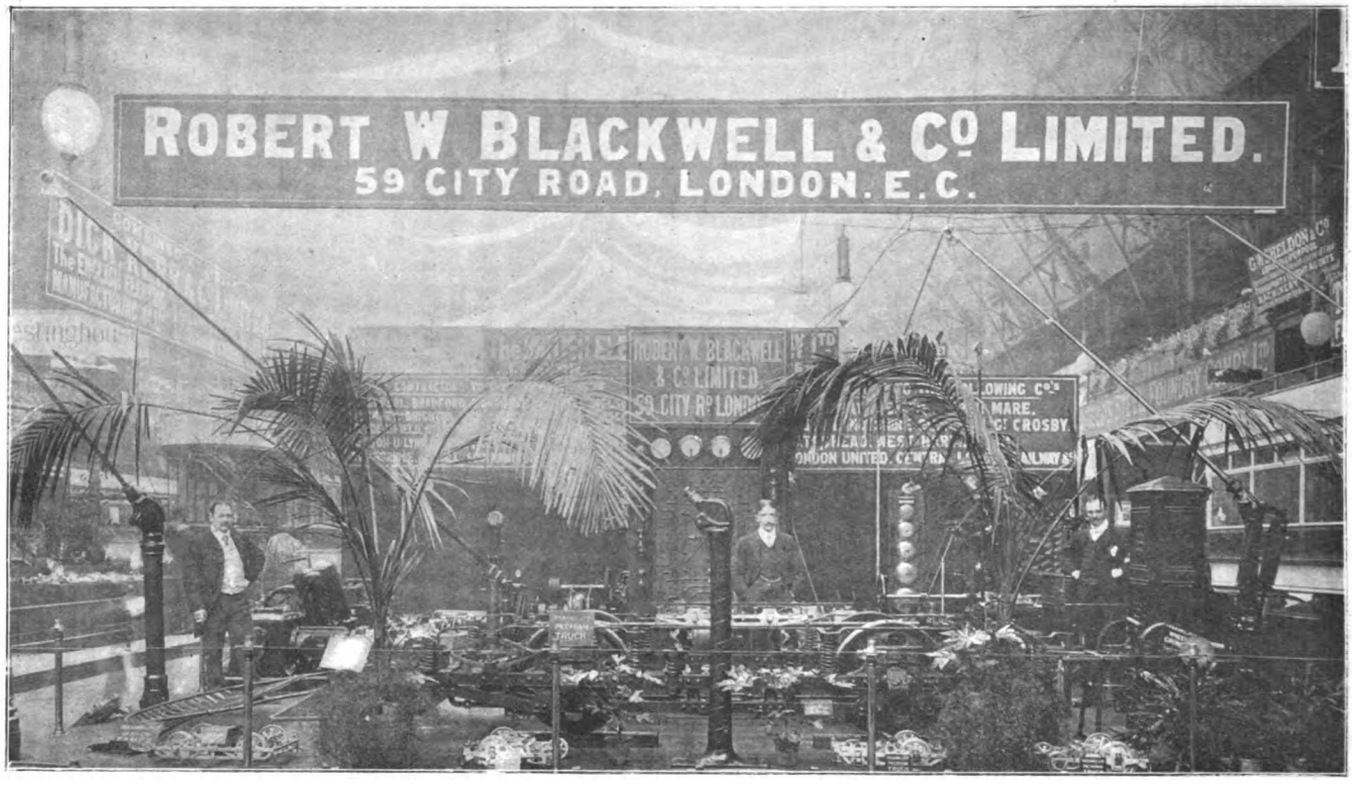
METHOD OF LAYING DOULTON MULTIPLE CONDUITS.

covers are made with projecting longitudinal ribs on the under surface, which hold them firmly in position laterally. As an alternative and cheaper form of cover, Messrs. Doulton & Co. supply Staffordshire blue bricks.

a tank, thence down a pipe to the bottom of a tank, where all impurities are deposited, and the softened water finally passes from the top of the filter to the storage tank. The average result of the last 75 water softeners erected for electric light stations, &c., shows that the waters have been reduced from 25·6deg. to 5·4deg., some of the originals having an initial hardness of 50deg. to 52deg., or over three times that of London tap water, whilst a large proportion were over 30deg. These 75 plants range in size from 300 to 12,000 gallons per hour. A boiler on these works has been supplied with soft water for the past eight years, using Lambeth main water of about 17deg. hardness. This is reduced to 5deg., and the report of the Manchester Steam Users' Association says :—"The shell crown and fire-box have only a coating of $\frac{1}{16}$in., which is very regular. No boiler fluid is used."

Messrs. Robert W. Blackwell & Co. have a well-arranged stand, which we show in one of our illustrations. In the foreground is the familiar "Peckham" truck, which is still in evidence in this country in spite of numerous rivals. Arranged about the stand are all the fittings and accessories for the electrical equipment of a tramway on orthodox American trolley principles. These include poles, brackets, boxes, trolley heads, standards and fittings, &c. Attached to the "Peckham" truck is a "tandem" lifeguard, which appears to be well adapted to its humane purpose. It will be seen from the photograph that this firm aspire to "take the palm" in trolley equipments. It will be noticed also, by the visitor to the exhibition, that other firms have similar aspirations.

Near the further end of the main hall and in a prominent position on the ground floor is the interesting stand of the Cape Asbestos Co., whose successful utilisation of blue asbestos for boiler and steam pipe removable coverings is well known



MESSRS. ROBERT W. BLACKWELL & CO.'S STAND

At one corner of the stand is shown one of Messrs. Doulton's automatic water softeners and purifiers. The water to be softened enters a tank through a ball valve, its force being utilised to drive a motor, which actuates shafting and gearing and stirrers at the bottom of two tanks. The day's supply of softening material is thrown into each tank simultaneously, and the solutions thus formed are kept at a uniform strength by the constant rotation of the stirrers. The hard water and reagents then pass down pipes, and mix in and appreciated by hundreds of station engineers and other steam users. At this stand is shown a model boiler with the removable covering in position, also specimens of pipe coverings, &c. There are also a number of photographs illustrating the contracts carried out by the Cape Asbestos Co. at various central stations; and our illustrations, taken from two of these photographs, show the use made of this company's removable asbestos coverings at the Willesden generating station of the Metropolitan Electric Supply Co.

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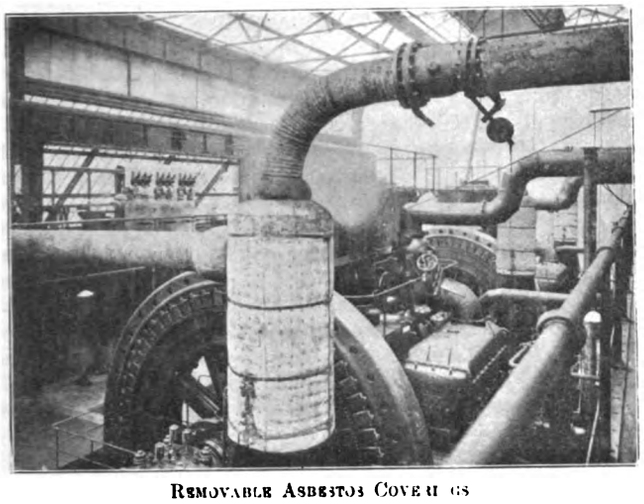
At stand No. 32 is shown a continuous rail joint, which should interest tramway engineers. The exhibit is made by the Continuous Rail Joint Co. The joint is a combination of angle bar and base plate made in one piece, from best quality

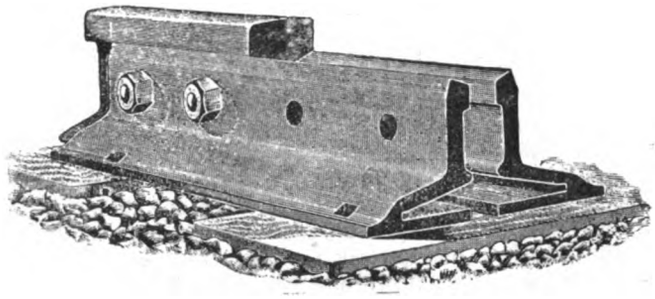


Removable Asbestos Coverings.

Removable Asbestos Coverings.

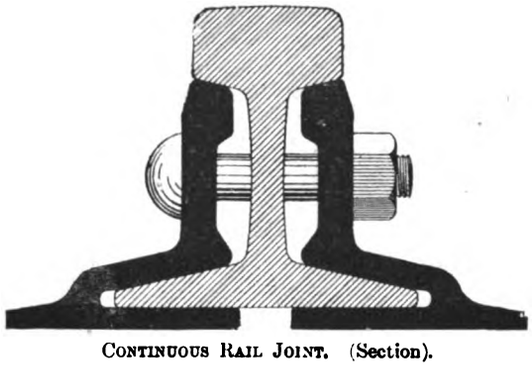
steel, rolled into accurate shape. It holds the rail ends in relation one to the other by engaging the rail under its head, and on the top and bottom of the flange, thus preventing any vertical or lateral play and giving a smooth riding track. The dipped ends of old rails can be successfully restored to a good surface by the application of continuous rail joints, thereby prolonging the life of the rail. More than 12,500 miles of tramway and main line railways are equipped with the continuous rail joints. Step joints and insulated joints of the continuous pattern are now largely in service.

The General Electric Co. (1900) are showing on their stand, No. 84, their standardised traction generator panel, which calls for some comment. The panel consists of a slab of white marble, 2in. thick and 5ft. by 2ft. in area, mounted on the G.E.C. system of cast-iron self-supporting framework, which is capable of indefinite extension in both directions, and the marble is surmounted by a 4-in. delta metal moulding. The capacity of the panel is 400 amperes, with 100-ampere lighting circuit, and the fittings are arranged for a 500-volt circuit. Starting from the top, the fittings comprise one G.E.C. "Stanley" dead-beat moving coil ammeter and one similar voltmeter, one "Stanley" maximum automatic circuit-breaker, one single-pole switch for the negative side of the generator, one double-pole positive and equaliser switch, and one combined shunt breaking and regulating switch. All the switches (except the shunt switch) are of the well-known G.E.C. knife pattern "Peel" type, the knife being of a special copper composition,



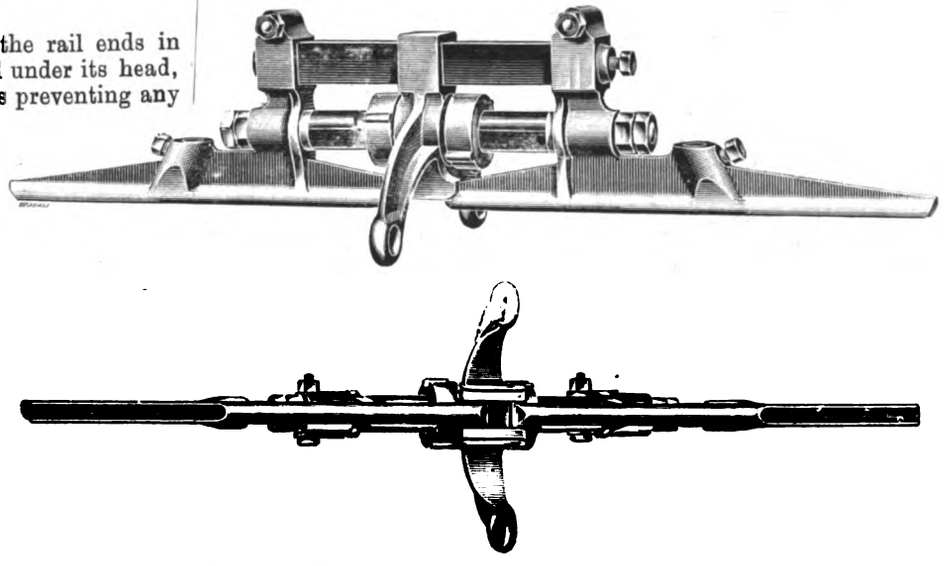
Continuous Rail Joint.

fixed on to the handle by means of springs in such a manner that it does not leave the contacts until the handle has been pulled out some way, the two contacts being broken at exactly the same time. The principal point in connection with the switches is the novel method of interlocking, devised by



Continuous Rail Joint. (Section).

Mr. Wood. The negative switch is so interloked with the positive and equaliser switch that the latter cannot be closed until the former has been "made." In addition to this, the positive and equaliser switch cannot be closed until the shunt making and regulating switch has been closed. Under ordinary



Plan and Elevation of the Wood Section Insulator.

conditions, therefore, it is possible for the attendant to close the negative switch at any time he likes without anything happening, but he has to "make" the shunt circuit before he can put the machine on to the 'bus bars, and, of course, the final operation is to close the automatic circuit breaker. The method of interlocking is as follows:—The negative switch and the positive and equaliser switch are connected by means of a spring-con-

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trolled rocking lever, which will allow the negative switch to be closed at any time, but bears on the other switch as long as the negative switch is open. It also prevents the latter being opened first. The interlocking arrangement with the shunt switch consists of a spring buffer which goes through the marble slab at a point where it can be moved by the equaliser knife blade at the switch pivot end. This spring buffer is bevelled at the back of the board, and it impinges on a similar bevelled buffer placed at right angles to it. The latter buffer bears on a small sector mounted on the spindle of the shunt switch, and as long as this sector is in the way neither buffer can move, and, therefore, the main switch cannot be closed. As soon, however, as the shunt switch is made, the sector is moved out of the way, and the spring buffer going through the marble slab can push away the buffer at the back of the board. Consequently, the main switch can be closed. In the same manner it is impossible to break the shunt switch until the main switch has been opened, as the sector is unable

MESSRS. W. F. DENNIS & CO.'S STAND.

to pass the buffer at the back. The panel is completed by a switchboard Aron watt-hour meter in a glass and brass case.

At this stand is also shown a large assortment of trolley equipment details, among which is Mr. Wood's section insulator, shown in elevation and plan in the illustrations on the previous page.

The Felten and Guilleaume Carlswerk Actien Gessellschaft, whose agents in this country are Messrs. W. F. Dennis & Co., exhibit at stand No. 64 a number of rail-bonds, cables, trolley wire samples, &c. We give an illustration from a photograph of one of their exhibits.

(To be continued.)

Moving Platforms for Brooklyn Bridge.—The congestion at present prevailing on Brooklyn Bridge has given rise to many suggestions for relieving the existing state of affairs, and probably the latest among these is one for the erection of moving platforms operated by electricity in a similar manner to those used at the Paris Exhibition, 1900. At a recent meeting of the Rapid Transit Commission it was proposed that three platforms be constructed, to move at speeds of 2½, 7 and 10 miles an hour respectively. According to *Electricity* of New York, the company was prepared to instal the system in 12 months, without interrupting the traffic, save for the last 10 days, and they would offer transportation for 1 cent, paying the city as much as it gets now, or $150,000. The platforms would carry about 75,000 persons.

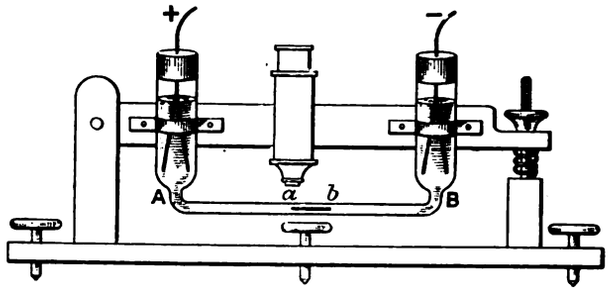
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Gaseous Electrolytes.—A. Hagenbach brings further evidence to support his contention, put forward in 1900, that gases are capable of dissolving and ionising salts. He made up a cell of platinum and copper electrodes, with a solution of rubidium iodide in liquid sulphurous anhydride. RbI was chosen on account of its great solubility and conductivity when dissolved. He then measured the resistance and E.M.F. of the cell at temperatures ranging from 26deg. to 157deg. At the latter point, which lies above the critical temperature, the cell acquired a resistance of 500,000 ohms, but the E.M.F. was not sensibly affected, being about 0·1 volt as against 0·07 volt at 26deg. and 0·12 volt at 100deg. The copper electrode was oxidised, and formed iodide of copper. The experiment shows that a gas is capable of ionising a salt held in solution—*i.e.*, of overcoming the ionic energy which binds opposite ions together. At the same time, the chances of re-combination are so much more numerous in a gas than in a liquid that the number of free ions is kept small. Hence the low conductiviy of gaseous electrolytes.

[A. HAGENBACH, *Ann. der Physik.*, No. 7, 1902.]

A New Capillary Electrometer.—Lippmann's capillary electrometer suffers under the defects that the mercury meniscus must not be kept for any long time in the capillary tube, and that it is difficult to get rid of gas bubbles. L. Houllevigue has designed a more convenient form, which is shown in the accompanying diagram. Instead of having a column of acidulated water between two mercury electrodes, there is a drop of mercury *ab* between two columns AB of acidulated water,



the current being introduced through platinum electrodes. An E.M.F. of $\frac{1}{20000}$th of a volt suffices to bring about a legible displacement of the mercury, and the apparatus may be rendered even more sensitive by reading, not the actual displacement, but the rate of displacement on tilting, which undergoes a perceptible acceleration or retardation on applying the E.M.F. For getting rid of bubbles, &c., the drop is brought into the wide tubes.

[L. HOULLEVIGUE, *Journal de Physique*, June 1902.

Liquid Thermometer for Very Low Temperatures.—R. Rothe specifies an improvement upon the use of petroleum ether for very low temperatures such as that of liquid air. The liquid recommended is what is known in Germany as "technical pentane," which probably contains a few per cent. of unsaturated carbohdrates. It has about the same coefficient of expansion as petroleum ether, boils at about 25deg., and can be used without further purification or drying just as it is bought. Pure pentane, indeed, is not suitable at all, since it precipitates solid conglomerates at the temperature of liquid air. Iso-amylene does not answer the purpose as it solidifies above that temperature. A mixture of both which might be used has not yet been discovered. As the viscosity of the technical pentane increases considerably towards −200deg., care must be taken that the cooling proceeds slowly. No difficulty is encountered in storing the liquid, as its boiling point is high enough.

[R. ROTHE, *Zeitschr. für Instrumk.*, June, 1902.]

Discharge between Flames.—J. Semenov has continued his researches on the discharge between and through flames, and

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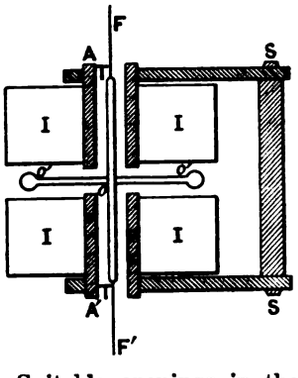
has arrived at some conclusions of great interest. He compares a straight flame with a pointed conductor, whose density of charge is, of course, greatest at the point. In the case of a flame, the charge produces a diminution of pressure within the flame. With an induction coil giving sparks of 20cm., and an original pressure of 2cm. of water in the flame, a manometer indicates a depression of 2mm. or 3mm. of water during the discharge. When the distance between two such flames is too great to allow of the passage of a spark, brushes appear at both flames, but in the case of the positive flame the brush is attached to it by means of a luminous thread 1cm. in length. When the flames are brought closer together the brushes are converted into a spark, and what the author makes out is that the current of air accompanying the positive brush contracts and forms the spark. There is no sudden transition of one form of discharge into another; for if a point wheel is substituted for the positive flame, its velocity of rotation diminishes steadily as the distance diminishes, and the brushes give way to the spark. The latter, then, consists of a positive air current and positive metallic ions. The author further proves that the negative air current proceeds in the opposite direction, and surrounds the spark like a sheath. If the spark has a diameter of 4mm. the negative sheath has one of 6mm. or 7mm. It extends as far as the positive pole if the spark is straight.

[J. Semenov, *Comptes Rendus*, June 16, 1902.]

Electrostatic Effect of Magnetic Variation.—Having apparently disproved Rowland's electric convection experiment, V. Crémieu presented another "Crémieurie" to the acumen of physicists by proving that the making or breaking of a magnetic circuit produces no impulse upon an electrostatic charge placed at its centre. To meet an objection raised by Carvallo (*Comptes Rendus*, June 9th) the author publishes the following experiment. A closed magnetic circuit, ASSA', excited by the coils II, contains an iron tube, AA', in which a light metallic rod, TT, is supported by a thin wire F, and held by



a silk thread F'. Suitable openings in the iron tube allow six light horizontal bars, oo', to penetrate the walls, and to the ends of these bars are attached six metallic spheres 15mm. in diameter, or six sectors of 20deg. The spheres or sectors are charged through the wire F, and every time the coils are excited an impulsive deflection should theoretically be shown by the spheres or sectors. The result, which according to Maxwell's theory should be very perceptible, is always nil. The author, therefore, maintains that no electric force is created in dielectrics by magnetic variations.

[V. Crémieu, *Comptes Rendus*, June 16, 1902.]

Period of the Zodiacal Light.—L. Décombe puts forward a curious interpretation of the 11-years' period of sun spots and of the zodiacal light. He considers that these periodic variations are of an electromagnetic character, and are propagated through what must be regarded as the residue of a flat solar nebula which extends far beyond the earth's orbit. The variations will die out in the course of time, but will persist, and have persisted, very long on account of the very slight damping they undergo. If they obey the ordinary laws of the vibrations of free plates, the sun must be at a ventral segment and the circumference may be regarded as a nodal line. The relation between the radius D of the disc, the velocity of propagation, V, of the disturbance, and the period T is given by the formula

$$D = VT.$$

Putting T = 11 years and V = the velocity of the slowest cathode rays, D comes out as about 10 times the distance of Neptune. The author vaguely suggests that the medium of propagation consists of free electrons or ions, but does not appear to take account of the fact that this would entirely alter the dynamical aspect of his speculation. In any case, the idea is novel and suggestive, and may prove useful in a somewhat modified form.

[L. Décombe, *Comptes Rendus*, June 9, 1902.]

Magnetic Deflection of Becquerel Rays.—The electrometer method offers certain advantages over the photographic method of studying the magnetic deflection of radium and uranium rays, inasmuch as quantitative results can be obtained and each experiment lasts a shorter time. E. Rutherford and S. G. Grier have, therefore, employed the electrometer method for determining the quantity of deflectible and non-deflectible rays in each kind of radiation, and for finding the degree of ionisation produced by the various types. They find that all permanently radio-active substances send out both deflectible and non-deflectible rays, except polonium, which only sends out non-deflectible rays. The latter consists, as is now assumed, of heavy positive ions, whose mass is so large that the magnetic field, in spite of its action upon the positive electrons contained in them, fails to overcome the inertia of the particles sufficiently to deflect them perceptibly. The negative electrons, on the other hand, are free. They are much less easily absorbed than the positive ions, on account of their small mass, but are easily deflected for the same reason. It would be interesting to know if polonium acquires a negative charge while it radiates. In any case, it cannot be described as a permanently radio-active substance. The authors' Paper suffers under the somewhat usual American fault of diffuseness and lack of system, and there are some bad misprints in the German translation. But an interesting and important result obtained is that the ionising power of the positive ions is about five times as great as that of the negative electrons. This leaves us in the dark as to what the superior energy consists in, whether it is the greater mass or velocity or charge of the non-deflected particles. But this will probably be cleared up together with the source of the energy of projection.

[Rutherford and Grier, *Physikal. Zeitschr.*, June 1, 1902.]

Oxy-acetylene Burner.—M. Fouché has devised a new oxygen-acetylene burner, in which the admixture of ether vapour is dispensed with, and a much higher temperature is attained. One volume of acetylene is mixed with 1·8 volumes of oxygen, this quantity being intermediate between the quantities required for combustion to CO and complete combustion respectively. The pressure used is higher than that formerly employed, being that of 400cm. of water, and the two gases are mixed inside the apparatus, back-lighting being prevented by means of porous bricks. The muzzle velocity of the gases must be 100m. to 150m. per second. The flame presents at its centre a greenish dart of extremely high temperature, and only about 6mm. long. Iron and steel can be soldered at the point with ease, and the flame neither oxidises nor carburises the iron. Silica is fused and volatilised. Alumina, magnesia and Drummond lime are also fused. On diminishing the quantity of oxygen the flame becomes luminous, and when it is projected on to chalk calcium carbide is produced. With a higher proportion of oxygen the flame becomes oxidising, as may be seen on fusing a piece of iron in it.

[Fouché, *Bull. Soc. Franc. de Phys.*, No. 182, June 6, 1902.]

Ionised Vapours.—F. Campanile and G. di Ciommo have tested whether ionised air, on being mixed with the vapour of a volatile liquid, undergoes any change of conductivity. They exposed a stream of air to Röntgen rays and then conducted it into a bottle containing a small quantity of alcohol, chloro-

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form, glycerine, turpentine, carbon bisulphide or water. In every case there was an increase in the conductivity, which was somewhat in accordance with the volatility of the liquid. Alcohol and turpentine produced about 30 per cent. of an increase. The mere presence of the vapour alone is not the determining factor, since, when ordinary air is passed through, the nature of the liquid is quite immaterial. The authors suggest that the vapours arising from a volatile liquid are initially ionised, but this explanation is not in accordance with other observations.

[CAMPANILE and DI CIOMMO, *Physikal. Zeitschr.*, June, 1, 1902.]

MR. J. H. RIDER'S PRESIDENTIAL ADDRESS TO THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.*

In occupying the presidential chair at the seventh annual convention of the Incorporated Municipal Electrical Association, my first duty is to thank the members for the honour they have done me in electing me to such a high and responsible position. It is no small thing to be the president of a body which is now representative of nearly 150 municipalities in the United Kingdom. Taking, as I did, some little part in the formation of the Association, it has been a matter of great personal gratification to me to watch its gradual growth from 1895, when some 25 engineers modestly formed themselves into the Municipal Electrical Association, up to the present, when we number not only about 210 municipal electrical engineers, but also 120 municipalities themselves, among our members. The record of work done is not a great one. It is fully set out in the various annual reports of the council, and I do not propose to deal with any of the points here. As the Association grows, its influence is bound to grow with it, but its sphere of usefulness is largely determined by the funds at its disposal. This is a matter about which more will probably be said at the annual business meeting on Saturday next.

There is one important feature, however, which has never been mentioned in any of the annual reports. I refer to the great good which the Association has done, and is doing, in bringing not only municipal electrical engineers, but also chairmen of committees, from all over the country, into personal acquaintance with each other. Valuable though our Papers and discussions often are, yet, in my opinion, the informal chats, the personal experiences, and the comparing of notes which take place during the conventions, are worth all the rest put together. These are matters which do not appear in our printed *Proceedings*, but to me they form probably the most enjoyable part of the whole convention. At nearly all our previous conventions we have had a Paper from a chairman of committee, and this year one on "Repayment of Loans" was to have been given. In consequence, however, of the subject having been so fully discussed at our special meeting in February last, it was decided to withdraw it. I hope, notwithstanding this, that the engineering matters which will be brought before you, in the Papers which follow, will not prove uninteresting even to the layman.

One of the subjects with which the municipal electrical engineer of to-day has to deal, and which has developed in this country almost within the life of this Association, is that of electric street tramways. In 1895 there were but five at work, and, with the solitary exception of Blackpool, they were all owned and operated by companies. At our 1896 convention I read a Paper in which the possibilities of a combined tramway and lighting load were pointed out and in which attention was drawn to the economies which were likely to result from such an arrangement. To-day there are 36 electric street tramways in operation, which are owned by municipalities, and 16 others in progress of construction. Of the former 28 are, and of the latter 11 will be, supplied with current from a municipal combined lighting and tramway station. There are also four instances in which the municipal station is supplying current to tramways owned by companies.

These figures bear testimony to the appreciation in which the principles of combination are held by municipal electrical engineers, principles which this Association has taken no small part in emphasising from time to time. If evidence be required of the economies to be obtained from a combined lighting and tramway load, we need only turn to a recent issue of the *Electrical Times*. In a list which is there given of those towns holding the record for lowest costs, the seven lowest have combined stations. Without in any way wishing to draw invidious comparisons, I cannot help mentioning two towns, the costs of which are analysed in the issue above mentioned. I will refer to them here as A and B, and I set out, in parallel columns, the figures relating to each :—

For year ending March 31, 1902.	A	B
Supply started	October, 1894.	January, 1893.
8 c.p. lamps connected	90,057	130,550
Units sold for lighting	1,121,069	1,490,099
Units sold for tramways	1,999,640	...
Average price obtained for lighting	3·41d.	3·83d.
Average price obtained for tramways	1·5d.	...

So far, therefore, as lighting goes, B has a greater lamp connection a larger output, and a bigger price per unit. But A has a combined lighting and tramway load, while B has a separate tramway station. Now let us look at the financial results. B has a deficit for the year of £2,783, with a total cost per unit of 2·35d. A has a net surplus of £4,752, and holds the record with a total cost per unit of only 0·96d. That these excellent results are largely due to the tramways I am sure the authorities at A would be the first to admit.

With about three exceptions, the whole of the electric tramways in this country are worked by the trolley system, and it is worthy of note that no company, whose first aim, after all, is to pay a dividend, has adopted any other. The Wolverhampton Corporation is experimenting with a surface contact system, the Bournemouth Corporation is putting down a short length of underground side-slot conduit, as part of a general scheme of overhead traction, and the London County Council has adopted the centre-slot conduit for practically the whole of its lines. The members of this Association are invited to inspect some of this latter construction on Friday next. The costs of the road construction for these three distinctive types of electric traction vary largely according to the local conditions, but are generally somewhat as follows—viz. :—

Overhead construction	£5,000	per mile of single track, including rails and paving in each case.
Surface contact construction	10,500	
Conduit construction	13,500	

In the face of the very great saving in capital expenditure, which can be made by adopting the overhead system, what are the conditions which would warrant the use of the conduit system? In the first place, in my opinion it is not warranted, unless a car service can be maintained with not greater than a two minutes' headway. The capital charges on the road construction are so heavy, that the only way to bring down the cost per car-mile is to increase the number of car-miles as much as possible, by working the lines for all they are worth. Several corporations have recently been considering the use of the conduit in a similar manner to Bournemouth—viz, for a small portion in the centre of the town, with the overhead system outside. I do not think the conduit is warranted under such circumstances. Certainly the additional cost, for such a short length, may be very small, when compared with the cost of the whole scheme. But is it worth while burdening the undertaking with a combined system, merely for æsthetic considerations?

It may be argued that such combined systems are working satisfactorily in Washington, Paris, Berlin and other places, and that the change from the conduit to the overhead wire, and vice versa, can be made in a very few seconds. That is quite true, but they mean (1) the constant additional labour of at least one man at each changing place, (2) the carrying of the idle trolley over the conduit section, and (3) either separate machines and feeders for the conduit conductor bars, or the permanent earthing of the negative bar, because of the rail return of the overhead section. With regard to the carrying of the idle trolley over the conduit section, this is quite an easy matter when single-decked cars are used, as the trolley arm can lie down flat on the car roof, and thus hardly be seen. But, with double-decked cars, there are several practical difficulties, since the arm must be kept out of the way of the passengers. The use of separate machines and feeders for the conduit section means considerable additional expense, but this cannot be avoided, if the advantages of an insulated negative conductor bar are to be retained.

The abandonment of the overhead for any other system, merely for æsthetic reasons, is, in my opinion, not justifiable. The examples of overhead construction, to be seen in several towns in the United Kingdom, are anything but pretty. Some of them are even ugly. But that is the fault of the designer, and not of the system. It is perfectly easy and practicable to design and erect an overhead line which shall look well in almost any locality. Neat, and even artistic, work costs very little more than rough and unsightly work. When, then, are we justified in adopting the conduit system? (1) When the traffic over the lines is so great that the heavy capital charges do not make any serious addition to the costs per car-mile. This is a condition of things only met with in metropolitan cities, and, after all, is no reason why the overhead system should not be used. (2) When the powers for the tramway can only be obtained on the condition that the conduit is used. (3) When the system of lines is so complicated that the overhead construction becomes cumbersome and dangerous. Both (2) and (3) are again controlled by (1), since, unless the traffic can be guaranteed, the line cannot pay, and had, therefore, better not be constructed.

* Delivered in London on Wednesday.

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One of the principal difficulties in designing neat overhead construction is that of guard wires. Many an otherwise neat line is entirely spoiled by them. Acting apparently with a view to the safety of the public, but really to protect the telegraph and telephone interests, the Board of Trade has recently issued a new set of regulations based practically upon those adopted by the Post Office. In order to hear the views of the various tramway authorities upon these regulations, a conference was held a week or two ago, at the offices of the Board of Trade. On the advice of the officials of the Post Office, and of the National Telephone Co., the Board of Trade refused to allow the principles of guard-wire protection to be discussed, and would only permit remarks on the various regulations which were proposed.

As is well known to those with the largest experience in overhead traction work, guard wires may be a protection in some few cases, but in the large majority they are the means of causing the very accidents which they are intended to avoid. Being of necessity only small wires, they are a constant trouble to maintain. They are very liable to break when heavy telegraph or telephone wires fall upon them. A number of automatic devices have recently been placed upon the market, with the object of cutting off the current should any other wire fall across the trolley wire. But neither guard wires nor any of these devices strike at the root of the matter, which is to prohibit entirely uninsulated wires of any kind crossing the trolley wires. If telegraph and telephone wires must be erected overhead they should only be allowed to cross the streets at right angles, the spans should be kept exceedingly short, and the wires carried as high up as possible, in order that a broken wire may not reach the street. They should be insulated at such crossings, and, if guards are insisted upon, in addition to the above, they should be provided by a netting or similar arrangement under the telephone wires, and not over the trolley wires. The recent accidents, which have happened in Liverpool and other towns, have been caused just as much by the telephone wires as by the trolley wires, but, in the mind of the public, they are called trolley-wire accidents, and nothing else. If local authorities would insist on all telephone wires being placed underground, there would be no necessity for guard wires, or such like unsatisfactory half measures.

Before bringing these somewhat rambling remarks to a conclusion, perhaps I may be permitted to say a few other words, more particularly to our younger engineer members. A visit to a number of electricity works in this country leads one to the conclusion that, in too many cases, plant of too small a size has been put in. By this I do not mean not enough plant, but generating sets for too small an output. Those responsible for the design of the works did not seem to have been very sanguine as to the future of the undertaking, and so they put in sets for as small as 50kw. output, and in some cases even smaller. In the course of a few years, when the station has grown, these sets have become too small, and are either never used or are sold at a loss. Surely, if we expect the business of electricity supply ever to approach the extent of gas supply, we should lay out our power-stations on generous lines, and put in plant with an idea to its future economical use, rather than to its suitability for just the number of customers we may have for the first year or two. I do not mean that we should put in plant enough to supply the town for the next 10 years. Such a thing is the prerogative of those gentlemen who are paid by commission. But we should select such sizes that they will form a useful part of a well-designed whole, even though they may be apparently much too large for immediate purposes.

The generating stations which we are able to visit, and the systems which we are able to inspect, during our conventions, are great object lessons to us. We can learn not only how to improve our own works, but, also, in many cases, what to avoid. No one among us has a monopoly of skill or ideas and the most able can learn something, even from the beginner. Electrical engineers are too apt to stay at home, to be content with their own plant, and to become even fossilised. In such a progressive science as electrical engineering, we must keep up with the times, or we shall certainly fall behind in the race. My advice to the municipal electrical engineer is, to travel (at the expense of somebody else, if he can), to inspect other people's stations and systems, and to discuss with other engineers the numberless points which arise in everyday work. This Association has already done a great deal in affording facilities for this. I know what it has done for me, and I cannot think I am alone in the matter.

I thank you, gentlemen, for the patience with which you have listened to these wandering words of mine, and I hope that this, our seventh annual convention, may be no less enjoyable and instructive than those which have preceded it.

Telephones on Electric Tramways.—All the cars of the Portland City (Ore.) and Oregon trolley line now carry telephones. At every switch the instrument in the vestibule of the car may be connected with the circuit running to the main office. A forked device, about 2ft. long, is hung on wires that are placed on an arm extending from the trolley poles.

DOUBLE-CURRENT GENERATORS AND THEIR APPLICATION.*

BY E. T. RUTHVEN-MURRAY.
(Electrical Engineer to the Willesden District Council.)

Previous to the year 1896 it might be said truly that continuous-current distribution was only employed when a small compact area had to be supplied. The superior limit of low pressure for continuous current, as defined by the Board of Trade regulations, then stood at 300 volts, and already many of the larger undertakings had reached the limit of economical supply from their existing works. It having been recognised that the limit of voltage set was undesirably low, and that it might be increased with safety to the public and the consumer, and to the mutual advantage of both the latter and the proprietors of the undertakings, the Board of Trade was petitioned to amend the regulation defining the limit of low pressure. After a lengthy conference with the engineers in charge of supply works and others interested, the definition was amended to read, "Where the conditions of the supply are such that the pressure may at any time exceed 500 volts if continuous, or 250 volts if alternating, but cannot exceed 3,000 volts, whether continuous or alternating, the supply shall be deemed a high-pressure supply." It appears at first sight that alternating-current distribution is handicapped, but this is not the case, since the first regulation provides that: "The pressure of a supply delivered to any consumer shall not exceed 250 volts, at any pair of terminals, except with the express approval of the Board of Trade." From this it is evident that a three-wire continuous current system with 500 volts across the outers is a low-pressure system, but a three-wire alternating supply with the same pressure is a high-pressure system. If, however, the middle wire is earthed, and only one outer conductor is brought into each consumer's premises so that the 250-volt limit cannot be exceeded, the supply is at low pressure.

The alteration of the limit to 500 volts enabled existing works to double their supply pressure and to deliver four times as much power from their existing mains with the same percentage line loss as before and without additional capital expenditure. But what was, perhaps, more important is that it also enabled supply to be economically given to consumers four times as distant from the works, and by this circumstance it opened a new field for continuous current. The satisfactory result has been a very large increase in the number of works supplying on this system. But many of these are now finding the limitations of direct supply, and a flexible and economical means of dealing with the increase in area, output and number of consumers is being eagerly sought.

One method of dealing with the increase is to build additional generating works, but this is neither an economical nor a satisfactory solution of the difficulty. The advantages of concentrating plant in large works and in large units is being more and more recognised, and a scheme in which this is possible will generally secure preference. It becomes economical to use high-pressure transmission to the more distant parts of the area of supply, and for this purpose either continuous or alternating current may be employed. The former is either generated in special machines delivering the full line pressure, or by lower voltage machines connected in series. Obviously the high-tension machines are the more convenient and efficient arrangement, although a considerably higher line pressure has been obtained safely from armatures in series. It is probable that 3,000 volts is the safe limit of pressure to generate in a single armature, since at a higher pressure the risk of flashing over on the commutator is considerable.

Alternating current, either single or polyphase, is generated either by simple alternators or by double current dynamos, the latter being machines designed to supply alternating or continuous current from one armature. If generated at low pressure, step-up transformers are used to get any economical line pressure required. The necessity for supplying beyond the economical limits of low pressure generally comes gradually, and the tendency is, therefore, to put in small units of the special type of plant chosen when the demand arises. The double-current machine may be put in for use entirely as a continuous-current dynamo until the necessity for long distance transmission requires it to be employed as an alternator, and it therefore may be installed even in the earliest days of the undertaking. In construction, such a machine is identical with a rotatory converter. It may be regarded either as a continuous-current dynamo with the addition of slip rings, from which alternating current may be taken, or as an alternator with the addition of a commutator, from which continuous current may be taken. It is, of course, well known that every armature generates alternating current, and that to obtain continuous current a commutator must be used to cause the generated currents to flow always in one direction. In the case of the double-current dynamo, as the armature windings are connected to both commutator and slip rings, both alternating and continuous current may be taken simultaneously from the machine.

* Paper read before the Incorporated Municipal Electrical Association on Wednesday.

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The frequency, or periodicity per second, of the uncommutated current generated in the armature of a two-pole dynamo will be the same as the number of revolutions per second, so that in the case of a machine running at, say, 375 revs. per min., it will be 6·25. In a multipolar dynamo there will be as many periods per second for every revolution of the armature as there are pairs of poles, therefore :—

$$\text{Frequency per second} = \frac{\text{poles} \times \text{revs. per min.}}{60 \times 2}$$

Frequencies of less than 25 per second have seldom, if ever, been used, but 25 periods per second not only has been recommended by the Institution of Electrical Engineers as the lower "uniform standard frequency" for use, but possesses many advantages for the purposes recommended in this Paper. To obtain this frequency only certain speeds are available, since it will be seen the product of pairs of poles × revolutions per minute must be 1,500, therefore a 2-pole dynamo would require to run at 1,500 revs. per min. ; 4-pole, 750 ; 6-pole, 500 ; 8-pole, 375 ; 10-pole, 300 ; 12-pole, 250 ; 14-pole, 214 ; and so on.

To obtain a single-phase alternating current from the armature of a two-pole dynamo, two tappings must be made 180deg. apart ; for two-phase, four tappings 90deg. apart ; for three-phase, three tappings 120deg. apart ; or if the dynamo is of multipolar type there must be the same number of tappings and the same angular relationship per 360 electrical degrees or per pair of poles.

The relationship of the continuous and alternating virtual voltages and currents is practically fixed, and will be as shown by the following diagrams, if it be assumed that the magnetic flux is distributed as a sine function with respect to the periphery of the armature, and that the circuits are non-inductive. In applying these figures in actual practice drop of voltage due to the resistance of the winding must be allowed for.

For three-phase double-current generator or rotatory converter :—

$$(n=3),$$

$$v = \frac{V}{\sqrt{2}} \sin 60° = \frac{\sqrt{3}V}{2\sqrt{2}} = 0{\cdot}612V,$$

$$a = \frac{\sqrt{2}A}{3 \sin 60°} = \frac{2\sqrt{2}}{3\sqrt{3}}A = 0{\cdot}545A,$$

$$a = \sqrt{3}a = \frac{2\sqrt{2}}{3}A = 0{\cdot}943A.$$

The ratio of the alternating to continuous voltage will remain practically constant, as in the case of the continuous current motor-generator, in which a double wound armature rotates in a single field, and any variation required must be obtained by the use of regulators in conjunction with the transformers. The double-current generator may have either separate, shunt, or compound field excitation. If the machine be required to supply both lighting and traction circuits simultaneously, or other similar rapidly varying loads, separate excitation will give the best regulation. It is also of great importance that the engine should govern as closely as possible consistent with good parallel running of the dynamo as an alternator, and that the turning moment should be even. If rotatory converters or synchronous motors are to be operated from the circuits, experience shows that the maximum variation from absolutely even angular velocity must not exceed one-fourth of 1 per cent. per revolution. Fig. 4 represents diagrammatically a compound-wound double-current generator, with three-phase, mesh-grouped, step-up transformers for supplying the transmission lines.

The slotted core, drum-wound armature, as used in most modern continuous-current dynamos, is especially suited for generating alternating current at low pressure, since, by reason of the distributed

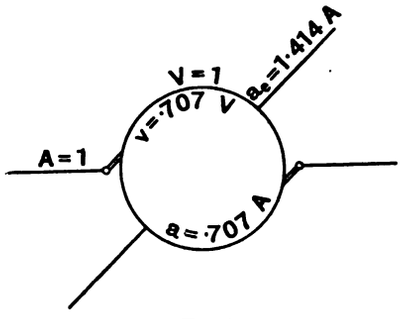

Fig. 1.

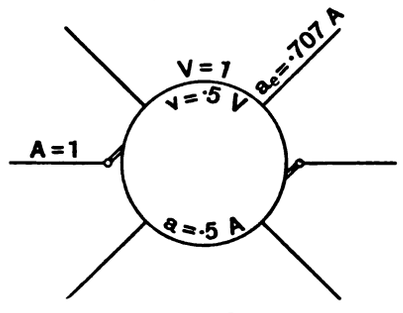

Fig. 2.

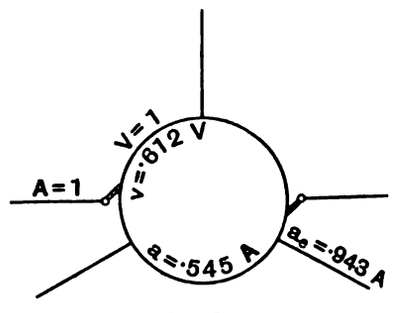

Fig. 3.

Figs. 1, 2 and 3 are respectively the cases of single-phase, two-phase, and three-phase, in which :—

V = E.M.F. between continuous-current brushes.
A = Current from continuous-current brushes.
v = Virtual volts between adjacent slip rings.
a = Virtual amperes in armature winding between adjacent slip rings.
a_e = Virtual amperes flowing to external circuit from each slip ring.
n = Number of slip rings.

The general formulæ for obtaining these values are as follows—viz. :—

$$v = \frac{1}{\sqrt{2}} V \sin \frac{\pi}{n},$$

$$a = \frac{\sqrt{2}A}{n \sin \frac{\pi}{n}},$$

$$a = 2a \sin \frac{\pi}{n}.$$

For single-phase double-current generator or rotatory converter :—

$$(n=2),$$

$$v = \frac{V}{\sqrt{2}} \sin 90° = \frac{V}{\sqrt{2}} = 0{\cdot}707V,$$

$$a = \frac{\sqrt{2}A}{2 \sin \frac{\pi}{n}} = \frac{\sqrt{2}}{2}A = 0{\cdot}707A,$$

$$a_e = 2a = \sqrt{2}A = 1{\cdot}414A.$$

For two-phase double-current generator or rotatory converter :—

$$(n=4),$$

$$v = \frac{V}{\sqrt{2}} \sin 45° \frac{V}{2} = 0{\cdot}5V,$$

$$a = \frac{\sqrt{2}A}{4 \sin 45°} = \frac{A}{2} = 0{\cdot}5A,$$

$$a_e = 2a \sin 45° = \frac{A}{\sqrt{2}} = 0{\cdot}707A.$$

winding the voltage curve will be very nearly a sine curve, and the armature reaction will be much less than in the usual mono-tooth alternator windings, and the regulation will be much better. The latter type of winding frequently results in a saw-tooth curve, which, having a higher maximum value, will subject the insulation of the cables, transformers, &c., to greater stress. Demagnetisation of the fields due to lagging current, arising from an inductive load, is also minimised in the distributed type of winding.

From every point of view the double-current dynamo is a good alternator, but mechanical considerations make it a less easy problem to commutate for continuous current if the voltage is not low. This arises from the fact that the peripheral speed of the commutator must be kept within practical limits, so that there may be no risk of the segments buckling on the one hand ; but, on the other hand, the voltage between adjacent segments and the width of these must be such as to ensure satisfactory operation. The problem, although by no means very simple, has been successfully solved by a few engineers who have built this type of machine. Its special sphere of usefulness is in the economical supply of large areas in which continuous current is to be distributed. It may be employed with advantage where otherwise separate continuous and alternating machines would be put down, and by its employment economy in both capital expenditure and running expenses will result—the former because one such machine will be a spare for either class of service, and the latter because by combining the outputs larger units of plant may be adopted, since it is quite feasible to take continuous and alternating current from the same machine simultaneously.

A number of large double-current generators are now in use in America for both lighting and tramway service ; in several cases the frequency of the alternating current being 60 per second. It is within the writer's knowledge that there will shortly be at least four electricity supply works in this country using double-current machines. The largest will be of 1,200kw. capacity. Three generators of this size—32-pole machines runnning at 94 revs. per min. are being put down to operate the Mersey Railway. The frequency will be 25 per second, and the continuous-current voltage 650.

The author is putting down two 300kw. double-current generators at the present time, some particulars of which may be of interest. Each dynamo will deliver continuous current from the commutator

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and three-phase alternating current from the slip rings, and is capable of giving:—

1. The full output as a continuous-current dynamo with either shunt or compound excitation.

2. The full output as a three-phase alternator.

3. Any proportion of continuous or alternating current up to the full output of the machine.

Each machine will carry 20 per cent. overload for two hours, 40 per cent. overload for short periods, and, while delivering full load on either alternating or continuous-current side, will be capable, at the same time, of delivering 50 per cent. of full load on the other side for one hour without injurious heating. From no-load to 20 per cent. overload collection will be sparkless, with no alteration to the lead of the brushes. The working pressure on the continuous-current side will vary between 480 and 560 volts as shunt, and 500 to 550 volts as compound, the voltage on the alternating-current side being 0 61 per cent. that of the continuous. The dynamos will be 12-pole, running at 250 revs. per min., and the frequency will be 25 per second. At a later date the author hopes to give some particulars of the performance of these machines, and also of the rotatory converters to be used in conjunction with them.

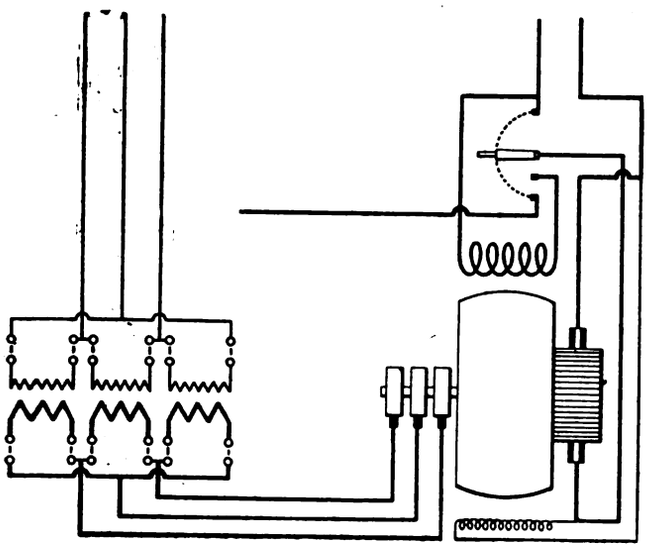

FIG. 4.

Where step-up transformers are required to raise the alternating voltage for transmission lines, three-phase will be preferred in most cases.

From the unalterable ratio of the alternating and continuous-current voltages it is evident that the excitation of the machine must be varied to meet the needs of one class of output only, and it will probably be found most convenient to regulate the field for the continuous-current output as if the machine were a simple continuous-current dynamo. The regulation on the alternating circuits may be then effected at either end of the transmission lines as may be most convenient. Unless a very high-line voltage is employed, it is preferable to arrange the transformers in mesh connection rather than star, with the transformers fused at both ends of each winding, as with this arrangement the supply may be maintained to two-thirds full output on the remaining transformers and lines in the event of one transformer or line failing. For the transmission lines multiple-core cables should be used; concentric cables, by reason of the difference in the conductor capacity, give rise to troublesome unbalancing effects.

To convert the alternating current to continuous at the sub-stations motor-generators (having either induction motors or synchronous motors) or rotatory converters may be used. An advantage possessed by the motor-generator is that the full line pressure may be taken, in many cases, into the motor, and the use of transformers avoided. The induction motor enables easier starting from the alternating-current side, but will produce a lagging current. The synchronous motor may be excited to give unity power-factor at all loads, as by under-exciting the fields a lagging current, and by over-exciting a leading current, will be produced. The effect of the former on the generator is to weaken the field strength and of the latter to increase it. As a wattless current reduces the useful output of both plant and mains, it is very desirable to secure a good power-factor, which may be obtained by the use of either synchronous motor generators or rotatory converters. The motor of a motor-generator set may obviously drive a dynamo of any type, series, shunt or compound-wound, or a pair of dynamos for balancing on a three-wire system. The efficiency of the combined machines will not be so high as if a rotatory converter and group of step-down transformers is used by from 5 to 7 per cent., although the voltage of the continuous-current machine will be quite independent of the variations on the alternating circuit.

When rotatory converters are used, step-down transformers must form part of the equipment, and, where lighting service is given, in which widely varying voltages are required, special apparatus must be used either on the step-up transformers to the line, or on the step-down transformers to the rotaries, to get this variation. In one arrangement tappings are taken from either the primary or secondary winding of the transformer and connected to a multiple contact switch of somewhat similar design to a battery regulator. The contacts must be numerous, so that the increase or decrease in the secondary pressure, as the switch is moved from contact to contact and the ratio of the transformation is varied, is not noticeable. Another arrangement may be employed in which the transformers are of the usual constant ratio type and inductance regulators are used to increase or decrease the pressure by producing a change in the phase relation of the primary and secondary voltage. This regulator is practically an induction motor with a very small air-gap, in which the rotor does not revolve by itself, but may be moved through a small angle. The secondary winding is on the stator, and the primary on the rotor. With this arrangement a perfectly gradual variation of voltage is obtained, although the range of variation will be less than in the method previously described.

There is a very interesting application of the rotatory converter, and also of the double-current generator, for balancing on a three-wire continuous-current circuit. If the alternating-current circuits of either machine are connected to star-grouped transformers, the middle wire of the three-wire circuit may be taken to the centre of the star, and balancing be effected in the machine. With transformers suitably proportioned and wound, an out-of-balance current up to as much as 75 per cent. of normal full load capacity of the machine may be dealt with in this manner. In the matter both of efficiency and cost the rotatory converter, including the necessary transformers, will show a considerable advantage over any type of motor generator, and either or both may be used to convert the alternating to continuous current. The rotatory converter has also an enormous overload capacity which renders it invaluable in certain cases.

Within the limits of this short Paper no attempt has been made to deal exhaustively with the whole problem of combined continuous and alternating systems, as the author's main object has been to direct attention to some of the uses and advantages of the special type of machine known as the double-current generator.

THE INTERNATIONAL TRAMWAYS CONGRESS.

The twelfth annual congress of the Union Internationale Permanente de Tramways was inaugurated on Tuesday last at the Agricultural Hall, Islington, N., under the presidency of M. Leon Janssen. Most of the proceedings took place in French, but occasionally in German or English. An interpreter summarised each speech in English for the benefit of those who understood not the Continental languages. We give below a synopsis of the proceedings on Tuesday and Wednesday:—

Tuesday, July 1st.

Sir C. Rivers Wilson, who will take the chair at all the meetings, speaking in French, said that, although this was the twelfth congress, it was the first which had been held in Great Britain. Although feeling this to be a great shame, it was neither the fault of the Union nor of the British industry. In his opinion the fault lay elsewhere. In Great Britain we prided ourselves on being a land of liberty, but this liberty had been abused in order to oppose the advance of the industry in which they were all interested. He was, however, delighted to see the foreign members, which would, no doubt, be decidedly helpful in advancing the interest which they all had at heart.

M. Lavalard then read his Paper on "Transfer Tickets." The discussion on this Paper was not of very great importance, and M. Röhl, president of the German Tramways and Light Railways Association, proposed that a commission should be formed to study this important matter. Every county and every town was different, and the congress could not come to a hasty conclusion. Such a commission as he suggested should, therefore, be appointed to report to the next congress.

M. Rasch then read his Paper on "A Proposed Basis for Estimating the Power of Motors."

The discussion was brief. Mr. McCroskie, who gave much attention to this matter in connection with the Paris Exhibition, suggested that the regulations and specifications described by the German Institution of Electrical Engineers should be accepted. Indeed, these were the only ones of their kind that had been formulated up to the present time, and they could not do anything better than accept them. M. Pedviali, of Brussels, made a similar proposal. M. Rasch held that the German regulations, as they now stood, were not sufficiently detailed for tramway working, and wished that the Union would take up the question further and add clauses with reference to tramway working. Mr. R. H. Scotter mentioned that in England there was a standardisation committee

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sitting, under the presidency of Sir William Preece, F.R.S., and the whole question was coming up sooner or later for discussion. He was sure this committee would be most happy to help the Union in any way. Perhaps a discussion of the matter on the part of both the committee and the Union would aid them in arriving at something like what might be called a universal standard. Another German speaker pointed out that the Americans had had a good deal more experience in tramway work than Germans had, and that the German conditions did not come up to those which American makers applied to their machines. He proposed that American methods of testing be adopted, and that the question of sparking and the overload should receive more attention than had hitherto been the case. M. Rasch pointed out that although in his abstract of the Paper he had not mentioned the question of sparking, this matter was dealt with in the Paper. The one difficulty concerning it was that accurate measurements could not be made. M. Doh, of Brussels, thought something should be done at once, as at the present rate at which work was going on in different countries with different specifications, it would eventually be very difficult to procure any uniformity whatsoever. Mr. R. H. Scotter undertook to place the discussion before Sir William Preece's committee at the earliest possible moment, a suggestion which was agreed to.

Wednesday, July 2nd.

Proceedings commenced as usual at 9:30 a.m., the chair being taken by Col. Boughey, H.M. Commissioner of Light Railways. A useful Paper by M. Ch. Thonet on "Central Stations" was the first read, but unfortunately led to no discussion, the chairman ruling that it hardly lent itself for discussion. The next Paper, on "Conditions under which Tramways may be Laid in Roads," read by M. Albert Janssen, dealt more with questions as to the financial terms for the concession for road tramways than with engineering matters. The Paper is, therefore, of little technical interest, the more especially as the terms for such concessions differ so widely in different countries. A Paper followed on the comprehensive subject of "Legislation in All Countries Relative to Tramways and Light Railways,' the author being Mr. R. H. Scotter. We hope to reprint this Paper in a later issue, as it is too lengthy and detailed to admit of being abstracted in this diary of the proceedings. In the discussion on this Paper several speakers took part. Mr. J. W. Addyman spoke on the legal aspects of the question, with respect to the Tramways and Light Railways Acts of this country. He advocated the encouragement of municipal trading through the agency of these acts, at the hands of the Board of Trade and the Light Railway Commissioners. Mr. Schendweiler stated that in Prussia concessions are sometimes granted with no time limit. The Government there has power to override the opposition of any municipal authority to the construction of a tramway.

Two Papers followed but were not discussed. These were a Paper on "The Arrangement of Car Sheds," by M. Trantweiler, and "Traction Systems," by M. Ziffer.

(To be concluded.)

ELECTRICITY WORKS ACCOUNTS.

Hull Municipal Electric Supply Works.

Considering the adverse circumstances of the working of this undertaking last year, the costs and the financial results generally are creditable. We learn from the engineer that the diminished total revenue was not only due to the reduction by a ½d. in the tariff, but also to the general slackness of trade in the district; that by an increase of 1s. 6d. in the £1 in the local rates nearly £200 extra was charged to the revenue; and that over £600 damage to the buildings, machinery and mains was sustained in August as the result of a phenomenal storm, when nearly 3in. of rain fell in one hour—deluging the engine room. That in these circumstances the costs of the preceding year were improved upon goes some way to discount the criticism arising from the fact that the costs are still too high at 2·35d. per unit. It is to be noted that the generating and works costs present very satisfactory figures indeed, considering the very low load-factor of 8·3 per cent. which obtained. It is to the increase in the item of rates and taxes that the total costs owe their still high value. In addition to this, the engineer's statements are confirmed by the increase in the repairs at the station, although this increase was more than neutralised by economies in other generating costs.

Passing on to the financial results, it will be noticed that, with the very moderate total revenue of 3·94d. per unit, there was a deficit representing 1·48 per cent. of the mean capital, but after the payment of capital charges out of revenue amounting to as much as 6·79 per cent. on the mean capital.

In relation to the output the capital expended appears to be very moderate at this place, and the chief requirement is a better quality of load. The present tariff scale, with its low initial price of 5d., acts, we believe, against the realisation of a good load-factor in being not sufficiently discriminating between the desirable and the undesirable consumer.

South Shields Municipal Electric Supply Works.

Last year we had cause to remark on the splendid progress which was being shown by this undertaking in the matter of costs. Again, in the accounts now before us, a most substantial improvement is recorded on the already economical figures of 1900 by which the total costs are now less than 1·44d., or, excluding the public lighting costs of attendance and renewals, 1·29d. per unit sold. This is indeed an excellent record for an undertaking with an output of under a million units in the year, and even considering the favourable load factor of 14·7 per cent. which characterised the load. All the several items of expenditure show consistently low figures.

With regard to the revenue, we quote the following from the engineer's report:—"It must not be forgotten that during this past year the charge for electrical energy has been at the rate of 7d. and 2d. per unit during the two winter quarters, whereas during the previous year the charge was 7d. and 3d. for the last quarter of the financial year, this usually being the quarter from which the greatest amount of revenue is obtained, and therefore is in itself no small item; and also the fact must be taken into consideration that the quarter was made to extend over a period of some 16 weeks by not reading the meters until the financial year had actually expired—viz., April 1st—thereby reducing the first quarter of the succeeding year by some three weeks, accompanied by a corresponding decrease in the revenue."

It would seem from this that the total revenue recorded is slightly under the true one for the year, but, in any case, it is very moderate.

Perhaps the weakest point in the financial status of this concern is the rather high capital expenditure in relation to the output. This would account for the financial results not being up to the high standard of the working costs.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 1900
Ayr (Municipal)	Oct. 11, 1901	Kens'gton & Knightsbr'(Co.)	Apr. 11, 1902
Barnsley (Municipal)	June 27, 1902	Kingston-upon-Hull (Mun.)	July 13, 1900
Bath (Municipal)	April 20, 1900	Kingston-on-Thames (Mun.)	June 20, 1902
Bedford (Municipal)	Aug. 8, 1900	Lancaster (Municipal)	Feb. 15, 1901
Belfast (Municipal)	Oct. 18, 1901	Leeds (Municipal)	June 27, 1902
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 28, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal)	Oct. 4, 1901	Leyton (Municipal)	Nov. 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Sept. 13, 1901
Bristol (Municipal)	Aug. 30, 1901	Morley (Municipal)	June 14, 1901
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	April 21, 1899	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	Aug. 9, 1901	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Nov. 29, 1901
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 16, 1901	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 28, 1900	Richmond (Company)	June 29, 1900
Croydon (Municipal)	Nov. 22, 1901	Salford (Municipal)	Jan. 24, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	Scarborough (Company)	Dec. 20, 1901
Derby (Municipal)	Jan. 26, 1900	St. Helens (Municipal)	Jan. 10, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dover (Company)	May 2, 1902	St. Pancras (Municipal)	July 5, 1901
Dundee (Municipal)	Dec. 6, 1901	Sheffield (Municipal)	Feb. 1, 1901
Eastbourne (Municipal)	Mar. 14, 1902	Shoreditch (Municipal)	Jan. 31, 1902
Edinburgh (Municipal)	Dec. 6, 1901	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Exeter (Municipal)	Aug. 5, 1898	South London (Company)	May 16, 1902
Folkestone (Company)	May 2, 1902	South Shields (Municipal)	Sept. 20, 1901
Glasgow (Municipal)	Sept. 27, 1901	Southampton (Municipal)	Feb. 8, 1901
Gloucester (Municipal)	Aug. 20, 1901	Southport (Municipal)	Jan. 17, 1902
Great Yarmouth (Mun.)	Dec. 13, 1901	Stafford (Municipal)	Aug. 16, 1901
Greenock (Municipal)	Aug. 30, 1901	Sunderland (Municipal)	Oct. 18, 1901
Guildford (Company)	Oct. 19, 1900	Taunton (Municipal)	June 16, 1899
Halifax (Municipal)	Dec. 27, 1901	Tunbridge Wells (Mun.)	Nov. 1, 1901
Hammersmith (Municipal)	Nov. 15, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hampstead (Municipal)	Nov. 22, 1901	Walsall (Municipal)	May 23, 1902
Hanley (Municipal)	Aug. 9, 1901	Wandsworth (Company)	May 9, 1902
Harrogate (Municipal)	Jan. 25, 1901	Westminster (Company)	April 4, 1902
Harrow (Company)	Dec. 21, 1900	Whitehaven (Municipal)	Feb. 8, 1901
Hast'gs & St. Leonards (Mun.)	July 12, 1901	Winchester (Company)	June 20, 1902
Hereford (Municipal)	Jan. 17, 1902	Windsor and Eton (Co.)	July 19, 1901
Hove (Company)	May 10, 1901	Woking (Company)	Dec. 22, 1899
Huddersfield (Municipal)	May 23, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Hull (Municipal)	Sept. 20, 1901	Woolwich (Company)	May 31, 1901
Isle of Wight Company)	Dec. 20, 1901	Worcester (Municipal)	April 18, 1902

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	HULL.	SOUTH SHIELDS.
Undertaking Worked by	Kingston-upon-Hull Corporation.	South Shields Corporation.
Date of Commencement of Supply	Jan. 16, 1893.	September, 1896.
System of Supply	3-wire con.-cur., with batteries and rotaries in [sub-stations.	Alt.-current trans. sub-stations with 2-w. dis- [tribution.
Chief Engineer	A. T. Barnard.	J. H. Cawthra.

YEAR ENDED	HULL. MAR. 31, 1901.	HULL. MAR. 31, 1902.	SOUTH SHIELDS. MAR. 31, 1901.	SOUTH SHIELDS. MAR. 31, 1902.
QUANTITIES—				
Units generated	1,962,657	2,308,500	944,629	—
„ **SOLD (TOTAL)**	**1,307,075**	**1,490,099**	**755,826**	**985,646**
„ sold to consumers	1,307,075	1,466,999	573,094	655,574
„ sold for public lighting, &c.	nil	23,100	182,732	330,072
„ sold for traction	nil	nil	nil	nil
„ used on works	427,341[a]	595,762	22,650	—
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**16·9**	**16·2**	**16·1**	**16·6**
Actual maximum supply demanded	1,639 kilowatts	2,044 kilowatts	705 kilowatts	767 kilowatts[g]
Load factor	9·11%	8·32%	12·24%	14·7%
Number of public lamps	nil	12 arc	84 arc, 107 glow[a]	84 arc, 283 glow[h]
Number of consumers	1,541	1,843	680	778
Connections to mains in 8-c.p. lamps at end of year	106,831	130,600	35,025	41,680
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	3,037	2,830	1,900	1,900

CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£170,415	£56·1	£244,032	£86·2	£150,837	£79·4	£150,647	£79·3
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	170,415	56·1	244,032	86·2	150,837	79·4	150,647	79·3
RECEIVED (TOTAL)	159,774	52·6	208,852	73·8	111,721[b]	58·8	136,040	71·6
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	159,774	52·6	208,852	73·8	110,782	58·3	136,040	71·6
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	10,641	3·50	35,180	12·4	40,055	21·3	14,607	7·69
Share (unissued)	—	—	—	—	—	—	—	—
Share (uncalled)	—	—	—	—	—	—	—	—
Loan (including Debentures)	10,641	3·50	35,180	12·4	40,055	21·3	14,607	7·69
REPAID (TOTAL)	11,546	3·80	21,266	7·52	3,138	1·65	5,529	2·91
RESERVE OR SINKING FUND	4,204	1·38	—	—	4,148	2·18	5,026	2·65
DEPRECIATION FUND	11,324[f]	3·73	8,588[f]	3·03	—	—	—	—
EXPENDED (TOTAL)	167,245[b]	55·9	202,483	71·5	128,489	67·6	138,801	73·1
Lands and buildings	15,727[h]	5·18	17,642[g]	6·24	15,741[n]	7·23	—	—
Plant	75,285	24·8	87,926[i]	31·1	58,666	30·9	—	—
Mains	75,083	24·7	95,765	33·8	54,572	28·7	—	—
Miscellaneous	1,150	0·379	1,150	0·406	1,509	0·794	—	—
BALANCE OF CAPITAL ACCOUNT	−7,471[c]	−2·46	6,369	2·25	−16,768[c]	−8·82	−2,761[c]	−1·45

REVENUE—	Total.	Per unit of total units sold.	Total.	Per unit of total units sold.	Total.	Per unit of total units sold.	Total.	Per unit of total units sold.
TOTAL	£24,577	4·515d.	£24,444	3·937d.	£11,925	3·788d.	£13,653	3·324d.
Revenue from supply	23,713	4·355d.	23,373	3·765d.	9,739	3·093d.	10,868	2·648d.
„ meters, &c.	769	0·141d.	934	0·150d.	280	0·089d.	336	0·082d.
„ public lighting	nil	—	122	0·020d.	1,903	0·604d.	2,448	0·596d.
„ supply for traction	nil	—	—	—	nil	—	nil	—
„ miscellaneous sources	94	0·017d.	15	0·002d.	3	0·001d.	—	—
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£13,736	2·523d.	£14,618	2·354d.	£5,914	1·878d.	£5,902	1·437d.
TOTAL WORKS COSTS	10,798	1·983d.	10,918	1·758d.	4,387	1·394d	4,397	1·071d.
Generation of electricity	*9,808*	*1·800d.*	*9,600*	*1·546d.*	*3,733*	*1·186d.*	*3,419*	*0·833d.*
Fuel (including cartage, &c.)	6,080	1·116d.	5,228	0·842d.	2,108	0·670d.	1,787	0·435d.
Oil, waste, water, stores	546	0·100d.	420	0·068d.	259	0·082d.	183	0·045d.
Wages at station	2,500	0·459d.	2,500	0·403d.	1,005	0·319d.	1,124	0·274d.
Repairs and maintenance at station	682	0·125d.	1,453	0·234d.	360	0·114d.	324[i]	0·079d.
Distribution of electricity	*990*	*0·182d.*	*1,244*	*0·200d.*	*122*	*0·039d.*	*367*	*0·089d.*
Wages, &c.	598	0·110d.	765	0·123d.	122	0·039d.	367	0·089d.
Repairs, renewals of mains, &c.	392	0·072d.	479	0·077d.				
Public lighting	—	—	*75*	*0·012d.*	*533*	*0·169d.*	*611*	*0·149d.*
Attendance	—	—	28	0·005d.	513	0·163d.	482	0·117d.
Renewals	—	—	47[j]	0·008d.	20	0·006d.	129[j]	0·031d.
MANAGEMENT AND PROPERTY CHARGES	2,938	0·540d.	3,699	0·596d.	1,527	0·485d.	1,505	0·366d.
Net rents	*255*	*0·047d.*	*284*	*0·046d.*	nil	—	*193*	*0·047d.*
Rates and taxes	*965*	*0·177d.*	*1,505*	*0·242d.*	*252*	*0·080d.*		
Management	*1,718*	*0·316d.*	*1,910*	*0·308d.*	*1,275*	*0·405d.*	*1,312*	*0·320d.*
Salaries	1,294	0·238d.	1,396	0·225d.	781[d]	0·248d.	857[k]	0·209d.
Stationery, &c.	147	0·027d.	183	0·029d.	85	0·027d.	80	0·019d.
Establishment charges	152	0·028d.	238	0·038d.	183	0·058d.	197	0·048d.
Law charges &c.	125[l]	0·023d.	93[k]	0·015d.	226[e]	0·072d.	178[l]	0·043d.

FINANCIAL RESULTS—	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£10,841	7·14%	£9,827	5·32%	£6,011	5·54%	£7,750	5·81%
Sum carried to Depreciation Fund	1,231[d]	0·810%	1,028[m]	0·556%	—	—	—	—
Sum carried to Reserve Fund	4,780[l]	3·15%	5,030	2·72%	2,067	1·90%	4,018	3·01%
Net interest on loans (incl. Debenture charges)	4,830	3·18%	6,501	3·51%	3,185	2·93%	3,138	2·35%
Net profit for the year	nil	—	—	—	759	0·699%	594	0·445%
BALANCE FROM LAST ACCOUNT	nil	—	—	—	211	0·194%	—	—
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	nil	—	—	—	1,679[f]	1·55%	431[o]	0·323%
Deficit	—	—	*2,783*[n]	*1·48%*	—	—	—	—
ORDINARY DIVIDEND PAID	—	—	—	—	—	—	—	—
PERCENTAGE OF TOTAL COSTS TO REVENUE	55·9%		59·8%		49·6%		43·2%	
Expenditure per mean kilowatt capacity	£5. 10s. 8d.		£4. 19s. 10d.		£3. 18s. 10d.		£3. 2s. 1d.	
REVENUE PER MEAN KILOWATT CAPACITY	**£9. 18s. 2d.**		**£8. 6s. 10d.**		**£7. 19s. 0d.**		**£7. 3s. 10d.**	
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**5s. 3d.**		**4s. 1d.**		**7s. 10d.**		**7s. 1½d.**	
Price charged for lighting, per unit	5½d. (1 hr.) to 2½d.[e]		5d. (1 hr.) to 2d.[e]		7d. to 3d.		7d. to 2d.	
Price charged for power, per unit	2½d.		2d.		2d.		—	
Price charged for public lighting	—		£22 per lamp per ann.		£22 10s. per arc per ann.[a]		—	
Receipts per unit for private supply	4·36d.		3·83d.		4·08d.		3·98d.	
„ „ public lighting	—		0·49d.[p]		1·80d.[m]		1·34d.[m]	
„ „ traction	—		—		—		—	

HULL.—*a* Circulating pumps, &c., electrically driven. *b* After deducting £2,735 from revenue written off meters and £106,189 temporary loans. *c* Over-expended. *d* Carried to reserve. *e* On maximum demand system or a flat rate of 5d. *f* Reserve fund. *g* Lands £1,501. *h* Lands £153. *i* Public lamps, including posts, cable, fixing, £494. *j* Carbons £45, fuses £2. *k* Insurance £91. *l* Includes £923 written off meters. *m* Written off meters. *n* Charged to reserve fund. *o* Maximum demand system or flat rate of 4½d. *p* After deducting cost of attendance and renewals (£75).

lamps 1s. 6d. per week, and for each post with two 32 c.p. lamps 2s. per week. *b* £939 premiums. *c* Over-expended. *d* Engineer's department £622, accountant and clerical staff £259. *e* Law £141, insurance £85. *f* Inclusive of £250 compensation received and £459 "transfers from Provision Account." *g* On January 25, 1902. *h* The public lamps are equivalent to 3,391 8 c.p. lamps. *i* Buildings £15, boilers £160, engines £113, alternators £9, pumps and pipes £88. *j* Repairs £60, renewals £35, rectifiers £34. *k* Clerical staff £299. *l* Law £96, insurance £82. *m* After deducting

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THE ELECTRICAL RÉUNION IN LONDON.

The present week has inaugurated a busy season for electrical engineers in London. On Monday, at the Agricultural Hall, Islington, Mr. GERALD BALFOUR, President of the Board of Trade, formally opened the second biennial International Tramways and Light Railways Exhibition. On Tuesday, within the same building, the Union Internationale Permanente de Tramways commenced its twelfth annual conference. And on Wednesday the Incorporated Municipal Electrical Association inaugurated its annual congress within the hospitable walls of the Institution of Mechanical Engineers' building in St. James's Park. Naturally, with so many powerful attractions, there has been a large influx of foreign and provincial electrical engineers into London, and these, together with the normal London contingent, have been kept exceptionally busy from early morning until late at night. Meetings for the reading and discussion of Papers in the morning; inspection of the exhibition stands, or visits to neighbouring electrical works, in the afternoon; and conversazioni and other social gatherings in the evenings, have filled up the day's work, and have afforded formal and informal opportunities for the interchange of views and ideas.

Turning first to the opening ceremony in connection with the tramways exhibition, our attention is directed to the speech made by Mr. GERALD BALFOUR when, at the luncheon, he proposed the toast of the Union Internationale Permanente de Tramways. A great part of this speech was occupied with a consideration of the relative backwardness of British tramways as compared with those of our Continental neighbours. We were compared to the sleeping hare, which had, temporarily perhaps, allowed the less swift tortoise to overtake it. Mr. BALFOUR hoped that this state of affairs would not last for ever, but that before long the hare, once in the vanguard, would again hold the leading place. Yet, while recognising the fact, Mr. BALFOUR refused to admit the cause which so many competent authorities allege. Although in form his speech was deferential, in essential substance it was defiant and unsympathetic. He denied that the Legislature was to blame for this state of affairs, and in the terms and tone of this denial we seemed to discern little promise, but rather the reverse, of any further assistance from the Government in the removal of those obstacles which are alleged, on such weighty authority, to be due to faulty legislation. Indeed, the President of the Board of Trade flattered himself upon the extreme leniency and moderation of the Board—for had not the Board graciously allowed the Portrush electric railway in the north of Ireland to be equipped on the third-rail system until two years ago, and that, notwithstanding the "mostly animals" which met with untimely death as the consequence of this generosity? But seriously, does Mr. BALFOUR imagine that the leniency of the Board of Trade, as to the working conditions of an out-of-the-way country

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line in Ireland, can be regarded by electrical engineers as any substantial offset against the severe and unnecessarily stringent legislation which Government has imposed upon the electrical industry at its fountain-head. Upon the face of it, it certainly looks as if Mr. GERALD BALFOUR has not accurately estimated the magnitude and importance of the electrical industry in the United Kingdom. It seems to have surprised him that the tramway interests in this country are so widespread and so deep-seated as to be capable of bringing together such a large gathering of representative men as assembled at the Agricultural Hall on Monday. If such is the case, we trust that what Mr. BALFOUR saw and heard on that occasion will furnish an effective object lesson to him regarding the importance of this particular branch of the Government department under his control.

With regard to the exhibition itself, our readers who may not have an opportunity to inspect it will best form an idea as to its scope by a perusal of the illustrated article commenced in our columns this week. We trust also that for those who intend to go through this exhibition it will furnish a useful guide. None can survey this exhibition from the vantage ground of the surrounding gallery without being forcibly struck with the rapid advance in electric tramway traction since the exhibition of 1900. Not only are the exhibits more numerous and, in many cases, more imposing, but examination of details reveals a greater solidity of construction and better experience in design. We have here, not merely a copy of American and Continental practice, but the exponent of a real and true British practice in electric traction—a practice which, however cosmopolitan in its origin and production, is essentially British and adapted to British requirements in all its manifold purposes. This argues real and substantial progress—a progression far more encouraging than the mere further spreading of business through process of time. It indicates that electric traction is taking root deeply in British soil, and that in its growth it has become acclimatised.

THE CHATHAM AND DISTRICT TRAMWAYS.

A system of about 8½ miles of tramways, built by the Chatham and District Light Railways Co., and a map of which we give below, was opened on June 17th. As indicated by the name of the company, powers for the line were obtained under the Light Railways Act. The scheme originally proposed was of greater extent and included the neighbouring city of Rochester, but had to be curtailed owing to the opposition of the Rochester Corporation.

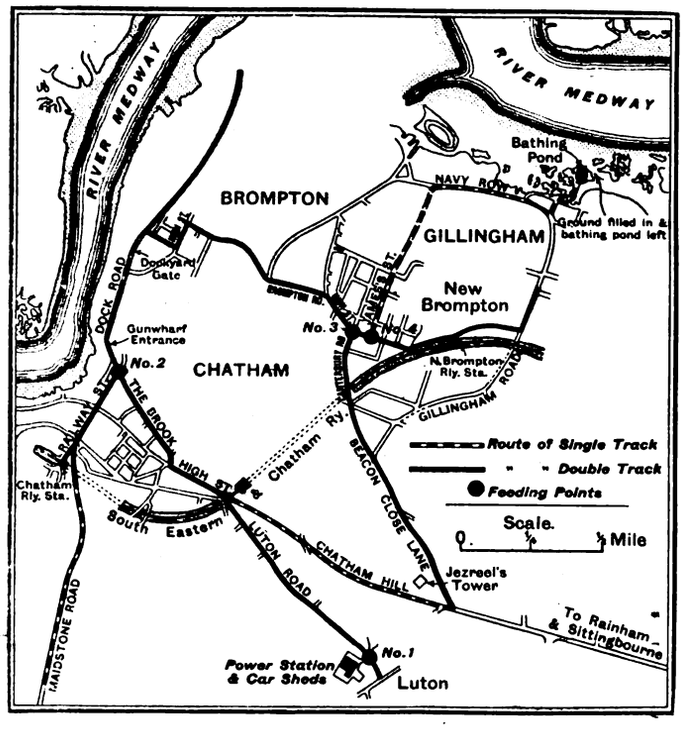
The contract for the complete equipment of the lines, as well as for the power station and cars was let in June, 1901, to the British Thomson-Houston Co. (which is practically the parent company of the Chatham and District Light Railways Co.), and the design and construction has been under the personal supervision of Mr. A. H. Walton.

Mr. H. W. Miller has had charge of the whole of the contract under Mr. Walton, whilst Mr. E. T. James has acted as resident engineer in charge of power-house plant, cars and overhead line, and Mr. W. H. Davis has superintended the track work and bonding. Throughout the work there has been cordial co-operation between the company and the Corporation, and in the speeches at the inauguration particular reference was made to the good spirit that prevailed, and the accomodating manner in which the company had received the suggestions and carried out the wishes of the local authorities through whose territory the lines pass.

Buildings.—The buildings, including the car sheds and repair shops, power house, tank house, cooling pump and sump, offices, &c., have been carried out by Messrs. West Bros., Messrs. J. W. Nash & Son attending to the architectural details and supervision of building.

The car sheds proper are laid out for 50 cars, in two bays each 38ft. 10in. wide by 193ft. 6in. long. One bay is aranged with four tracks, having inspection pits running the whole length of the shed, the rails being laid on longtitudinal sleepers. The other bay is arranged for four tracks, but the rails in this case rest on a concrete bed. Each bay is covered by a roof constructed of wrought-iron trusses, the outer ends resting on the building walls and the inner ends on a lattice girder of wrought-iron. The roofs are covered with slate, and a skylight runs on each slope of the roofs from end to end, so as to light the interior of the building. A complete system of fire and water hydrants is provided so as to protect the building in case of fire and furnish a supply for general purposes. At the end of the car sheds, and forming a part of them, arrangements are made for a set of workshops, consisting of paint shop, machine shop and general repair shop, these being equipped with the necessary tools and appliances for carrying out this work.

The power-house is arranged in two sections, one for the engines and generators, with auxiliary plant, and the other containing the steam boilers. The building is constructed of



MAP SHOWING ROUTES, &C., OF THE CHATHAM AND DISTRICT LIGHT RAILWAYS.

brick on concrete foundations. Each section contains the necessary foundations in brick and concrete for its respective plant, and the floor of the engine and tank-rooms is formed of rolled steel joists and brick arches, the boiler-room floor being prepared of concrete. The roofs of the building are constructed of wrought-iron trusses, provided with lanterns and framed with skylights so as to light the interior of the building.

Adjacent to the building housing the fuel economiser in connection with the boiler plant, and attached to this, is a flue and brickwork pedestal for carrying a steel-plate chimney. The chimney is 150ft. high from the under side of the cast-iron base plate, 7ft. 9in. diameter at the top of the shell, and having a clear internal diameter of 7ft. The base-plate is made of cast iron in sections bolted together on the inside, and prepared with holes for the holding-down bolts securing it to brick foundation. The shell is made of steel plates, lap-jointed and riveted, tapering upwards, and finished with an ornamental cap at the top, the thickness of the plates varying from ⅜in. at the bottom to ¼in. at the top. A steel ladder is fixed to the outside of the chimney, extending from the base to the top of the cap. The interior of the chimney

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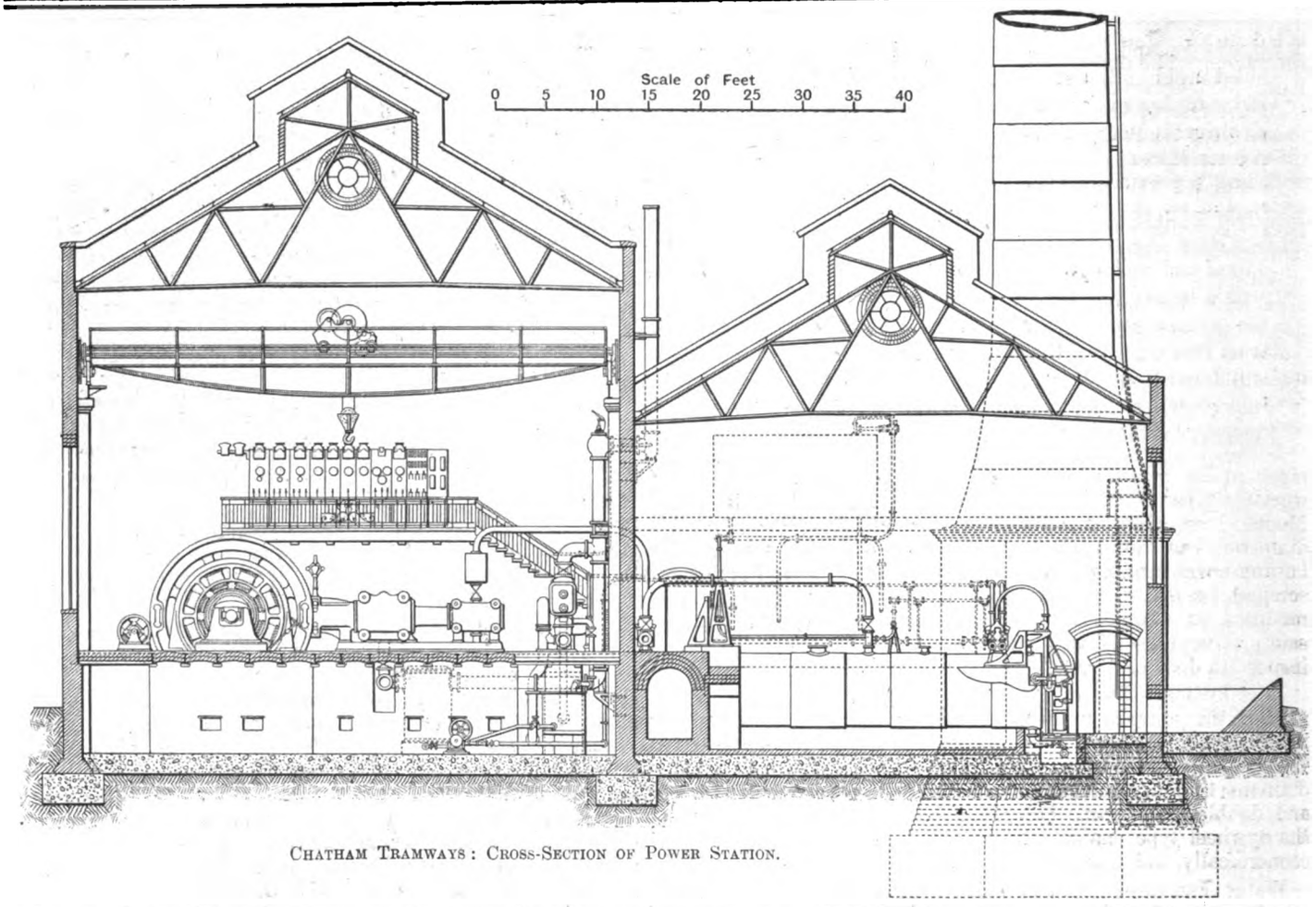
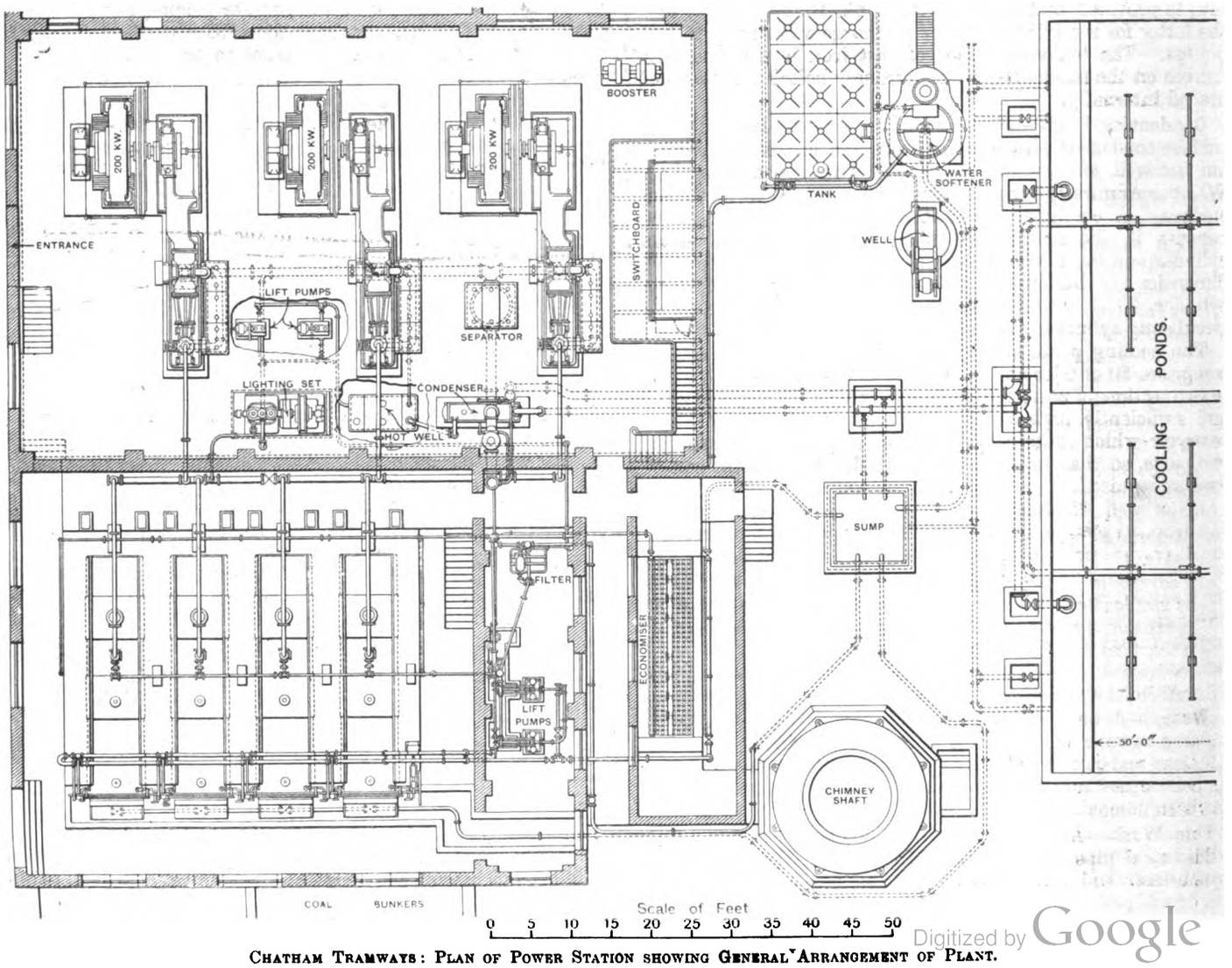


CHATHAM TRAMWAYS: CROSS-SECTION OF POWER STATION.



CHATHAM TRAMWAYS: PLAN OF POWER STATION SHOWING GENERAL ARRANGEMENT OF PLANT.

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is completely lined with fire-brick specially, moulded to suit the radius. The chimney was supplied and erected by Messrs. Head, Wrightson, of Middlesbrough.

At the rear of the generating station a tank house is built for carrying the main storage tank, the interior of house being utilised for stores. A cooling pond, built of brick on a concrete bed, is provided for the supply and storage of condensing water, and adjoining this is a brick sump for blow-off water from the boilers, so as to allow this water to cool before entering any drains.

Boilers.—The boilers are four in number, of the Lancashire type, each 30ft. long and 7ft. diameter in the shell, with two flue tubes, each 2ft. 9in. in diameter, and are made by Messrs. Yates and Thom. The working pressure is 160lb. per square inch, and the evaporative duty 5,900lb. of steam per hour. Each boiler is fitted with Vicars stokers, driven from an overhead shaft by means of an electric motor.

Economiser.—An economiser is provided consisting of 288 pipes in 36 sections, each eight pipes wide, suitable for a working pressure of 160lb. per square inch, and made by Messrs. Lowcock & Co. The pipes are 9ft. long by $4\frac{9}{16}$in. diameter, cast vertically, turned and fitted into top and bottom boxes forming metal-to-metal joints. The self-acting scrapers are driven by a diminutive horizontal steam engine mounted on a bracket. The economiser is furnished with safety valve, blow-off valve, soot doors and frames, dampers, inspection door and frame, pressure gauge, pyrometer, &c.

Feed Pumps.—Two of Pearn's quadruple-acting pumps are fixed in the pump-room, each of sufficient capacity to deliver 2,400 gallons per hour against a pressure of 185lb. per square inch. Each pump comprises two steam cylinders, 6in. diameter by 5in. stroke, mounted upon four vertical columns, and double-acting rams 8in. diameter. The pump being of the flywheel type enables steam to be used expansively and economically, and also provides for a positive length of stroke.

Water Tanks.—One main storage tank, 20ft. by 12ft. by 8ft., is provided, and one receiving tank, 16ft. by 8ft. by 8ft., the latter for receiving air-pump discharge and supply to feed pumps. The tanks are made of cast iron in sections, with flanges on the inside, the whole strongly bolted together and braced internally.

Condensing Plant.—The condensing plant includes one surface condenser with combined air and circulating pumps, one hot well, and two lifting pumps. The condenser is of the Wheeler Admiralty type, and contains 1,200 sq. ft. of cooling surface. A combined air and circulating pump is fitted beneath it, the two pumps being operated by one steam cylinder and the pistons being all mounted on one rod. The dimensions of this pump are as follows:—Diameter of steam cylinder, 12in.; diameter of air cylinder, 14in.; diameter of circulating cylinder, 14in.; stroke, 12in.

The cooling pond, already referred to under "Buildings," comprises 50 of Gjer and Harrison's simplex spraying nozzles, in two sections of 25 nozzles each, arranged as shown in the plan, and sufficiently high above the surface of the water. The reservoir which contains this system of pipes is divided into two parts, so that one-half or the whole of the plant can be used as required.

A hot well, 8ft. long and 4ft. wide by 4ft. deep, made of cast iron, in sections bolted together, is provided for receiving the discharge from the air pump, and there are two Blake and Knowles lifting pumps to raise the water from the hot well to the receiving water tank over the pump-room. The pumps are of the three-throw single-acting ram type, each being of sufficient capacity to lift 1,500 gallons of water per hour against a head of 65ft. An extended base-plate is provided for carrying the pumps and their motor.

Water.—A well has been sunk in the depôt yard to supply water for both the make-up feed and circulating, and, in addition, water supply can be taken from the town mains. As both these supplies are hard, a Desrumaux water-softener has been erected.

Pipe Work.—All steam pressure piping is of heavy lap-welded steel pipe, tested by hydraulic pressure to 500lb. per square inch, and provided with cast-steel flanges. The valves are of the high-pressure straight-way type, with outside screw and yoke, and the construction is such that they may be packed when the valve is wide open. These valves are provided with hard metal seats, suitable for a working pressure of 250lb. per square inch, and, as the piping, were tested to 500lb. per square inch before delivery. The exhaust piping is of lapwelded wrought-iron pipe, with cast-iron flanges made of good quality gray iron. One automatic relief pressure valve is provided and placed on the exhaust main for use when running non-condensing, and a Baker oil separator is inserted in the line of main exhaust pipe between the engines and condenser, together with a small direct-acting steam pump for extracting the oil. A duplicate system of extra heavy lap-welded wrought-iron feed-water piping is provided, and the feed-water valves are of an extra heavy straight-way gate-type with hard metal seats. All pipes, valves and other fittings as well as top of boilers are covered with non-conducting composition, by Messrs. Haacke. A light platform constructed of wrought iron is provided and fixed over boilers for access to boiler stop valves.

Overhead Travelling Crane.—The overhead traveller in the engine-room is capable of lifting 15 tons, and has a span of 51ft. 4in. centre to centre of rails. This crane was supplied by Messrs. Booth Bros.

Main Generating Engines.—The engines are three in number, of the horizontal compound tandem type, each developing a normal load of 320 I.H.P. and a maximum of 480 I.H.P., when working with steam of 150lb. pressure and running at 100 revs. per min. and working condensing. They are made by Messrs. Yates and Thom. The cylinders are 15in. and 29in. diameter by 36in. stroke, steam jacketed and fitted with Corliss valves and guaranteed to govern within $2\frac{1}{2}$ per cent. above and below the normal speed. The crankshaft is made of open hearth steel, $16\frac{1}{2}$in. diameter in the body, and provided with journals 14in. diameter by 22in. long, running in bearings lined with Babbitt metal. At one end of the shaft a crank of the counter-balance disc type is placed, fitted with a steel crank pin $6\frac{1}{2}$in. diameter by 8in. long. At opposite end of shaft and adjacent to the flywheel, provision is made for mounting the generator. The flywheel is 15ft. diameter and weighs $20\frac{1}{2}$ tons.

The valve gear is of Messrs. Yates and Thom's "Dobson" type, consisting of hardened steel catch-plates attached to blocks which are connected by links to the steam valve levers, and have also spindles or rams coupled to the dash-pot pistons. The construction of this is seen in the illustr tion on page 430. On a cast-iron guide-plate, bolted to the bottom of the dash-pot, slides a long cast-iron slipper, having a constant reciprocating motion imparted to it by an eccentric fixed on the crankshaft. To this slipper are attached by screws two rectangular-shaped blocks or turrets, through which slide the above-mentioned blocks, carrying the steel tripper plates. In the upper part of each turret is placed a hardened steel die of rectangular shape which drops under the action of its own weight and a light spring whenever the slide-plate is at the extreme end of its travel in either direction. This brings it into gear with the end of the steel tripper plate, which it carries with it on the return stroke as well as the gear attached to the valve lever, thus opening the valve and at the same time compressing a spring placed in a cast-iron dash-pot. The valve is closed by the action of this spring when the catch-plates are released. The manner in which this release is effected is as follows:—Each of the turrets carrying the steel dies is provided with a small rocking shaft on which are fixed two levers provided with toe-pieces, which, by the motion of the slide-plate, are brought into contact with projections on the steel dies, thus lifting them out of gear and allowing the springs to close the valves. In the case of both cylinders the position of the tripper levers is automatically regulated by the governor, which is connected to them by suitable gear. The exhaust valves are worked by separate eccentrics and gear. A "knock-off" gear is fitted to the governor, arranged to disconnect the trippers and hold them in such a position as to prevent steam being admitted to the cylinder if the engine attains an excessive speed or upon an accident happening to the governing gear.

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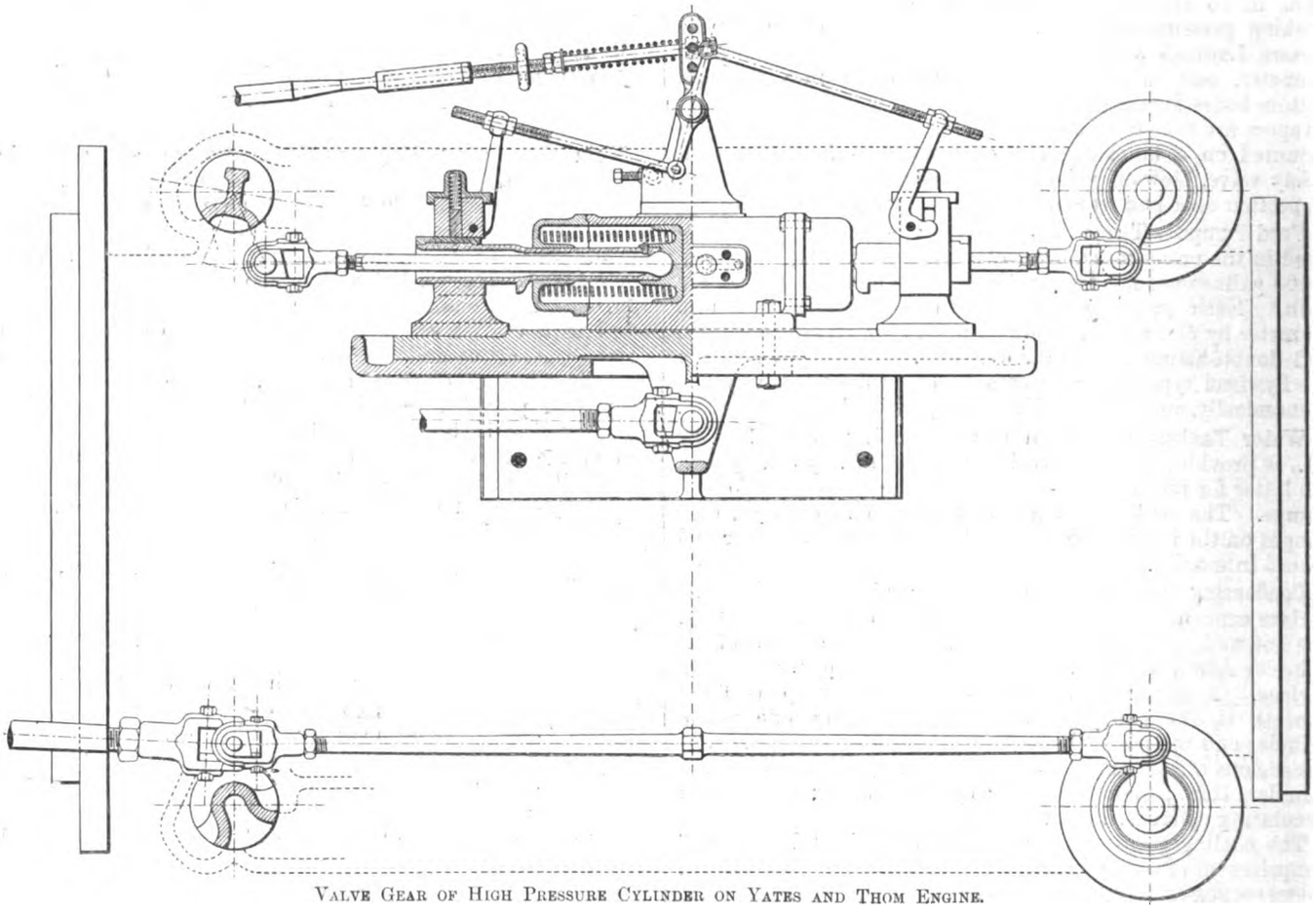
Main Generators.—The three continuous-current generators, each having a normal full-load capacity of 200kw. at 550 volts when running at a speed of 100 revs. per min. are of the British Thomson-Houston Co.'s standard railway type, and are directly connected to their respective engines, as stated above. They are of the slotted core type with carbon brushes, and are eight-polar, the field poles being removable and the field frames being divided horizontally.

Negative Booster.—One series-wound booster is employed, consisting of a 500-volt shunt-wound motor, driving a series-wound generator having a normal full-load capacity of 17½kw. at 50 volts. These two machines are mounted on a common bed-plate with three bearings, and the set runs at an approximate speed of 700 revs. per min. This booster is for the track; no positive boosters—or battery—are employed.

Switchboard.—The switchboard is of the British Thomson-Houston Co.'s standard pattern, and consists of panels of slate 2in. thick, enamelled black on front face and all edges, and with a ⅜in. bevel on all front edges. Each panel is 90in. high, built up in two pieces, the upper part being 62in. high and the lower, or sub-base, 28in. The panels are assembled on vertical angle irons, with nickeled bolts and washers, the adjacent panels butting together, rendering the framework invisible from the front. Floor brackets are provided, and tie-rods for supporting the board from the wall. There are three generator panels, each 24in. wide, on which the equaliser switch is placed as well as the ordinary equipment; and four single-pole feeder panels, each 18in. wide, provided with an auxiliary 'bus bar, connected in such a manner that the booster field may be excited jointly from three feeders. An adjustable resistance is connected in circuit with feeder No. 1 to adjust the drop in it. The booster panel, which comes next, taking the board from left to right, is 24in. wide, and next to this is the lighting generator panel, 18in. wide, for the control of the 75kw. generator set mentioned below. The lighting feeder panel which adjoins this is 24in. wide, and controls six power and lighting circuits in the station, car shed and yard; provision is made on it for interconnecting the lighting and traction 'bus bars, and for connecting either lighting circuit on to either pair of 'bus bars. At the extreme right of the board is the Board of Trade panel, equipped with the usual apparatus, and at the extreme left there are voltmeters mounted on swinging brackets in accordance with the customary British Thomson-Houston practice. The magnetic blow-out circuit breakers, copper knife-blade switches, magnetic blow-out lightning arresters, Weston ammeters and British Thomson-Houston wattmeters offer no new features. The booster motor switch is of the knife-blade type, so arranged that the blade passes through three contacts before reaching its final position, and thus switching on the motor gradually.

Repair Shop.—This is equipped with a shaping machine, a 7½in. screw-cutting lathe, a 12in lathe, a vertical drill, a grindstone, a Tangye wheel press, two smiths' hearths with tools and anvil, and a motor-driven blower for the latter. A 7½ H.P. motor with controlling panel supplies power for driving this shop through countershafting.



Valve Gear of High Pressure Cylinder on Yates and Thom Engine.

Overhead Line Construction and Cables.—Double overhead line equipment has been carried out along the whole of the routes, together with single lines over the various tracks in the car sheds and in the yard of the power-station. The trolley wire of 00 B. & S. gauge is of hard-drawn copper. Side pole and bracket construction has been used throughout, except in a few places, where spans are erected. The bracket arms vary from 8ft. to 18ft. in length, and have ornamental scroll-work. The overhead line is divided into ½-mile sections by section insulators, and guard wires have been erected where necessary.

All the cable work was carried out by Messrs. W. T. Glover & Co. All the cables are insulated with impregnated paper and lead-covered, and are laid in a wooden trough on distance pieces and filled up with insulating compound. Wherever practicable, the cables are laid under the footways. The line feeders are four in number, and are connected to the overhead line at the points marked in the map. Their areas are:—No. 1, 0·1 sq. in.; No. 2, 0·35 sq. in.; No. 3, 0·25 sq. in.; and No. 4, 0·25 sq. in. There is a 0·5 sq. in. return feeder from No. 3 feeding point, and the rail feeder to the power

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house end of the line is 0·2 sq. in. Along the whole of the routes in which the tramways run, a three-core test and telephone cable is laid, two cores being used for telephone and one for pilot.

Permanent Way.—The track is laid to a gauge of 3ft. 6in., the mileage amounting to 8 miles 4 furlongs 4·6 chains, of which 2 miles 6 furlongs 8·6 chains is single track with turnouts. The contract for this was sub-let to Mr. Osman, of Southampton. The rails are of the girder type, 6in. deep, weighing 92½lb. per lineal yard. They were supplied by the Barrow Haematite Steel Co. in 45ft. lengths, with a proportion of 30ft. and 36ft. lengths. There are five tie-bar holes in 45ft. rails and proportionately in the shorter lengths. The fishplates are 28in. long, weighing 44lb. per pair, and are secured with six 1in. bolts and nuts. Sole plates are fitted under all rail joints and held securely in place with eight bolts and nuts. The tie-bars are of flat mild steel, provided at each end with a round shank screwed with ⅞in. Whitworth thread and with two nuts, and of suitable length for a gauge 3ft. 6in. Drain rail boxes are provided where necessary. All points and crossings are of crucible cast steel, and were made by Messrs. Hadfield's Steel Foundry Co. The paving is in granite or wood, as arranged with the local authorities. Each rail joint is bonded with two Chicago bonds, 0000 B. and S., with cross bonding at suitable intervals.

Rolling Stock.—The company has started service with 25 cars. The bodies have been built by Messrs. G. F. Milnes & Co., and are of the double-deck type, with reversed staircases, the seating capacity being 26 outside and 24 inside. They are mounted on Brill 6ft.-wheel base trucks, fitted with Peckham life-guards and slipper brakes. The equipment consists of two B.T.H. motors of the GE 58 type, and B.T.H. B 18 controllers, with rheostatic brakes. The trolley is fixed centrally on the top deck, and is of the new B 1 B.T.H. type.

THE CORONATION ILLUMINATIONS.

Electricity has probably never been adopted to such a large extent for illumination purposes as on the present occasion. Owing to the sad illness of His Majesty the King, and the consequent postponement of the celebrations, it has not been possible to form any opinion with regard to the actual effect of the different devices erected, although in some few cases certain installations were switched on a night or two before it was known that they would not be required. The appearance of hundreds—in some cases thousands—of different coloured lamps grouped into crowns, letters, figures, and intertwined with flowers and leaves on long festoons, was exceedingly pretty and striking. There were, perhaps, more gas than electrical fittings, and this can be accounted for in various ways. A great many people already had gas fittings which they had used on former occasions, and therefore did not want to go to extra expense; some prefer gas to electric light, because they say it gives a more pleasing effect when blown about by the wind, whereas electric light only gives a steady glare; lastly, the attitude of some of the various supply companies was not conducive to their obtaining a large number of connections; indeed, one or two stated that they did not want the extra load, although others did all they possibly could to encourage applications.

Daly's Theatre.

The technical regulations made by the supply companies were not severe, but the charges of some for connecting were too great for a consumer with only a small number of lamps. This latter difficulty was overcome in some instances by allowing the connection to be made to the existing permanent installation where such existed. The following is a copy of a letter sent by the London County Council to each of the electric lighting companies and each of the metropolitan borough councils supplying electric current in London:

Spring-gardens, S.W.,
June 21, 1902.

Sir: The chief officer of the Fire Brigade has pointed out, in connection with the electric light installations for illumination purposes in connection with the approaching Coronation festivities, that there is considerable risk of fire. The danger would appear to lie—(a) In the character of many of the installations which are temporary, and (b) in the fact that current in excess of that ordinarily supplied is likely to be used with temporary circuits added to existing installations. The Council's statutory powers under the Fire Brigade Act are limited to the extinction of fires and the protection of life and property in case of fire; but the chief officer of the Fire Brigade having thus called attention to the special danger likely to arise during the next few days, you will probably agree that it is not out of place for this communication to be addressed to you. The chief officer suggests that in all cases in which a request is made for the supply of current for illuminating purposes, either by means of existing permanent installations or by means of temporary installations, care should be taken to see that the insulation tests are sufficient and that a certificate to that effect is given by a competent surveyor.

Although the London County Council did not frame special regulations to govern temporary installations, the above letter shows that they were aware of an element of danger, and, therefore, did all that they could to prevent any untoward incident occurring to mar the festivities which should have taken place. Some of the installations were examined by the inspectors of the London County Council, who expressed themselves as being entirely satisfied with all the arrange-

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ments made and with the way in which the wiring had been carried out.

The Charing Cross and Strand Electricity Supply Co. stated that they probably would not notice any difference from their ordinary load, owing to the large number of theatres on their mains being closed. They had applications for connections equivalent to 18,000 8 c.p. lamps, two of the largest being the Hippodrome and Daly's Theatre, each taking about 1,500. Even had the ordinary load been on at the same time as the temporary one, the company have enough spare plant to deal effectively with it all. Each installation was taken on its own merit, and no hard-and-fast rules were laid down. A separate meter was inserted in each case, and the consumer was charged the actual cost of the connection plus 25 per cent. Current would have been charged for at the same rate that the individual consumer pays for that used in the ordinary course. Those who usually consume energy for motors only and desired to illuminate their premises were charged at the rate of 5d. per unit beside the cost of connection.

In a circular issued by the Westminster Electric Supply Corporation, it was stated that the company were anxious, by supplying additional current, to afford every facility to those who desired to illuminate by electricity, and that as the amount of current which could be supplied was limited, the company should have ample time to make arrangements. The charge made was 6d. per 8 c.p. lamp connected (with

THE LONDON HIPPODROME.

THE BIRKBECK BANK.

a minimum of £1), to cover the cost of special connections and testing. Current was charged for at the ordinary rates. Separate fuses and meters were inserted for each temporary connection, and each installation taken on its own merits with reference to insulation resistance, &c. All three of this company's stations were prepared for top winter load, and applications had been received for the equivalent of over 40,000 8 c p. lamps, including the London and North-Western Railway offices at the corner of Bridge-street and Parliament-street, with no less than a number equivalent to 4,800, and the Army and Navy Stores with 1,500 lamps. The company were quite confident that the extra load would cause them no inconvenience, and that no fear need be entertained of anything at all unusual occurring.

The St. James' and Pall Mall Electric Light Co. were particularly anxious to encourage the use of their current for the purpose of illumination, and refrained as much as possible from framing rules imposing severe restrictions and charges upon intending consumers. No notice whatever was taken of small devices connected to the permanent installation, on the condition that lights inside were switched off during the time that the same number were being used outside. Thus the charges for making connections and fixing separate meters and fuses

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were entirely eliminated for small consumers. For large connections a charge of £1. 1s. was made to cover the cost of labour, &c.; an extra meter was inserted and current charged for at the rate of 6d. per unit. No special arrangements were made for coping with the load, and it was anticipated that anything in excess of the ordinary top load could easily be dealt with by the spare plant. Applications had been received by this company for connections to 25,000 8 c.p. lamps, and although this does not include any very large individual connections, yet it takes in a great many of the clubs, such as the Reform, Travellers', Carlton and Carlton Hotel, each of which had over 1,000.

The City of London Company received applications for 30,000 8 c.p. lamps, and made no special arrangements to deal with the load. The total capacity of their Bankside station is 25,000kw., and a good proportion of that is available as spare plant. Large temporary installations were provided with separate services and meters, but small ones were permitted to be connected to the permanent wiring. Regular consumers were supplied at their usual rate, but those who went on for the illuminations only were charged 5d. per unit. The Sun Insurance Office in Threadneedle-street with 2,500, and the Stock Exchange with 1,320 lamps were two of the most notable connections made to this company's mains.

The London Electric Supply Corporation (Ltd.) merely charged, to each consumer using current for purposes of illumination, the actual expenses incurred in making the extra connection and the fixing of a separate meter and fuses. Applications for between 15,000 and 20,000 5, 8 and 16 c.p. lamps were received; a large proportion of this number being 8's. No special arrangements were made, and the top load on either last Thursday or Friday night was not expected to exceed half the top load in winter. The Walsingham House Hotel and the Grosvenor Club were two of the largest installations connected. The following regulations for wiring were framed and issued to intending consumers and contractors by the London Electric Supply Corporation (Ltd.).

1. All illumination lighting will be supplied through a special meter. It must not on any account be connected to the existing wiring.

2. When the total demand exceeds 300 amperes at 100 volts, or 150 amperes at 200 volts, the wiring must be divided into two equal and separate installations.

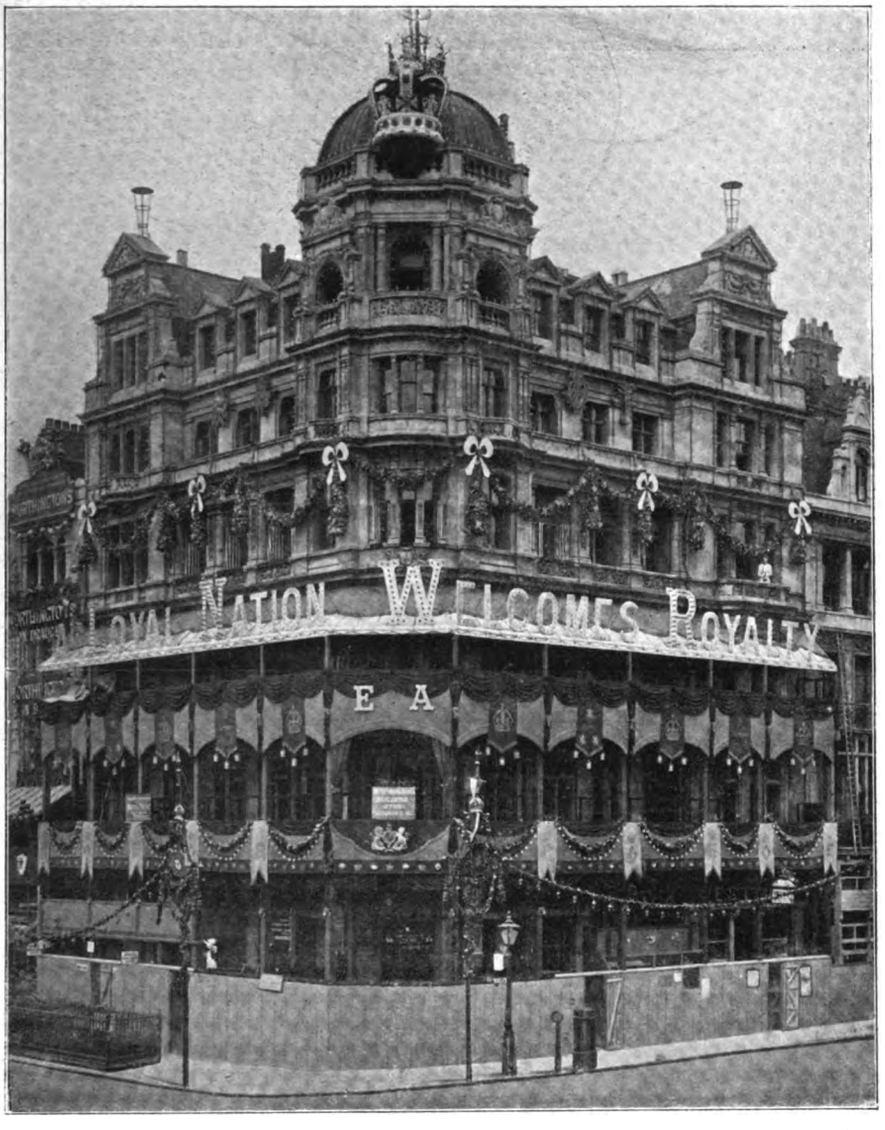
3. Every installation must be provided with a main switch and two single-pole fuses, and the mains brought down to the point of supply, as arranged by the company's engineer.

4. The company reserves the right to supply energy for illuminating purposes either at 100 or 200 volts, and the contractor should consult the company's engineer before starting the work.

5. The wiring must be divided up into circuits, each circuit not exceeding 20 amperes at 100 volts, or 10 amperes at 200 volts, with a switch and fuse on each pole.

6. Should the installation have a lower insulation resistance than 50,000 ohms, or should the company's inspector detect any work which is dangerous or likely to interfere with the general supply, the company will refuse to turn on the current.

7. The company will not be responsible for damage arising wholly or in part from defective or insufficient work or materials in the installation, notwithstanding that they may have had them inspected in anticipation of the supply of current from their mains.



L. & N.W. Railway Offices (corner of Bridge St. and Parliament St., Westminster).

The Metropolitan Electric Supply Co. allowed small devices to be connected to the ordinary services, but large ones were put on an entirely separate service with meter and fuses. A charge of 6d. per 8 c.p. lamp was made to cover the cost of making a separate connection, and the usual rate per unit charged. No special arrangements were made for dealing with the extra load, which consisted of about 15,000 lamps. The Empire Theatre, with 1,000 lamps, was about the largest temporary connection made to the Metropolitan Company's mains. Others were Meux's Brewery, Tottenham Court-road, Pears' Soap offices, New Oxford-street, and Crosse and Blackwell's, Charing Cross-road, each of which had 500 lamps.

On the many places where electricity was employed as an illuminant, various systems of wiring were in evidence. The E.L.B. system, which consists in simply sticking two copper pins, forming the terminals of a lamp, into two pieces of flexible cord embedded in asbestos, and a composition manufactured by the company, was used in a large number of cases. The principal advantage of this system is the ease with which a design can be made up or altered, and the consequent low cost of labour involved in putting up the illumination. It has been employed at the Hippodrome, several well-known clubs, H.M. Office of Works, Westminster Abbey, and many other places.

Probably the finest electrical display in London was that on the exterior of the London and North-Western Railway offices at the corner of Bridge-street and Parliament-street, West-

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minster, with, as already stated, a number of lamps equivalent to 4,800 8 c.p. The work has been carried out in casing throughout, except, of course, the festoons which are wired with "Fairyland Strip." A modified and cheap form of batten holder has been used and the whole installation, when tested on a fine dry day, gave an insulation resistance of 0·8 megohm on each side of the system. The lamps in the crown are of 32 c.p. each, all other coloured lamps are 16's, while those on the outline of the building are 8's. The whole installation has been split up into two parts—one on each side of the three-wire system—with a four-way distribution board on each. From each of these four-way boards are taken circuits, four of which go to the roof and four to a balcony. The circuits are then further subdivided into switched on. Between the windows of the top floor there are huge cathedral glass imitations of a rose, shamrock, thistle and leek, representing the four countries comprising the United Kingdom. It was intended to illuminate these with electric lamps placed behind. Stray wires on the face of the building are conspicuous by their absence, and the whole arrangement presents a most pleasing appearance. All wires which run in dangerous places are wrapped in asbestos tape, as are those on the roof—in fact, extreme measures have been taken to guard against any risk of fire or other accident, no matter how small the risk may be. When the main switch was closed for the first time it was discovered that there was one circuit which would light up without being switched on; examination revealed that a wire was earthed, and this was

THE CANADIAN ARCH.

5 ampere circuits. There are about 600 lamps fed from each distribution board and each 5 ampere circuit is provided with a double-pole fuse and single-pole switch. The main distribution boards have each a double-pole switch and fuse. There is no switch or fuse between the main distribution board and the Supply Company's fuses. The crown at the top of the building is an exact copy, in every detail, of the original crown of King Edward and the various jewels are represented by lamps of the correct colour. There are lamps inside the balconies which cannot be seen from the outside and these all help to make the effect more beautiful when the current is soon remedied. The work was carried out by Messrs. Foote and Milne.

The new building of the Birkbeck Bank, Holborn, was illuminated by 2,000 8 c.p. lamps, each of which was enclosed in a red celluloid globe. Four circuits, consisting of 27/16's were taken up from the main board with a switch and fuse in each; these were subdivided into 40 circuits, each carrying about 8 amperes and controlled by a single-pole switch and double-pole fuse. No special system of wiring was used, but the wire simply hung on the face of the building with the holders tacked on at the required places; 2,000 megohm wire was used throughout, and great precautions were taken against an

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outbreak of fire, although they were, perhaps, hardly necessary. A length of hose was connected to a hydrant on each floor and unrolled so that its other end reached to a convenient window. It was also arranged for four firemen to be on duty in various parts of the building during the time it would have been illuminated. The authorities at the Birkbeck Bank carried out some interesting experiments on the celluloid globes. They put one of them in direct contact with a very old lamp that got extremely hot when run for any length of time. The result was that it had practically no effect after a continuous run of several hours. Then it was tried on a hot plate, which caused it to shrivel up slightly. A red-hot cigar-tip was then thrust through, and the globe gave off a little vapour. Immediately it was placed in contact with the flame of a match, it, of course, became ignited. These experiments are interesting in view of the curious rumours that have been circulated lately with reference to celluloid decorations.

The Canadian arch has probably attracted as much attention as any other decoration erected in London in honour of the Coronation. The lighting of it was carried out by the Electrical Co. for the Allgemeine Elektricitäts Gesellschaft of Berlin. There are 5,000 5 c.p. 100-volt lamps used, on 150 5-ampere circuits, and they are arranged in two rows, in series, of 25 lamps, the supply being three-wire, 200 volts from outer to middle. Each circuit has a double-pole fuse and switch, and another double-pole fuse and switch is provided for every 25 circuits. There are four main circuits of 100 amperes each, provided with a wattmeter and fuses by the Westminster Supply Company. The complete installation was carried out in 10 days. A current density of 600 amperes per square inch has been allowed, and the wires are placed one each side of a batten about 1in. thick. The wire on one side of the batten is connected to a holder with a screw thread inside, and a pin soldered to the other wire is brought through the batten. The lamp has a screwed cap, and a small brass plate on the top. It is screwed into the holder which forms one pole, and the plate on the top touches the pin which forms the other pole. It is claimed for this system that it is the only one which allows the lamps to assume a position parallel with the batten instead of at right angles to it. The wires are bare, and with 500 volts an insulation resistance of 50,000 ohms was obtained. One batten of 25 lamps gave a resistance of 0·2 megohm when dry, and after having a pail of water thrown over it, it gave 1,000 ohms. For some reason it appears that the Westminster Supply Company refused to connect the installation, and Mr. Freeman, engineer to the Wolverhampton Exhibition, who made the above tests, says that he does not consider there is any danger even in wet weather, and cannot understand the action of the Supply Company. The battens used on the Canadian Arch are the same as were used on the Imperial buildings at Berlin during the stay there of the Emperor Franz Joseph.

The triumphal arches only on London Bridge have been electrically illuminated, and these with silver-topped lamps. They are intertwined with the flowers on the festoons, and give a very pretty effect. The gas jets on the bridge itself appear to be dangerously close to the festoons hanging immediately above them.

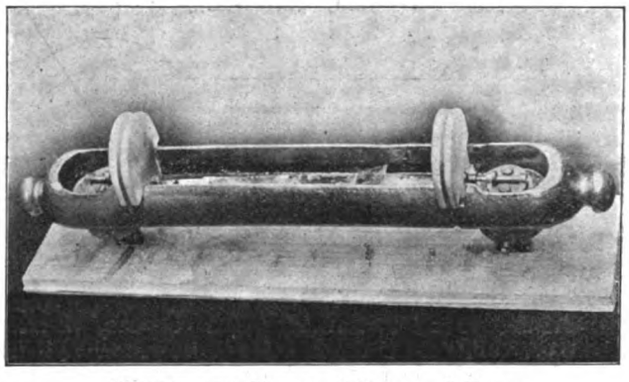
Daly's Theatre looked exceedingly well with its 1,500 8 c.p. lamps. The wiring was done with ordinary casing and batten holders, and was split up into 96 5-ampere circuits, each provided with two single-pole switches and one double-pole fuse. The total insulation resistance obtained was 2·5 megohms. Current can be obtained from either the Maiden-lane or Short's-garden's station of the Charing Cross Company by means of a two-way switch, so that the supply for the outside illuminations was obtained from a totally different source from that which was used for lighting the interior of the theatre, and therefore preserved the ordinary installation from harm in the event of anything going wrong with the temporary work. The outside main current was controlled by a three-wire switch and was supplied with a separate meter. The crown was composed of red, white and mauve lamps on a gold ground, with a crimson cloth underneath.

The Hippodrome was also notable, and its fine dome, lined with lamps, looked very nice, and would undoubtedly have produced a brilliant effect if lighted up. Messrs. D. H. Evans & Co., drapers, of Oxford-street had a large display, consisting of about 3,000 lamps of all colours. The wiring was carried out as usual, in casing, and the various designs consisted of crowns, the letters "E.R.," and those representing various colonies. Red, white, blue and frosted lamps were used. The Army and Navy Club and the Holborn Restaurant had a pair of Union Jacks crossed, surmounted by a crown, with the letter "E." on one side and "R." on the other. The Army and Navy Stores had their entire frontage lined, and the letters "E.R." and a crown worked in various colours. There was no casing, the wire simply hanging on the walls. Altogether about 1,000 lamps were used.

Other places using electricity for illuminations were the Civil Service Co-operative Society, the Pavilion Theatre, Messrs. Marshall and Snellgrove, Prudential Assurance Co., United Service, Devonshire and Conservative Clubs, Grand Hotel and Agricultural Hall. It was also proposed to have a search-light on the Monument, and another on the Roman Catholic Cathedral at Westminster.

THE PARTRIDGE "SPARKLET" FUSE.

It is well known that a "sparklet" will manufacture a bottle of most delicious "soda" water for the modest sum of 1½d. sterling, but it is not so well known that the same little capsule of liquid carbonic acid is equally efficient in breaking a 10,000-volt spark between contacts ½in. apart. The "sparklet" fuse is the invention of Mr. G. W. Partridge, chief engineer of the London Electric Supply Corporation, and although it has been known to his friends for some time, and has proved itself of considerable service in connection with the mains and transformers of the London Electric Supply Corporation, it has made its first public appearance at Messrs. Elliott Bros.' stall at the Tramways and Light Railways Exhibition this week.



PHOTOGRAPHIC VIEW OF "SPARKLET" FUSE.

The "sparklet" is a small steel capsule containing liquid carbonic acid, of course under considerable pressure, and sealed by a steel cap and rubber ring held in place by the edge of the main part of the capsule being turned over. This will be familiar to the majority of our readers in the aerated water machines already referred to. In the fuse, the sparklet is so placed that if the arc continues the cap of the sparklet is melted off, and the carbonic acid gas coming off under pressure effectually blows out the arc. We give in Fig. 1 a photographic view of the pattern of fuse most employed, and in Fig. 2 a sectional elevation and plan showing the details of its construction. The fuse wire is laid on a mica strip in an earthenware trough, and to within about ½in. of the ends is covered with a second strip of mica, the two mica strips being held together by a paper fastener. This fuse, which is about 9in. long for a 10,000 volt arc, is clamped between contacts in the usual manner, and a sparklet fits through a hole in the porcelain screen at each end, as seen in the figure. The solid end of the sparklet, behind the screen, makes contact with the terminal of the fuse by means of a spring contact, but the

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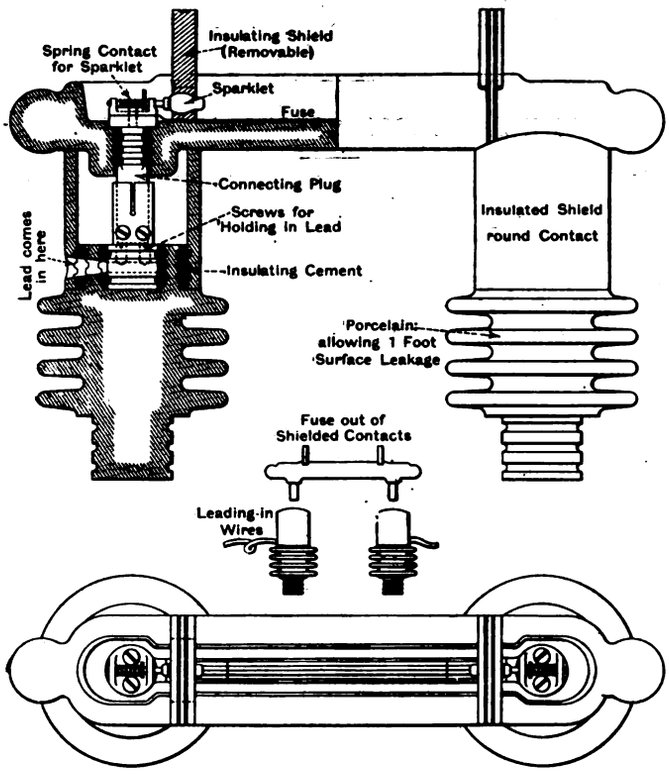
other end of the sparklet, containing the cap, is above the uncovered part of the fuse wire, so that the sparklet does not form part of the main circuit until the arc rises from the fuse. The heat of the arc melts off the caps of the sparklets, and the jet of carbonic acid blows out the arc.

As mentioned above, a break of about 9in. will be the standard, but Mr. Partridge showed us last week an experimental fuse in which the length of the break could be varied. About 80kw. at 10,000 volts was short-circuited through a fuse, first 6in. or 9in. long, and then reduced to ½in., and in all cases the arc was blown out effectually. As a matter of fact, the arc persisted a greater time when the break was longer, owing to the heating of the end of the sparklet being slower in the latter case. A peculiar and interesting thing to observe after the test was that the metal of the sparklet was still intensely cold, due to the rapid expansion of the carbonic acid, and appeared as if it had not been heated by the arc at all.



THE PARTRIDGE "SPARKLET" OPEN-TYPE FUSE FOR 10,000 TO 20,000 VOLTS.

In addition to these fuses, of which one only of two or three types (differing in detail but not in principle) is illustrated above, a simple fuse is also made for network boxes. In all of these it is essential that the sparklet is connected to the fuse terminal by a good contact that will not heat, and that the cap end of the sparklet be directly above the exposed part of the fuse. This ensures that the wrong end of the sparklet will not melt, and the porcelain screen (a marble screen has been used on the heavier types of fuse) prevents the arc getting round to the terminal or the back part of the sparklet. When a fuse blows, nothing is destroyed except the fuse wire and mica and the sparklets; the earthenware trough and the fuse terminals are uninjured.

Mr. Partridge proposes also to employ the sparklet on switches and automatic cutouts in place of the carbon break. In this way, if the arc persists, it melts the end of the sparklet and is blown out. A further modification of this, which Mr. Partridge is directing his attention to, is the addition of a sort of magazine, so that, after a sparklet has blown, the action of replacing the switch brings a new one in position.

The sparklet fuse is shown in action at the Tramways and Light Railways Exhibition, and we recommend those of our "municipal electrical" readers, who are only in London temporarily, not to miss the opportunity of inspecting it.

CORRESPONDENCE.

AN UNDESIRABLE GUEST.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Last evening, when just escorting three ladies to the door at the close of the conversazione of the Institution of Electrical Engineers, I was accosted by a gentleman, unknown to me, in evening dress, who appeared to be under the influence of liquor. He addressed me by name and said that he wished to tell me that I was a cheeky young cad whose letters were not worth answering, and that I must take care. He was repeating his insult, when I remarked "I do not know you," and turned on my heel. He was of medium height, with fair hair, and apparently about 30 years old. Would any member who may have witnessed the incident kindly help me to identify the individual and ascertain who is responsible for his admission in this state?—Yours, &c.,

London, N.W., July 2. SILVANUS P. THOMPSON.

ESPRIT DE CORPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to a short notice in your issue of June 27th, headed "Esprit de Corps," in which a correspondent complains that a well-known electrical engineer who took a prominent part in the deputation to Mr. Balfour had a few days before given evidence against an electrical tramway in the House of Commons, and apparently favoured omnibuses. As this probably refers to me, who gave evidence, on behalf of the Roads Improvement Association, against laying an electrical tramway across the existing Hammersmith Bridge, but not at all on the grounds mentioned by your correspondent, and as this matter is of interest to electrical engineers, I thank your correspondent for giving me the opportunity of bringing my views before the main body of your readers. Some of them may have read my last year's address to Section G of the British Association, in which I pointed out that one of the most important problems in modern locomotion is that caused by the congestion of street traffic in our towns, and by the undoubted difficulties which exist in carrying our workers to and from their homes in the country to their places of employment in our towns. I then pointed out that a great deal of mischief might accrue from an ill-considered occupation of our streets by tramways, and gave as one of my reasons that the carrying capacity of a street is not increased, but rather diminished by laying tramrails in it, and that this is due to the want of overtaking power of vehicles running on rails.

Your readers will see that there are several solutions of this problem of street traffic, but not the least interesting one to them is that of the development of electrically-driven cars or omnibuses to take the place of our present horse-drawn vehicles. Thanks to the efforts of a few electrical engineers, who have, in the face of great discouragement, persevered with their work, we already see considerable numbers of these vehicles running satisfactorily in the streets, and I learn that the next year will see an enormous development of this use of electrical power. It is needless for me to point out how important it is to the electrical industry that this development should have full scope and every possible chance of success given to it. Our electrical supply undertakings will benefit by the charging of these accumulator cars, which can be carried out at fixed hours of light load. The construction and simplification of the cars themselves, in the means for charging them and maintaining them at the lowest possible cost, will give a field of employment for electrical engineers, so that if we take the extremely narrow view held by your correspondent—*i.e.*, that engineers should not be allowed free speech on any matters which might in any way be construed to be inimical to their industry, a view which I need hardly say that I, in common with every self-respecting engineer, must totally disagree—it can be shown that electrical engineers as a whole,

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and the public generally, are likely to benefit to a greater extent by the wide development of electrically-driven vehicles to take the place of our present horse-drawn vehicles than for electrical tramways to be developed on certain lines of road in such a manner as to hinder the progress of these smaller electrical cars, for no one, not even Mr. Clifton Robinson himself, imagines that electrical tramways can be laid in every street in our towns, and unless this were done it is always necessary to encourage the development of mechanically-propelled vehicles to take the place of the horse-drawn traffic. If the encouraging progress which has already taken place in the development of all classes of mechanically-propelled vehicles continues at anything like the rate attained during the present year, we shall soon find a notable decrease in the number of horses. Our streets will rapidly become cleaner; the surface of the roadway will not suffer so much from the impact of the horses' feet; the reduced cost of cleansing and upkeep which will follow on this will make it economical, year by year, to increase the number of streets and roads laid with perfected surfaces. Every street which at that time has been laid with tramrails will be dangerous and difficult for use by vehicles having smooth tyres, and all such thoroughfares will then be a hindrance instead of assistance to the flow of traffic.

I know that I am not alone in holding these views, but all who agree with me must from time to time find themselves compelled to oppose the indiscriminate laying of tramrails, especially on the old lines of road leading out of London, which are in most cases the only means by which the Londoner can obtain access to the country, or on which garden and other country produce can be brought in. The promoters of these electrical tramlines laid on our lines of road out of London know well that their future profits depend not on carrying the omnibus traffic which already exists, but on stimulating a greatly increased traffic by encouraging new building estates along their line. Thus, as London is rapidly extended along these lines of road the traffic on them, other than that carried by the tramcars themselves, is more and more congested, and those living in London thus find themselves further removed from the country scenery and country air. These lines are really railways, and ought to be constructed on land purchased for the purpose.—Yours, &c., R. E. Crompton.

London, W., July 1.

MOVING-COIL INSTRUMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue for May 30th there is an illustrated account of a new type of instrument devised by M. Weiss for eliminating the error in a moving coil galvanometer, which arises from the weakening of the permanent magnet, and which, the article says, "gives great trouble to manufacturers and users of instruments, as it is by no means an easy matter to make it negligible."

Later on, in your issue for June 13th, appeared a letter from Mr. Harris pointing out that the idea was not new, that the method described had been patented by Mr. Soames about eight years ago, and that a number of these instruments had since been made by Nalder Bros. & Co., succeeded by Nalder Bros. and Thompson (Ltd.).

That the principle of replacing the spring control of a moving coil galvanometer with a magnetic control has been commercially utilised by this firm is to me a matter of much interest. For this principle is still older than Mr. Harris thinks, being, in fact, the subject of patent No. 8,795, taken out in 1887 by Prof. Perry and myself, and of a communication "On Permanent Magnet Ammeters and Voltmeters with Invariable Sensibility," given by us to the Physical Society on June 25th of that year. On that occasion the first instrument which we had constructed in this way was exhibited, and particulars given of the considerable variations that experiment had shown could be made in the strength of the magnetic field without materially affecting the sensibility of the instrument. The subject is also dealt with in "Practical Electricity," § 89, p. 150, under the heading "Moving Coil Ammeter with Magnetic Control."—Yours, &c.

London, July 1. W. E. Ayrton.

ANNUAL MEETING OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The seventh annual convention of the Incorporated Municipal Electrical Association met on Wednesday morning at the building of the Institution of Mechanical Engineers, under the presidency of Mr. John Rider (Electrical Engineer to the London County Council Tramways Department), and will continue until Saturday. In accordance with our usual custom we give here a brief *résumé* of each day's proceedings, and publish a full report of the papers and discussions, partly in this and partly in future issues.

Wednesday, July 2nd.

Mr. Rider introduced to the meeting Sir John McDougall, chairman of the London County Council, who welcomed the Association to London in the following terms:—

It appeared to him to be very fitting, he said, that the chairman of the central authority of the metropolis should welcome the members of the Association. In the matter of locomotion London was a long way behind many of the smaller cities and boroughs, but London was exceptional. It was divided into many authorities for many purposes, and therefore there was not the union that there would be if it was only one small community. The area was something like 120 sq. miles and the population close upon five millions of people, so that it was easy to see the grave need there was that the locomotion should be of the very best, and he was quite sure that it would be to the benefit of London that the Association was meeting here this year. To be sure, there was the great question of the housing of the working classes—one of the greatest difficulty—because numbers of working men were being removed from their residences because of improvements and the needs of great industrial concerns such as railways and railway stations. Therefore, he looked upon it that, while the electric light might be for the richer classes of London, municipal tramways were really the poor man's carriage. He welcomed the Association, and hoped that the results of their discussions and deliberations would be to encourage municipalities, not only in London, but throughout the country, to push forward electrical matters. If there was one matter between companies and municipalities which was exemplified very strongly in London it was the perpetual breaking up of the streets. This was always being put down to the London County Council through some of the contractors being sharp enough to put up a board saying that the road was stopped "by permission of that body." But the London County Council did not give any such permission. They could only claim to be notified of the fact. In such matters as these they were perfectly helpless, and as a consequence looked forward to the time when municipalities would come to the fore.

Mr. Rider then read his presidential address, which was characterised by certain passages of dry humour and a critical survey of some matters of a technical nature with which he can speak with authority. Without troubling the meeting with long abstracts of reports and rows of statistical figures relating to the progress of the municipal electrical industry, he briefly commented on the good work done by the Association, hinted that the question of funds would be considered at the business meeting on Saturday, and referred to the useful function of the Association, not reported in the *Proceedings*, in making both municipal engineers and chairmen of committees personally acquainted with one another. The remainder of his address was devoted chiefly to electric traction questions, quoting figures in favour of a combination of electric lighting and traction undertakings, and giving an average estimate of the cost of the road construction for overhead, surface contact and trolley systems. He considered that the abandonment of the overhead system merely for "æsthetic" reasons was not reasonable, and stated three conditions under which he thought the conduit system was justifiable. Coming next to guard-wires, he criticised the action of the Board of Trade in the matter of their regulations. Mr. Rider concluded his address with a few words of caution to the younger members who did not put in large enough units of plant when designing their stations, and added a recommendation to them to travel as much as possible, so as to see other works than their own. We give a verbatim report of the address elsewhere in this issue.

Mr. E. T. Ruthven Murray (Willesden) then read his Paper on "Double-Current Generators." In the Paper, a full reprint of which will be found on another page, he pointed out the advantage of employing these machines, which could generate from the same armature low-pressure continuous current for the district near the works and three-phase currents for transforming to high pressure and conveying to districts beyond the economical limits of direct low-pressure distribution. He

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discussed the design and properties of these machines, two of which he is putting down at the Willesden municipal electricity works, and referred briefly to methods employed for the sub-stations and for regulating.

Mr. C. H. Wordingham, who opened the discussion, congratulated the reader of the Paper on preserving an open mind with regard to rotary converters, and characterised the disinclination some engineers had to using them as mere prejudice in view of what had to be paid for it in loss of efficiency. He allowed that there was a difficulty as regards regulation, and said that the best solution was to keep the line loss small, to have several small sub-stations close together, much copper in the secondary network, and few feeders. Mr. A. B. Mountain (Huddersfield) did not think Mr. Ruthven-Murray's arrangement would work well if both alternating current and continuous current were being generated at once, but later in the discussion Mr. C. F. Scott (of the Westinghouse Company, U.S.A.) was able to cite a number of large plants which he had erected in the United States and in which the same machines did this every day most efficiently. Mr. W. B. Esson was strongly of opinion that it was not worth while converting alternating to continuous current unless for tramways. He preferred to distribute three-phase current, and balance the load by means of a fourth wire, which, he said, reduced the copper in the mains by 40 per cent. Both he and Mr. C. F. Scott spoke in favour of induction motors, which, Mr. Esson said, could now be made with power-factors of 0·9 to 0·94. Mr. Scott, however, when he had made light of the power-factor difficulty, and praised the robustness of induction motors, pointed out that synchronous motors were far less reliable, and then proceeded to extol rotary converters as against induction motor-generators, an inconsistency that Mr. Ruthven-Murray did not omit to point out in his reply. There was a short passage-at-arms between Mr. L. Andrews (Hastings) and Mr. Esson with regard to boosting up the pressure of the alternating current, neither quite understanding the other's point. Mr. S. Z. de Ferranti refused to speak, not having had any experience with double-current generators. Mr. Albert Gay (Islington) claimed to have prophesied the advent of these machines years ago, when he had stated that the system of the future would be a high-tension, low-tension, alternating-current, continuous-current system. Mr. F. C. Raphael asked for further particulars of the method of balancing and regulation, and pointed out that an alteration in the diagram of transformer connections shown would be necessary if the author were to do without a balancer as he proposed. Mr. Faraday Proctor (Bristol) and Mr. Barnard (Hull) also spoke briefly. Mr. Rider, speaking before Mr. Ruthven-Murray's reply, congratulated him on being practically the pioneer of this system in England, but yet expressed his preference for two separate machines (alternating and continuous current) coupled to the same engine. He considered a double-current generator a bad compromise between a continuous-current and an alternating machine, on account of the number of poles necessary to obtain the requisite frequency. Mr. Ruthven-Murray having replied to the discussion, Mr. P. N. Hooper (St. Pancras) asked leave to correct a statement which had been made to the effect that the St. Pancras Borough Council had ordered a double-current generator. They had specified one, but could not get a firm to build it in accordance with the specification.

Mr. Barnard (Hull), who read the next Paper, is an advocate of the high-pressure continuous-current system, with which he has had favourable experience in Hull. He sketched briefly the development of this system, and pointed out that high-pressure continuous-current dynamos are cheaper than three-phase machines, the relative prices per kilowatt as disclosed in recent tenders for a machine of about 500kw. capacity and driven by a fast-speed enclosed engine being £8. 6s. and £9. 1s. 8d. respectively. A great advantage over the three-phase continuous-current system with sub-stations was, he pointed out, that the sub-stations for converting continuous-current from high to low pressure needed no attendant, the switching being done by automatic devices at the generating station or a main switching station. The Paper, although short, was most interesting, and brought forward several points in connection with high-pressure continuous-current systems which are not well known.

Mr. J. F. C. Snell (Sunderland) opened the discussion, and contended that Mr. Barnard's figures for the cost of three-phase machines were too high, and that the advantages he claimed thus resolved themselves only into the saving of superintendence in sub-stations. An engineer, he said, should give the matter most serious consideration before he decided to have a sub-station with running machinery and without an attendant to look after it. He analysed the costs at Hull, pointing out that the large fuel item and the interest and sinking fund largely accounted for the deficit. Why, he asked, as Hull had such a low load-factor, was there an independent station for the tramways? If for engineering and not merely departmental reasons, it was a serious indictment of the system. Mr. Wyllie (Walsall) said he had found the high-pressure continuous-current system reliable. He employed one man, a junior, to look after all nine of his sub-stations, and this man had time to do other work, such as putting up meters, as well. Mr. C. E. C. Shawfield (Wolverhampton) endorsed generally what Mr. Barnard had said in his Paper. When he first took over the works at Wolverhampton he had had trouble due to the switch gear, but he found it was mainly caused by the Ferranti oil-type quick-break fuses which broke circuit too sharply. If a short occurred in one transformer, the fuses in the other transformers acted as well. He had found no difficulty in starting up after a breakdown, and had had plenty of experience in doing this at Wolverhampton. In one case, with a dead short on the network, he had run up and switched in on lower pressure until the short was removed.

Mr. A. B. Mountain (Huddersfield) compared the capital of £78 per kilowatt at Hull with the corresponding figure of £65 at Huddersfield, and pointed out that the works costs were less also. In the latter place the single-phase transformer sub-stations cost 80s. per kilowatt as against £10. 10s. at Hull. Consumers should not mind sacrificing 5 per cent. in motor efficiency if they gained 10 per cent. in the price per unit. Mr. H. R. Burnett (Barrow-in-Furness) gave some interesting particulars of the troubles he had had to overcome on his high-pressure continuous-current system. He confirmed what had been said as to machines sparking across the brushes when switching off. After he had had short-circuits he ran up again quietly on low-tension plant. Mr. W. A. Chamen (Glasgow) asked whether the mains on which the rise of pressure occurred on switching off were continuous or alternating. Mr. Ferranti sketched the early history of high-pressure continuous current in France; the experiments were with extra high-pressure, using several machines in series. Marcel Duprez was the first, then Thury, and besides this there was the Popp system with compressed air motors. All had disappeared, but we had now come to a time when good electrical distribution was possible on any system. As an instance of early difficulties, he recalled a case of six fires occurring simultaneously on one system using house transformers. He thought that the only thing that continuous-current was necessary for was for lifts—say 8 per cent. of the total energy. The single-phase system had the advantage of saving costs both capital and works costs, by establishing a uniform system without complications. Mr. Wordingham, speaking during the last two minutes of the meeting, believed that the sole reason the high-tension continuous-current system would not do was the limitation in pressure to about 3,000 volts. He also expressed his surprise that Mr. Barnard was not compelled by the Board of Trade to put a competent assistant permanently in each sub-station. Mr. Barnard was asked to reserve his reply for communication to the journal, and the meeting was adjourned.

In the afternoon visits were made to the Shepherds Bush generating station of the Central London Railway, the Willesden works of the Metropolitan Electric Supply Co., and to the works of the Incandescent Electric Lamp Co. at Brook Green.

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Thursday, July 3rd.

In the morning the members of the Association visited the Tramways Exhibition at the Agricultural Hall, and the meeting was held there in the afternoon. Mr. Fedden being absent through illness his Paper on steam turbines, with which the proceedings opened, was read by the Honorary Secretary. It was apparently intended as an answer to those critics who have blamed Mr. Fedden for starting a large power house with steam turbines. He expressed his confidence in this form of engine, however, for large sizes (200kw. to 300kw. and upwards) and not small sizes, provided that surface condensers were employed. The large steam consumptions recorded in the early days were, he considered, due to the turbines being small and running non-condensing, and he was convinced that the larger steam turbines now on the market could hold their own in the matter of steam consumption against any triple expansion engine yet produced. He then related how the 500kw. steam turbine exhibited in Paris came directly to Sheffield, where it ran on the town load within three days of its arrival at the railway station. Besides a good vacuum, a high degree of superheat was a condition which Mr. Fedden considered important. He is installing a 1,500kw. turbo-alternator at the Sheffield power station.

Mr. A. A. Day (Bolton) followed with the longest Paper before the Convention, on "The Correct Type of Engine for Large Generating Stations." He favoured the slow-speed horizontal engine on account of its low steam consumption, and maintained that the question of space occupied was not important with large units, as there was no necessity for the engines to occupy less than the length of engine-room covered by their boilers. Horizontal engines, he had found on inquiry, had given an indicated horse power-hour for less than 0·1d. with coal at 7s. per ton in large cotton mills whose variation of load was 10 per cent. Mr. Day alluded further to the saving in steam piping in horizontal engines, and other advantages. He prefers to have the dynamo between the two lines of cylinders, and pointed out that this is inconvenient in the case of vertical engines owing to extra difficulty in lifting the top half of the field magnets. The question of even turning moment had been made too much of, in Mr. Day's opinion, and he stated that there were single-crank three-phase machines on the Continent with a variation in the angular velocity of 0·3 per cent. He did not deal with the arrangement of the cylinders, or compare triple-expansion and compound engines, except to say that, personally, he would divide the plant up—some triple expansion and others compound.

After the reading of these two Papers, Mr. Rider, having to attend an important committee meeting, vacated the chair in favour of Mr. J. F. C. Snell, one of the vice-presidents. The two Papers were discussed together, the discussion being opened by Mr. Hamilton Kilgour (Cheltenham), who, while agreeing generally with Mr. Fedden as to the advantages of steam turbines over reciprocating engines, did not agree with him that they must be in large sizes and be run with surface condensers. Small sizes were, he said, fairly economical,—for example, a 100kw. steam turbine took only 24lb. to 26lb. of steam per kilowatt-hour,—and in his own station he ran turbines with jet condensers. The absence of cylinder lubrication was a great saving of trouble, the effects of priming were not serious, and, finally, the repairs bill was small. He had had many repairs, but chiefly on account of accessories. The question of price was discussed very much, some stating that steam turbines cost more than reciprocating engines, others that they cost less. The statement of Mr. Martin, of the Parsons Company was that the cost of small sets, say, up to 100kw., was about the same as the best quality of reciprocating engines, and that those of a larger size were cheaper. Mr. Wordingham, however, cited an instance in which the recent tenders for a small set were 50 per cent. greater for a steam turbine drive than for drive by reciprocating engines by leading makers. Mr. Wordingham and other speakers referred to the commutator difficulty on continuous-current turbo-generators, stating that the commutators of turbine-driven machines wore very rapidly, and that it was impossible to use carbon brushes as these caught fire on account of the friction at the high speed of the engine. The necessity for frequent inspection of steam turbines was also referred to, Mr. Wordingham citing a case in which it was suddenly discovered that one of these machines was using 57lb. of steam per kilowatt-hour. Complaints were also made that variations were continually being made in the design, so that it was difficult to obtain two successive steam turbines exactly alike. Criticising Mr. Day's Paper, Mr. Wordingham pointed out that it was not merely a question of saving floor space, but also buildings, and in concluding his speech he said that, if one looked as far ahead as Mr. Day, one must look for gas engines. This remark served to include gas engines in the discussion. Mr. T. P. Wilmshurst (Derby) humorously remarked upon the vibration of the gas-engine plant, which was distinctly troublesome, in the meeting hall. Mr. Ferranti said that people would stand a good deal of noise if it was cheap, but pointed to the synchronising and other troubles with gas-engine driven alternators. A general laugh was raised when Mr. Chamen (Glasgow) said that he himself, when with Messrs. Crompton, had put down the first three of the gas engines at the Agricultural Hall, about which the members were complaining. He had designed the foundations most carefully, with the very object of preventing vibration in the lecture room, but there had been considerable trouble through the engines moving about on their foundations, and finally the Agricultural Hall authorities had filled up all the foundations with cement. The Agricultural Hall people, however, who were keen business men, seemed to be pleased with gas engines, for they had put in additional gas-engine driven plant of larger size since.

Mr. Wilmshurst could see no ground for Mr. Day's statement that either very high or very low-speed engines should be used, and spoke in favour of the Ferranti engine with its slowly-travelling valve gear. Mr. Ferranti emphatically announced his opinion that the driving of electric generators was more important than all the other problems of electric supply put together. He also criticised the steam turbine. He admitted that it was all the fault of the dynamo, but thought that neither for continuous nor alternating current could turbine-driven generators compare with those driven by moderate-speed engines. On the question of wet steam, about which there appeared to be a difference of opinion, he referred to Prof. Thurston's experiments, which showed that, other things being equal, double work was obtained by superheating the steam 100°F. Others spoke on this point, and the discussion on it practically came to this—that steam turbines would run without trouble with very wet steam, but at a much lower efficiency than if the steam was dry. As an instance of a case of the supersession of the steam turbine by reciprocating engines, Mr. Ferranti mentioned the Metropolitan Electric Supply Co., who, although they had had as much experience as anyone in their older station, had first adopted moderate-speed engines and then slow-speed Sulzer engines in their Willesden works. Mr. Martin, of the Parsons Company said, however, that the reason why the last Metropolitan sets had been ordered abroad was because they could find no English maker who had made any of such a large size. Referring to Mr. Fedden's suggestion of a gas turbine, Mr. Ferranti said that, according to many scientists, the theoretical maximum efficiency of such engines would be low, but he was not prepared to vouch for the accuracy of this. Finally, Mr. Ferranti said that, if people were prepared to pay for horizontal engines and the larger buildings they required, excellent results could be obtained, but, taking the interest and sinking fund into account, the less efficient vertical engines were cheaper in the end. Mr. Chamen mentioned that Manchester had ordered two turbine-driven continuous-current sets, each of 1,800kw. capacity. Mr. Martin said that his firm were now making brush gear for their steam turbines which could be rotated by means of a relay worked by the varying pressure in the steam chest. He did not think the variation in design from time to time was very great, and stated that the vibration which some speakers had referred to was only in running up to speed.

Mr. A. B. Mountain (Huddersfield) complained that the

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steam consumption in the high guarantee and reception tests were not repeated in everyday working, and said that in some cases each pound of steam saved per kilowatt-hour meant a saving in capital expenditure of £700. Mr. L. Andrews (Hastings) said that he had found that a 500kw. turbo-alternator took no more steam on the very light day load at Hastings than other machines of 100kw. He had found that his Parsons machine would run in parallel with Mordey alternators. Mr. Rogerson (Halifax) referred to some highly satisfactory tests with steam turbines, and said he could start them up in a quarter or one-eighth of the time of other sets. Messrs. Crawford (of Messrs. Bellis and Morcom), H. W. Booth, J. S. Highfield (St. Helens), W. H. Tittensor (Dundee), Dr. Panton (Bolton), F. A. Newington (Edinburgh), V. A. H. McCowen (Belfast), and J. F. C. Snell (Sunderland), also spoke. Mr. Fedden not being present could not reply to the discussion, and Mr. Day preferred to reserve his remarks for communication to the Association journal. The meeting was then adjourned until this morning at 10 o'clock at the Institution of Mechanical Engineers, St. James's Park.

HIGH-TENSION CONTINUOUS-CURRENT SYSTEMS.*

BY A. S. BARNARD.
City Electrical Engineer, Hull.

A few years ago the expressions high and low-tension systems were practically synonymous with alternating and continuous-current systems. A high-tension system implied a single-phase alternating generator supplying from house to house through separate transformers fixed for each consumer or group of consumers. Equally, a continuous-current system implied continuous-current dynamos generating at a pressure of probably 200 to 250 volts, supplying the low-tension network to which the service cables were attached, there being no intermediate machinery between the dynamos and the lamps on the consumers' premises. So far as regards the distributing network and appliances on consumers' premises, continuous current now seems to have completely beaten alternating current out of the field; and, on the other hand, in the matter of generators and feeders to the network, the alternating current appears to be rapidly becoming universal, though generally three or two-phase plant is installed instead of single-phase.

The object of this Paper is to show that those engineers who have pinned their faith to continuous-current plant are able to offer a reliable alternative to the three-phase generator and transformer. As far back as the year 1890 direct-current generators and transformers, working at a pressure of 1,000 volts, were installed at the Crystal Palace. The dynamos were of the ordinary two-pole type, rope-driven and separately excited from smaller machines driven off the main generators. Transformers, which were also of the two-pole type, with high and low-tension windings on the same armature, were erected in conjunction with storage batteries on the low-tension side, and were started as motors off the low-tension network, and were switched into parallel with the high-tension generators when they had attained their proper working speed. In 1892 a great advance on this system was made at Oxford, where the works were designed to control the various transformers from one central switchboard, the transformers being started as motors from the high-tension side, and switched into circuit on the low-tension network by means of electrically-controlled switches operated from the central switchboard.

When starting the transformers a very heavy current was called for from the high-tension generators, which caused fluctuations of the light at the instant of switching in. To obviate this, a series winding was put on the transformers which carried the high-tension current the whole time the transformer was at work. This arrangement had the drawback that it decreased the efficiency of the transformer, and was also costly in copper. It is now the usual practice to retain the series coil in circuit only until the transformer has attained its proper speed, when it is cut out by an electromagnetic switch excited by means of the current passing round the shunt winding of the transformer.

The next important step in the use of high-tension continuous current appears to have been made when the municipal station at Walsall was opened with direct-coupled high-speed generators, working at a pressure of 2,000 volts. At the present day there are central stations at work on the Oxford system, or modifications thereof, in addition to those already mentioned, at Wolverhampton, Morecambe, Barrow-in-Furness, Bromley, Folkestone, Guernsey and Hull, as well as a number of private plants owned by railway companies and others, where the pressure at the generators is from 1,000 to 3,000 volts. Some of the London companies have also adopted continuous-current transformers for raising the pressure of particular feeders to 2,000 or 3,000 volts, transforming down again to low-tension at the other end of the feeder, and a small proportion of the plant at Manchester is, the writer believes, operated on this system.

At Hull, the main generators are of the four-pole type, coupled direct to high-speed engines, and giving an output of 510kw. each at 2,250 volts. These appear to be about the largest high-tension continuous-current generators in use in this country, but from their satisfactory behaviour there really seems no reason to anticipate difficulty in designing dynamos for very much larger outputs at the same or higher pressure.

The continuous-current generator appears to be less expensive to make than the three-phase alternator, as the following figures from recent tenders show :—

Output. Kw.	Speed. Revs.	Type.	Price.	Price per kw.
480	375	Enclosed engine, three-phase alternator	£4,360	£9. 1s. 8d
510	270	Enclosed engine, four-pole high-tension continuous-current dynamo	£4,231	£8. 6s. 0d.

In this comparison it will be noticed that the output is almost identical, and that the speed of the continuous-current machine is considerably the lower, and it might have been expected, therefore, that the price would have been the higher of the two.

Fig. 1 shows an efficiency curve of a 510kw. four-pole generator at the Hull works, and while, perhaps, this is not so good at some loads as the curve of a three-phase generator of similar output, there does not appear to be any very great advantage in either.

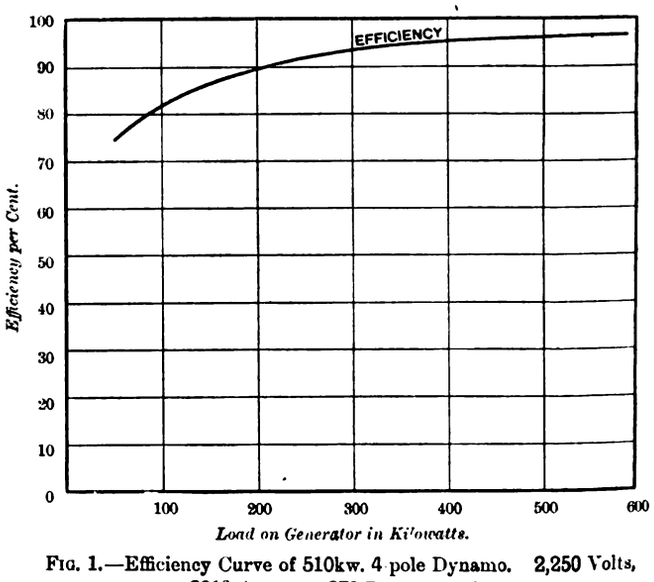

FIG. 1.—Efficiency Curve of 510kw. 4-pole Dynamo. 2,250 Volts, 226⅔ Amperes, 270 Revs. per min.

When we consider the transformers, the continuous-current plant appears to have a decided advantage over the polyphase plant. In the first place, a transformation from 3,000 to 220 volts on the continuous-current system is effected by one machine. On the three-phase system there is generally in addition to the motor-generator a static transformer, and the two together occupy more space and represent more capital outlay than does the one rotatory transformer of the continuous current system. In each case there are parts which require lubrication, and, therefore, a certain amount of attention whilst running, but the attention required at the continuous-current sub-station appears to the writer in practice to be considerably less than that required at a three-phase sub-station with motor-generators. It must be remembered that, as the transformers are started and stopped, and entirely controlled by an attendant at the central switchboard (in Hull this is at the generating station), there is no need for an attendant at the sub-station to manipulate switch gear. In a recent Paper before the Institution of Electrical Engineers Prof. Carus-Wilson estimates the wages at seven rotary sub-stations on an Italian railway system as *not more than* the wages at the generating station—*i.e.*, £4,000 per annum. In the writer's opinion this item would be *not more than* one-half of the wages at the generating station, and probably a good deal less, if the system in use were high-tension continuous current.

Another advantage of the continuous-current transformer is, that there is no phase difference between the E.M.F. and the current, and consequently no excess of current is demanded at light loads, as

* Paper read before the Incorporated Municipal Electrical Association on Wednesday.

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is the case with the polyphase converters; and there is no possibility of the transformers "hunting," but each takes its own load steadily, and the proportion it takes can be adjusted by the attendant at the central switchboard so as to keep the pressure level on the low-tension network as he choses. In this connection it may also be pointed out that in the high-tension continuous-current system the momentum of the moving parts is a very important advantage. When a sudden fluctuation of load occurs on the low-tension side, the momentum of the armature causes it to act to a considerable extent as a generator. This renders the whole system more flexible, and mitigates the strain on the engine. The momentum of the armature of a rotatory converter, however, would appear to be absolutely disadvantageous, as tending to throw the machine out of step with the generator.

In starting up a continuous current transformer there is never any difficulty with regard to polarity on the low-tension side, as is the case with polyphase converters when these are not started from the continuous-current side. The efficiency of the continuous-current transformer is not so high as that of a three-phase rotary converter, but it must be remembered that in addition to the converter, the polyphase system generally employs a static transformer, and it is the combined efficiency of the two which has to be compared with the efficiency of the continuous-current transformer. The efficiency of the three-phase rotary converter is probably about 96 per cent., and that of the static transformer the same. The combined efficiency, therefore, is only about 90 per cent., whereas that of the continuous-current transformer is as high as 92 per cent. Fig. 2 gives the

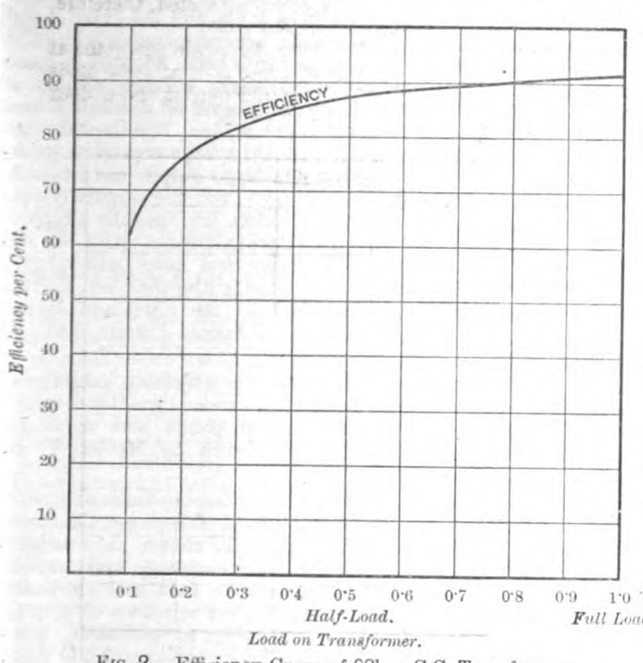

FIG. 2.—Efficiency Curve of 92kw. C.C. Transformer. 450 Volts Secondary, 2,000 Volts Primary.

efficiency curve of one of the Hull 92kw. continuous-current transformers, and this compares very favourably with the guaranteed efficiencies of some of the Tyneside 500kw. three-phase transformers, as being 89 per cent. at full load and 73 per cent. at one-third load.

Modifications of the Oxford system in which the transformer is used rather as a throttling valve between the high and low-tension mains, without their being absolutely separated from each other, can show much higher efficiencies than those given above, and any reasonable sized machine would give at least 96 per cent. at full load, dropping to about 90 per cent. at quarter-load. This, of course, is owing to the fact that a portion only of the energy is actually transformed, the remainder passing through the motor armature in series with the load. Several plants have been installed on such a system with the most satisfactory all-round results, the feeders having an effective voltage of double the network pressure. Some of the plant on the City and South London Railway may be cited as an example of this system.

A comparison of the cost of rotatory transformers for continuous, and motor generators for three-phase, current shows a similar result to that of the generators.

Output. Kw.	Speed. Revs.	Type.	Price.	Price per kw.
92	500	High-tension continuous-current rotatory transformer	£705.	£7 13s. 3d.
100	500	Three-phase to continuous-current motor-generator	£1,050	£10. 10s. 0d.

With three-phase rotary converters the cost per kilowatt can be as low as £4. 10s.; equally, with continuous-current "reducer" transformers, where a portion only of the high-tension current is transformed, and when there is no necessity to absolutely separate the low-tension mains from one pole of the high-tension mains, the cost per kilowatt will come down to about the same figure.

Perhaps the most interesting part of high-tension continuous-current work is the switch gear employed at the generating station and sub-stations. Briefly, there are required at the generating station a number of dynamo panels, corresponding to the number of dynamos to be run in parallel, and transformer panels to correspond with the number of transformer circuits controlled at the generating station. For everyday working, when all the plant and mains are in perfect order, the switches on either class of panel can be of the simplest, and merely have to control comparatively small currents, and very low pressures. This is due, of course, to the fact that the rotatory transformers take an appreciable time to come to rest after being disconnected, and so the switches open a circuit having for the pressure across their contacts only the *difference* between the pressure of the 'bus bars and the back E.M.F. of the rotatory transformer, which is temporarily acting as a generator. In the event of a fault occurring, however, such as a short circuit on a high-tension feeder, it is necessary that the switch controlling that circuit should open automatically, and this time it will have to open with a considerable current and the full E.M.F. of the system. Now the difficulty of opening a circuit with even 20kw. or 30kw. passing at 2,000 volts pressure is considerable; and if the circuit be (as it generally is) a fairly inductive one, the rise of E.M.F. will depend very largely on the type of switch adopted, and the writer has found that with an instantaneous non-arcing switch opening a circuit where 10 amperes were passing at 2,000 volts, the rise was no less than 600 volts, and possibly more. With a carefully designed flare switch, where the arc is gradually allowed to die away, this effect can apparently be entirely overcome, and from experiments made the writer is of opinion that the difficulties are by no means insuperable, and that the switching arrangements can be made as reliable and safe as in a low-tension system. Indeed, there are advantages in the high-tension switches owing to the proportionately smaller currents to be carried and the smaller risk of heating from bad contacts.

The switch gear in use for controlling the transformers has been very carefully worked out, and is, of course, the subject of several patents. The most important item is the "long-range" switch, which consists of a single-pole low-tension switch, whose moving part is actuated by an electromagnet, the coil of which is placed in circuit, through a pilot wire, with a voltmeter at the generating station. By short-circuiting this voltmeter, the resistance of the whole pilot circuit is sufficiently reduced for a predetermined current of, say, 5 amperes, to pass. This is enough to suck up the armature of the electromagnet, and in so doing to close the low-tension switch. Opening the voltmeter short-circuit drops the electromagnet armature again, and the next operation of the electromagnet is arranged to open the low-tension switch, thus disconnecting the low-tension side of the transformer. In Hull, three-core pilot wires are used—one wire being connected to the negative low-tension mains (which are also permanently connected through a plug-board to the negative side of the transformers), one to the positive low-tension main, and one to the positive side of the transformer. By means of a two-way switch at the generating station, the attendant can assure himself that the E.M.F. of the transformer is the same as that of the mains before operating the long-range switch. The third pilot wire is a valuable adjunct, as while it is necessary to have one wire permanently showing the pressure on the mains, yet, in the event of a break-down when the low-tension mains were "dead," there would be no power available on that wire to operate the long-range switches. With the three pilot wires from each, a number of transformers may be started up, and switched simultaneously on to a "dead" network, although they are fixed in sub-stations possibly a couple of miles apart.

While there are many details of interest of which no mention has been made above, the writer is in hopes that sufficient has been said to provoke a useful discussion, and to show that for pressures of 2,000 to 3,000 volts, at least, there are some advantages to be gained by using continuous current. In conclusion, he gives a record of the actual results achieved on the ordinary daily load on two of the high-tension feeder circuits in Hull. These tests show the actual efficiency of conversion and transmission from the high-tension omnibus bars at the works to the low-tension distributing mains 3,000yds. away.

First Test. *Circuit No. 10.* March, 3, 1902.

Length of feeder—approximately 3,000yds. each way.
Conductors—19/16 S.W.G. concentric cable.
Transformer—92kw. "Parker," 500 revs. per min.
Duration—One hour.

Average—High-tension amperes	38·23
,, High-tension volts	2,156·23
,, Low-tension amperes	156·47
,, Low-tension volts	462·48
High-tension kilowatt-hours	82·45
Low-tension kilowatt-hours	72·36

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Second Test. *Circuit No. 11.* March 8, 1902.

Length of feeder—approximately 3,000yds. each way.
Conductors—19/16 S.W.G. concentric cable.
Transformer—92kw. "Parker," 500 revs. per min.
Duration—One hour.

Average—High-tension amperes	.....	40·00
,, High-tension volts	.....	2,154·60
,, Low-tension amperes	.....	162·03
,, Low-tension volts	.....	459·00
High-tension kilowatt-hours	.....	86·18
Low-tension kilowatt-hours	.....	74·35

Efficiency of circuit and transformation, 86·28 per cent.

Instruments:—Kelvin electrostatic voltmeters, Crompton ampere-meters, all newly calibrated to 0·2 per cent. maximum error.

INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

MISCELLANEOUS EXHIBITS.

Only second in importance to the exhibits of generating plant, rolling stock, overhead trolley plant and accessories, permanent way material and the more direct accessories of electric traction work, are the exhibits of a miscellaneous character which go to swell the entries and increase the interest of the display now open at the Agricultural Hall, Islington, London. It is a noticeable feature of these miscellaneous exhibits that they cover a much wider field than was the case when the last exhibition of this kind was held in the same hall in 1900; and it cannot even now be said, comprehensive as these miscellaneous exhibits undoubtedly are, that they cover all the trades and manufactures which go to make up the electric traction and allied industries of to-day. The automobile branch of road locomotion is not at all in evidence in the exhibition, and consequently the multiplicity of apparatus which is employed in this branch is absent, except in the case of some of the exhibits of traction cells. This notwithstanding, the miscellaneous exhibits show much variety, as will be seen from the following brief review:—

Asbestos Goods.—In addition to the exhibit of the Cape Asbestos Co., described in another column, an excellent show is made by the United Asbestos Co. at stand No. 181, where this company's well-known "Gladiator," "Eclipse" and "Victor" packings and jointing materials are exhibited. This stand includes a good assortment of engineers' requisites, including tools, beltings, packed and plain asbestos, steam fittings, boiler and pipe coverings, and a large and varied selection of crude asbestos of an interesting character. The new asbestos cellular pipe covering, known as the "Viceroy," is also exhibited, and will interest engineers and other users of this class of material.

Boiler Mountings, &c.—An effective display of boiler mountings, safety valves and similar engineering accessories is made by Messrs. J. Hopkinson & Co. at stand No. 18.

Car Seats (inside and outside).—In this class of exhibit there is a large selection, especially of seats for the tops of tramcars. The claims in most cases relate to simplicity and efficiency of the seats under conditions of wet weather. This is an important matter in tramway working, and there is doubtless room for considerable ingenuity of design to overcome the great drawback of wet seats. There still seems much room for improvement in this respect, and although many of the designs exhibited show much merit, the ideal dry seat has yet to be provided. There was, so far as we were able to judge, always some disadvantage to be placed against the advantages offered in the seats that came under our inspection. These contrivances are shown at stands Nos. 8, 35, 91, 131, 147, 150, 156, 159, 161, 162 and 165, so that buyers of this class of goods have an embarrassment of choice. Notwithstanding this the dry seat, which can be manufactured at low cost, and which will stand the wear and tear of everyday tramway work, has yet, we think, to be evolved.

Elevating and Conveying Machinery.—At stands Nos. 1, 6 and 93, various types of elevating and conveying machinery are shown by Messrs. Graham, Morton & Co., Mr. G. F. Zimmer and Messrs. E. Bennis & Co., and in each case evidence is given that simplicity of design and the saving of labour wherever possible has been the main object of all recent improvements in this class of apparatus.

Gates and Railings.—In the modern tramcar gates and railings form an important feature, and at stand No. 24 the Bostwick Gate Co. show a patent collapsible gate in two different forms suitable for tramcars and used by a number of the principal railway companies on corridor trains. Messrs. Francis Morton & Co., at stand No. 184, show a number of gates and several patterns of railings for the tops of tramcars, &c.

Insulating Materials, Paints, &c.—Here, again, a variety of material is at the command of the manufacturer, and many of the compounds, varnishes, &c., used in this work are specially designed for tramways. Goods of this class are exhibited at stands No. 22, 26, 29, 32A, 39, 40, 53, 60, 63, 64, 66, 79, 88, 120, 127, 146, 170 and 181.

Interior Furnishings for Tramcars.—In this important department of tramcar construction, the exhibit of Messrs. G. D. Peters & Co., at stand No. 20, is one of particular interest, for the tendency to beautify the public car is one in which the taste to be displayed is naturally limited to the materials at command. For many years Messrs. Peters & Co. have been engaged in the manufacture of articles and material specially suitable for seat coverings, roof, side and end panels, window furnishings, sunblinds, steam-heating apparatus, and similar accessories which go to make up the finished car. Tincrusta, one of the firm's specialities, is largely used in tramway and railway carriage furnishing.

Lubricants and Lubricators.—At stand No. 111 the Vacuum Oil Co. have a good show of lubricants and lubricators, and at No. 32A the Joseph Dixon Crucible Co. show special forms of graphite, plumbago and blacklead lubricants, &c. In this section may also be mentioned the exhibit of the United Asbestos Co. at stand No. 181.

Metals and Alloys.—Notable displays of anti-friction and other metals and alloys are made at stands Nos. 2, 76 and 94, by the Glacier Anti-Friction Metal Co., the Tandem Smelting Syndicate, and the Atlas Metal and Alloys Co., and the displays made by these firms show how largely anti-friction metal enters into the construction of tramway rolling stock.

Paving.—Of the several exhibits of paving materials, granite and wood form the chief. The Guernsey granite sets and wood blocks of the well-known firm of William Griffiths & Co. and the granite and stone sets of Messrs. A. and F. Manuelle are conspicuous, while the Sanitary Block and Tile Co. (whose paving is being adopted in some places by the London County Council) make a large exhibit of sanitary block paving for which special claims of durability and freedom from expansion or contraction are made. The Cardiff Corporation electricity department has also laid a large area of its tramway track with this material, of which a large output can be made from the company's works at Briton Ferry. For the conduit system of electric traction it is claimed these blocks are specially adapted. Lava sets and Rhenish basalt macadam are exhibited at stand No. 138 by the London Basalt Stone Co. The lava sets have been largely used in road paving by a number of local authorities, &c., in this country. The well-known wood blocks from the Karri and Jarrah forests are shown by Millar's Karri and Jarrah Foreste, Ltd, at stands Nos. 182 and 183.

Points, Crossings, &c.—In addition to the extensive exhibits of Messrs. Askham Bros. and Wilson, there are several smaller displays of automatic moveable and other types of points and crossings, including Kenway's patent latch point, shown by Messrs. F. H. Lloyd & Co. at No. 28.

Telephone Apparatus.—Amongst the miscellaneous stalls of special electrical interest is that of the Consolidated Telephone Construction and Mfg. Co. (No. 23) where there is shown an excellent variety of telephonic apparatus for both exchange and private telephone working, and for operations in the field and on board ship. In addition, the company show a good selection of electric light and power circuit appliances, including switchboards, fuseboards, switches, &c., for currents up to 5,000 amperes and 1,000 volts. Cabinet work for all kinds of electrical instruments and apparatus is a feature of this exhibit.

Tramway Officials' Uniforms.—Several excellent exhibits of uniforms for inspectors, drivers and conductors on tramways, motor vehicles, &c., are shown, particularly good exhibits of these goods being made by Messrs. Pearson, Huggins & Co. at stand No. 31, and by Messrs. Wathen, Gardiner & Co. at stand No. 117. There is considerable variety in the make-up of these goods.

Water-Softening Apparatus.—Messrs. Lassen and Hjort, Messrs. Doulton & Co., and Desrumaux's Automatic Water-Softener and Purifier (Ltd.), at stands Nos. 4, 51 and 100, make an interesting display of apparatus for the automatic softening of water, the apparatus being specially adapted for use in electric power stations. The first-named firm claim a special ingenuity in the method of mixing the water with certain chemicals, with the constant precipitation of all foreign matters in the settling tank provided, leaving the purified and softened water available for boiler purposes. Messrs. Doulton & Co. show a model on a large scale of their patent water softener, and the Desrumaux's Company, who have a complete system of water softening, make an instructive exhibit.

(To be continued.)

LEAMINGTON AND WARWICK ELECTRICAL CO. (LTD.)—A petition has been presented to the Chancery Division for confirming a special resolution altering the memorandum of association to enable the company to carry on business as electrical engineers, electricians, engineers and contractors, manufacturers of and dealers in electrical apparatus, &c., and to generate and supply electricity, &c.

PARLIAMENTARY INTELLIGENCE.

THE TUBE RAILWAY SCHEMES.

Mr. Campion, one of the examiners of standing order proofs, sat in the House of Commons on Tuesday to consider various allegations of non-compliance with the rules of Parliament in connection with the London United Electric Railways Bill, the Brompton and Piccadilly Circus Railway Bill, and the Piccadilly-City, and North-East London Railway Bills.

Mr. CRIPPS, on behalf of H. L. Florence, chairman of a residents' committee, and others, alleged non-compliance with standing orders in the case of the London United Electric Railway Bill, which contemplated the construction of a tube railway under Knightsbridge-road, the complaint being that a clause had been inserted declaring that where the property of owners, lessees or occupiers was injured by vibration caused by the working of the tubes, and it was not clear to which railway the damage was due, an arbitrator might sit and consider the matter and apportion the compensation jointly or severally. The allegation was that this clause had been inserted without notice to the persons interested or to the public.

For one of the promoters it was pointed out that Lord Windsor's Committee had forced the clause on the companies, and that the officials of Parliament had altered the bill, whether the promoters liked it or not.

Mr. GREG, representing one of the promoters, said it was true the Arbitration Act was embodied in the clause, but that was frequently done without notice when protective clauses were inserted. The question dealt with was only that of vibration. It was not a matter of taking property, but of the construction and working of the railway. If the property was damaged, but not taken, compensation was to be given.

The EXAMINER, in giving his decision, said no doubt the clause related to an important matter, but so far as notice was concerned it was only a technical point, because, after all, the discussion which had taken place before the Committee of the House of Lords had been known to all parties. When a bill was altered in one House the examiner had wide discretion in dealing with the standing orders when it went to the other House. In the exercise of his discretion, and having regard to the object of the clause, which was really for the protection of the landowners, he should not sustain the objection.

Mr. CRIPPS then pointed out that the memorial of Mr. Florence and the other residents raised another allegation of non-compliance, namely, as to absence of notice in regard to material alterations of plans and sections, but the examiner decided to disallow the allegation.

Mr. CRIPPS next alleged non-compliance in respect of clause 107, which confirmed an agreement between the London United Electric Railways Co. and the Piccadilly and City Railway Co. for through fares and through traffic facilities over the respective lines. He contended that this was an agreement exactly of the nature required by the standing orders to be expressly stated in the notices of the bill, and the promoters had failed to include it in any of their notices.

Mr. GREG said that when the notices were issued there was absolutely no connection between the two companies, and that, therefore, it was impossible to cite the Piccadilly and City Railway Co. by name. He held, also that the notices given were sufficiently wide to cover this particular agreement.

The EXAMINER said that the agreement undoubtedly came within the requirements of the standing orders, and there could be no question that the notices did not comply with the standing orders, in so far as they failed to specify the agreement in the terms required or to mention the persons with whom it was proposed to make the agreement. This bill, however, was the result of a compromise between the competing parties which was sanctioned by Lord Windsor's Committee, and which had effected what he might call a redistribution of the powers sought by the various promoters. That redistribution unquestionably constituted a very serious alteration in the bills, and he did not think he should be justified in withholding the question from the Standing Orders Committee of the House of Commons. He did not regard it so much as a matter between the parties or between the promoters and the public. It was, he thought, a question between the two Houses, and for that reason he should support the allegation and report both bills as having failed to comply with the standing orders in regard to this matter.

Some other allegations of non-compliance against the Piccadilly and City Railway and against the Brompton and Piccadilly Circus Railway were overruled.

POKESDOWN (BOURNEMOUTH) ELECTRIC LIGHTING ORDER.

On Wednesday a Select Committee of the House of Lords, presided over by the Earl of Erne, had under consideration a bill for the confirmation of the provisional order granted by the Board of Trade for the purpose of enabling the Bournemouth and Poole Electricity Supply Co. to light the parish of Pokesdown, which was added to the Borough of Bournemouth last year. This bill raises a question of considerable interest with regard to the granting of provisional orders (see *The Electrician* of June 13, p. 290).

Mr. BALFOUR BROWNE, K.C., for the promoters, said that the order, confirmation of which was now sought, was granted by the Board of Trade after a local inquiry, at which the Corporation of Bournemouth were represented. The Corporation, who already possess powers as to electricity for tramway purposes, asked that if the order was confirmed it should be on condition that clauses should be inserted for the protection of their roads, and to enable them hereafter to acquire the electric light undertaking of the company. The Board of Trade refused to grant either condition, and approved of the order in the form in which it was now presented to the Committee. The Board of Trade also declined to add any clauses other than those contained in the Electric Lighting Clauses Consolidation Act.

Mr. EDWARD INGRAM, engineer to the promoting company, was called, and briefly explained the intentions of the promoters with regard to the lighting of Pokesdown.

Mr. FREEMAN, K.C., with whom was Mr. W. H. Dickinson, on behalf of the Corporation of Bournemouth, addressed the Committee without calling evidence, asking that, as a condition of confirming the order, a clause should be inserted preventing the company from breaking up the streets in Pokesdown for the purpose of laying mains to supply outside districts, and providing that they should be obliged to erect a new generating station in the Christchurch area for that purpose. He further asked the Committee to add a provision empowering the Corporation to acquire the electric lighting undertaking of the company, so far as it affected Pokesdown, in 1911, the year in which they were entitled to acquire the undertaking in respect of Bournemouth and the remainder of the district. The Committee without clearing the room to deliberate in private, decided to confirm the order without any of the special conditions asked for.

BERMONDSEY ELECTRIC LIGHTING.

The Committee of the House of Lords, presided over by the Earl of Erne, gave their decision yesterday in the case of the bill to confirm a provisional order granted by the Board of Trade under the Electric Lighting Acts to the Corporation of Bermondsey for extending their area of supply to the Parish of Rotherhithe. On Wednesday the Committee had decided, after hearing Sir R. Littler, K.C. (with Mr. H. Avory) for the bill, and Mr. Balfour Browne, K.C. (with Mr. Rostron) for the petitioners, the South Metropolitan Gas Co., that protection should be given to the latter roughly in the terms of clause 15 of their petition. The clause was as follows:—"If the grant of the power sought by the order can be justified (which your petitioners deny), your petitioners submit that provision should be made in the order to ensure that the price charged for electricity shall be such as will make that undertaking self-supporting, and that the powers of charging the rates with the deficiency in the income of the Council's undertaking should not be sanctioned."

Mr. Balfour Browne brought up a clause to carry out the decision of the Committee, but this Sir R. Littler objected to, on the ground, amongst others, that it would refer to Bermondsey as well as Rotherhithe, and therefore would modify old legislation, and that it would apply generally to all consumers and not to the gas company exclusively. He, on his part, proposed a clause to the effect that, if after a certain lapse of time, it was found that there was a loss on the undertaking, the gas company as ratepayers should not be charged any proportion of the loss in respect of their property in the parish of Rotherhithe. Mr. Balfour Browne would not consent to the alternative proposition. He said that in the clause he had submitted he had followed the precedent of the Rochdale Bill before a Committee presided over by the Earl of Camperdown.

The Committee, after hearing the arguments, decided to retain clause 6 of the bill, which imposed on the undertakers the obligation to purchase part of the London Electric Supply Corporation's undertaking within Rotherhithe, and to add the South Metropolitan clause in a modified form, so as to provide that, after the first year's working, the promoters should cause to be prepared statements of accounts drawn up on the Board of Trade system, and an arbitrator should thereupon fix annually the charges to be made for the supply of energy in the ensuing year, the rates not to exceed the maximum in the order, so that so far as was reasonably practicable the revenue for each year should not be less than the expenditure of that year.

OTHER ELECTRICAL BILLS.

On Thursday last week, in the House of Lords, the Swansea Corporation Bill was read a third time. In the House of Commons, on the same day, the Bradford Corporation and the Northumberland Electric Tramways Bill were read a third time, and the Newcastle-upon-Tyne Corporation Tramways Bill and the Tyneside Tramways and Tramroads Bill, ordered to lie upon the table, were considered.

The Halifax Corporation Bill was read a third time in the House of Lords on Friday last week, and the Lords' amendments to the South Wales Electric Power Distribution Bill were agreed to in the House of Commons on the same day.

The Leicestershire and Warwickshire Electric Power Bill was read a third time and passed in the House of Lords on Tuesday.

In connection with the Edgware and Hampstead Railway Bill, which was read a second time in the House of Commons on Tuesday, Sir James Dickson-Poynder moved the following, which was agreed to:—"That it be an instruction to the Committee on the Edgware and Hampstead Railway Bil to insert, as far as practicable in the bill, provisions to carry out the recommendations as to workmen's trains and fares contained in the report of the Joint Committee of Session 1901 on Underground Railways, and to deal with railways promoted by different companies, but forming continuous through routes, as one railway for these purposes."

The Exeter District Tramways Bill has been entirely withdrawn, owing to the opposition of the Corporation. The Corporation itself is contemplating the purchase of the existing horse tramway, under sec. 43 of the Tramways Act of 1870, with a view to constructing electric lines.

The consideration of the Rhondda Urban District Tramways Bill by the House of Commons Committee was further considered on Monday, June 30, and following days. Further local evidence for the promoters was given. Mr. R. Hammond and other experts also gave evidence for the bill. On behalf of the Taff Vale Railway Co., the principal opponents, counsel wished to show that the proposed tramways would not pay. Sir Douglas Fox, C.E.,

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having given evidence in support of the bill, Mr. Page, K.C, opened the case for the frontagers, who claimed that as in many cases the forecourts of their houses were taken, the property, being deteriorated, should be wholly purchased, and evidence to this effect was also given. Mr. Fitzgerald, K.C., for the Taff Vale Co., addressed the Committee on the point of unfair competition, and the proceedings were adjourned.

ELECTRIC TRAMWAY ACCIDENTS IN GLASGOW.

In the House of Commons on Wednesday,

Mr. WEIR asked the President of the Board of Trade for the number of accidents which had occurred on the Glasgow Corporation tramways during the year ended June 1 last.

Mr. GERALD BALFOUR replied there had been, apart from trifling occurrences, 215 accidents—viz., 19 fatal, 111 cases of injury not resulting in death, and 85 cases of damage to property. The number of passengers carried during the period in question was 163,000,000.

LEGAL INTELLIGENCE.

J. Ambler & Sons (Ltd.) v. Bradford Corporation.

This was an appeal action before Lords Justices Vaughan Williams, Romer and Stirling, brought by defendants from a decision of Mr. Justice Joyce (fully reported in *The Electrician* for Aug. 2 and 9, 1901). The damages claimed amounted to upwards of £33,000. The arguments of counsel occupied the Court for several days and in the result their lordships affirmed the decision of Mr. Justice Joyce and dismissed the appeal, with costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Bournemouth Town Council require a chief clerk, assistant clerk, chief inspector, two shift engineers, two fitter drivers, and a carshed foreman for their tramway department. An advertisement contains further particulars Applications to the borough and tramway engineer (Mr. F. W. Lacey), Municipal Offices, Bournemouth, by July 9.

The Derby Technical Education committee require an assistant lecturer and demonstrator in physics and electrical engineering for the Municipal Technical College. Forms of application, to be returned by July 10, from the principal. See advertisement.

The Stepney (London) Guardians require an engineer for their Childrens' Homes at Stifford, Essex. Applications to the clerk (Mr. S A. Lewis), Guardians' offices, Barnes-street, Ratcliff, E., by July 23 See advertisement.

Hammersmith (London) Borough Council require a station superintendent for their electricity works. Applications to borough electrical engineer (Mr. G. Gilbert Bell) by July 11. See advertisement.

A lecturer in electrical engineering and physics is required for the Halifax Municipal Technical School. Applications to the principal by July 16. See advertisement.

An assistant for sub-station and outside work is required by the Walsall Corporation; also an improver. Applications to the borough electrical engineer (Mr. Alex. Wyllie), Wolverhampton-street, Walsall. See advertisements.

An assistant engineer is wanted for the Middlesex Hospital, Mortimer-street, London, W. Apply personally on July 7. See advertisement.

Hornsey Local committee of Middlesex County Council, require a teacher of electric lighting and electric wiring. Applications to Mr. B. S. Gott, Guildhall, Westminster, by July 12.

Swindon Corporation require an electrical engineer and tramways manager. Applications to town clerk by July 9.

Edinburgh Corporation require an assistant to the superintendent of mains. Applications to resident electrical engineer by July 7.

The School Board for London requires a science organiser. Applications to clerk by July 12.

There are a number of appointments vacant in the colonial postal telegraph service of Cape Colony. The salaries range from £120 to £320 per annum.

Mr. G. W. Sykes, Blackburn, has been appointed shift engineer at Hull Corporation electricity works.

Mr. Arthur Spyer, Admiralty engineering inspector, has been appointed assistant managing director of Babcock and Wilcox (Ltd.).

Mr. George Wm. Humphreys has been appointed works manager by the London County Council at £1,200 per annum.

Mr. S. Joyce, M.I.E.E., has been appointed professor of physics and of electrical engineering at the Victoria Jubilee Technical Institute, Bombay.

Mr. C. F. McInnes has been appointed resident electrical engineer at Gravesend for five years at £250 per annum.

The Pulsometer Engineering Co. have appointed Mr. W. D. Shaw-Browne as manager of their Liverpool office.

Mr. J. E. Edmundson has resigned his position as resident engineer of the Angus Electric Light and Power Co. to take up a similar position under the Urban Electric Supply Co. at Camborne.

Mr. C. W. Durnford, A.I.E.E, assistant manager of the electric light and power department of Messrs. Johnson and Phillips, has been appointed teacher of electric lighting and power transmission at the Acton and Chiswick Polytechnic, Bedford Park, London, W.

Alfreton.—The District Council are negotiating with the Derbyshire and Nottinghamshire Electric Power Co. for a supply of electricity in bulk.

Aston.—An arrangement has been made with the Birmingham and Aston Tramway Co. under which the Council take over the tramways from June 30, the company acting as agents until actual date of purchase. Sir F. Bramwell has been appointed arbitrator as to the purchase price.

Barrow-in-Furness.—Owing to a fire at the steam tramway depôt on Saturday, most of the rolling stock was destroyed, and the public are, consequently, without a tramway service. Four out of 12 tramcars and two engines were got out in a more or less damaged condition, and 10 steam tram engines and four tramcars were destroyed, with a vast amount of stores. The British Electric Traction Co. recently took a 21 years' lease of the lines from the Corporation with a view to the adoption of electric traction, and it is now probable that the trams will not run again until the system has been converted.

Bath.—The Local Government Board have sanctioned the borrowing of £11,196 to cover excess expenditure on authorised works in connection with the electricity supply undertaking, and have deferred their decision as to the balance of the £25,000 applied for.

Birkdale.—A motion in favour of Sunday trams was defeated at the Council meeting on Tuesday.

Birkenhead.—From Sept. 30 the charge for electric current for power and heating will be 2½d. per unit for the first 500 units per quarter, 2d. for the first 1,500 and 1½d. for over 1,500 units per quarter.

Bolton.—Sanction to a further loan of £124,030 for electric lighting extensions has been obtained by the Council.

The salary of Mr. W. J. Barker, assistant fittings superintendent of the electric light department, has been increased to £120 per annum.

Bournemouth.—The work of constructing and equipping the municipal electric tramways is rapidly approaching completion, and it is anticipated that the lines will be opened for traffic early next month

Bradford.—The Undercliffe electric tramway route was opened for traffic on Saturday.

Colchester.—Application has been made by the Council for an extension of 12 months in which to comply with the terms of their tramway provisional order.

Coronation Telegraph Work at the Post Office.—The postponement of the Coronation ceremony and the subsequent rejoicings naturally entailed an immense amount of additional work upon the postal telegraph department in London. The amount of telegraphic work which passed through the central telegraph office on Tuesday and Wednesday of last week was altogether unprecedented and represented considerably over 300,000 messages at that office alone, or more than 50 per cent. increase over the normal, while in connection with the postponed Naval Review, the work at Portsmouth and Ryde, and in the immediate vicinity of the ships, represented between 7,000 and 8,000 telegrams per day in excess of the ordinary traffic. The pressure on the delivery department was, as might be imagined, of an exceedingly heavy nature. Some delay occurred in the London surburban traffic, but the general London and provincial business was handled without hitch. The number of foreign telegrams and the very large additional amount of press work proved a heavy tax upon the resources of the department. There was employed at the central telegraph office alone a staff of over 3,500, exclusive of messengers.

Devonport.—The accounts of the Electric Power committee for the nine months ended March 31 show an income of £5,024. 7s. 9d. against an expenditure of £3,563. 16s. 9d., leaving a gross profit of £1,460. 11s. After paying interest and sinking fund instalment there is a deficiency of £1,266. 9s. 11d. The total capital outlay to March 31 was £79,027. 8s. 11d.

Dewsbury.—Application has been made for sanction to borrow £10,000 for extensions of the electricity works, mainly for providing additional plant for supplying current to the electric tramways.

Doncaster.—The Station-road–Racecourse electric tramway route was opened for traffic on Monday. The Hyde Park route will be opened in about a month.

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Ealing.—Acting on a recommendation of the business manager of the electricity department (Mr. Lewis), the Council have applied for a further loan of £10,000 for extensions of the plant and mains. An enquiry will shortly be held in regard to an application for £7,881 for feeder mains.

East Cowes.—The Isle of Wight Electric Light and Power Co. offer to tender for the public electric lighting, and the offer is under consideration.

Exeter.—Owing to the opposition of the Corporation, the Exeter and District Tramways Bill has been abandoned. A meeting of the Tramways committee has been called to receive the report of the deputation recently appointed to visit British and Continental electric tramways. The Corporation propose to acquire the existing tramways of the city.

Exhibition.—The Universal Exposition of St. Louis (U.S.A.) which was originally intended to be held in 1903, has been postponed until 1904. We are informed that up to the middle of June the total appropriations (State and national) for the exposition amounted to over £4,000,000.

Exmouth.—The Council are notified that a company is about to make application for a provisional electric lighting order for the district.

Fire.—The works of Messrs. Goddard, Massey and Warner, engineers, Nottingham, were totally destroyed by fire early on Saturday morning last, and the adjacent premises of Messrs. W. J. Furse & Co., electrical engineers, were damaged. The total damage caused by the fire is estimated at £50,000.

German-Dutch Telegraph Cable Enterprise.—The First Chamber of the Dutch States-General has approved the bill for the construction and laying of cables between Germany and Holland and their Asiatic possessions. This bill, as announced in our issue of April 11, had already passed the Second Chamber.

Glasgow.—The annual accounts of the Corporation tramways show total revenue £614,413, working expenses, £405,042, gross profit, £209,371, which has been applied as follows:—Interest and sinking fund on Govan tramways £5,057, interest on capital £54,282, sinking fund £36,974, payment to common good £12,500, net balance to general reserve £100,556. The sums set aside for renewal of permanent way and depreciation of plant, &c. (£111,758), are included in working expenses. Last year's gross profit was £87,630, the net balance £11,622.

The salary of Mr. W. J. Poole, assistant engineer of the electricity department, has been increased to £250 per annum.

Gravesend.—Messrs. Preece and Cardew have been appointed consulting engineers at an inclusive fee of 100 guineas.

Incandescent Lamp Manufacture in Spain.—New works are about to be established in Madrid by a company formed to manufacture incandescent lamps under the patents of Senor Bernardo Cabanas.

Islington (London).—For the year ended March 31 the total receipts were £41,308. 8s. 3d., and the annual expenditure £24,639. 17s. 8d., leaving a gross profit of £16,668. 10s. 7d. After payment of interest and sinking fund there was a net profit of £1,402. 6s. 6d. The capital expenditure now amounts to £365,842. 12s 10d. The question of a reduction in the charge for current is to be considered shortly.

Italy.—The accumulation of smoke and the difficulties of ventilation of the tunnel railways in Italy have long been a source of anxiety to the railway authorities of that country, notwithstanding extensive and expensive improvements in the ventilation arrangements. It is found to be difficult to increase the traffic owing to the obscuration of signals and other similar causes limiting the number of trains which can be run through. It is, therefore, proposed to introduce electric traction on a line from Sampierdarena to Rorco (Genoa), which is to be reserved for goods traffic only. It is calculated that this line will deal with 2,500 loaded trucks per day, and form a considerable relief to the general traffic of the district. Two steam power stations are to be erected, one at each end of the line, and a water-power station about mid-way at Mignanego is to be driven by a fall from the reservoirs of the De Ferrari Galliera aqueduct.

The whole of the tramway system of Turin is now worked by electric traction on the overhead system. One new line is being constructed, and several others are projected.

Kingston-on-Thames.—The Council have requested the president of the Institution of Electrical Engineers (Mr. James Swinbourne) to nominate three experts with a view to the selection of one to prepare a report, at a fee of £100, and to advise as to the best system of charging for electric current, the relative advantages of arc and incandescent lighting for street illumination, the provision of additional plant, and the desirability of altering the present system of supply.

Light Railways.—The Board of Trade, having heard the objections of the South-Eastern and Chatham Railway Companies' managing committee to the confirmation of the Canterbury and Herne Bay Light Railway Order, have decided to approve the order as issued. The engineers for the scheme are Messrs. Pritchard, Green & Co.

On Tuesday the Worcestershire County Council appealed against the confirmation of the Halesowen Light Railway (Extension) Order on the ground that certain sections of the proposed line should be widened at once to 35ft., but the promoters contended that they were allowed seven years for giving that width of road under their order. Evidence having been given by both sides, Sir Herbert Jekyll said the promoters wished to have freedom to acquire land on either side of the road within seven years, and they did not want to be tied down to buy the land at once. The proviso which was now sought to be put upon the promoters was not before the Light Railway Commissioners, and he was not prepared to advise the Board of Trade to do what the County Council desired.

Liverpool.—The Treasurer's accounts for the year ended Dec. 31 show that the total capital expended on electricity supply was £1,187,621, and of this amount £139,062 was spent during 1901, the largest items being £52,982 on new machinery and £66,757 on electric mains. The ordinary expenditure during the year was £85,186; the receipts for the 12 months were £98,311 from the sale of electric energy for lighting and power, £1,907 for public street lighting, and £68,912 for tramways, making, with miscellaneous items, a total of £168,489, leaving a gross profit of £83,302, and after adding £2,379 for interest, the amount for disposal on the year's working was £85,681, which was allocated as follows:—Interest, £37,194; sinking fund, £24,400; reserve, £10,000; renewals, £6,503; contribution to general rate, £7,538.

The Tramways committee's total receipts for the year were £474,508, traffic receipts being £468,759. The total expenditure was £327,451, leaving £147,056 profit, which was allocated as follows:—To various sinking funds, £48,931; interest, £42,343; bank interest, £4,523; relief of general rate, £17,007; reserve, renewal and depreciation account, £35,214.

Llandudno.—The surplus on the past year's working of the electricity department amounted to £627. 19s. 8l., of this £300 has been transferred to depreciation.

London and Brighton Electric Railway.—It is announced that the survey for this line is to be commenced at once, and that renewed application for Parliamentry powers will be made in the next session.

London County Council.—At Tuesday's meeting the Highways committee were authorised to expend not more than £4,500 in the erection of an engine house for a temporary electricity generating station at Loughborough Junction in connection with the reconstruction for electric traction of the Council's tramways south of the Thames. The tender of Messrs. W. Jones & Sons, Bow, of £4,176. 9s. 11d. was accepted for the work.

Tube Railways.—The Highways committee in their report refer to a report previously made by them urging the necessity of some specially-constituted body being established to hear new schemes for the provision of means of transit in London in order to secure uniformity and systematic action in the matter. The committee now recommended that they be authorised to urge upon the President of the Board of Trade the desirability of establishing some statutory authority to deal with all proposals relative to locomotion in London. This was approved.

Tramway Rolling Stock.—The Highways committee further reported that it would be necessary to obtain electric cars of a special kind for use on the Streatham lines, with the bodies of the cars carried on single trucks, and not on bogies, as are those for the Tooting lines, the reason being that the gradient of Streatham Hill is steep. The weight of a single truck car, the committee urge, is about 2 tons less, and as the new cars will first have to be pulled by the existing cable, this point was of considerable importance. It was recommended that the committee's estimate of £59,000 be approved, and that advertisements be inserted for tenders. Consideration of the recommendation was postponed.

Works Management.—In the report of the General Purposes committee reference is made to the appointment of a manager of works at a salary of £1,500 per annum. In response to the Council's advertisement 105 applications were received. This number was reduced by the Works committee to five, and subsequently reduced by the General Purposes committee to three. The three candidates whose names were submitted to the Council for final approval were Mr. George Hay, Mr. G. W. Humphreys and Mr. A. Robertson, and the committee's recommendation fell upon Mr. G. W. Humphreys, whose qualifications, the committee consider, render him well suited to fill the position of works manager to the Council. The Works committee having suggested that the salary attached to the appointment should at first be £1,200 instead of £1,500, the General Purposes committee concurred, and recommended that the resolution of the Council of Feb. 18, in connection with this appointment should be varied accordingly, and that Mr. George William Humphreys be appointed to the post. The conditions of the appointment are that the appointment be held during the pleasure of the Council; that the candidate's whole time be given to the Council's business; that any

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fees received by him in any capacity, and any discount or allowances on materials purchased, shall be paid to the Council; that on retiring he shall not be entitled nor make any claim for a retiring allowance; and, finally, that he will submit to the Council's regulations in respect to the superannuation, &c. It was further recommended that Mr. A. Robertson (at present principal assistant in the works department and one of the above-mentioned candidates) be promoted to assistant manager of works, at an increased salary from £450 to £700 per annum, and an honorarium of £150 in recognition of special services rendered.

Price of Gas North and South of the Thames.—The City Corporation have agreed to join with the County Council in a protest against the difference in the charge made by the Gas Light and Coke Co. to gas consumers north and south of the Thames. The present charge per 1,000ft. on the north side is 3s., and on the south 2s. 3d.

Paving Tramway Tracks.—The Council, on the advice of Dr. A. B. W. Kennedy, are adopting the special form of block paving manufactured by the Sanitary Block and Tile Pavement Co. for a portion of their Westminster-Tooting tramway track. This type of paving is said to possess several meritorious points over granite and wood sets.

Malaga.—In the great mining centre of Garrucha, in this district, the General Pumping Co., a German concern, some years ago established pumping stations at El Artiel and Herrerias, and by the aid of three mammoth pumps succeeded in effectually dealing with the large body of water accumulating in the mines of the district. The area of the company's operations has been divided into three zones, two of which have been successfully drained. The third zone is now being dealt with, and a pump worked by electricity is being installed. The plant will include a 70 H.P. steam engine, electric motors and compressed air plant for perforating, lighting, ventilating, and even for cooling the rock. At Dec. 31 last the total depth drained by the plant already installed was down to a 270ft. level. The company is, in addition to this work, about to establish a central electrical station with a view to substituting electric for steam power, to enable the workings to be carried on at depths and in places never previously explored. In this way additional valuable silver mines will be workable in this district.

The Malaga electricity works are about to lay down direct-current plant in addition to their high-tension system, which will in future serve only for the outskirts of the town, the cables to be of English make, but the engines and dynamos to be American. We understand that the orders are not yet given out, and hope that English firms will have an opportunity to tender.

Motherwell.—Extensions to the electric light plant estimated to cost £12,500 have been decided upon by the Council.

Nottingham.—The Sherwood Rise electric tramway route was inspected on Wednesday, and will be opened for traffic on Monday.

Obituary.—The death occurred suddenly last week, at the early age of 30, of Mr. B. A. Giuseppi, on the electrical staff of the British Insulated Wire Co. Deceased was attached to the staff appointed to carry out the scheme of the South Lancashire tramways.

Pennsylvania Railroad Telegraph Service.—Reuter's Agency announces that the directors of the Pennsylvania Railroad Co. have approved of an agreement whereby the Postal Telegraph Co. will control the telegraph service on the lines of the Pennsylvania Railroad east of Pittsburg and Erie for 15 years, beginning December next.

Police Lamps.—Last week the Cardiff Watch committee let the contract for police lamps for the ensuing year.

Councillor Hallett asked why an electric lamp was not chosen, but the Chief Constable replied that he had seen none sufficiently perfected to be an efficient substitute for the ordinary oil lantern. Councillor Hallett replied that continual improvement was going on with portable electric lamps. Eventually it was decided that before another stock of lamps is ordered the question of the utility of electric lamps should be fully considered.

Porto Rico.—In this newly-acquired territory of the United States there is firmly established an electric lighting company which has been working very successfully. The capital is £12,000 and the dividend for 1901, recently declared, was 18 per cent. An American syndicate has recently offered £18,000 for the business as a going concern, but the fortunate stockholders are not disposed to close with this offer.

Railway Station Lighting.—The Glasgow central station of the Caledonian Railway Co. is being greatly enlarged, and the company will put down new electric lighting plant.

Rotherham.—The salary of the borough electrical engineer (Mr. E. Cross) has been increased to £250 per annum. The salary of the assistant engineer has also been advanced.

St. Helens.—Meter rents have been abolished by the electricity department.

Salford.—The Corporation have decided to supply electric current at 1½d. per unit to any consumer guaranteeing a minimum annual consumption of 50,000 units.

San Francisco.—It is announced that the largest electric transmission plant in North America, except that at Niagara, is to be developed in Plumas County (California) on the north fork of the Feather river. Various water sheds are to be drained over an area of about 600 sq. miles, one portion of which is within the perpetual snow line. It is estimated that 300,000 H.P. of electric energy can be generated by this means, the main object of the promoters being to transmit power to San Francisco for use in manufacturing operations. The transmission line will aggregate 250 miles. Another big transmission undertaking is being developed to utilise the water shed of Mount Hamilton, the eminence on which the famous Lick Observatory is built. This undertaking is to transmit electric energy a distance of nearly 70 miles to San Francisco. Already two companies are established in the State of California—the Bay Counties Power Co. and the Standard Electric Co.—the former transmitting energy into Oakland, over 150 miles distant from the point of generation, and the latter company anticipates extending its lines to San Francisco during 1902.

Los Angeles, in this district, is claimed to be for its size the best lighted city in the world, and to be exceptionally well supplied with electric railways. A system of electric roads is now being constructed at a cost of over £1,000,000, to connect Los Angeles with all the towns and villages of the vicinity.

Shipley.—The official inspection of the electric tramways took place on Tuesday.

Stepney (London).—The accounts of the electricity undertaking for the period since commencement of supply (two years and three months) have been issued. The delay in publishing the accounts of the first 15 months is partly due to the dislocation caused by the change of local government and partly to the date of the Local Government audit. The accounts for the year to March 31, 1902, show total capital expenditure £114,890. 7s. 1d., of which £109,000 has been borrowed. The receipts from the sale of current for private lighting were £8,230. 10s. 10d., and from public lighting £1,908. 5s. 9d., making, with meter rentals and miscellaneous receipts, £11,222. 18s. 5d. The total annual expenditure was £6,012. 6s. 10d., leaving £5,210. 11s. 7d. to meet interest (£2,956. 10s. 11d.), instalment of money borrowed (£117. 3s. 8d.), and cost of temporary building during year (£102. 9s. 7d.), leaving £2,034. 7s. 5d. for extinguishing deficit at March 31, 1901, future capital charges and depreciation. The deficiency for the period to March 31, 1901, was £2,743. 8s. 3d. The units generated during the past year were 1,149,114, compared with 665,738 for the 15 months to March, 1901. 283,500 units were supplied for public lighting (compared with 202,739), and 724,537 to private consumers (compared with 360,321), and 13,901 were used on works. There are 95 arc and 13 incandescent lamps used in public lighting, and the total maximum supply demanded was 506kw. The average price obtained for current for private lighting was 2·73d., and for public lighting 1·62d. At the end of the last financial year the equivalent of 33,146 8 c.p. lamps was connected, compared with 18,393 in 1901.

Stoke-on-Trent.—A Board of Trade inquiry was held on Tuesday into the dispute between the Corporation and the Potteries Electric Traction Co. as to whether there should be a double or a single line on the proposed tramway route between Stoke and Newcastle via Hartshill. The Corporation urged that a double line would be dangerous on account of the narrowness of the road in parts and also of the steep gradients. The inspector (Major Druitt) traversed the route, and his decision will be given in due course.

Stourbridge.—The Council have decided, on the recommendation of the Electric and Gas committees, to retain their electric lighting powers, and the Gas committee has been authorised to carry out the terms of the electric lighting order.

Sutton Coldfield.—Sanction to a loan of £5,000 is being sought in order to extend the electric lighting mains into the Four Oaks Park Estate and in other directions.

Swansea.—The local gas company has notified the corporation that it proposes to terminate at Michaelmas its existing agreement, and that in future the same charge will be made for public as for private consumers. The corporation will reply by extending its public electric lighting.

Theft.—At Loughborough last week a man named Hammond, an employé of the Brush Company, was charged with committing a series of thefts at the works. Accused was seen to leave a marine store dealer's premises, and it was found that he had sold 5lb. of brass fittings at 3d. per pound. On arrest he stated that he had sold similar goods at the same stores about 20 times. Fined £10, or six weeks' hard labour.

Torquay.—A preliminary report on electric tramways, with a suggested list of routes, was approved by the Council on Tuesday.

Tramcar Accidents.—An accident took place on the Huddersfield electric tramways on Saturday, resulting in the death of three persons and serious injuries to several others. The accident took place on the Almondbury route. Between 10 and 11 p.m. on Saturday a car got beyond control, and failing to take a sharp curve crossed the street, smashing the pavement, and dashing into a shop which was wrecked, and the car front wedged in. The coroner's

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inquiry into the deaths of the three victims was opened on Tuesday, and after formal evidence had been taken the inquest was adjourned until 11th inst. A Board of Trade inquiry is to be held.

A serious tram accident occurred on Sunday night in Bradford. A car was standing at Thornton terminus, when, in the absence of the driver, the car started towards Bradford full of passengers. As the speed increased the passengers became alarmed, and some jumped off, with the result that one woman was killed and several other persons injured. An inquest was held on Tuesday, when the jury returned a verdict of accidental death, adding a rider that the driver and conductor were guilty of negligence in leaving the tramcar unattended.

Trunk Telephone Communication.—Telephonic communication on the Post Office trunk telephonic system of the country has been established with Barnstaple and Ilfracombe.

Warrington.—Sanction to a loan of £27,000 for electric tramways has been obtained by the Council.

Watford.—The Board of Trade have refused to entertain the Council's application for a licence to supply electricity outside the present area of supply, and recommend procedure by provisional order.

West Bromwich.—The first annual report of the electricity undertaking has been issued. Supply was commenced on May 24, 1901, and to March 31, 1902, 62,894 units of current were supplied to private consumers. The maximum load occurred on Dec. 20, and amounted to 122kw., equal to 83 per cent. of the total number of lamps. The total cost per unit sold was 4·48d. per unit. There were 50 consumers, representing 3,208 8 c.p. lamps, or 66 per cent. of the total number of lamps connected. On the 10 months' working there was a deficiency of £1,403.

Weymouth.—The Electric Lighting committee recommend the Council to erect electricity works at an estimated cost of £44,800.

Withington.—An extension of 12 months for carrying out the terms of the Council's provisional tramway order has been applied for.

Wrexham.—Application has been made for sanction to a further loan of £11,000 for additional generating plant. The agreement between the Town Council and the British Electric Tramways Co. for the supply of current to the company has been approved.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

The Visiting committee of *Devon* County Asylum, Exminster, invite tenders for wiring alterations and additions, 2,000 lamps, booster dynamo and motors, switchboard, replacing of battery of 120 700-ampere-hour cells, &c. Plans, &c., may be inspected and specifications obtained of the consulting engineers (Messrs. O'Gorman and Cozens-Hardy), 82, Victoria-street, Westminster. Tenders to the clerk to the County Council (Mr. H. Michelmore), The Castle, Exeter, by noon July 23. An advertisement contains further particulars.

Swansea Electric Lighting and Tramways committee invite tenders for the supply, delivery and laying of earthenware conduits, cables, pilot wires, street boxes, &c. An advertisement contains further particulars. Specifications from the borough electrical engineer (Mr. C. A. L. Prusmann). Tenders to the town clerk (Mr. John Thomas) by noon July 10.

Wigan Electric Light and Tramways committee invite tenders for 1,500yds. of 0·1 sq. in. lead-covered paper-insulated cable. Particulars from the engineer and manager (Mr. H. Collings Bishop), and tenders to town clerk by July 14. See advertisement.

Pontypridd Urban District Council invite tenders for cables and dust destructors. Specifications, &c., from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster. Further particulars are given in an advertisement. Tenders (addressed chairman of Electric Lighting and Tramways committee, Town Hall, Pontypridd) by July 31.

The *Crown Agents for the Colonies* invite tenders for generating plant for Kuala Lumpur, Selangor. Particulars of the plant required are given in an advertisement. Specifications, &c., from the Crown Agents, Downing-street, London, S.W., after 7th inst. Tenders to Downing-street by noon of Aug. 21. Further information can be obtained from the consulting engineers (Messrs. Preece and Cardew), 8, Queen Anne's-gate, London, S.W.

Falkirk Corporation invite tenders for steam, exhaust, drain and other pumps, feed pump, tank, &c.; balancing transformers and motor generators; storage batteries; switchboard and connections; arc and incandescent lamps and fittings; cable work and travelling crane. Tenders to town clerk by noon July 14.

Epsom District Council invite tenders for a semi-marine dry-back boiler, with fittings, &c.; ejector condensers, circulating pumps and pipework; spray cooling ponds; steam feed and drain pipes, &c.; and a 150kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, &c. Tenders to clerk by noon July 18.

Gillingham Urban District Council invite tenders for water-tube boilers, steam and exhaust piping, condenser, cooling tower, three high-speed engines, 250kw. tri-phase alternators, switchboard, underground cables, arc lamps, crane and well. Tenders to clerk by 3 p.m. July 17.

London County Council invite tenders for 50 double-deck electric tramcars, a 25-ton electric and three 10-ton hand-power overhead travelling cranes; also for trench work, &c., for their southern tramways. Tenders by July 15.

Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board require tenders for three 500kw. steam-driven, direct-coupled, three-phase alternator sets; three 50kw. ditto continuous-current exciters, &c.; and permanent way. Tenders to the clerk by July 7.

Teddington Urban District Council invite offers for taking over the Teddington provisional order, 1901, and for a scheme for the electric lighting of the district. Tenders to clerk by July 12.

Chester Corporation invite tenders for permanent way construction, bonds, overhead equipment and cars; also for accumulators and reversible battery booster. Tenders by July 7.

West Ham Borough Council require 50 double-deck electric tramcars, complete with electrical equipment. Tenders to town clerk by 4 p.m. July 8.

Lowestoft Corporation invite tenders for rails, fish-plates and bolts and permanent way construction for their electric tramways. Tenders to town clerk by 5 p.m. July 12.

Sunderland Tramways committee require tenders for permanent way and overhead equipment and cables. Tenders to chairman by July 9.

Newcastle-on-Tyne Guardians invite tenders for lighting three relief offices. Tenders by noon July 11 to Mr. J. W. Gibson, 127, Pilgrim-street, Newcastle-on-Tyne.

Newcastle-upon-Tyne Corporation invite tenders for 2,000 tons of tramway rails, fish-plates, &c. Tenders to Chairman Tramways committee by noon July 10.

Barking District Council invite tenders for rails and fish plates and bolts, and for permanent way construction. Tenders by 5 p.m. July 31.

Willington Quay and Howdon Industrial Society invite tenders for electrical plant. Tenders by July 14.

Okehampton Town Council invite tenders for public lighting. Particulars from town clerk.

Manchester Ship Canal Co. invite tenders for carbons and other stores. Tenders by July 11.

Manchester Electricity committee require tenders for three electric locomotives for their Stuart-street works. Tenders by noon July 17.

TENDERS RECEIVED AND ACCEPTED.

Worthing Town Council have accepted the tender of Messrs. Mather and Platt for an additional dynamo at £1,790; that of Mr. J. Thompson for a boiler at £650; and that of Messrs. Miles and Warner for the erection of a circular brick chimney shaft.

Stretford District Council have accepted the tender of Messrs. E. Heaton & Sons for the supply and erection of boilers, &c., for their electricity supply station at £3,095; that of the British Westinghouse Co. for steam dynamos, condensing plant, pipes and accessories at £5,619; and of the Anchor Cable Co. for cables and mains at £9,682.

Barnstaple Town Council have accepted the tenders of the Electrical Co. and the Simplex Steel Conduit Co. for fittings for 300 lights at £220 less discount.

Bristol Electrical committee have accepted the tender of Messrs. Clarke, Chapman & Co. for feed and general service pumps, and that of Messrs. Doulton & Co. for water softener for the Temple Back electricity works.

The Lancashire Dynamo and Motor Co. have received an order for a balancer for the Tynemouth electricity works, and also for a 300kw. generator (through Messrs. Reavell & Co.) for Dartford.

Stockton Town Council have accepted the tender of Riley Bros. for two Lancashire boilers at £816, and that of Messrs. J. and H. McLaren for a 400kw. steam dynamo at £3,784.

Ilford District Council have accepted the tender of Messrs. Rhodes and Webster for the supply of three motors for the pumping station.

Southend Town Council have accepted the tender of Messrs. Willans and Robinson for a 225kw. steam dynamo for £2,477.

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Bath Corporation have given an order to Messrs. Dick, Kerr & Co. for additional plant for their electricity works at £4,871.

Rotherham Town Council have accepted the tender of Mr. W. H. Treherne for the building of tramcar sheds at £3,988, and that of the Manchester Iron and Steel Co. for steel roof, &c., at £418.

Hawick Town Council have accepted the tender of the Urban Electric Supply Co. for electric lighting of the streets at £1,070 per annum.

BUSINESS NOTICES.

The Universal Electric Supply Co. have opened head offices and warehouse at 60, Brook-street, Chorlton-on-Medlock, Manchester, where all communications should be addressed.

The offices of the Baker Street and Waterloo Railway Co. have been removed to Hamilton House, Victoria Embankment, London, E.C.

The chief office and London works of the Consolidated Telephone Construction and Mfg. Co. (Ltd.), are now at Northampton Works, Northampton-grove, Canonbury, London, N., and the City office at 19, New Union-street, Moorgate-street, E.C.

LIQUIDATION.

Statutory meetings of creditors and shareholders of the Meyra Electric Co. (Ltd.) took place on Tuesday. The assistant receiver (Mr. Winearls) reported that the company was registered in Sept., 1900, with the nominal capital of £10,000 in £1 shares, to acquire and work an invention of Mr. P. Meyer relating to primary batteries. Under an agreement of Sept. 7, 1900, the company acquired Mr. Meyer's patent rights, and was also to acquire a secret process for manufacturing dry batteries and the trade mark "Meyra." The purchase price was fixed at £14,993, to be satisfied by the issue of 9,993 fully-paid shares and by the issue of £5,000 debentures on the whole of the assets of the company. The failure was attributed to insufficient working capital. No statement of affairs was submitted, but liabilities were put at £1,650, with assets estimated to realise £400. The official receiver is liquidator.

Plant, &c., for Sale.—An art metal works business (including electric light and gas fittings) is for sale as a going concern in the city of Bradford. An advertisement contains further particulars. Cards to view from Messrs. Butterfield and Hartman, C.A., 2, Darley-street, Bradford, or 3, North-parade, Manchester.

Particulars of some electric lighting plant for sale, are given in an advertisement. The plant includes two Crossley 16 H P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Coventry Electric Light committee have for disposal a 100 B H P. Fowler horizontal compound engine, in good order. Permission to view may be obtained from the manager (Mr. J. A. Jeckell), Corporation Electricity Works, and tenders must be delivered to the town clerk (Mr. Lewis Beard) by July 19.

An electric launch, a Crompton motor, dynamo and other plant, are advertised to be sold by auction on Friday, July 18. The plant is at Morecambe, and can be seen and particulars obtained from the auctioneer, Mr. J. Nicholson, Lake-road, Bowness, or from Mr. J. Gibb, 6, Skipton-street, Morecambe.

The Journal.—Part No. 157 of the *Journal* of the Institution of Electrical Engineers is now ready, price 5s. An advertisement contains further particulars.

High and Low Temperature Indicating Apparatus.—Messrs. P. Hensel & Co., 12, Long-lane, London, E.C., have been appointed agents for the sale of a new design of electrical apparatus for indicating high and low temperatures. The apparatus is made under the Reuner patent, and has been designed for instantly recording increases or decreases in temperature. The device consists of an ordinary battery and bell complete in conjunction with the indicator, the main feature of which is the contact breaker. The pointer on the dial is placed to indicate the temperature which it is desired to maintain, and directly the surrounding atmosphere arrives at this point the alarm bell rings. The advantages claimed are that the apparatus is of simple design, no glass is used, the attention required is small, and the cost of installation low. The maximum degree of temperature recorded by the indicator is about 1,000°F., the minimum about 500° below freezing.

Catalogues.—Lists Nos. 15 and 16 just issued by the Lahmeyer Electrical Co., 109–111, New Oxford-street, London, W.C., treat of "Belt-driven three-phase generators" and of "Multiphase induction motors" respectively. The lists are both fully illustrated, With regard to high-tension three-phase power transmission, the Lahmeyer Company point out that the system was practically first used by Messrs. Lahmeyer & Co. at the Frankfort Exhibition, 1901, when a 10km. transmission line from Offenbach to Frankfort was connected up to a three-phase continuous-current converter station situate in the exhibition grounds. Special attention has been given by the company since that time to this class of plant, especially in the construction of large slow-speed generators and motors.

A series of four pamphlets (126–129) is issued by the British Thomson-Houston Co., dealing respectively with motor starting rheostats, field rheostats, radial fan motors and desk lamp fixtures.

Messrs. Ernest Scott and Mountain are issuing a circular prepared by Mr. W. C. Mountain, entitled "The Utilisation of Electrical Machinery in Coal and other Mining."

Sir W. H. Bailey has invented a "Coronation" electric clock, and a circular relating to this can be obtained from W. H. Bailey & Co, Albion Works, Salford. Time is indicated on a 6ft. circle, upon which there are fixed 12 convex bulbs. Behind each of these is an electric lamp, which serves the double purpose of giving light in 12 distinct places in each hour, and illuminating a white background formed of a sheet of enamelled metal. The "Coronation" application of the dial is the substitution of the words King Edward VII. and a crown in place of the usual 12 figures on an ordinay dial.

The General Electric Co. have ready list No. L 1,009, describing the "Air-to-Earth" system of lightning conductors (Hedge's patent), which has been adopted at St. Paul's Cathedral, Westminster Abbey and on other public buildings. The company are sole agents for this system, with which is connected a patented tubular "earth," which ensures the charge being effectively conducted to earth.

Electric Construction Co.—A handsome souvenir of the Wolverhampton Exhibition, 1902, has been prepared by the Electric Construction Co., in which are given a few illustrations of certain classes of electrical machinery manufactured at the company's extensive works at Bushbury.

Duncan's Tramway Manual.—We have received a copy of the 25th (1902) edition of this work of reference, which has just been issued by Messrs. T. J. Whiting & Sons, 7A, South-place, London, E.C., at 5s. The information given is fairly accurate and up to date, and includes particulars of the directors and leading officials, capital authorised and issued, reserve fund, an analysis of revenue accounts, extracts from the Tramways Act, 1870, relating to purchase, offences and penalties, system of traction, miles open, as well as sample bye-laws and regulations, and an alphabetical directory of directors and officials. All British undertakings (municipal and company-owned) and foreign companies with London offices are dealt with in the Manual.

United States Electrical Exports.—The value of the electrical exports from the United States in April was $335,066, of which $538,118 represented electrical machinery and $296,948 electrical appliances (including telegraph and telephone instruments)—an increase of $11,294 over the corresponding month of 1901. The principal exporters of electrical machinery for the month were: United Kingdom, $365,450; British North America, $91,235; British Australasia, $29,015; Mexico, $20,941; Brazil, $4,688; France, $2,858; Africa, $2,699; British East Indies, $2,462; places in Europe not otherwise specified, $15,105.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from June 25 to July 1, with the ports of destination:—

Africa—Cape Town, £547 (including £307 telegraph apparatus); Durban, £1,776 (including £289 telegraph material); Port Elizabeth, £79. *Australasia*—Adelaide, £70; Christchurch, £131; Melbourne, £130; Wellington, £675. *Ceylon*—Colombo, £121 (including £61 telegraph material). *Channel Islands*, £66. *France*—Boulogne, £45. *Germany*—Hamburg, £410 (including £30 telegraph material). *Gibraltar*, £20 (telegraph material). *Holland*—Rotterdam, £95 (telegraph material). *India*—Bombay, £1,661 (including £378 telegraph wire); Calcutta, £1,984; Madras, £950. *Japan*—Nagasaki, £336; Tokio, £47; Yokohama, £2,830. *Russia*—St. Petersburg, £125 (telegraph material). *Straits Settlements*—Singapore, £89. Total £12,187, against £68,930 in the corresponding week last year (June 26 to July 2).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"William Gilbert of Colchester": A Sketch of his Magnetic Philosophy. By C. E. Benham. (Colchester: Benham & Co.) 2s.

"Proceedings of the Royal Society." No. 461. Vol. LXX. (London: Harrison & Sons.) 2s. 6d.

"Dynamo-electric Machinery." By S. Sheldon and R. Mason. Vol. II., "Alternating-current Machines." (London: Crosby Lockwood & Son.) 12s. net.

"Notes on the Construction and Working of Pumps." By E. C. R. Marks. (Manchester: The Technical Publishing Co.) 3s. 6d.

"Science Abstracts." June. (London: The Feilden Publishing Co.) 2s.

"Journal of the Institution of Electrical Engineers." Part 5. Vol. XXXI. Edited by W. G. Macmillan. (London: E. & F. N. Spon, Ltd.) 5s.

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

April 18, 1902.

9,040. S. G. BROWN. Conductors.
9,044. S. G. BROWN. Telephonic apparatus.
9,057. R. ROUGÉ. Winding electric machines and appliances.
9,062. F. GUBING and J. AUERBACH. Arc lamps.
9,068. J. LEIGHTON and R. HACKING. Sectional conductor, tram and railway system.

April 19, 1902.

9,074. NERNST ELECTRIC LIGHT and S. GOWAN. Series resistances for Nernst lamps.
9,077. W. JACKSON. Hull. Automatic life-guard for tramcars.
9,135. BRITISH THOMSON-HOUSTON Co. and F. HOLDEN. Coin-freed electric meters.
9,143. R. GRISSON. Production of secondary electric currents.

April 21, 1902.

9,150. S. W. NORTH. Leeds. Clock-controlled mechanism for turning on electric current, &c., at predetermined times.
9,178. G. C. LILLEY. Magnetic-compasses.*
9,208. A. W. Y. D. CHAPMAN. Switch and fuse boards.
9,229. R. OXLADE and W. J. W. RICHARDSON. Audible telegraphy.*
9,281. J. H. MEYER. Counting telephonic conversations.

April 22, 1902.

9,256. C. M. HERON. Glasgow. Glass shades.
9,264. W. ALLMAN. Birmingham. Lamp-holders.
9,265. A. J. MORGAN. Llandaff. Water-tight insulating coupling for electric cables.
9,267. A. H. FINLAY. Belfast. Dynamo-electric machine.
9,278. M. HAYASHI. Incandescent lamps.
9,296. H. GULLIVER and H. G. ROBINSON. Indicator for electric signalling on railways, tramways and the like.*
9,315. C. T. J. OPPERMANN. Electric controllers.
9,317. G. L. GOWLLAND. Current meters.*
9,325. M. MEIROWSKY. Insulating tubes for winding of electric machines.*

April 23, 1902.

9,397. S. R. JACKSON. Leeds. Trolley poles
9,380. F. RENDER. Manchester. Fuse head for electric blasting.*
9,397. H. CHITTY. Dynamo-electric machines.
9,419. G. B. BOWELL and PEARSON FIRE ALARM SYSTEM. Sounding and recording code signals for fire alarm.
9,423. H. BEVIS. Flexible conductor from any point of which current may be taken.
9,439. F. W. SCHNEIDER and A. STRAUSS-COLLIN. Protecting apparatus for controlling consumption of current.
9,441. H. H. LAKE. Electromagnetic traction. (A. Pacinotti, Italy.)

April 24, 1902.

9,488. A. W. BEUTTELL. Fittings for electric illuminations.
9,503. G. D. POGUE. Lamp attachments. (Date applied for, April 29, 1901, date of application in U.S.)*
9,504. M. NORDEN. Lamp sockets.*
9,519. W. C. JOHNSON. Brakes for submarine cable-laying machines.
9,529. W. R. EDWARDS. Terminals and binding screws for batteries and connections.
9,531. G. BYNG and E. SAYER. Maximum demand electricity meters.

April 25, 1902.

9,592. E. F. MOY, P. H. BASTIE and E. F. MOY. Fuse boxes.
9,630. A. C. ALBERTSON. Liverpool. Railways and cars and magnetic appliances therefor.*

April 26, 1902.

9,663. T. RHODES. Bradford. Tramcars.
9,669. T. H. CHURTON. Leeds. Starting alternating-current motors.
9,701. J. LEIGHTON and R. HACKING. Tram and railways on a sectional conductor system.
9,704. A. VANDAUR and T. H. MARSH. Switches, wall-plugs and bases.*
9,720. P. OFFENBROICH and L. MAFELL. Automatic electric fire alarms.*
9,721. A. VOSMEAR and A. LEBRET. High-tension condenser.

April 28, 1902.

9,780. J. KREMENEZKY. Incandescent lamp-fitting.
9,788. W. M. BROWN. Electric switches and application to electrically-propelled vehicles.*
9,789. H. E. KEELER. Electric railway systems, particularly crossings and switches for same.*
9,800. L. M. ERICSSON. Switch or ring-keys for telephone switchboards.*
9,801. L. M. ERICSSON. Telephone jack-strips.*
9,803. M. WILDERMANN. Electrolytic decomposition of alkaline salts.*
9,812. A. J. BOULT. Electrolytic production of bleaching liquor. (H. Seibert and G. Tempel, Germany.)

April 29, 1902.

9,815. W. L. WISE. Prevention of sparking on the interruption of ethereal telegraphic and other electric circuits. (K. Birkeland, Norway.)
9,819. J. B. SMITH. Fleetwood. Insulators for supporting electrical conductors for tramways.
9,825. B. F. HALL. Birmingham. Fuse-boxes for street mains.
9,836. W. B. SMITH and G. NAPIER & SONS. Southampton. Working trolleys in electric traction.
9,849. W. BARKER. Burnley. Connecting incandescent lamps in festoons and for like temporary uses.*
9,859. C. C. SIBLEY. Implements for stripping insulation from wire.
9,873. A. G. BROOKES. Cable joints. (H. G. Thompson, U.S.)
9,885. A. H. GIBSON. Electrical rock-drills.
9 895. H. J. HADDAN. Automatic signals for electric railways. (Storm Railway Signal Co., U.S.)*

April 30, 1902.

9,947. C. A. ALLISON. Electric low-water alarm. (A. Graham, U.S.)*
9,949. J. YOUNG. Telephonic intercommunication.
9.956. H. H. LAKE. Telephone receivers, audiphones and the like. (Akonphone Manufacturing Co., U.S.)*
9,977 and 9,978. BRITISH THOMSON-HOUSTON Co. Pole-pieces and shoes for dynamo-electric machines. (A. Churchward, U.S.)*
9,982. E. BEDE and A. A. CONDAMIN. Current collecting devices for electric traction systems.

May 1, 1902.

10,000. A. H. MAYES. Hove. Resistances.
10,008. G. E. BECKETT. Manchester. Intercommunication telephones.
10,010 and 10,011. C. POLLARD. Leeds. Magnetic brake for printing machines.
10,021. J. SHIRTON and H. YEATES. Worcester. Appliance for stopping clocks and giving an alarm.
10,022. R. SLACK. Manchester. Automatic shuttle changing motions of looms.
10,063. H. J. HADDAN Insulating materials. ("Pyrisolith" Insulating Material Mfg. Co., Hungary.)*

May 2, 1902.

10,097. L. BARLOW and J. YOUNG. Conduits for electric mains and jointing same.*
10,098. T. E. WEAVER. Birmingham. Starting switches.
10,102. F. J. JACKSON. Coventry. Electro-plating.
10,137. J. B. GOODWIN. Reflector for electric lighting.
10,141. F. PROCHASKA. Electrically-operated switch, locking and operating devices for railway and like purposes.*
10,144. J. J. RAWLINGS, W. R. RAWLINGS and RAWLINGS BROS. Fuse holder.
10,181. C. J. LODGE and A. MUIRHEAD. Syntonic space telegraphy.
10,185. I. SHONE and E. AULT. Removing moisture from electric conductor conduits.
10,189. A. L. LEAN. Leeds. Incandescent lamps and means for connecting the same to circuit.

May 3, 1902.

10,193. H. PEACE. Birmingham. Collectors for overhead traction systems.
10,204. J. HARGREAVES, J. W. STUBBS and J. KEARSLEY. Farnworth. Electrodes.
10,206. E. G. PULFORD. Liverpool. Electrical fire alarm and signalling systems.
10,231. S. Z. DE FERRANTI. High-speed electrical generators and motors.
10,237. K. EDGCUMBE, E. EVERETT and F. PUNGA. Phase indicators.
10,245 and 10,246. G. MARCONI and MARCONI'S WIRELESS TELEGRAPH Co. Receivers for wireless telegraphy.
10,262. W. E. EVANS. Controlling automatic electric regulators, cell switches and the like. (A.E.G., Germany.)*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

4,489. VOGELSANG. Electrolytic cells and electrodes.
6,649. QUAIN and TURNBULL. Heater cutouts and holders for incandescent lamps.
6,739. GASTER. Utilisation of hydrocarbon mixtures for manufacture of electrodes.
6,780. HIRST and BEVIS. Vessels for liquid resistances.
7,067. SYKES. Electro-mechanical interlocking apparatus for railways.
7,553. THOMPSON. Electric alternate current motors.
7,586. YOUNG. Apparatus for separation of iron or steel filings from non-magnetic substances.
7,958. WILKINSON. Signalling for electric tramway systems, &c.
8,015. LENDERYON and WYATT. Regulator and brake for arc lamp.
8,110. HARRISON. Raising, lowering and supporting arc lamps and for electrically connecting them with mains.
8,648. WISE (American Machine Telephone Co.). Exchange apparatus.
8,653. RIDINGS and VERITYS LIMITED. Starters for electric motors.
9,019. BJORNSTAD. Electric gear for controlling lifts.
9,080. TIMMIS. Controlling railway signals and points by electricity.
9,303. BERRY. Transformers.
9,692. HAGGENMILLER. Sectional conductor system of electric traction.
9,740. RECKENZAUN. Ceiling switch.
10,743. MAYER. Electric engines for surgical and dental purposes.
10,888. BUSCH. Electric switches.
11,237. SOCIETÁ GENERALE ITALIANA EDISON DI ELETTRICITÁ. Arc lamps. (Date applied for Nov. 26, 1900.)

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11,307. WILKINSON. Overhead trolleys for electric tramways.
11,308. HOLMES. Joints for conducting cables.
11,676. PERKINS. Rheostat elements or resistance boxes. (Date applied for, Nov. 9, 1900.)
11,677. THOMAS. Protecting devices for electrical apparatus. (Date applied for, Nov. 9, 1900).
11,709. ALLCROFT. Contact maker for electric motors.
12,088. WEISSMANN. Taking electric current from transformers. (Date applied for, Dec. 5, 1900.)
13,139. DUFF and UNITED ALKALI Co. Electric furnaces.
15,366. RUDHARDT. Safety devices. (Date applied for, Jan. 25, 1901.)
15,598. SHEPPARD. Printing telegraphs. (Date applied for, Jan. 3, 1901.)
15,689. QUAIN. Lamp-holders and switch.
15,818. LLOYD. Storage batteries and insulation thereof.
16,902. WHEATLEY (Electric Typewriter Co.). Electric typewriter.
18,569. QUAIN. Incandescent lamps.
21,935. MCCULLOUGH. Incandescent lamps. (Date applied for, April 2, 1901.)
22,183. OPPENHEIMER (Mix and Genest A.G.). Connections for telephone exchanges, with automatic switching-off of operator's telephone.
23,380. BRITISH THOMSON-HOUSTON Co. (Wood). Electric fans.
24,594. BORIE. Fixing capsules on bottles by electricity.
24,805. BRITISH THOMSON-HOUSTON Co. (Rosad). Electrical measuring instruments.
24,810. BRITISH THOMSON-HOUSTON Co. (Holmes and Cox). Charging stations for electrically propelled vehicles.
24,812. BRITISH THOMSON-HOUSTON Co. (Potter). Signalling between drivers on electric trains.
25,218. ELECTRIC CONTROLLER AND SUPPLY Co. (Johnson). Resistance coils.
25,390. BRITISH THOMSON-HOUSTON Co. (Mackintosh). Rheostats.
25,941. BRITISH THOMSON-HOUSTON Co. (Hilliard). Tripping electric circuit-breakers or cutouts.
25,943. BRITISH THOMSON-HOUSTON Co. (Potter). Electric railway systems on a sectional conductor system.
26,135 and 26,348. BRITISH THOMSON-HOUSTON Co. (Woodbridge). Starting alternating current machines.
26,138. BRITISH THOMSON-HOUSTON Co. (Potter). Electric railways on a sectional conductor block system.
26,691. BRITISH THOMSON-HOUSTON Co. (Hewlett). Electric circuit controllers.
26,692. BRITISH THOMSON-HOUSTON Co. (Knox). Electric current controlling devices.
26,748. SIEMENS BROS. & Co. (Siemens and Halske A.G.). Safety indicating and cutout apparatus for polyphase electric circuits.

1902.

303. ROCHE. Circuit closers for portable electrical apparatus.
914. OTTO. Arc lamp for light-cure purposes.
1,027 and 1,028. FARNHAM. Sectional conductor systems of electric railways.
3,248. JENSEN (Yurgae Signalphone Manufacturing Co.). Electric signal register and telephone systems.
3,374. JOHNSON (Electric Controller and Supply Co.). Protective device for electric motors.
4,096. BOULT (Hatch). Dynamo-electric machines.
4,134. MOENNINGHOFF. Revoluble telephone mouthpiece.
4,273. OFFENBROICH and MAFELL. Automatic fire alarms.
4,368. GAILLARD and DUCRÉTET. Microphones for high-tension currents.
4,374. RIGNON and EISENMANN. Arc lamps.
4,377. FELL (Union Typewriter Co.). Electrically printing or inkless typewriters.
4,729. KNOWLES. Incandescent lampholders.
5,065. CRIBB. Trolley wires.
5,530. MERZ. Measuring and indicating electricity supply.
5,366. MÉRAN. Electric accumulators.
5,802. SIEMENS BROS. & Co. (Siemens and Halske A.G.). Safety fuse appliance.
5,862. LUNDIE. Rheostats. (Date applied for, Aug. 16, 1901.)
6,026. WILSON. Magneto-electric generators.

COMPANIES' MEETINGS AND REPORTS.

West African Telegraph Company (Ltd.).

The seventeenth ordinary general meeting was held on Thursday, the Most Hon. the MARQUIS OF TWEEDDALE, K.T., presiding.

The SECRETARY (Mr. John Cambrook) read the notice convening the meeting and the auditors' report, after which

The CHAIRMAN said: The gross revenue for the past year amounted to £75,554, a decrease of £6,014. Analysing this revenue, we find the principal decrease is in South African joint-purse receipts, Government and Press traffic not being so heavy as it was during the earlier stages of the war. Now, however, that peace has been established, we look forward with confidence to a considerable increase in commercial messages, more especially when the great resources of the country have been developed. On the other hand, other classes of traffic show a satisfactory increase, and, owing to the Portuguese exchange having been more favourable during the year, the loss on this account has been about £2,000 less than it was last year. The total working expenses for 1901 amounted to £220,674, or a small increase of £206, chiefly due to the cost of replacing worn out furniture at Loanda, Principe, San Thomé, Bolama and Gaboon stations, and to repairs to the company's stations at San Thomé, Kotonou and Conakry. The expenses attending repairs and renewals of cables have been very large this year, amounting to £17,721, as against £9,035 in 1900, or an increase of £8,686. We have, unfortunately, had heavy expenses in connection with the repairs to our cables this year, especially the Bolama T-piece and the San Thomé-Loanda cable; the cost of cable expended amounted to no less than £4,868. You will see by the report that we have included in our revenue a further sum of £12,000 in respect of the French subsidies due for last year, but which have not been paid, and we have transferred a similar amount from our general reserve to a special fund for subsidy unpaid by the French Government. It is desirable that it should be made perfectly clear to you that, although by including in our revenue the French subsidy for the year, we have placed £13,000 to the general reserve fund, yet only £1,000 of this sum will actually be added to this fund, because, as I have just stated, £12,000 has been transferred from the general reserve fund to a special fund against the subsidy which was due from the French Government for the year ended December 31, 1901, and which will not now be paid by them, under the conditions of the agreement we have entered into. You will also see from the report that since the date of these accounts we have received the first instalment of £112,000 due from the French Government on account of the cables purchased by them. The amount is payable in Paris in francs, and there will, consequently, be a loss on exchange in transferring the money to England, which will, of course, be dealt with in next year's accounts. As was fully explained at the extraordinary general meeting which took place on May 21 last, the cash received from the French Government would be principally devoted to the repayment of the outstanding mortgage debentures. If, therefore, our receipts are maintained the Company will be in a better financial position, inasmuch as the £24,000 hitherto required annually for interest on and redemption of the five per cent. debentures will be saved. Arising out of the agreement with the French Government, however, this Company has to lay a new cable between Bathurst and Bissao, a distance of about 213 knots, and, in conjunction with the African Direct Telegraph Co., one between Kotonou and Lagos, a distance of about 65 knots. We have also to carry out certain works in connection with joining up the different sections taken over by the French Government to meet their requirements, and in order to maintain the through line to the Cape via Loanda. It is not easy to state at the present time how much this work will cost, but it will probably come to about £40,000, nor have the Directors yet decided as to how this expenditure will be met, but full details will appear in next year's accounts, when all these outstanding matters will have been finally dealt with, and the financial position of the Company will be more clearly understood. I think, gentlemen, that we are to be congratulated on having got through a very important business in a manner not unsatisfactorily on the whole. With these observations I move the adoption of the report and accounts.

The MANAGING DIRECTOR (Sir John Denison-Pender, K.C.M.G.) seconded, and the motion was carried unanimously.

The retiring director, Mr. R. Kaye Gray, and the auditors, Messrs. Deloitte, Dever, Griffiths & Co., were then re-elected, and a hearty vote of thanks to the chairman and directors terminated the proceedings.

United River Plate Telephone Co. (Ltd.).

The sixteenth annual meeting was held on Tuesday under the presidency of Mr. J. IRVING COURTENAY.

The SECRETARY (Mr. E. M. Reiss) read the notice convening the meeting.

The CHAIRMAN then said: Gentlemen, the period dealt with in our accounts was in many respects a trying one for all business in the River Plate; short crops, followed by trade depression (attended with many failures) were succeeded by political disquietude and a war scare, which, in December last, seemed likely to culminate in a veritable crisis; but, fortunately that acute stage was averted, and a more settled feeling has been established than has existed for a long time in that part of the world—a condition which will be greatly strengthened by the arbitration treaty between Argentina and Chile. Such a series of adverse circumstances could not but leave its mark on every business connected with the country—the rise in the gold premium being a principal result—and it was matter of surprise that the rise did not reach a much higher figure than it did. Our receipts in the River Plate amounted to nearly £115,000, showing an advance of £5,300, and would have been more had the gold premium remained at about the average of the previous year; but the average for our financial year ended last March was higher, and the balances in the accounts are converted at a rate higher by 12 points than was the case a year ago. Similarly, maintenance charges show an increase of £5,000, due in part to the higher gold premium. Thus the full benefit of the continued growth of our business is not apparent, but the improvement exists none the less. Our capital outlay of £25,271 is £5,700 less than in the previous year. This expenditure is largely placed in our subway work, progress in which has not been so rapid as anticipated chiefly on account of climatic delays and difficulties inherent to the nature of such work; nevertheless, the underground plant has become an accomplished fact in Buenos Ayres, and its use is highly satisfactory. Sundry debtors, £14,265, are less by £6,600, mainly on account of advance payments for material being less. Real estate in the River Plate, £87,744, is slightly more. This item, as I have dwelt on previously, is one of the strongholds in our position, rendering us almost entirely free from the caprices of landlords. Securities at cost, £120,568, is practically the same, but in view of our forthcoming capital expenditure, will not remain much longer at that figure. The securities are not much changed in themselves, and are worth to-day their full cost. Office furniture and stock of materials are items self-explanatory, which also may be said of the last two items, bills receivable, £15,500, and cash at bankers and at call, £29,098, both substantial sums, you will agree, to have in the treasury. On the other side of the balance-sheet the

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capital items remain the same. I would point out that we have now, for the first time, a full year's interest on the total issue of preference shares charged in the accounts, making £2,883 more paid out of our profits. The item of sundry creditors, £6,604, is about the same, and is composed of the usual outstanding accounts and subscriptions. Reserve fund, £55,000, is another strong feature, to be increased this year to £75,000, A I have explained before, it is our policy to build up a large reserve to meet any contingencies that may arise, and it is gratifying to know that in this policy we have the great body of our shareholders in agreement with us. The balance of profit, £33,405, does not materially differ from that of the previous year. With the amount brought forward there is a total balance available of £39,464. We propose to continue the dividend of 7 per cent. on our ordinary shares, place £20,000 to reserve, and carry forward £6,414. We have recently acquired the business of the Provincial Telephone Company (the Compañia Telefonica de la Provincia de Buenos Aires) in which we have long had an interest, comprising a system of telephone lines connecting several towns of importance with the city of Buenos Ayres, and having exchanges in Bahia Blanca, Mar del Plata and other places in the province. The lines and plant acquired are to be improved and considerably extended. They already add over 700 subscribers to our list and are proving a valuable source of revenue. In further development of our business, we some time since obtained from the province of Cordoba a concession which was mainly dependent for its value upon a supplementary one being obtained from the city of Cordoba. This, I am pleased to say, has been recently obtained upon favourable terms, special features of which include exemption from both provincial and municipal taxation for a period of 20 years. Other important improvements and additions to our business are in contemplation and in process of being carried out, and from what has been said the shareholders will feel assured that the Directors appreciate the opportunities for advancement in telephony that the River Plate affords, and that no effort is being spared to extend our business and to increase its efficiency. I now move the adoption of the report and accounts.

Mr. FRANK W. JONES (Managing Director) seconded, and said: Making allowance for the additional amount paid as dividends on our preferred shares, the accounts show a net profit exceeding that of any previous year by £1,300, and, after providing for the third successive dividend of 7 per cent. on the ordinary shares, permit the placing of £20,000 to reserve. This is assuring evidence of the stability of our business and the reliability of its earning capacity. The acquisition of the Provincial Company and the concessions for the province and city of Cordoba are very important and valuable. The former gives us 15 new exchanges in the province of Buenos Ayres, and will, it is anticipated, result in extending our business to all places of much commercial value in that portion of the republic. Several of the exchanges are already connected with our system in the city of Buenos Ayres, and others will from time to time be connected. After the installation of this and two other offices which we have immediately in prospect, we shall have 50 working exchanges in Argentina.

Dr. ELLIS pointed out the desirability of adding a small bonus to the ordinary dividend. It had been a prosperous year and a bonus of 1 or 2 per cent. would give a certain amount of encouragement to purchasers of shares.

The CHAIRMAN, in reply to Dr. Ellis and other shareholders, said: I am not sure that an increase of dividend would give an increase in the prices of the shares. I am one of those who think that the shares ought to stand at a higher price, but I doubt very much whether you will attain that by giving more dividend rather than by giving the impression to the public investing that this is a strong and substantial Company. I think the latter would operate greatly, and I hope that the shares will advance to something more than their intrinsic value, not to be measured only by actual dividends of 7 per cent. I am glad you are in favour of having a large reserve.

The motion was then carried.

The retiring Directors and auditors were then re-elected, and a cordial vote of thanks to the Chairman, Directors, Secretary and staff terminated the proceedings.

Electric and General Investment Co. (Ltd.).

The thirteenth ordinary general meeting was held yesterday, Mr. GEORGE HERRING presiding.

The SECRETARY (Mr. J. Cecil Bull) read the notice convening the meeting, and the report of the auditor.

The CHAIRMAN said: On the capital side of the balance-sheet I do not think I need make any comment. On the other side—and this is a point you will naturally look to—is the item "By Investments at Cost"—namely, £222,670. Hitherto I have always been able to tell you that these investments are worth more than they appear at in the books. I cannot say that this time, but I can certainly say that they are at the present market prices within a fraction of the amount put down in the balance-sheet. I turn now to the profit and loss account, where you will see each item set out. You may notice that the dividend on the preference shares now requires £5,970 from the profits, but the gross profits were £32,000, and the net profits, after paying the preference dividend and all charges, amounted to £20,470. The Directors propose to carry £10,470 to the contingencies account in order to strengthen the funds available for dealing with further business. This will leave a balance of £10,000. The payment of £50 a share on the founders' shares is absolute dividend, but we cannot say the same of the extra £10 a share we propose to pay on those shares, although it comes out of dividends we have received, or the greater part of it does. But my colleague, Mr. Braithwaite, started an objection, in which I thought he was quite correct—that is, we doubt whether we have the power to re-invest your dividends, and therefore we determined on distributing this sum. The same remark applies to the ordinary shares reserve fund. Before I sit down I think we have the right on both sides of the table to do a little boasting. We started this Company in 1890. We first paid a dividend of 10 per cent. and we have gradually gone on until, in the course of 11 year's working, we have paid you 72s. on your £1 share. That is not bad. We have also during that time either assisted or promoted 24 companies, and there has not been a single failure. They are all more or less flourishing, and are all paying dividends, and I do think that we have a right to boast on that point. We think we have credit, and we certainly have a very good position, and there is no reason why we should not go on progressing in a similar manner. I may tell you that our profits are not entirely derived from promotion, although we receive, of course, a certain sum from that, but the principal amount of our profits is derived from the fact that we have such belief in the companies which we either assist or bring out that we take lines in them ourselves, and when the companies are proved to be successful, we sell them at a premium, and thereby increase our profits. There is one other point I wish to mention—namely, that at the present time our trustees' fees are nearly sufficient to pay all our expenses, while the dividends from the securities we hold are nearly sufficient to pay our preference dividend. Therefore, to put it perfectly plainly to you, if we do no further business this coming year, we should be very little out in the preference dividend and in our expenses; and all the profits we derive from any venture that we make will go to the ordinary shareholders. I now move the adoption of the report.

Resolutions approving the dividends and bonus set out in the report, and re-electing Mr. Emile Garcke a director and Mr. G. T. Rait, the auditor, were then carried, and the proceedings terminated.

Electric Construction Co. (Ltd.)

The directors' report for the past year states that the net profit is £20,496. 19s. 11d., and, adding £2,853. 18s. 2d. brought forward, the amount available for distribution is £23,350. 18s. 1d. It is recommended that the 7 per cent. preference dividend be paid on July 31, absorbing £4,394. 12s., and a dividend at the rate of 6 per cent. on the ordinary shares (one-half on July 31 and one-half on Jan. 31, 1903), requiring £13,452. £2,000 is placed to reserve, and £3,504. 6s. 1d. carried forward. The general reserve fund will then amount to £32,000. The buildings and plant have been thoroughly maintained out of revenue, and £5,000 has been credited to depreciation, which now amounts to £43,000.

The contract for the electrical equipment of the Islington extension of the City and South London Railway was completed at the end of last year, and the plant has since been working to the full satisfaction of the railway company. Large machines have been supplied to the Corporations of Leeds, Sheffield, Halifax, Shoreditch, Croydon, Brighton, Devonport, Wolverhampton and others. Notwithstanding the keen competition in the manufacture of electrical plant, especially during the latter half of the financial year, the works are fairly supplied with orders, and it is believed that the company's staff, workmen and plant at Bushbury can turn out electrical machinery on as favourable terms as any other establishment.

The relations between the management and all classes of the employés continue cordial, and in acknowledgement of zealous co-operation in promoting the company's interests the directors recommend the distribution among the employés of the usual bonus. The compensation paid under the Workman's Compensation (1897) Act for the year is £36. 13s. 3d.

The revenue of the Madras Electric Tramways shows a healthy increase, and the development so far during the current year promises even a larger improvement.

Rand Central Electrical Works (Ltd.)

In the report for the year ended Dec. 31, 1901, the directors express regret that the war prevented the resumption of operations until Sept. 22, 1901, and that from Jan. 20, 1901, to that date the plant was lying idle and unremunerative, as the board thought that it would be highly dangerous to re-start the works without having such military protection as would practically ensure immunity from further raids. The statement of accounts shows a loss of £9,570. 2s. 8d., and adding £8,710. 5s. 6d. for depreciation, and the balance (£6,951. 1s. 8d.) from 1899, the total debit balance is £25,231. 9s. 10d. The following table shows the amount of power supplied since the resumption of work:—

September 22 to 30...	54,135 kw.-hours generated,	500	max. load.
October.....	218,460 "	600	" "
November.....	234,743 "	610	" "
December.....	263,350 "	700	" "

The revenue from all sources amounted to £8,529. 4s. 5d., compared with £25,395. 7s. 8d. for 1900, and working expenses (including depreciation) to £26,809. 12s. 7d., against £32,847. 17s. 9d. Revenue from supply of power was £7,869. 16s. 5d., against £24,470. 5s. 2d. in the previous year. The contract with the Johannesburg municipality has been completed and is yielding a satisfactory return. The municipality have already given notice that they will require the full amount of power contracted for—viz., 600kw. in about six months' time and 700kw. from Jan. 1 next until expiration of agreement. From the returns to hand for the present year, which show a large increase each month (the power supplied for April being more than double that in January), the directors confidently hope that at the next meeting they will be able to report an increased and remunerative share of the business which is expected to accrue as a result of the cessation of hostilities.

Attached to the directors' statement is the report of the general manager (Mr. H. Spengel) for the period from Aug. 1 to Dec. 31. On the former date, when Mr. Spengel took over the management, the plant with three engines ready for use was lying idle, only some repair and improvement work going on. In September it was decided to re-start the works. The first current was sent through the main line on Sept. 22, the day load varying from 60kw. to 100kw. and the night load reaching about 350kw.

The number of consumers gradually increased, the day load going up to about 330kw., and the maximum night load to 700kw. The total number of kilowatt-hours generated amounted to 770,688. The working of the plant must be considered satisfactory, especially when all the difficulties are taken into account. A great proportion of the staff were quite new to their work, telephonic communication was most unreliable, working in the open at night time was impracticable in view of the military precautions to be observed, and native labour was very scarce. The total interruptions amounted to 22 hours 55 min., out of which 6 hours 13 min. were with notice for general work on the line, 1 hour 15 min. were due to outside interference, and out of the remaining 15 hours 27 min., 7 hours 58 min. were due to an unfortunate accident, a terrific gale blowing off a great part of the engine-house roof. The part of the line west to the city and suburban switch was without current for 4 hours 38 min. longer.

A number of the company's customers did not require any power at all, and some only a trifle in comparison to the amount contracted for, but an enforcement of the minimum payment was considered unfair. An arrangement was, therefore, arrived at, to which all agreed, under which the contracts were considered suspended during the time of such non-supply, and the period of such suspension was added to the end of the term contracted for. A new tariff has been resolved upon under which a separate charge for rent and maintenance of installations according to capital outlay will be made where plant is supplied by the company, and the charge for current supplied will be reduced to 6d. per kilowatt-hour for the first two hours' average daily use and 1d. per kilowatt-hour after. A new contract has been concluded with the May Consolidated Gold Mining Co. for the supply of 125 H.P., as well as a contract for the temporary supply of about 400 H.P. with the City and Suburban Gold Mining and Estate Co. to drive their mill, haulages, tailings, wheels, electric plant and pumps. Other contracts of the company include: New Transvaal Chemical Co., New Primrose Gold Mining Co., Imperial Military Railways (Elandsfontein and Johannesburg), Johannesburg Municipality, Wemner Gold Mining Co., Rand Central Ore Reduction Co., Robinson Gold Mining Co., Jumpers Gold Mining Co., Crown Deep and the Village Main Reef Gold Mining Co.

ELECTRICAL POWER STORAGE CO. (LTD.)—The report of the directors for the year to May 31, just issued, states that the profit, including £432. 9s. 1d. brought forward, is £11,346. 2s. 9d. £5,000 has been carried to the reserve fund and £1,000 to the contingent fund, and a dividend of 5 per cent. on the ordinary shares is recommended, absorbing £4,491. 8s., leaving £854. 14s. 9d. to be carried forward. The buildings, plant, tools, &c., have been maintained in thorough condition out of revenue at a cost of £3,059. 15s. 10d. The directors record a continued increase in business, the company's output having been larger than in any previous year. This increase has not been confined to one class of cell, the smaller as well as the larger type, and still more, the batteries designed for the propulsion of electrical vehicles having shared in the growing demand. Among the orders completed during the year have been some very large contracts for public lighting and traction undertakings, and the company enters on a new financial year with its order book well filled.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRICAL INSTRUMENTS SYNDICATE (LTD.)—Reg. June 21, capital £2,000 in 1,500 preference shares of £1 each and 2,000 ordinary shares of 5s. each, to enter into an agreement with L. J. Aron and J. W. Flower to acquire and develop patents relating to the production, storage or utilisation of electricity, the manufacture of electricity meters, electric lamps, instruments and accessories, electrical and general engineers, electricians, &c.

ENGLISH POWER CO. (LTD.)—Reg. June 28, capital £100 in £5 shares, to manufacture, sell and purchase plant and machinery used in the creation or application of any motive power, particularly compressed or heated air and electricity, &c., to adopt an agreement with the Pioneer Power Co., to equip, maintain and work trains or railways or other system of vehicular communication, to construct tramways, light railways, rolling stock, &c.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 15/16d. per oz. (July 3). Consols (2¾ per cent.) 96 13/16—96 15/16 for money, 96 15/16—96 15/16 for account; 2½ per cent. 96—96½ (July 3). Consols Pay Day Aug. 7; Stocks and Shares Continuation Days, July 9 and 28; Ticket Days, July 10 and 29; Pay Days, July 11 and 30; Mining Share Carry-over Days, July 8 and 25.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The 6 per cent. preference dividend has been declared for the six months to June 30.

DEUTSCH ATLANTISCHE TELEGRAPHEN GESELLSCHAFT.—At the general meeting held at Cologne, on Monday, the report of the directors for the year 1901, set out in our last issue, was adopted, and it was resolved to duplicate the company's system between Emden and New York, for which purpose 4 per cent. debentures to the nominal amount of £1,000,000 in bonds of £50 each are issued. The 4 per cent. interest is guaranteed by a subsidy from the German Government, a portion of which is held in trust for the debenture-holders. The debentures are redeemable at par from 1905. We are informed that the whole of the debentures have been taken up. After making provision for reserve, amortisation, &c., a dividend of 4½ per cent. has been declared on the company's capital of £1,050,000, £9,270 being carried forward

EDMUNDSON'S ELECTRICITY CORPORATION (LTD.).—The Directors have declared a final dividend on the ordinary shares of 9 per cent. per annum for the half-year ended March 31, making, with the interim dividend of 5 per cent. already paid, a dividend of 7 per cent. for the year.

FRINTON-ON-SEA AND DISTRICT ELECTRIC LIGHT AND POWER CO. (LTD.)—This company, which has a share capital of £5,000 in £1 shares, is inviting applications for 3,000 shares.

SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER CO. (LTD.)—We are informed that warrants for the interest to June 30 on the 4½ per cent. first mortgage debenture stock of this company were posted on Monday.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has been asked to allow the further issue of 5,000 ordinary £5 fully-paid shares of *Callender's Cable and Construction Co. (Ltd.)* to be quoted in the official list.

TELEGRAPH MANUFACTURING CO. (LTD.)—It is announced that the name of the British Insulated Wire Co. (Ltd.) is shortly to be altered so as to embrace the characteristics of that company and the Telegraph Manufacturing Co. (Ltd.), with which it is now amalgamated.

THOMAS PARKER (LTD.)—The annual meeting was held on Monday. The chairman (Mr. W. Thomas) said the state of affairs did not look so favourable as a year ago, but things were quite as satisfactory as they could expect them to be. A period of trade depression had been passed through, and the company went through the trouble very well. They had now 20 per cent. more orders than at the corresponding period of last year, and the prices of materials were much reduced, so that altogether they were much better off.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a).
		£	£		£	£
Aberdeen Corporation...	June 28	1,296	+ 511	4	3,949	+ 982
Ayr Corporation	„ 28	455	...	6	1,828	...
*Birmingham Tramways.	„ 28	5,878	+1,151	25	119,198	+30,450
*Blackburn Corporation..	„ 27	1,195	+ 574	26	18,497	+ 2,946
Blackpool Corporation...	„ 26	998	+ 87	13	8,574	- 815
Blackpool and Fleetwood	„ 28	946	+ 6	26	9,261	- 695
Bolton Corporation	„ 29	2,519	+ 944	13	21,240	+ 1,656
Bradford Corporation ...	„ 22	3,288	+2,361	12	37,695	+25,405
Brighton Corporation ...	„ 29	1,046	...	31	19,715	...
Brisbane Tramways.....	May 14	2,325	+ 317	20	46,539	+ 5,515
*Bristol Trams & Carriage	June 27	5,480	+ 737	25	107,596	+ 4,103
Burnley Corporation ...	„ 28	933	+ 490	‡13	9,150	+ 3,265
*Buenos Ayres & Belgrano	„ 1	2,891	+ 176	...	...	...
Calcutta Tramways Co...	„ 23	R24.423	+R5,127	26	R578,277	+R57,177
Cardiff Corporation	„ 21	1,523	...	...	...	...
Carlisle Tramways Co....	„ 28	291	+ 104	†26	3,865	+ 82
Central London Railway	„ 28	10,041	+3,89¢	26	179,437	+18,254
City & South London Ry.	„ 29	2,880	+1,005	26	77,345	+26,531
Cork Elec. Tramways Co.	„ 26	660	+ 102	§25	11,427	+ 478
Devonport & Dist. Trams	„ 20	437	...	24½	9,851	...
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	„ 28	234	+ 55	13	2,786	- 68
Dublin & Lucan Railway	„ 30	179	+ 59	26	2,611	+ 120
Dublin Southern Dist....	„ 27	1,254	+ 311	¶25	20,342	+ 4,199
Dublin United	„ 27	4,503	+ 538	¶25	90,283	
Dudley—Stourbridge ...	„ 20	718	+ 69	24½	16,823	+ 2,326
*Dundee Corporation ...	„ 25	790	+ 80	...	...	...
East Ham Council	„ 28	688	+ 214	1	688	+ 214
Gateshead & Dist. Trams	„ 20	770	+ 265	24½	16,375	+ 1,763
Glasgow Corporation ...	„ 28	13,217	+1,229	4	48,684	+ 1,780
Greenock & Port Glasgow	„ 20	528	+ 335	24½	10,664	+ 6,126
Hartlepool Tramways ..	„ 20	277	+ 36	24½	5,314	+ 411
Hull Corporation	„ 28	2,181	+ 535	13	22,331	+ 835
Isle of Thanet Co.	„ 21	607	- 145	...	...	...
Kidderminster & Dist....	„ 20	135	+ 16	24½	2,638	+ 36
Leeds Corporation	...	...	...	...	...	...
*Liverpool Corporation...	„ 14	9,277	+ 152	24	218,811	+15,972
Liverpool Overhead Rly.	„ 29	1,6?0	- 6	‡26	37,488	- 3,433
Manchester Corporation	„ 28	7,025	+5,971	§55	130,149	...
Merthyr.....	„ 20	202	— 19	24½	4,811	- 709
Middleton	„ 20	271	...	12½	3,767	...
Newcastle-on-Tyne Corp	„ 28	4,238	...	...	...	...
Oldham, Ashton & Hyde.	„ 20	539	+ 36	24½	12,077	+ 136
Perth (W.A.) Elec. Trams	„ 27	1,011	+ 207	†52	51,181	+15,691
Poole & Dist.....	„ 20	250	+ 3	24½	5,441	- 97
Portsmouth Corporation	„ 28	3,248	+2,344	...	...	...
Potteries	„ 20	1,493	+ 10	24½	34,585	+ 1,211
Salford Corporation ...	„ 30	3,519	+1,637	13	33,019	...
*Sheffield Corporation ..	„ 29	4,966	+1,203	26	100,167	+16,400
Southampton Corporat'n	„ 26	1,139	+ 291	...	...	...
Southport Tramways ...	„ 20	272	+ 125	24½	4,997	+ 1,504
*S. Staffordshire Trams...	„ 20	785	+ 50	24½	18,496	+ 516
Sunderland Corporation.	„ 29	1,871	+ 620	13	14,889	+ 1,688
Swansea Trams.....	„ 20	463	+ 19	24½	10,509	+ 864
Taunton Trams.....	„ 20	58	...	24½	1,419	...
Tynemouth & Dist.	„ 20	271	+ 27	24½	5,346	+ 288
Wigan Corporation	„ 26	357	+ 160	...	...	...
Wolverhampton District	„ 20	145	+ 92	24½	3,494	+ 2,239

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 24.	Price Wednesday, July 2.	Rate per Cent. Yielded.	Dividend Due.	Business Done During 8 Days Ending July 2.	
						£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.						
100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½ ¼	½ ¼				
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100 101	100 104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11 12	11 12	5 16 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10⅛	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.) xd	101 101	101 104	4 6 7	...	10⅛	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9 9⅛	9 9⅛	4 4 3	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	March and September	...	...
2½,000	5	3/6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8½ 9½	8½ 9½	3 3 2	...	...	...
10,000	5	3/4.3/10	Do (Nos. 20,001-30,000)	8½ 9½	8½ 9½		...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105 107	105 107	3 15 2	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9 10	9 10	5 0 0	February and August	9¼	...
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...	..	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6⅛	5½ 6⅛	3 18 3	,, ,,	1⅛	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red. xd	105 107	105 107	3 14 9	...	...	...
44,426	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5 5½	5 5½	2 14 6	March	5½	...
£1[illegible],000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108 111	109 112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8 9	8 9	5 5 7	February and August	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	11½ 12½	11½ 12⅝	4 13 0	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) xd	121 126	121 126	4 0 8	June and December	...	...
£300,000	Stock	4½%	Do, 4½% 2nd Deb. Stock Certs. (all pd.) xd	101 104	101 104	4 6 7	...	...	...
40,000	10	6/0	County of London and Brush Prov. Ordinary	7⅞ 8⅛	7½ 8½	4 14 2	...	8⅛	8 1/16
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 13	12 13	4 12 4	March and September	13	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.) xd	107 110	108 111	4 1 1	...	...	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	6⅛ 6½	6⅛ 6½	3 12 0	...	...	...
£50,000	Stock	...	Do, 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½ 6⅝	6½ 6⅝	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104 107	104 107	3 14 11	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1½ 1⅝	1½ 1⅝	...	...	...	...
49,340	5	3/0	Do. 6 per Cent. Preference	4 4⅛	4 4⅛	6 13 4	...	...	...
£150,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	94 99	94 99	4 0 10	Mar., June, Sept., Dec.	95	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16 17	16 17	3 16 6	April and October	16⅝	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage xd	109 113	109 113	3 19 8	June and December	...	...
£240,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.) xd	97 100	93 101	3 10 0	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary	14 15	14 15	4 0 0	March	...	...
19,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	99 102	99 102	3 18 10	...	...	...
200,000	1	...	Rand Electric	⅛ ⅛	⅛ ⅛	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70 75	70 75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103 105	103 105	4 6 9	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15⅛	...
30,000	5	3/6	Do. 7 per Cent. Preference	8½ 9⅛	8½ 9⅛	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.) xd	97 100	97 100	3 10 0	...	99	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1½ 2½	1½ 2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2⅝ 3½	2⅝ 3½	..	...	...	...
110,000	5	5 6	Westminster Electric Supply Ordinary	11 12	11 12	4 7 6	March and September	...	...
28,141	5	1/3	Do. 5 per Cent. Cum. Pref. (£2. 10s. paid)	3½ 4	3½ 3⅝	...	...	3½	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4½ 4⅝	4⅝ 4⅝	4 11 5	April and October	...	...
£280,000	Stock	6%	Do. Permanent 6% Deb. Stock xd	125 130	125 130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	8 9	8 9	3 6 8	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference xd	8⅛ 9¼	8½ 9⅜	5 5 3	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95 100	95 100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½ 14½	13½ 14⅝	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3⅜ 4½	3⅜ 4½	...	...	...	...
75,000	5	2/6	Do. 5% Cum. Pref.	4½ 5	4½ 5	5 0 0	...	4 1/8	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs. xd	102 105	102 105	4 5 9	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd) xd	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures xd	106 108	105 07	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7 7½	7 7½	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9⅜ 10½	9⅜ 10⅜	4 17 6	May and November	9⅜	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102⅝ 104⅞	102⅞ 104⅞	4 6 9	...	...	...
100,000	10	12/0	British Electric Traction Ordinary xd & rights	12 13	12 13	6 18 6	...	12⅞	12⅝
100,000	10	6/0	Do. 6% Cum. Pref. ex rights	11⅞ 12½	12 12⅜	4 16 0	February and August	12⅜	11⅞
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	...	...
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅜ 1⅝	1⅜ 1⅝	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 14 3	...	...	...
27,500	5	10/0	Do. "B"	5 5⅛	5 5⅛	5 9 1	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures xd	102 105	102 105	4 15 3	...	104	103
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd. xd	95 98	95 98	5 2 0	...	...	...
25,000	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	...	...	2 0 0	...	...	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red) xd	106 108	106 108	4 3 7	...	...	...
480,000	1	1/2⅞	Cape Electric Tramways Shares	2⅜ 2⅝	2⅜ 2⅝	3 16 2	...	...	...
£1,810,014	Stock	4%	Central London Ordinary Stock	104 107	106 109	3 13 5	June and December	108	106
£494,093	Stock	4%	Do. 4% Preferred Stock	105 108	106 109	3 13 5	...	106½	...
£494,993	Stock	4%	Do. Deferred Stock	100 103	103 106	3 15 6	...	102½	100½
£698,201	100	4%	Do. 4% Deb.	117 120	117 120	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	4⅜ 4⅝	4⅜ 4⅝	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...	...
£1,330,000	Stock	2½%	City and South London Railway Con. Ordinary	71 74	73 76	2 15 10	February and August	74½	71½
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	...	...	...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	..	...	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 16 5	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	123 131	128 131	3 17 8	...	...	...
£150,000	Stock	...	Do. (1901)	122 126	122 126	...	...	...	...
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115 118	115 118	3 9 7	May and November	...	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛ 12⅛	11⅛ 12⅛	3 16 11	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14⅜ 15⅝	14⅜ 15⅝	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½ 4⅝	4½ 4⅝	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.) xd	99 101	99 102	4 18 0	...	...	...
78,000	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	...	...	...
30,000	10	8%	†Imperial Tramways Ordinary	23 24	23 24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference xd	13½ 14	13½ 13⅝	4 7 3½	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture xd	110 112	108 110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½ 5	4½ 5	...	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4 13/16 4 15/16	4 13/16 4 15/16	3 0 3	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅛ 11	10⅛ 11	4 11 1	,, ,,	...	...
£135,000	Stock	4%	Do. 4 per Cent. Debenture xd	99 101	97 99	4 0 0	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid) xd	10½ 11	10½ 11	4 10 11	...	10 11/16	...
20,999	10	2/3	Do. (£7. 10s. paid) xd	5½ 6	8 8½	...	...	...	...
£655,341	Stock	¾%	Do. 4% 1st Mortgage Debenture Stock xd	104 106	105 107	3 14 9	...	106½	106½
£169,659	Stock	18 0	Do. Prov. Certs. (£75 paid) xd	54 56	79 81	...	...	...	...
$8,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	115 119	115 119	4 5 7	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908)	104 106	104 106	4 14 9	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	104 106	104 106	4 6 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 13 4	...	...	...
40,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3 4	3 4	7 10 0	May	...	...
£181,800	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.) xd	96 100	93 98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk. xd	99 102	99 102	4 18 0	...	...	...
13,334	10	8/0	Potteries Electric Traction Ordinary	9 10	9 10	4 0 0	...	10½	101
30,000	10	5.0	Do. 6 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	...	...
£220,000	Stock	4½	Do. 4½ per Cent. Debenture Stock	107 110	107 110	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...	...	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 24.		Price Wednesday, July 2.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During 8 Days Ending July 2 Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.) xd	100	104	98	102	3 18 5	January and July	100¼	...
25,000	10	...	Amazon Telegraph	3½	4½	3½	4½	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£788,840	Stock	12/6	Anglo-American	44	47	45	48	5 18 1	Feb., May, Aug., Nov.	...	...
£3,105,580	Stock	25/0	Do. Preferred	87	89	88	90	6 9 2	,, ,,	90	87½
£3,105,580	Stock	2/0	Do. Deferred	6½	7	6¾	7½	1 7 7	,, ,,	7	...
$13,333,300	$100	$1½	Commercial Cable Capital Stock xd	165	175	170	180	4 8 11	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock xd	94	96	94	96	4 3 4	,, ,,	98½	...
16,000	10	4/0	Cuba Submarine Ordinary	4½	5½	4½	5½	7 5 6	February and August	5	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½	13½	12½	13½	7 8 2	,, ,,	12½	...
13,000	5	2/0	Direct Spanish Ordinary	2½	3½	2½	3½	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8½	9½	8½	9½	5 5 3	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99%	103%	99%	103%	4 7 8	January and July	...	...
60,710	20	3/0	Direct United States Cable	9½	10½	9½	10½	6 3 10	Jan., Apr., July, Oct.	10	9½
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	xd100	103	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200) (red.)	120	130	120	130	5 7 8	Jan., Apr., July, Oct.	124	120½
£1,955,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	88	91	88	91	3 17 8	,, ,,	88	...
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	107	111	107	111	3 12 2	May and November	103½	...
300,000	10	6/6	Eastern Extension	12	13	12	13	5 7 8	Jan., Apr., July, Oct.	12 1/16	12
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	108	113	108	113	3 11 4	February and August	109	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100	103	100	103	3 19 0	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.	100¾	103¾	100¾	103¾	3 18 3	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen ex coupon 55	25	27	25	27	5 11 1	January and July	...	...
£70,000	100	4½%	Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos.	xd100	103	99	102	4 8 1	June and December	99½	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	37	41	37	41	6 1 11	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.) xd	99	102	99	102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3½	4½	3½	4½	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	100	103	100	103	4 18 5	March and September	...	...
30,008	2½		West Coast of America	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures xd	99	102	97	100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	⅜	⅝	⅜	⅝	...	May and November	...	...
34,563	10	£/0	Do. 6 per Cent. 1st Pref.	5½	5¾	5½	5¾	10 8 8	,, ,,	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3½	4½	3⅜	4⅜	...	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures xd	101	104	99	102	4 18 0	January and July	...	...
207,930	10	3/0	Western Telegraph (late Br zil'n Submarine) xd	11½	12½	11½	12½	5 16 4	Mar., June, Oct., Dec.	1⅞	11½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1868) xd	102	105	101	104	4 16 2	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.) xd	97	100	97	100	4 0 0	...	98½	...
			TELEPHONES.								
44,000	£5	5 0	Chili Telephone (fully paid)	4¼	4½	4¾	4½	5 18 0	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	⅝	½	⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	,,	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	95½	...
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	3⅛	3⅜	4⅛	4⅜	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	53	57	54	58	7 15 2	...	55	...
15,000	10	£/0	Do. 6 per Cent. Cumulative 1st Preference	12	14	12	14	4 5 9	February and August	12½	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	12	14	4 5 9	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	4⅞	5⅛	4 17 6	,, ,,	...	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.) xd	93	96	93	96	3 12 11	June and December	95	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.) xd	102	106	102	106	3 15 6	...	...	...
171,504	1	0/8½	Oriental	1 1/16	1 1/16	1	1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	5	5⅛	5	5⅛	6 7 3	July	...	...
140,000	5	2/6	Do. 5% Cumulative Pref. xd	4½	5	4½	5	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) xd	101	104	101	104	4 16 2	June and December	103	102½
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅝	¾	⅝	¾	5 14 3	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛	¼	⅛	¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜	⅝	⅜	⅝	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7½	8½	7½	8½	5 17 8	July and February	...	...
70,000	5	3/0	Do. 6 per Cent. Preference	5½	6	5½	6	5 0 0	January and July	...	...
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red. xd	100	103	100	103	4 7 7	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	5¾	6½	5¾	6½	4 18 0	...	6 1/16	6
105,731	2	...	Brush Electrical Engineering	1⅛	1⅜	1⅛	1⅜	...	March	1½	...
150,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cum.	1⅜	2⅛	1⅜	2⅛	...	March and September	1⅞	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	101	104	4 6 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock xd	94	99	94	99	4 10 10	January and July	...	...
30,000	5	10/0	Callender's Cable Construction Ord.	16	17	16	17	4 8 3	,, ,,	16	...
40,000	5	5/0	Do. 5 per Cent. Cumulative Preference xd	5½	6	5½	6	5 0 0	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb.(red.) xd	109	113	109	113	3 19 8	November and May	...	...
450,000	1	0/3½	Castner-Kellner Alkali Co. (fully paid)	1	1½	1	1½	4 16 0	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	93	98	93	98	4 13 9	...	...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary xd	¾	1	¾	1	8 0 0	March	...	...
85,000	3	1/9½	Crompton and Co. (Nos. 1 to 54,000) xd	3	3½	3	3½	6 8 6	January and July	3½	3½
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb.(red.)	103⅝	108⅝	101⅞	106⅞	4 14 4	,, ,,	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅛	⅜	⅛	⅜	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1½	2½	1½	2½	...	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb.Stock(red.) xd	73	77	73	77	5 3 11	June and December	...	...
25,500	5	2/6	Edmundson's Electricity Corporation Ord.	6½	6⅝	6½	6⅝	5 3 8	Half-yearly	...	...
30,000	5	3/0	Do. 6% Cumulative Preference	5½	6½	5½	6½	4 16 0	...	6 1/16	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	108	111	107	110	4 2 9	...	108	107½
112,100	2	1/2½	Electric Construction Co.	1½	1½	1½	1½	6 17 2	January and July	1½	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2½	3	2⅝	3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 11	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾	1½	¾	1½	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref. xd	10	10½	9½	10½	4 17 7	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98	101	98	101	3 19 3	...	...	...
35,000	5	5/0	Henley's Telegraph Works Ordinary xd	16	17	16	17	4 8 3	February and August	16 1/16	16½
35,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	,, ,,	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb.Stock(red.)	111	115	111	115	3 18 3	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works xd	21	22	21	22	4 10 11	,, ,,	21½	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	103	100	103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½	16½	15½	16½	6 1 3	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34	37	34	37	6 9 8	March and July	36	34½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909 xd	103	106	101	104	3 16 11	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	9½	10½	...	...	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	...	...	4 3 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	...		...	...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	...		...	...	...	,, ,,	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref. xd	5½	5¾	5½	5¾	5 9 1	...	...	...
180,227	10	2/6	Globe Telegraph and Trust	8	9	8	9	5 16 8	Jan., Apr., July, Oct.	8⅛	8
180,042	10	3/0	Do. 6 per Cent. Preference	12½	13½	12½	13½	4 8 11	,, ,,	13⅜	12⅞
11,839	8	4/0	Reuter's	7	8	6½	7½	5 6 8	April and October	...	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110	120	110	120	5 0 0	,, ,,	110½	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

WE conclude this week our summary of the proceedings at the Seventh Annual Convention of the Incorporated Municipal Electrical Association. The general excellence of the Papers and discussions was maintained, and the Association settled down to work each day in a more serious and earnest mood than has frequently been the custom at previous meetings. The fortuitous absence of Papers read by Chairmen of Committees, and the highly technical character of the subjects discussed in the Papers of the engineer members contributed largely to this. We think that the electricity committee section should be encouraged to express their views on managerial and administrative methods, and that, when good Papers on such subjects have been contributed, a "Town Councillors' day" might well be set apart for them, as has been done on frequent previous occasions; but, in return for this, there should be a tacit understanding that their fluent but oft-times pleonastic oratory should not be interposed during discussions on purely technical subjects.

AMONG the items in the Council's report which will be read with considerable interest, is an announcement to the effect that a Corporation has succeeded in obtaining Parliamentary sanction for a "stand-by supply" clause. This clause, it will be seen, makes it legal for the Corporation to demand a reasonable sum for allowing their mains to be used as a stand-by to a private plant, even if no current be taken from them; and, in the event of dispute, provision is made for arbitration. The question of guard wires is also dealt with in the report, and their abolition is recommended. It may be pointed out in this connection that the Post Office holds a paramount position, and if the Postmaster-General insists on guard wires the Board of Trade is powerless to interfere. A friendly conference between representatives of the municipal and company tramway interests and engineering representatives of the Post Office, the National Telephone Co., and the Board of Trade would probably accomplish more than deputations.

IN our current issue we continue the description commenced last week of the splendid collection of tramway *matériel* constituting the second International Tramways and Light Railways Exhibition. This exhibition will close to-morrow night, after a highly successful run of 12 days. It has been well attended, for although, perhaps, the general public has not crowded the aisles, the attendance has been mainly of persons interested in tramway affairs, and we are glad to learn that the exhibition has resulted in the transaction of a large amount of business. If there is one regret, it is that it has been found impracticable to extend the period before bringing it to a close, and we hope that the next exhibition in this series will be opened for at least a month. Another regret, which we ourselves feel personally, is that space has not permitted of our describing all the many interesting exhibits before the closing day. We devoted a large portion of our last week's issue to these exhibits, and a still larger part of the current issue is devoted to the same purpose. In future issues we shall describe the remaining exhibits, so far as they are of interest to our readers. We congratulate the promoters of the exhibition upon the success they have attained, and we tender to them our best thanks for the assistance we have received from them in the preparation of our articles.

IT was suggested in the illustrated article on "The Coronation Illuminations," in our issue last week, that had all the electrical illuminations been called into simultaneous use, as originally intended, their effect would not have raised the station load anywhere to more than the top winter load. Our contemporary, the *Journal of Gas Lighting*, has investigated this matter, from the gas lighting point of view, and what it has been able to discover possesses no little interest

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for electricity supply engineers. Broadly speaking, our contemporary finds that in many important places where gas illuminations have been exhibited on an extensive scale the day's consumption of gas has not exceeded the consumption on the corresponding day in 1901. For instance, in Dublin, where illuminations were in full swing on Monday and Tuesday last week, the gas consumption was 2,228,000 and 2,286,000 cubic ft. respectively. On the corresponding days last year the consumption was 2,894,000 and 2,486,000 cubic ft. respectively—actually higher figures on each day. This should encourage electricity supply engineers in the belief that even a large amount of current for electric illuminations would not over-tax a properly-equipped station, nor put any severe strain on the station staff.

We publish in another column of this issue a *résumé* of the report of the Select Committee appointed to consider the question of the repayment of loans by local authorities. The most important recommendation made by this Committee is that in the case of "Reproductive Work" (which expression the Committee prefers to "Municipal Trading") the repayment need not be recommenced immediately. On the other hand, it declares emphatically against the payment of interest out of the capital borrowed. For the benefit of the municipal section of the electrical industry we hope that this recommendation will be adopted in a Government Bill next session.

An interesting arbitration recently occurred at Devonport between the Corporation and the local tramway company. For nearly a year the Corporation supplied electric energy to the tramway company before the price was decided upon, and, as a result, the amount to be paid had to be decided by Major Cardew, as the arbitrator appointed by the Board of Trade. The company's original offer was on a sliding scale of 1¾d. per unit for the first 100,000 units, 1½d. for the second 100,000 units, 1¼d. for the third 100,000 units, and 1d. for all beyond. The Corporation insisted on a flat rate of 2½d. per unit—which was not only flat, but tall. Each gave way ¼d. on the prospect of arbitration, but these concessions did not mend matters. The award of the arbitrator was made on the maximum demand system, assuming a maximum load of 500kw., and as a result the charges are equivalent to a flat rate of 1·8d. per unit. This, indeed, is quite high enough a charge for an electric light committee to make for the privilege and advantage of having a tramway load added to their lighting load. It should be possible for the Corporation to supply the tramway company at a much cheaper rate than this.

The majority of electric traction engineers will have read with no little astonishment the letter from Lieut-Col. R. E. Crompton in our last issue, on the relative merits of electric tramways and omnibuses. That so experienced and greatly respected an engineer should hold such views as are expressed in that letter, and that he should have the confidence and courage to advance them before a Parliamentary Committee, are facts which demand from the electric traction fraternity careful consideration of Lieut-Col. Crompton's position. The champion of these new and astounding doctrines is far too experienced an engineer to warrant cavalier and flippant treatment from his critics. It is rather incumbent on them to examine carefully, to see what degree of substance and solidity there may be in the foundation for these remarkable views.

Examining first the positive side of Lieut.-Col. Crompton's position, we find that it is primarily based on a belief in the accumulator omnibus. We are told that "we already see considerable numbers of these vehicles running satisfactorily in the streets." This statement makes us rub our eyes and ask, "Where?—which streets?" We cannot find these 'buses anywhere. The next statement is that "next year will see an enormous development of this use of electrical power." So it has been every year since accumulator cars were first thought of—it has always been "next year will see," &c. Even on tramrails accumulator cars are far from being a success; they are being given up in most of the Continental cities where they have been tried—*vide* our report this week of the recent Tramway Congress at Islington. And if these cars are uniformly such a failure when run on rails, what hope of them for common roads? We fear that the problem of "carrying our workers to and from their homes in the country to their places of employment in our towns" has but a poor chance of solution if we are to put our trust in the accumulator omnibus.

But let us look at Lieut.-Col. Crompton's negations. And, granting, for the sake of argument, that the accumulator omnibus has a commercial existence—which it has not—let us see how he compares its performance with that of the trolley car. Lieut.-Col. Crompton denies that the carrying capacity of a street is increased by tramways, but he offers no proof of this singular assertion. It is a matter of wide practical experience that the reverse is the case, provided the number of slow horse-drawn vehicles is not so great as to prevent the trolley cars from running at their full safe speed. As to congestion, it is ridiculous to say that the trolley cars are the cause, when it is always the horse-drawn vehicle—perhaps laden with "garden or other country produce"—which blocks the way. Who ever heard of a trolley car with a clear headway causing congestion? Another of Lieut.-Col. Crompton's bogeys is that tramways cause congestion owing to the "want of overtaking power of vehicles running on rails." What magic have rails to produce such a defect? Really, it is surprising that anyone who has ridden on trolley cars so much as Lieut.-Col. Crompton must have done should have failed to perceive their marvellous "overtaking power." We would back a fully-loaded trolley car against any accumulator omnibus yet built, to have a far superior overtaking power—and with far less risk to pedestrians in the performance.

Finally, we may notice the curious reflection that "no one, not even Mr. Clifton Robinson himself, imagines that electric tramways can be laid in every street in our towns, and unless this were done it is always necessary to encourage the development of mechanically-propelled vehicles to take the place of the horse-drawn traffic." We imagine that Mr. Clifton

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Robinson would not object to taking tramways into every street, if it would pay to do so; while we cannot conceive that even Lieut.-Col. Crompton would venture to run public electric omnibuses through "every street" if it would *not* pay. What reason is there for supposing that the people living in side-streets want Lieut.-Col. Crompton's 'buses any more than Mr. Clifton Robinson's tramcars? And what evidence is there that they would pay, even if people do want them?

As a matter of fact, Lieut.-Col. Crompton, although professedly the champion of the electric omnibus, has shifted his ground more than once in his letter. Where he inveighs against tramrails he is really the champion of the cyclist; where he speaks of our roads "rapidly becoming cleaner," he is attacking, not the trolley car, but the horse, and thereby is advancing no argument against tramways. Where he talks about "overtaking power" he is doubtless thinking of police regulations against excessive speed, but he forgets that—theoretically, at any rate—these regulations are directed quite as much against his electric omnibuses as against tramcars. Where he speaks of congestion, he is in reality arguing against all heterogeneous traffic, whether drawn by horses or propelled mechanically; and quite unintentionally, but nevertheless most forcibly, he is thereby advancing one of the strongest arguments in favour of all traffic being conveyed on rails, wherever speed and large carrying power are matters of importance.

Sir Oliver Lodge.—The Council of the Birmingham University, meeting on Wednesday, passed a resolution congratulating Sir Oliver Lodge on the honour which had been conferred on him, and expressing its gratification that, on a national occasion, the principal of the university should have been selected by His Majesty for special distinction among men of science.

Lancashire Light Railways.—The first important section of the undertaking of the Lancashire Light Railways Company has been completed, and on Monday, the 30th ult., the first electric cars ran through from Liverpool to St. Helens. A 15-minute service of cars, covering the distance in about 1 hour 10 minutes, has been arranged, and the through single fare will be 9d., as compared with 11½d. charged by steam railways.

Institution of Junior Engineers.—On Saturday the 5th inst., the members of this Institution paid a visit to the American Exhibition at the Crystal Palace, the exhibits of Messrs. Babcock and Wilcox, the Fairbanks Company, Messrs. Charles Churchill & Co., Messrs. W. C. Horne & Sons, the Blaxton Engineering Co., the Niles Cement Pond Co., and Messrs. Stirlings Motor Carriages Co. receiving special attention.

Northern Section of the National Electrical Contractors' Association.—A meeting of the above Association was held in Sheffield on Saturday last, when representatives from most of the towns in the North were present. At this meeting the rules of the Association were discussed and finally passed, and a scheme for the registration of workmen discussed and approved. Matters relating to organisation and to amalgamation for certain purposes with kindred associations were also discussed, and it was reported that the local associations had been found of use in many ways.

Wireless Telegraphy.—A statement was lately published by Laffan's Agency that the wireless telegraph station of the Marconi Company at Glace Bay (Cape Breton) was fully equipped, and that the transmission of messages across the Atlantic was to be effected about the middle of July. Another report was that wireless messages had been exchanged between the Cape Breton station and Poldhu, on the Cornish coast, but with what success was not recorded. We understand that neither statement is correct, and that much work has yet to be done before the interchange of wireless messages between England and America is established.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Bolama	April 19, 1902 ...	—
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Jeddah—Suakim	June 18, 1902 ...	July 8, 1902
Mozambique—Majunga (Madagascar)	June 19, 1902 ...	—
Santa Cruz—Teneriffe	July 7, 1902 ...	—

More Newspaper Science.—The following delightful example of newspaper science is worth reprinting. We extract it from a northern contemporary of large circulation:—

GERMAN INVENTOR'S GREAT TRIUMPH.

A New Gas from Air.

Following the announcements of the success of oil as a fuel comes a statement from Cleveland, Ohio, that a German resident of that town named Soeder, has invented a new gas from air, which he claims will propel vessels across the Atlantic at a nominal cost. A very small quantity is sufficient to do an enormous amount of work, and on an ocean vessel the space occupied by cylinders containing the gas would take up space so small as not to enter into the calculations of constructors. Capitalists are shy of entering into negotiations with Soeder, but the latter offers to submit his invention to any test desired except that of allowing other scientists to examine his apparatus for making the gas.

An Alleged New Element.—The Berlin correspondent of the *Standard* states, in yesterday's issue, that Prof. Marckwald, of the Berlin University, announced, at the last meeting of the Berlin Physical Society, that he had discovered a new element. The element in question is radio-active, and of extraordinary energy. Herr Marckwald has separated it from the radio-active bismuth. The so-called "polonium," of the uranium salts, consists, in Herr Marckwald's opinion, substantially of ordinary bismuth and of a new metal, in the proportion of 1,000 to 1. The new metal can be separated by electrolytic process. The rays it emits are something like those of radium, but differ in being almost completely absorbed by paper, as well as by glass. Herr Markwald has proved that a porcelain tube, heavily charged with electricity by rubbing, immediately lowers its charge when a morsel weighing hardly a milligramme of this metal is brought within a distance of 1 decimetre. The chemical separation of the new metal is rendered very difficult by the fact that 1 ton of ore contains hardly 1 gramme of it.

Magnetism of a Moving Charge.—In a recent issue of the *Philosophical Magazine* Prof. R. W. Wood describes a most ingenious modification of Rowland's famous experiment, going to show that a moving particle charged with electricity may deflect a magnetic needle, just as a continuous current of electricity does. In Rowland's experiment, and in repetitions of it since made, the charged body was on the rim of a revolving disc, and the highest speed with which the charge can be moved is, with this arrangement, less than 300ft. per second. Prof. Wood, has, however, succeeded in obtaining a stream of charged particles moving at a speed of about 2,000ft. per second, and with these the effect on a magnetic needle is very marked. He uses a modification of Armstrong's hydro-electric machine, in which, it will be remembered, a jet of steam is electrified by friction as it rushes through a suitable orifice. In Prof. Wood's apparatus, however, the steam was replaced with carbon dioxide flowing from a cylinder, in which it is stored at very high pressure. The jet used was 2·5mm. in diameter, and, as usual, a portion of the issuing gas solidified on its escape. These solid particles were charged with positive electricity, the potential being such that sparks about 1cm. long could be drawn from the iron cylinder in which the CO_2

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was stored. The flow of charged particles was directed through a glass tube placed about 1in. below a magnetic needle, and marked deflections of the latter were obtained, which were reversed in direction when the flow of gas was reversed.

The Liverpool Self-propelled Traffic Association.—The annual meeting of the Liverpool Self-propelled Traffic Association was held on the 3rd inst., under the presidency of Mr. S. B. Cottrell. The report by the Council stated that they had approved amended terms of affiliation under which members of the Association obtained the advantages of membership of the Motor Union, in accordance with a resolution passed by the Automobile Club. The privileges, it was reported, included defence where any principle was at stake, or in case of an intolerant magisterial ruling. The Council were strongly of opinion that the Association should continue its special work on behalf of heavy automobilism. At the same time they saw no reason why, having assisted in bringing that branch of the movement to a stage where it was powerful enough to develop commercially the scope and aims of the Association, it should not include the interests more generally associated with the pleasure or light carriage branch. It was, therefore, recommended that arrangements be made to provide the nucleus of a club-house. In conclusion, the Council expressed their regret at the resignation from the honorary secretaryship of Mr. E. Shrapnell Smith, whom they described as the founder and guiding spirit of the Association. It was stated that Mr. Smith would continue to serve as a member of the Council. The report was adopted. Office bearers were afterwards appointed, the Earl of Derby being re-elected president, Sir Alfred Jones vice-president and Prof. Hele-Shaw chairman of the Council.

The Galileo Ferraris Award.—The committee for the Galileo Ferraris Award, which was instituted in 1898, being composed of the representatives of the executive committee for the General Italian Exhibition held in Turin in 1898, of the Chamber of Arts and Commerce, of the Royal Academy of Science and of the Royal Industrial Museum in Turin, have determined to open an international competition for the award of this prize on the occasion of the unveiling of the monument to that illustrious scientist in Turin in the latter half of the month of September next. The award is of 15,000 Italian lires (£600) together with the compound interest thereon accumulated since the year 1899 up to the day of the award, and it shall be granted to the inventor of some practical application of electricity, from which some noteworthy progress may arise. Competitors may produce either pamphlets, schemes and drawings, or machines, apparatus and contrivances concerning their invention. The jury, composed of the aforesaid committee, shall have full power to cause practical experiments to be made upon the inventions entered for competition, and upon the relative apparatus, contrivances and machines. Competitors are to file their application and deliver their works, machines, apparatus and whatever appertains to their invention not later than 6 p.m. on September 15, 1902, at the office of the secretary of the committee, care of the Administrative Committee of the First International Exhibition of Modern Decorative Art, in the buildings of the Chamber of Commerce and Art, 28, Via Ospedale, Turin, Italy.

Retirement of a Metropolitan Telegraph Superintendent.—Mr. C. T. Fleetwood, who for many years had the chief superintendence of the great metropolitan postal telegraph system, has just retired from the service, having passed the age at which retirement becomes compulsory. Mr. Fleetwood owed his important position to his complete mastery of the underground and overhead systems of telegraphy owned by the Electric and International Telegraph Co., in which company he had served since 1854. On the retirement of Mr. Isherwood at the time of the transfer of the telegraph companies to the State, his principal assistant was Mr. Fleetwood, who consequently came into prominence as the only man left available to carry out the vast extensions in London necessitated by the concentrations of the companies and the reductions of tariff. A highly intelligent officer, an excellent organiser and possessed of remarkable grasp of the details of the metropolitan telegraphic arteries, he was also greatly valued by his new employers by reason of his extreme amiability of character, which recommended him greatly to the official mind. Of late years Mr Fleetwood's labours were much enhanced by the changes and enlargement which have taken place in the telephonic branch of the service, and it is not unlikely that some change will have to be made so as in future to lighten the responsibilities of this important office. Mr. Fleetwood has on more than one occasion earned and received public commendation for the services he has rendered; once on the occasion of the carrying over in 1873 of the wiring from its old situation in Telegraph-street to the new central office provided in the General Post Office buildings, St. Martins-le-Grand, and more recently in connection with Queen Victoria's Diamond Jubilee, when special arrangements had to be made for transmitting her late Majesty's Royal messages to the colonies and to India. Mr. Fleetwood's unfailing kindliness and modesty of character endeared him to his subordinates, by whom his retirement will be much regretted.

A New Air-lift Pump.—In yesterday's issue of the *Financier and Bullionist* there is an article describing a new air-lift pump which has been installed at the power stations of the Central London Railway and at Ilford. It is well known that the efficiency of an ordinary deep-well pump is only about 40 or 50 per cent. after it has been working for some time, while the efficiency of an ordinary air pump is 25 per cent. at the best. In the event of any grit getting in the valve of a deep-well pump the result is anything but pleasing. The pump has to be stopped for a period of several days, sometimes weeks, and the slightest breakdown of any detail in connection with the pump occasions a long delay and a consequent waste of a large amount of time and money. The risk of breakdown is almost eliminated in the air-lift pump, and the simplicity of the system is a distinct point in its favour. One power house can supply the necessary power for any number of pumps, and when all expenses entailed by repairs, &c., are taken into account, it is not at all certain that the efficiency of the deep-well is better than that of the air-lift pump—at any rate, from a financial point of view. This only applies to an air-lift pump with an efficiency of about 25 per cent., but by the invention of Mr. Joseph Price, of the firm of Messrs. Le Grand and Sutcliff, it is claimed that this can be increased by 40 per cent. With the ordinary air-lift pump a certain amount of water is forced up a tube of uniform bore by compressed air, which, as it rises, expands and parts with a good deal of its energy in giving momentum to the column of water above it. This, of course, causes the water at the top of the tube to move considerably faster than that at the bottom. Mr. Price has departed from the rule of making the tube of uniform bore, and has made the rising main to taper. As the air rises with the water it still expands, but as the tube is greater in diameter it can expand laterally, thus leaving the actual height of the column the same as when it entered the tube at the bottom. No additional momentum is given to the water, and it leaves the rising main at precisely the same rate as it entered. This pump should be of considerable service to central station engineers and to those engaged in mining work, and in any case where a continuous supply is needed.

Experiments on Alternating-current Electrolysis.—The experiments on alternating-current electrolysis, briefly referred to by Mr. Trotter at the meetings of the Incorporated Municipal Electrical Association last week, consisted in passing a small alternating current between two lead surfaces a few inches apart and separated by moist earth, and observing the effect on the lead after a protracted period. Since the meeting we have been able to inspect the result of Mr. Trotter's experiments, and in response to our enquiries he has given us some additional particulars of the tests. First, two 18in. lengths of 1¼in. pipe were laid parallel to one another about 6in. apart, and a current of 1 ampere at ~ 83 from the Deptford mains was passed between them. The pressure was 100 volts, the dampness of the earth being adjusted to maintain 1 ampere. A distinct and sharply-defined incrustation on the lead, evidently due to electrolysis, was observable in six weeks. It was confined on each

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pipe to about 45 sq. in. This effect was then compared with that of still lower current densities by burying a series of plates in the same way, the first plate having a surface of $\frac{1}{4}$ sq. in. exposed (the remainder of the plate being painted), the second a larger surface, and so on up to 9 sq. in., the current sent through the series being $\frac{1}{180}$ ampere, so that the current density at the surface of the first plate was $\frac{1}{40}$ ampere per square inch, the same as on the pipes, and on the last plate $\frac{1}{1440}$ of an ampere per square inch. The incrustation on the first plate was comparatively thick, and even on the largest plate of 9 sq. in. surface showed slight but unmistakable signs of corrosion. The outermost faces of the series of plates showed only very slight traces of corrosion. This latter effect was observed after four weeks. The earth used was taken from the garden in front of Mr. Trotter's office. Mr. Trotter was, unfortunately, unable to devote to the experiment the time necessary for making a proper quantitative test of the weight of lead removed or of the minimum voltage necessary to start the electrolysis. He regards the result, however, as a proof that—contrary to the opinion expressed by Mr. W. M. Mordey at the Institution of Civil Engineers—alternating currents will electrolyse lead pipes at current-densities lower than 1 ampere per square inch, and he considers that the burden of determining the amount of this electrolysis should rest with those advocating electric traction by alternating currents.

Fire at the London Wall Telephone Exchange.—All our readers, whether telephone engineers or not, will sympathise with the National Telephone Co. in the severe loss it has sustained by the burning down of the London Wall telephone exchange on Wednesday night. This exchange was one of those which had been entirely re-equipped recently on the central battery system, so that in addition to the loss and inconvenience owing to the disorganisation caused in its London telephone service, the company has been deprived of one of its finest and most valuable pieces of engineering work. The fire, the cause of which is not known, was first observed at the intermediate distributing board on the first floor at 8 o'clock in the evening. The day staff had left, but endeavours were made by the male night staff to extinguish the flames. These efforts were unavailing, the fire having apparently taken a hold beneath the flooring, and the fire brigade when it arrived was no more successful. The few of the staff who were at work in the building were able to leave without difficulty when it became evident that they could do nothing to prevent the spread of the fire; but the switchboard was entirely destroyed and the complete building was gutted, all the apparatus, with the possible exception of the battery and some of the power plant, being rendered absolutely valueless. Although the large derrick at the top of the building remained standing, the wires have, of course, become a mass of confusion; and unfortunately this is not confined to the lines of subscribers on the London Wall exchange, but extends to a large number of junction lines between other exchanges which pass through test jacks at the former buildings on their way. In all, about 2,500 subscribers were connected to the exchange, and the junction wires leading to and from it bring the total number of lines interrupted up to about 3,000. The first work of reconstruction, which is already partly completed, is the sorting of the through lines referred to, and re-establishing their continuity. Arrangements have already been made for transporting a spare switchboard now at the Holborn exchange to temporary premises adjoining the building which has been destroyed, and fortunately a 1,500-subscriber extension to the central battery switchboard at London Wall was already on order. The building must be re-erected, however, before any permanent connections can be made, and the disorganisation of telephone traffic will necessarily extend over a long period. Luckily, the magnetogenerators had not yet been removed from the subscribers' instruments, so that the temporary connections to the indicator board from Holborn will be less difficult than would otherwise have been the case. Subscribers will be seriously inconvenienced by this untoward event, and they must seek what comfort they can in the assurance that the company will go forward with the work of reconstruction and re-connection as expeditiously as is possible.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Atomic Weights.—J. H. Vincent has discovered a new numerical relation between the atomic weights of the elements. It is

$$W = N^{1\cdot21},$$

where W is the atomic weight, and N the number of the element in an ascending series. There are, however, certain gaps in the series which the author allocates to elements yet to be discovered. Hydrogen would, of course, be No. 1. Helium, the next element of the known series, has to be called No. 3, as $3^{1\cdot21} = 3\cdot780$, which agrees with the observed value 3·93 within 3·8 per cent. Lithium is No. 5, as $5^{1\cdot21} = 7\cdot012$. This leaves gaps for elements of atomic weights 2·313 and 5·352. After lithium, the series is continuous up to No. 60 (samarium), for which $60^{1\cdot21} = 147\cdot5$. The remainder of the series up to uranium contains 13 gaps, the atomic weights for which are, in round numbers, 150, 153, 162, 168, 177, 186, 213, 216, 219, 222, 225, 228, 235. If any or all of these gaps are subsequently filled up, the author's formula will achieve a great success. Meanwhile, it is interesting to notice that the greatest deviation from the rule is shown by iodine, whose atomic weight comes out wrong by 3 9 units. But this, as the author clearly shows, may be due to a wrong serial number assigned to it. If it changed places with tellurium, not only would the error be much less, but the periodic law would be better observed.

[J. H. Vincent, *Phil. Mag.*, July, 1902.]

Discharge from Hot Metals.—R. J. Strutt has found that the discharge of positive ions by hot metals can be detected at much lower temperatures than has hitherto been supposed, becoming apparent very far below red heat, and increasing rapidly with the temperature. It will be remembered that, according to W. Wien, the discharge potential at the ordinary temperature and in an "absolute" vacuum is +8,000 volts. The lowest temperature at which the author found a discharge was 200°C. The temperature at which the effect becomes sensible does not appear to depend very largely on the nature of the metallic surface or on the surrounding gas, but, like contact electricity, it alters nearly as much from slight changes in the condition of the surface of the metal, produced by continued heating, as it does when an entirely different metal is substituted. Oxidation appears to be, on the whole, unfavourable to the discharge of the metal. Thus, with a charge of 100 volts, silver showed a leak of 10 divisions of an electroscope scale in hydrogen at a temperature of 228deg., whereas the same leak required a temperature of 287deg. when the metal was copper and the gas was air, and 310deg. when in the latter combination the copper was oxidised and hydrogen substituted for air. The metal was in the form of a wire heated in a gas stove.

[Hon. R. J. Strutt, *Phil. Mag.*, July, 1902.]

Lenard Rays.—The velocity of Lenard rays produced under various pressures, as well as their energy and ionising power, have been determined by J. J. E. Durack, who used the photographic and electrometer methods for the purpose. The apparatus employed is shown in the diagram, which shows a discharge tube, L, of the Lenard type. A plane aluminium disc, *c*, served as cathode; the rod of aluminium connected with *e* was enclosed in a thick-walled glass tube to prevent the discharge taking place from the rod, and the back of the disc was covered with glass. An aluminium cylinder, *aa*, was used as anode. The end of the discharge tube facing the cathode was drawn down, and a brass tube, *t*, cemented on with sealing wax coated on the outside with soft Munich wax. This, it appears, gives a perfectly air-tight joint, but the sealing-wax must only be melted, not burnt. An aperture about 1 5mm. in diameter was bored in the end of the brass tube, the brass being rather thick to prevent heating, and the hole bevelled on the inside; on the outside a piece of aluminium leaf 0 0043mm. thick was fastened with soft wax. This constituted the "window" W. A water-jacket, *jj*, surrounded the tube to keep the window cool. An outside

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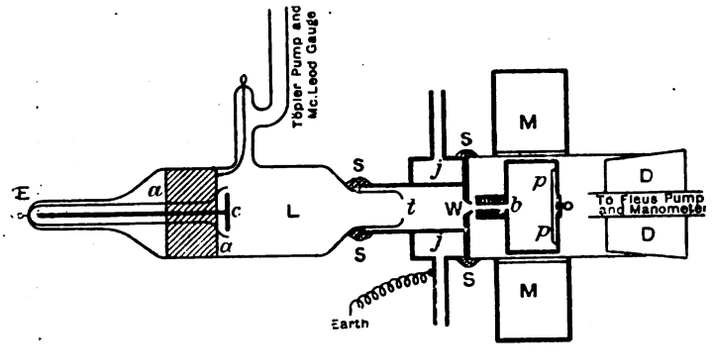
observation tube was cemented on to the tube t with sealing-wax; this tube contained the camera b, and was closed at the end with a rubber stopper, D. The velocities were found by measuring the deflections produced by the electromagnet MM. They were found to range from 5×10^9cm. per second at the higher potentials to $3{\cdot}2 \times 10^9$, or one-tenth of the velocity of light, for the lower ones, but the author thinks that higher velocities could be obtained with better insulation. When a large charged disc was brought near the window, it was found that the current discharged from it varied inversely as the square of the distance from the window. The author also found a figure for the number of pairs of ions made by the collisions of one electron in travelling 1cm. of air at a pressure of 1mm. of mercury. The figure is 0·43, or one-fiftieth of



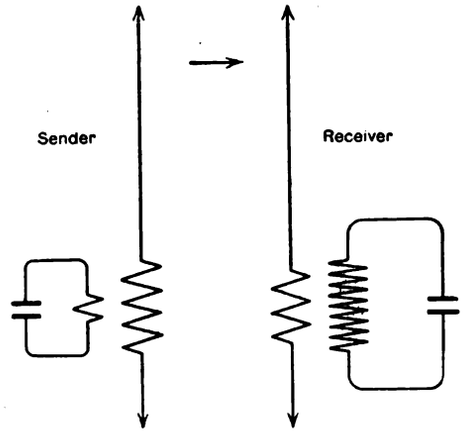
Townsend's value. The slower an ion moves, the greater is its absorption, and the greater also its ionising power. The author makes an interesting estimation of the radius of an electron, and assigns to it the approximate value 10^{-11}cm. This lies midway between two limits fixed by other considerations.

[J. J. E. Durack, *Phil. Mag.*, July, 1902.]

A Micro-balance.—An approximation to within 1 per cent. is difficult to obtain when weighing a body of about 1 milligramme with a chemical balance. E. Salvioni, therefore, uses an apparatus, which he calls a "micro-balance," for determining weights of the order of 0·001 milligramme. It consists essentially of a horizontal thread of glass, fixed at one end. The body to be weighed is mounted on the other end, and the flexure of the thread is measured by a micrometer microscope. A simple calculation shows that a glass thread of circular section, about 0·15mm. in diameter and 10cm. long, can support 100 milligrammes without breaking, and can serve for finding its weight within 0·001 milligramme with an optical enlargement of 100 times. The objects to be weighed are suspended from the end by a carrier attached to a thin glass fibre, which also carries a spider's thread to serve as a reading mark. The evils attending elastic fatigue are eliminated by keeping the thread constantly bent when not in use. The weights used for control are platinum wires above 5 milligrammes, and silk threads for smaller weights. To avoid hygroscopic action, it is best to operate in dry air and in closed vessels.

[E. Salvioni, *Nuovo Cimento*, May, 1902].

Wireless Telegraphy.—M. Wien investigates the mathematical significance of the "coupled" systems of senders and receivers introduced by Braun, and since adopted by both Marconi and Slaby. The vibrations are not excited in the strongly-damped mast-wire, but in a feebly damped primary electric system of great capacity. The system is sketched in the accompanying diagram. The author quotes a very apt acoustic analogy to the coupled instrument. The independent exciter corresponds to a tuning-fork, which radiates little energy and is only slightly damped. The mast-wire corresponds to the resonance box which takes up energy from the tuning fork and sends it out. The transmission of vibration from one tuning fork to another is greatly enhanced by the resonance box, though the latter by itself can possess only very slight energy of vibration. The author distinguishes between "loosely coupled" and "closely coupled" systems, which differ by the mutual inductance between the circuits of the coupled elements, this being low in the former and high in the latter. The closely-coupled systems are especially adapted for long-distance telegraphy, as the energy radiated is great. The loosely-coupled systems radiate less energy, as the damping is great, but, on the other hand, they admit of close "tuning," so that they make simultaneous telegraphy possible. The author sketches a system of combined long-distance (single) and short-distance (multiplex) telegraphy, which should not interfere with each other. The coast station would be advised by the long-distance system of the approach of a vessel,



and could prepare its loosely-coupled systems for communication at short range. Of such communications, 50 or so could be carried on simultaneously. The tuning should not be more difficult than that of a good piano.

[M. Wien, *Ann. der Physik.*, No. 7, 1902.]

Telephone Vibrations.—R. Kempf-Hartmann publishes the results of a lengthy investigation of the vibration of telephone membranes, undertaken with a view to clearing up the disturbing noises attending the telephonic transmission of sound. The telephone problem is that of receiving a series of variations of density of the air at one point and faithfully reproducing them at another point. The practical solution is somewhat indirect, and consists in converting the changes of density into vibrations of an elastic disc, and reproducing them by electromagnetic means. This introduces complications due to the natural vibration of the disc such as would not exist if the transmitter were, say, a small gas jet, whose variations with the pressure were transmitted with the aid of a selenium cell. The author recorded the vibrations of a telephone diaphragm by means of a mirror stuck on to it, and an arrangement of an arc light, a point diaphragm, a system of lenses, and a revolving cylinder of sensitive film. The first point investigated was whether a note received by the diaphragm gives rise to a corresponding series of vibrations of the diaphragm at once, or whether the vibration only gradually fell in with that of the air. The photographic traces of a tuning-fork note show that the reaction is practically instantaneous, the "period of latency" not exceeding 0·0005 second. The maximum amplitude is attained as soon as two full periods have passed through. After that the curve for a constant sound remains remarkably constant. When the note ceases the proper vibration of the diaphragm persists long enough to be seen and even heard, but it is greatly damped by a rubber plug attached to the centre of the diaphragm. It also appears that the overtones which produce the rattling and clattering noises in the telephone are the more prominent the greater the amplitude of the diaphragm. This is contrary to what happens in reeds and strings, where the fundamental note becomes more prominent the greater the force with which the note is sounded. As regards the comparative sensitiveness of the eye and ear, the author mentions that, generally speaking, the records show a sound whenever a sound is heard, and vice versa. In traces of complete words, however, the records show a number of details which are quite beyond the perception of the ear. He gives some interesting curves representing vowels and consonants, which are reproduced with the finest detail.

[R. Kempf-Hartmann, *Ann. der Physik.*, No. 7, 1902.

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ANNUAL MEETING OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

(*Continued from p. 440.*)

Friday July 4th.

On Friday two Papers were read dealing with allied subjects, but they were discussed separately. The "Notes *re* Earthing" of Mr. H. Faraday Proctor (Bristol), were a series of notes on the question whose logical sequence was not always apparent. In fact, members were asking what was really Mr. Proctor's own opinion on the matter. No definite answer was given to this either by Mr. Proctor himself or any other of the speakers; but it was generally assumed that he favoured earthing the middle wire of a three-wire system at several places instead of at the station, and that, whatever the conditions of earthing or not earthing, he recommended the insertion of fuses on the middle wire.

The discussion, which was opened by Mr. F. C. Raphael at the president's request, chiefly referred to these two matters. Nobody else, except Mr. F. Bathurst—who, of course, represented the views of a certain section of wiring contractors—supported Mr. Proctor in his desire for earth connections in more than one place. Mr. Raphael said that the actual fire risk was diminished theoretically by one conductor of the house wiring being at earth potential, but that whether it was actually at zero or at 2 or 3 volts potential did not make much difference. A point Mr. Proctor had entirely overlooked was the difficulty of detecting and localising faults if there were earths all over the system. If the earth connection were at the station it could be removed temporarily for testing, or its resistance could be allowed for. As to the insertion of fuses in the middle wire, he gave reasons for thinking that, even in the numerical example cited by Mr. Proctor, the risk would be greater if the fuse were inserted than if it were omitted. Mr. Highfield (St. Helens), the next speaker, also pointed to the desirability of being able to remove the earth connection on the middle wire. He preferred not to make use of middle-wire fuses on the network, but, nevertheless, to insert fuses on both poles of the common wiring. Mr. F. A. Newington (Edinburgh) thought fuses on the middle wire necessary, and Mr. L. Andrews (Hastings) used single-pole fuses, but thought he might change his views. Mr. McCowan (Belfast) said he localised faults on his system by the compass method, but this would not work if earths had been placed at several points.

Mr. A. P. Trotter, referring first to the uninsulated middle wire, said that, so far as house-wiring was concerned, the matter was settled by the central station engineers refusing to connect to their mains house wiring with one pole uninsulated. There was a long list of towns on the Continent with an uninsulated middle wire on the network, but the local conditions there were different to those obtaining here. A difficulty was that it would be unfair to allow an uninsulated middle wire when the undertaking was small, and then to insist on its insulation if this became necessary when the system grew. He would rather see villages supplied by overhead wires—a remark which was received with great applause. Major Cardew, his predecessor at the Board of Trade, had laid down that there should be no fuses on the middle wire, but it was not quite clear "where these no fuses ought to be put." It was now at the supply station engineer's discretion whether he put in fuses or links. Mr. Trotter concluded his remarks by referring to some experiments on alternating-current electrolysis. Two lengths of pipe and also some plates buried in earth, and with a small alternating current flowing between them, showed distinct signs of electrolysis. Mr. Mordey had stated that 1 ampere per square inch would not be harmful, but, as a matter of fact, Mr. Trotter's experiments showed signs of electrolysis at current densities considerably less than $\frac{1}{10}$ ampere per square inch. No other quantitative observations had been made by him, however. This matter is also referred to in a note in this issue.

Mr. S. F. Walker did not approve of any earth connection at all. In mining work, with which he was chiefly occupied, if an earth were employed, the mine itself became one of the conductors of the system. He thought that the whole standard of insulation should be improved, and particularly with regard to its mechanical strength. Finally, Mr. W. B. Esson pointed out that, in any system, to get an efficient and complete earthing of one main throughout, considerably more copper would be required on that main than at present. Mr. Proctor's reply was reserved for communication to the *Journal* of the Association.

The last Paper to be read and discussed may be characterised as a "fighting" Paper. Mr. John F. C. Snell (Sunderland) had convinced himself, and endeavoured to convince others, that the three-wire system of distribution was an over-rated thing, and that a simple two-wire system was preferable. Unfortunately, as was pointed out by Mr. Ruthven-Murray (Willesden), who opened the discussion, the figures worked out in support of this contention were based on a wrong assumption—viz., that of equal current density in the network instead of equal percentage fall of volts. Mr. Snell's case was that the actual economy in the conductors arrived at by using the three-wire system was counterbalanced by the trouble of balancing and the incidents arising out of the necessity of a balanced load, by switchboard complications, less reliability of supply, and finally by the increase of leakage from the negative pole by using an earthed middle wire. Mr. Ruthven-Murray's indictment of Mr. Snell's views had evidently been carefully prepared. He criticised Mr. Snell's conclusions severely, and joined issue with him on almost every point. The denunciation of the correctness of Mr. Snell's figures had rather the result, however, of frightening other members from discussing the Paper freely, as most of those who had read the Paper had been content to take Mr. Snell's figures and their basis as accurate, and had decided on their attitude towards the Paper upon this assumption. In fact, until Mr. Snell's reply, the nature of the mistake was not generally appreciated.

Mr. Snell had briefly referred to gas consumption in his Paper, and Alderman Morton (Stafford) wished for "an amplification of the comparisons between gas and electricity"; but the president interposed to the effect that this was a side issue. As in the case of the other discussions, therefore, the speeches were all on technical matters. Mr. F. A. Newington (Edinburgh) confirmed Mr. Ruthven-Murray's statement that the figures were calculated on the basis of half the percentage drop for the three-wire system. He also said that he had not experienced any of the difficulties with the system to which Mr. Snell had referred; and other speakers, including Mr. Chattock (Bradford), Mr. Shoolbr Mr. Boot (Tunbridge Wells), Mr. Tittensor (Dundee, and Mr. Barnard (Hull) bore him out in this statement. Mr Trotter also spoke briefly on this Paper. Mr. Snell, in his reply, contended that in practice his comparison of costs would prove correct, as it was always found necessary to lay a larger conduit than what would be required for the same percentage drop of pressure. He asserted that he knew of two cases in which there were differences of potential of 8 or 10 volts between different sections of the water-pipes in a town, but he did not give any actual case of damage to pipes by electrolysis due to a system of lighting mains.

In the afternoon visits were made to Balham, to inspect the conduit tramway construction which is being laid down for the London County Council, and to the Bankside station of the City of London Electric Lighting Co. The smoking concert in the evening proved a most successful innovation, and was greatly appreciated.

Saturday, July 5th.

The annual general business meeting was held on Saturday, and for the first time the press were admitted. After the minutes of last year's business meeting were read and confirmed, the secretary read the annual report of the Council (abstracted on another page), which elicited very little discussion. In connection with the section on repayment of loans, it was decided to send out a circular to all Corporations, asking for copies of any acts and bills during the past few years which contained clauses bearing on this question likely to aid the committee which has been appointed by the Association. Mr. Chattock having read the set of rules for police

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in case of breakage of overhead wires, which a sub-committee has drawn up, as mentioned in the annual report. These are to be sent around as a basis upon which local rules can be formulated. The report was adopted.

The election of officers and Council for the ensuing year was the next business. For the office of president Mr. J. F. C. Snell, borough electrical engineer at Sunderland, proposed by Mr. T. P. Wilmshurst (Derby), was unanimously elected, and Sunderland was unanimously chosen for the meeting place in 1903. Prior to the ballot for the members of council, the president (Mr. Rider) remarked that it had come to his ears that there was a feeling of dissatisfaction amongst a certain section of the Association with the method of election of the Council, and a suggestion had been made that the Council was a clique—which was as far from the truth as anything could well be. The Council was elected in open meeting, and everything was absolutely fair and above-board. Mr. Albert Gay (Islington) quoted from Hamlet, "Be thou as chaste as ice, as pure as snow, thou shalt not escape calumny," and matters proceeded. The constitution of the Council for next year was finally decided as below. It will be noticed that there are now nine engineer members and five chairman-of-committee members, as against eight and four respectively last year:—

President.

* J. F. C. Snell (Borough Electrical Engineer, Sunderland).

Vice-Presidents.

T. P. Wilmshurst (Derby), * J. E. Edgcome (Kingston-upon-Thames).

Past Presidents.

W. A. Chamen (Glasgow), A. B. Mountain (Huddersfield), * J. H. Rider (London County Council).

Council.

L. Andrews (Hastings), *H. Faraday Proctor (Bristol), *V. A. H. McCowen (Belfast), *J. Christie (Brighton), *Ald. Bruce (Sunderland), Councillor J. P. Smith (Barrow-in-Furness), Dr. Panton (Bolton), *Councillor J. T. Skinner (Hull), Ald. G. Potter (Taunton), A. S. Barnard (Hull), R. A. Chattock (Bradford), J. S. Highfield (St. Helens), F. A. Newington (Edinburgh), C. D. Taite (Salford).

Hon. Solicitor—Ald. G. Pearson (Bristol).

Hon. Treasurer—J. H. Rider (Chief Engineer, L.C.C. Tramways).

Hon. Secretary—E. T. Ruthven-Murray (Willesden).

Secretary—C. MacArthur Butler, St. James's Hall, Piccadilly, W.

Those marked with an asterisk were either not on the council last year or are elected in a new capacity this year.

Mr. Christie will only serve for one year as he takes the place of Mr. Edgcome, who has been elected vice-president, and had one year to serve on the council.

The balance-sheet for the year to December 31, 1901, was next presented. This shows a deficit of £57. 1s. 11d., the first deficit since the Association was formed. The president explained, however, that special expenses had arisen due to the incorporation last year; it was also the first full year during which the services of Mr. Butler had been available, and there was also the testimonial to Ald. G. Pearson, so that it would be seen that the Association was not actually working at a loss. The deficit this year has been taken out of the reserve and a credit balance of £174. 3s. 8d. still remains. At the same time, it was pointed out that in view of the gradually increasing scope of the Association and the necessarily increasing expenditure in connection therewith, an increase in the annual subscription was not out of the question to meet this. There were some additional members, however, since December last, and it had been decided to wait until next year before making any announcement on this point, a course of procedure which met with the approval of the meeting. The only criticism on the accounts was as to why the honorary auditors, who were appointed at Glasgow, had not signed the audit certificate, and also why one of them had not even received a copy of the accounts, two queries put by Mr. Boot (Tunbridge Wells). In answer to this the president explained that since the Glasgow meeting the Association had been incorporated, and this necessitated a professional auditor. It had been an oversight on his part that the two gentlemen who were elected had not had the matter explained to them. Councillor Smith, of Barrow, one of the honorary auditors in question, said he was perfectly satisfied with what had been done, and had no regrets in handing the work over to a professional auditor. The accounts were then approved. Votes of thanks were next passed to the President and Council of the Institution of Mechanical Engineers for the loan of their building, to the committee of the Tramway and Light Railways Exhibition, and to the various companies whose works were visited during the Convention. Mr. J. H. Clothier (Stafford) made a suggestion that municipal technical schools and colleges in city boroughs should be affiliated to the Association. Apart from the question that this step ought to augment the revenue largely, he thought a great deal could be learned by the students visiting the stations. The president asked Mr. Clothier to send in a draft of his proposal to the secretary when the Council would give it consideration. A vote of thanks to the retiring president concluded the business meeting.

A special general meeting of the contributors to the Benevolent Fund followed, when the following resolution, passed at a council meeting on February 21 last, was agreed to:—

That it be a recommendation from this Council to a special general meeting of the subscribers to be held after the 1902 convention, to discontinue the Benevolent Fund and to hand over accrued donations and subscriptions to the like fund of the Institution of Electrical Engineers.

ELECTRICITY WORKS ACCOUNTS.

Bury Municipal Electric Supply Works.

A material improvement in the position of this undertaking is shown by the accounts for the year ended at March 31st last. A glance at our analysis indicates that reductions have been effected on all the generating costs—the fuel and stores items showing particularly creditable figures. We learn that the average price paid for fuel during the year was 9s. 3d. per ton, as against 12s. 6d. per ton in the preceding year, and, further, that the quantity of fuel used per unit sold was reduced 2½ per cent.

The slight increase in the load-factor, showing that the maximum load obtained for an average of 3 hours 14½ minutes per day as compared with 3 hours 12 minutes in 1900–1, was due to the extended use of the supply for power purposes. The majority of the motors are in daily use for driving workshops. At the end of the period there were 25 motors installed with an aggregate capacity of 117½ H.P. The supply for motors and heating purposes is being rapidly increased. During the year 59,778 units were supplied for these purposes, compared with 24,471 units in the preceding year—an increase of 144 per cent.

It is distinctly unfortunate that a deficit had to be recorded. In relation to the output, the total costs and the capital expenditure are lower than the average—especially the costs. As usual, the deficit is attributable to the low tariff scale, which resulted in an average price for private supply of 3 23d. per unit and for public lighting of 2 08d.

Crewe Municipal Electric Supply Works.

The second table summarises the accounts of the working at Crewe during the first complete year. Making allowance for the public lighting, costs of attendance and renewals, the total costs are well below the average of municipal concerns of similar size. The several items, especially the management and property charges, present exceedingly low values. With a net total revenue from all sources amounting to only 3·5d. per unit there was a working profit equivalent to 8·84 per cent. of the mean capital expended. We do not remember having before come across results of equal merit produced in the first year of working of an undertaking, and considering,

REMARKS.

BURY.—*a* Land £1,817. *b* £967 on public lamps and £1,636 on accumulators. *c* Over-expended. *d* Insurance £23. *e* Maximum demand system (1 hour scale). *f* Each of the 17 incandescent lanterns contains two 8 c.p. lamps. *g* There were 48 motors aggregating 1·7 H.P. *h* Public lamps £1,009, accumulators £1,636. *i* Buildings £72, engines and boilers £109, accumulators £92. *j* Buildings £5, engines and boilers £112, accumulators £171. *k* Engineers' department £354, collecting and office staff £85. *l* Engineers' department £413, collecting and office staff £86. *m* Insurance £23, auditing £15. *n* After deducting costs of attendance and renewals.

CREWE.—*a* The total equivalent of the public lamps in 8 c.p. is 2,200. *b* Maximum demand system, also uniform rate of 4½d. per unit. *c* Land £1,408. *d* Including cost of converting street lamps. *e* £2,282 for current, £89 for cleaning and attendance, and £58 for repairs and renewals. *f* Including portion of assistant engineer's salary. *g* Engineer £207, clerk £68. *h* Insurance. *i* After deducting cost of attendance and renewals.

BURTON-ON-TRENT.—*a* Insurances.

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	BURY.		CREWE.	BURTON-ON-TRENT.	
Undertaking Worked by	Bury Corporation.		Crewe Corpn.	Burton-on-Trent Corporation.	
Date of Commencement of Supply	November, 1896.		Dec., 1900. [batts.	March, 1894.	
System of Supply	Three-wire continuous-current.		3-w. con.-cur. with	Alternate-current transformer sub-stations.	
Chief Engineer	S. J. Watson.		H. H. Denton.	F. L. Ramsden.	
YEAR ENDED	MAR. 31, **1901.**	MAR. 31, **1902.**	MAR. 31, **1902.**	MAR. 31, **1901.**	MAR. 31, **1902.**
QUANTITIES—					
Units generated	282,056	349,030	347,758	—	—
„ **SOLD (TOTAL)**	**261,247**	**323,337**	**310,505**	**189,441**	**241,534**
„ sold to consumers	209,997	270,073	127,970	189,441	241,534
„ sold for public lighting, &c.	51,250	53,264	182,535	nil	nil
„ sold for traction	nil	nil	—	nil	nil
„ used on works	8,231	10,122	19,090	—	—
UNITS SOLD per MEAN 8 c.p. CAPACITY	**15·1**	**18·7**	**18·4**	**12·1**	**11·9**
Actual maximum supply demanded	224 kilowatts	272·9 kilowatts	245 kilowatts	244 kilowatts	306 kilowatts
Load factor	13·3%	13·5%	14·5%	8·87%	9·02%
Number of public lamps	33 arc	31 arc, 17 glow[f]	3 arc, 675 glow lmp.	nil	nil
Number of consumers	254	305	166 [psts.[a]	215	251
Connections to mains in 8 c.p. at end year	18,559	24,668[g]	18,200	15,456	19,314
CAPACITY of PLANT in KW. at END YEAR	**554**	**554**	**540**	**500**	**800**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kw. capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£50,000 / £90·3	£50,000 / £90·3	£41,675 / £77·2	— / —	— / —
Share	— / —	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	50,000 / 90·3	50,000 / 90·3	41,675 / 77·2	— / —	— / —
RECEIVED (TOTAL)	39,765 / 71·8	48,475 / 87·5	26,000 / 48·1	— / —	— / —
Share	— / —	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	39,765 / 71·8	48,475 / 87·5	26,000 / 48·1	— / —	— / —
AUTHORISED, NOT RECEIVED (TOTAL)	10,235 / 18·5	1,525 / 2·75	15,675 / 29·0	— / —	— / —
Share (unissued)	— / —	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —	— / —
Loan (including Debentures)	10,235 / 18·5	1,525 / 2·75	15,675 / 29·0	— / —	— / —
REPAID (TOTAL)	2,246 / 4·05	3,246 / 5·86	1,240 / 2·30	— / —	— / —
RESERVE OR SINKING FUND	1,020 / 1·84	1,209 / 2·18	— / —	— / —	— / —
DEPRECIATION FUND	— / —	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	46,300 / 83·6	51,127 / 92·3	39,421 / 73·0	£44,096 / £88·2	— / —
Lands and buildings	9,398[a] / 17 0	10,671[a] / 19·3	8,804[c] / 16·3	8,354 / 16·7	— / —
Plant	19,776[b] / 36·1	21,548[h] / 38 9	12,544 / 23·2	18,222 / 36·4	— / —
Mains	16,520 / 29·8	17,818 / 32·2	16,383[d] / 30·3	16,459 / 32·9	— / —
Miscellaneous	606 / 1·09	1,090 / 1·97	1,691 / 3·13	1,060 / 2·12	— / —
BALANCE OF CAPITAL ACCOUNT	−6,535[e] / −11·8	−2,652[c] / −4·79	−13,421 / −24·8	— / —	— / —
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£4,365 / 4·010d.	£5,173 / 3·839d.	£4,691 / 3·625d.	£4,276 / 5·418d.	£5,198 / 5·164d.
Revenue from supply	3,619 / 3·325d.	4,346 / 3·227d.	2,167 / 1·673d.	4,038 / 5·118d.	4,996 / 4·961d.
„ meters, &c.	150 / 0·138d.	232 / 0·172d.	52 / 0 040d.	147 / 0·186d.	179 / 0·178d.
„ public lighting	568 / 0·522d.	586 / 0·435d.	2,428[e] / 1·877d.	nil / —	nil / —
„ supply for traction	nil / —	nil / —	— / —	nil / —	nil / —
„ miscellaneous sources	27 / 0·025d.	9 / 0 007d.	43 / 0·033d.	90 / 0·114d.	23 / 0·023d.
EXPENDITURE—					
TOTAL COSTS	£2,714 / 2·494d.	£2,724 / 2·023d.	£1,921 / 1·484d.	£1,864 / 2·363d.	£2,083 / 2·069d.
TOTAL WORKS COSTS	1,821 / 1·673d.	1,765 / 1·311d.	1,458 / 1·127d.	1,575 / 1·995d.	1,773 / 1·762d.
Generation of Electricity	*1,547* / *1·421d.*	*1,572* / *1·167d.*	*1,231* / *0·95 d.*	*1,524* / *1·931d.*	*1,726* / *1·715d.*
Fuel (including cartage, &c.)	734 / 0·675d.	655 / 0·486d.	760 / 0·587d.	251 / 0·318d.	360 / 0·358d.
Oil, waste, water, stores	78 / 0·072 l.	82 / 0 061d.	34 / 0·026d.	94 / 0·119d.	97 / 0 096d.
Wages at station	463 / 0·426d.	545 / 0·405d.	391[j] / 0·302d.	1,085 / 1·375d.	1,168 / 1·161d.
Repairs & maintenance at Station	273[i] / 0·251d.	289[j] / 0·215d.	46 / 0·036d.	94 / 0·119d.	101 / 0 100d.
Distribution of Electricity	*152* / *0·140d.*	*69* / *0·051d.*	*80* / *0·062d.*	*51* / *0·065d.*	*47* / *0·047d.*
Wages, &c. } Repairs, renewals of mains, &c.	152 / 0·140d.	69 / 0·051d.	53[f] / 0·041d.; 27 / 0·021d.	51 / 0·065d.	47 / 0·047d.
Public Lighting	*122* / *0·112d.*	*124* / *0·092d.*	*147* / *0·114d.*	nil / —	nil / —
Attendance	42 / 0 039d.	54 / 0·040d.	89 / 0·069d.	— / —	— / —
Renewals	81 / 0·074d.	70 / 0·052d.	58 / 0·045d.	— / —	— / —
MANAGEMENT CHARGES, &c.	**893** / **0·821d.**	**960** / **0·713d.**	**464** / **0·359d.**	**289** / **0·366d.**	**310** / **0·308d.**
Net Rents	nil / —	nil / —	nil / —	77 / *0·098d.*	79 / *0 079d.*
Rates and taxes	*324* / *0·298d.*	*301* / *0·223d.*	*92* / *0·071d.*	*212* / *0·269d.*	*231* / *0·229d.*
Management	*569* / *0·523d.*	*659* / *0·489d.*	*372* / *0·288d.*	132 / 0·167d.	170 / 0·169d.
Salaries	438[k] / 0·403d.	499[l] / 0·370d.	301[g] / 0·233d.	58 / 0·074d.	49 / 0·049d.
Stationery, &c.	34 / 0·031d.	32 / 0·024d.	44 / 0·033d.		
Establishment charges } Law charges, &c.	97[d] / 0·089d.	128[m] / 0·095d.	19 / 0·015d.; 8[h] / 0·006d.	22[a] / 0·028d.	12[a] / 0·012d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'd.**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£1,651 / 3·80%	£2,449 / 5·03%	£2,770 / 8 34%	£2,412 / 5·70%	£3,115 / —
Carried to Depreciation Fund	— / —	— / —	— / —	nil / —	nil / —
Carried to Reserve Fund	1,013 / 2·33%	1,173 / 2 41%	824 / 2·48%	992 / 2·35%	1,015 / —
Net int. on loans (incl. Deb. charges)	1,294 / 2·97%	1,436 / 2·95%	997 / 3·00%	1,304 / 3·08%	1,554 / —
Net profit for the year	— / —	— / —	949 / 2 86%	115 / 0·272%	545 / —
BALANCE FROM LAST ACCOUNT	— / —	— / —	nil / —	— / —	— / —
Do. AVAILABLE for DISTRIBUTION, &c.	— / —	— / —	949 / 2·86%	115 / 0·272%	545 / —
Deficit	*658* / *1·51%*	*159* / *0·326%*	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —	— / —
PER CENT. of TOTAL COSTS to REVENUE	62·2%	52·7%	41·0%	43·6%	40·1%
Expenditure per mean kilowatt capacity	£4. 18s. 0d.	£4. 18s. 5d.	£3. 11s. 1d.	£3. 14s. 7d.	£3. 4s. 1d.
REVENUE PER MEAN KW. CAPACITY	**£7. 17s. 7d.**	**£9. 6s. 10d.**	**£8. 13s. 10d.**	**£8. 11s. 0d.**	**£8. 0s. 0d.**
REV. PER 8-C.P. CONNECTED, MEAN	5s. 3d.	4s. 9d.	—	6s. 3d.	6s. 0d.
Price charged for lighting, per unit	6d. to 3d.[c]	6d. to 3d.[c]	6d. (1 hr.) to 3d.[b]	—	6d. to 3d.
„ for power, per unit	3d. to 1d.[e] [per ann.	3d. to 1d.[e]	3d.	—	3d. to 1d.
„ for public lighting	£17. 10s. and £15 per arc	—	3d.	—	—
Receipts per unit for private supply	4·13d.	3·23d.	4·07d.	5·12d.	4·96d.
„ „ for public lighting	2·09d.[n]	2·08d.[n]	3d.[i]	—	—
„ „ for traction	—	—	—	—	—

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moreover, that the engines were run non-condensing, the figures given are, indeed, remarkable. We hope that it will be found possible to maintain even in some measure the results shown.

Burton-on-Trent Municipal Electric Supply Works.

A study of the following subsidiary table will show that, somewhat late in the day, the two years covered by our analysis were the first to be free of deficits. The chronically stagnant character of this undertaking is sufficiently explained by the mere mention of the fact that the gas supply undertaking is also owned by the local authority. It has taken seven years for the electricity department to become self-sustaining, even if a concern can be so characterised before it has written off anything on account of depreciation and while it has not returned to the rates its total deficit. In the present case this total deficit since the concern was started in March, 1894, amounts to somewhere near £7,300, against which has to be set the net profits of the last two years amounting to £660.

It is only fair to state that, nothwithstanding the low load factor, the costs are now satisfactory. The total revenue per unit is somewhat high, and, unfortunately, the capital expenditure is heavy in relation to the output of the station.

Year.	No. of consumers.	Equiv. 8 c.p. lamps connected.	No. of units sold.	Total costs.	Rev. Total.	Working profit.	Deficit.†	Surplus.†
1894...	53	4,130	19,291	£844	£529	-£315*	£1,802	...
1895...	68	5,472	40,094	1,343	1,051	- 292*	1,779	...
1896...	80	6,132	58,189	1,232	1,521	+ 289	1,579	...
1897...	104	7,726	79,492	1,369	2,073	+ 704	1,164	...
1898 ..	137	9,586	108,290	1,669	2,590	+ 921	931	...
1899-0	173	11,890	154,304	1,698	3,732	+2,034	6	...
1900-1	215	15,456	189,441	1,864	4,276	+2,412	...	£115
1901-2	251	19,314	241,534	2,083	5,193	+3,115	...	545

* Working loss. † After payment of interest and sinking fund charges.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 1900
Ayr (Municipal)	Oct. 11, 1901	Kensington & Knightsbr'(Co.)	Apr. 11, 1902
Barnsley (Municipal)	June 27, 1902	Kingston-upon-Hull (Mun.)	July 13, 1900
Bath (Municipal)	April 20, 1900	Kingston-on-Thames (Mun.)	June 20, 1902
Bedford (Municipal)	Aug. 3, 1900	Lancaster (Municipal)	Feb. 15, 1901
Belfast (Municipal)	Oct. 18, 1901	Leeds (Municipal)	June 27, 1902
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 26, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal	Oct. 4, 1901	Leyton (Municipal)	Nov 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Sept. 13, 1901
Bristol (Municipal)	Aug. 30, 1901	Morley (Municipal)	June 14, 1901
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6. 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	April 21, 1899	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	Aug. 9, 1901	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Nov. 29, 1901
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 8, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 16, 1901	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 28, 1900	Richmond (Company)	June 29, 1900
Croydon (Municipal)	Nov. 22, 1901	Salford (Municipal)	Jan. 24, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	Scarborough (Company)	Dec. 20, 1901
Derby (Municipal)	Jan. 26, 1900	St. Helens (Municipal)	Jan. 10, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dover (Company)	May 2, 1902	St. Pancras (Municipal)	July 5 1901
Dundee (Municipal)	Dec. 6, 1901	Sheffield (Municipal)	Feb. 1, 1901
Eastbourne (Municipal)	Mar. 14, 1902	Shoreditch (Municipal)	Jan 31. 1902
Edinburgh (Municipal)	Dec. 6, 1901	Smithfield Markets, Lond. (Co.)	Mar. 8. 1901
Exeter (Municipal)	Aug. 5, 1898	South London (Company)	May 16 1902
Folkestone (Company)	May 2, 1902	South Shields (Municipal)	July 4, 1902
Glasgow (Municipal)	Sept. 27, 1901	Southampton (Municipal)	Feb. 8. 1901
Gloucester (Municipal)	Aug. 20, 1901	Southport (Municipal)	Jan. 17 1902
Great Yarmouth (Mun.)	Dec. 13 1901	Stafford (Municipal)	Aug. 16 1901
Greenock (Municipal)	Aug. 30, 1901	Sunderland (Municipal)	Oct. 18. 1901
Guildford (Company)	Oct. 19, 1900	Taunton (Municipal)	June 16. 1899
Halifax (Municipal)	Dec. 27, 1901	Tunbridge Wells (Mun.)	Nov. 1, 1901
Hammersmith (Municipal)	Nov. 15, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hampstead (Municipal)	Nov. 22, 1901	Walsall (Municipal)	May 23, 1902
Hanley (Municipal)	Aug. 9, 1901	Wandsworth (Company)	May 9, 1902
Harrogate (Municipal)	Jan. 25, 1901	Westminster (Company)	April 4, 1902
Harrow (Company)	Dec. 21, 1900	Whitehaven (Municipal)	Feb. 8. 1901
Hast'gs & St. Leonards (Mun.)	July 12, 1901	Winchester (Company)	June 20 1902
Hereford (Municipal)	Jan. 17, 1902	Windsor and Eton (Co.)	July 19, 1901
Hove (Company)	May 10, 1901	Woking (Company)	Dec. 22, 1899
Huddersfield (Municipal)	May 23, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Hull (Municipal)	July 4, 1902	Woolwich (Company)	May 31, 1901
Isle of Wight Company)	Dec. 20, 1901	Worcester (Municipal)	April 18, 1902

THE INTERNATIONAL TRAMWAY CONGRESS.

(*Concluded from page 424.*)

Thursday, July 3rd.

Mr. John Young, of Glasgow, occupied the chair, and the attendance was somewhat larger than usual. A Paper was read by M. Poetz, of Hamburg, on "Tramway Brakes." The Paper described tests on the power of different brakes, their power being expressed in terms of the distance in which a given car could be brought to rest from a given speed. We hope to reprint this Paper in a later issue. In the discussion M. Thonet spoke in support of the author's tests and results. He gave the following results of tests made under his direction, at a speed of 20km. per mile. The figures give the distance in metres run before stopping :—

For one car	14·0	for air brake.
,, ...	12·5	,, General Electric brake.
,, ...	11·6	,, Thomson-Houston brake.
For one car and one trailer ...	18·1	,, air brake.
,, ,, ...	15 6	,, General Electric brake.
,, ,, ...	11 7	,, Thomson-Houston brake.
For one car and two trailers...	20·7	,, air brake.
,, ,, ...	19·4	,, General Electric brake.
,, ,, ...	14·7	,, Thomson-Houston brake.

Herr Koehler disapproved of the magnetic brake, which he had tried in Berlin. He regarded the air brake as more reliable. Herr von Leiber, speaking on behalf of the Austrian Government, supported the author's claims as regards electric brakes. In Vienna they had decided to adopt e ectric brakes.

A Paper was read on "Narrow *v.* Ordinary Gauges," by M. C. de Burlet, of Brussels, and evoked considerable discussion. The author, however, admittedly excluded electric tramways from consideration.

Friday, July 4th.

M. Janssen occupied the chair. Papers on "Heating of Cars," by M. Peiser, and "Uniform System of Accounts," by M. Janssen, were read, after which Mr. P. V. McMahon read a very valuable Paper on "Underground Tube Railways." This Paper presented a comparison between the existing electric tube railways in London ; it further discussed the relative advantages of deep and shallow level tunnels, arguing convincingly in favour of the latter. At the opening of the City and South London Railway it was looked upon by Continental and American engineers as a fine piece of engineering. But it went on quietly carrying seven million passengers a year without any notice from the general public and the press until the Central London Railway was opened, and then it was re-discovered. It paid a dividend from the start. Separate locomotives have many advantages over the system in which motors are fixed to each car. They tried a motor car train several years ago on the City and South London line. It gave greater seating capacity for the same weight, and the coal consumed per passenger carried was slightly less, but unnecessary time was lost at terminal stations, due to the driver and assistant having to change positions from one end of the train to the other. More spare carriages are required and sidings have to be larger. If one compares the continuous-current system on the City and South London with the Central London three-phase system it is seen that less has to be spent in copper.

In the Waterloo and City Railway the generating station is at Waterloo, and it is worked on the two-wire direct system at 500 volts. There are no lifts, and motor car trains are used. For heavy traffic four-coach trains are run. The front and rear carriages have two motors on the leading and trailing bogies ; they carry 46 passengers each, while the two intermediate carry each 56 passengers, making a total seating capacity of 204 passengers. The normal rating of motors is 42 B.H.P.—that is, 70 to 100 amperes at 500 volts. These are run for three and a-half to four hours in the morning. The total weight of train is about 100 tons, and the time taken between stations is five minutes, the average speed being 18 miles per hour. For light loads single motor cars are run, weighing 26 tons, and make the journey in four minutes, speed 22·5 miles on the average. They ascend the 1 in 60 gradient at 30 miles an hour. The coal consumption is 5lb. per unit. The number of passengers in the half-year is 2½ millions.

On the Central London Railway current is generated at 5,000 volts, and reduced to 550 at the line. Each train consists of seven carriages on eight-wheeled bogies, weight unloaded 98 tons, and the seating capacity 336. Locomotives are used, but motor cars are being made. Each locomotive is 117 H.P. The maximum current at full-load is 1,200 amperes for each locomotive, and its weight is 44 tons. The passengers carried for half-year are 20,802,650.

Into the discussion the subject of accumulators intruded itself, and occupied considerable attention, although none of the existing tube railways are worked with batteries. Herr Köhl described the battery system in Hanover as absolutely ruinous, and said that both in Hanover and at Hagen accumulators had been given up. M. Thonet, of Liege, said that, although the horse tramways at Dunkirk had been worked for 19 years and paid a good dividend, when accumulator traction was adopted the concern soon became a losing one. The batteries only lasted five months, there were numerous stoppages, and, as a result, traffic was disorganised. Several other speakers condemned the battery system.

Wire Fences as Telephone Wires.—Barbed wire fences are being utilised for telephonic communication among the farmers in California. The greater part of the lines consist of wire fences, running along the sides of the roads or dividing the farms, poles and elevated wires being supplied wherever necessary. Branches or loops are added extending to the residences of the farmers living along the route.

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THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

(*Continued from page 418.*)

In the arcade leading from the entrance in Upper-street into the main hall are a number of interesting exhibits. Messrs. Graham, Morton & Co. show a selection of photographs of their elevator and conveyor machinery, which has been erected at a large number of power stations. At stand No. 2 is the exhibit of the Glacier Anti-Friction Metal Co. The Simplex Steel Conduit Co. have a stand higher up the arcade, in which a number of their conduits, fittings, &c., are conveniently arranged. Near by Messrs. V. Demerbe & Co. show their system of track construction, as used at Bradford and Bolton. The ends of the rails are shown placed together and embedded in concrete; there are two points with tongues operated automatically, the mechanism of the operating box permitting of motion to the case. To give this increased bearing the body of the points is undercut on each side.

At stands Nos. 10 and 14 in the arcade two well-known firms of boiler-makers are in evidence, stand No. 10 being occupied by Messrs. Babcock and Wilcox and No. 14 by the Stirling Boiler Co. These latter show a model section of their water-tube boiler, also a miniature glass model gas-fired and showing well the circulation of water in the Stirling boiler. At the passage from the arcade into the main hall the "Empire" Roller Bearings Co. have their stand. The principal advantages arising from the use of these roller bearings are great reduction in starting effort—equal to 8lb. per ton of load (or 75 per cent.)—resulting in savings in coal

THE INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

right or left. Opposite are stands Nos. 15 and 16, where the Hadfield Steel Foundry Co. exhibit their steel forgings, castings, &c., from the Hecla Works, Sheffield. This company has a larger stand at No. 85 in the main hall, where a greater profusion of details is shown. Amongst the exhibits will be found samples of the Hadfield points 100ft., 200ft. and 250ft. radius for the ordinary girder rails, also for the Demerbe rails; points fitted with a manganese steel renewable intersection piece and connected movable points. These points are made throughout of manganese steel. This renders it practically unmachinable and one of the most durable material in the market to-day. The point, which can be supplied in any length from 5ft. 6in. to 15ft., is so designed that the tongues are the same width on the base for their full length, instead of tapering towards the toe, as is usually the consumption, electrical energy or other motive power from 20 to 50 per cent. The economy in lubrication is equal to 50 per cent., and, of course, with a properly-attended bearing there is no heating. Our illustration shows the Empire roller bearing as used on the axles of the Brill truck.

We now enter the main hall just below the part of the gallery from which was taken the panoramic view published in our issue last week. The general panorama of the main hall in our present issue was taken from the opposite end of this hall. Resuming the round of the main hall, which we commenced last week, we may visit, first, stand No. 26, where Messrs. Johnson and Phillips have a truly instructive and interesting show. It is impossible to find space to describe all there is to be seen on this stand, the variety in which is shown in our illustration. At the rear

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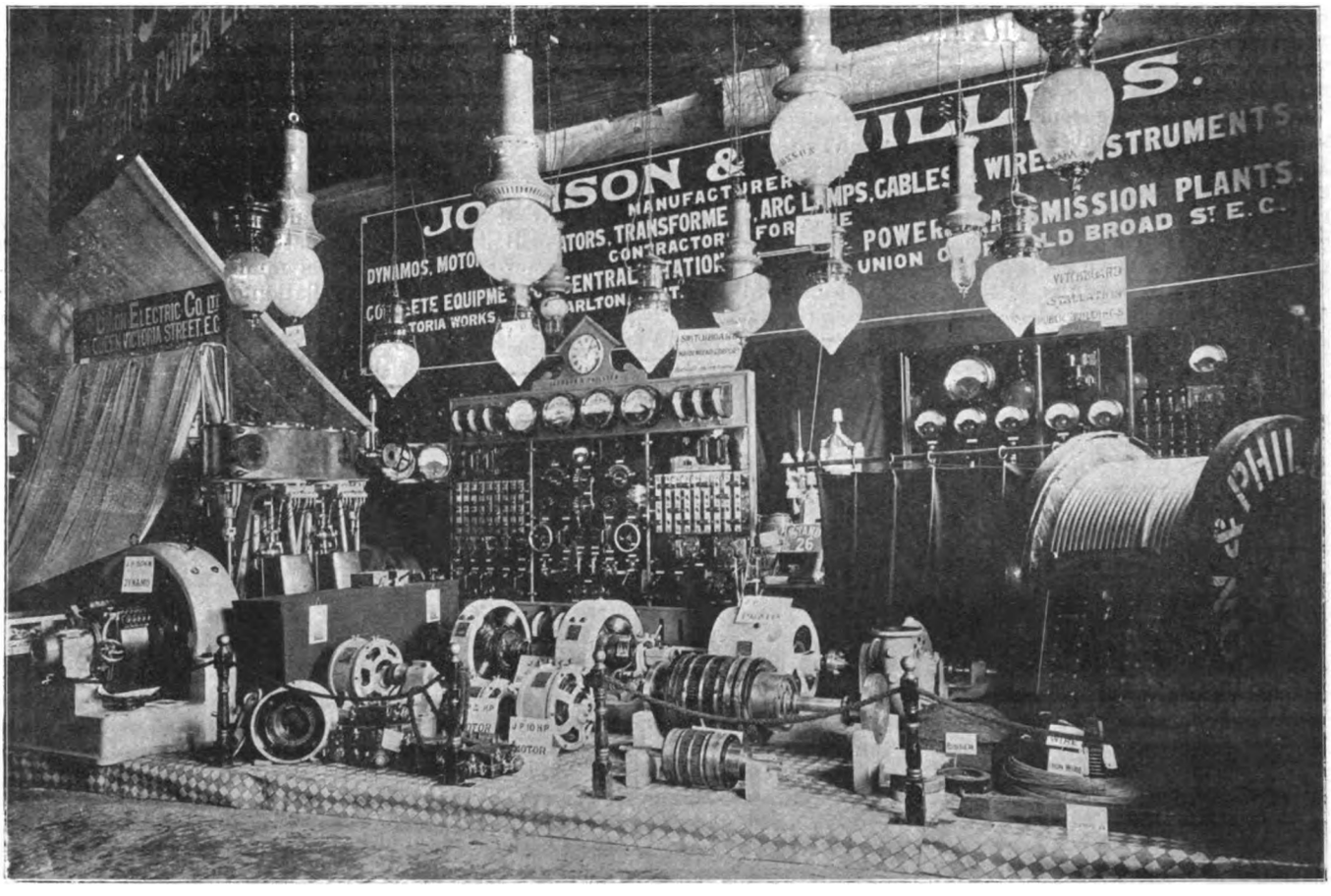
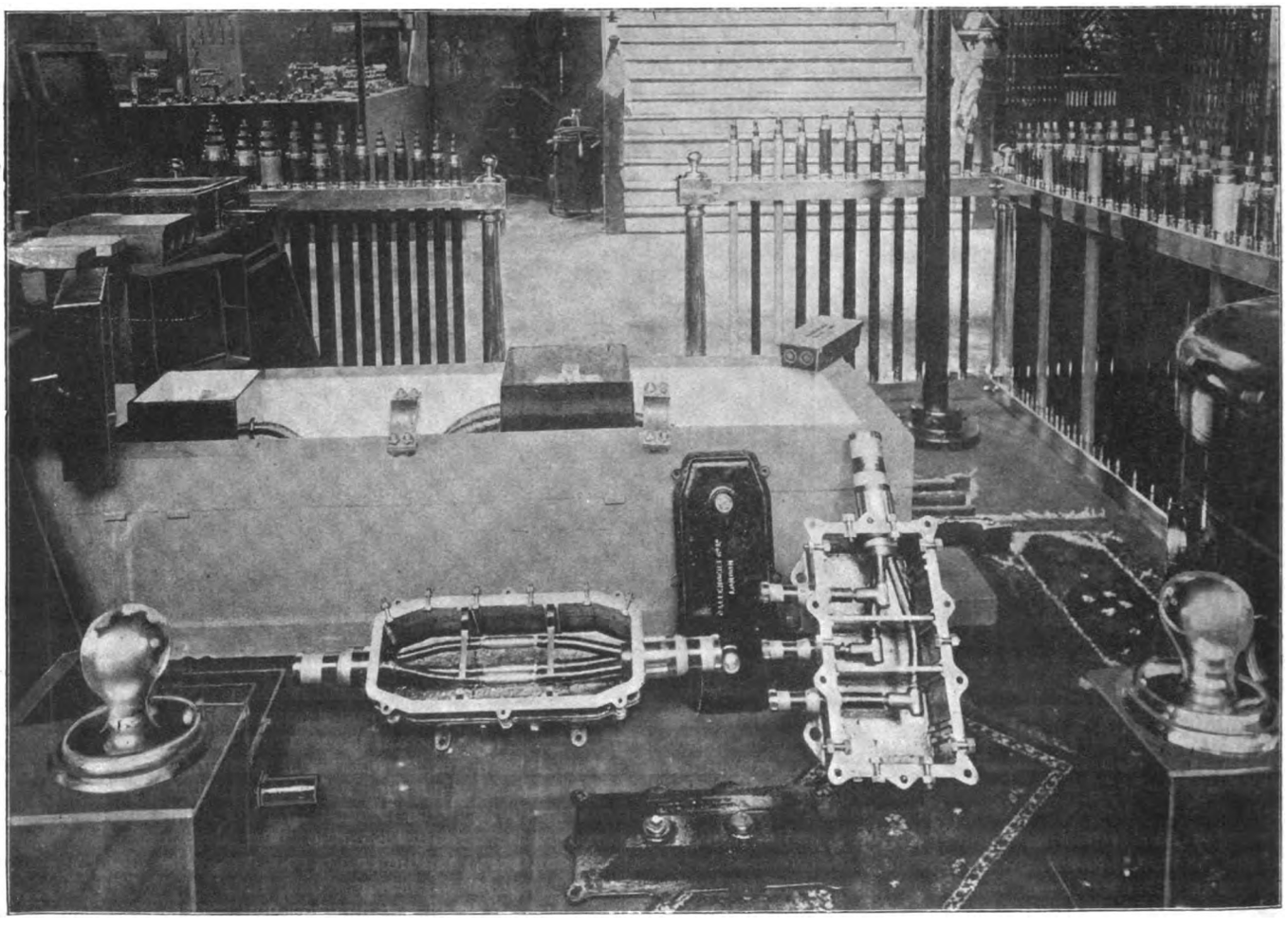


MESSRS. JOHNSON AND PHILLIPS' STAND.



PART OF MESSRS. CALLENDER'S CABLE AND CONSTRUCTION CO'S STAND.

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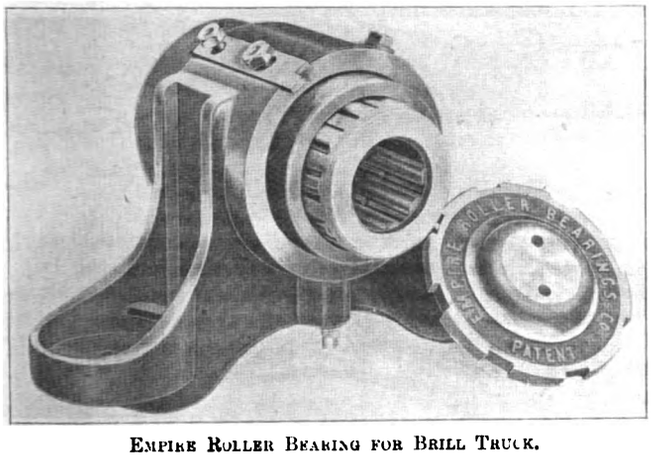
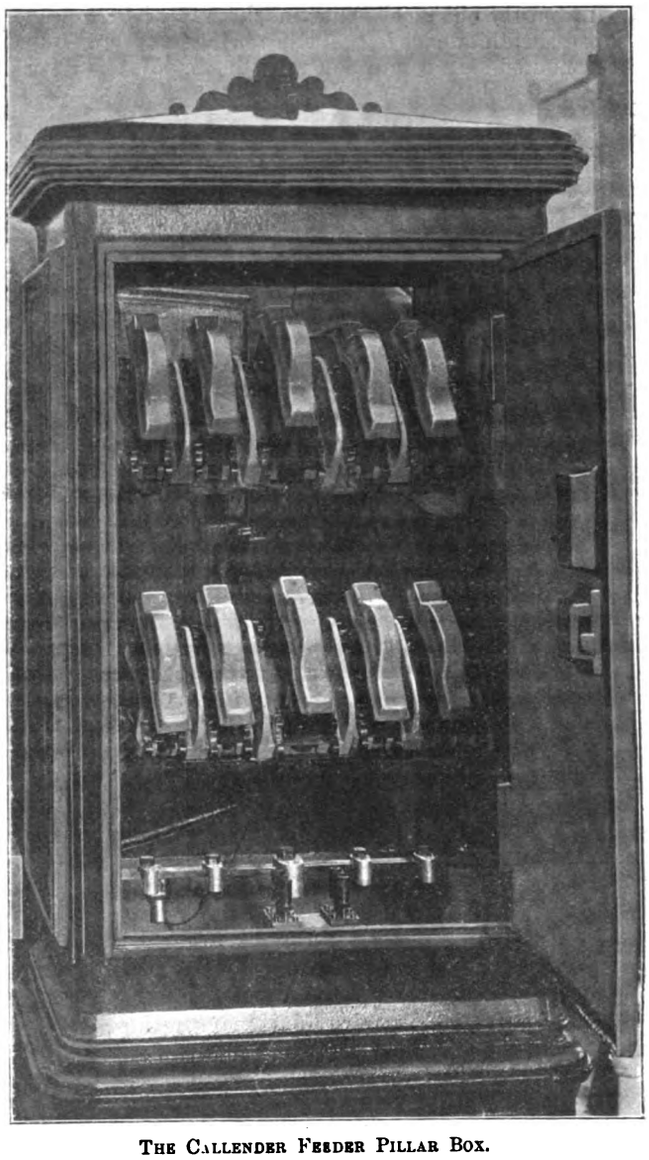
of the stand are some excellent specimens of switchboard work; overhead are a variety of this firm's "Ark" lamps; on the left is a compact little 50kw. steam dynamo set of Messrs. Johnson and Phillips' railway pattern, the steam engine having been built by Messrs. Wm. Foster & Co., of Lincoln. Cables, feeder and terminal boxes, boosters, armatures, motors, pumps, &c, fill up the complement of this attractive collection of exhibits, all of which are eloquent of highest finish and the best workmanship. The St. Helens Cable Co.'s stand is close by, and includes, among a number of cable exhibits, a tank containing two drums of cable under 2,000-volt insulation test. One of these drums contains cable not covered with lead, and insulated with this firm's latest "Dialite" insulation. The other drum contains lead-covered cable, but the lead has been cut away at an immersed part to show that water is not injurious to these cables. In order to convince the sceptical as to these drums really being under 2,000 volts pressure, there is a bank of 20 glow lamps in series which is lighted up when the cables are being tested. The cable is insulated as follows:—Next the core is placed a layer of paper lapped on in the usual way. The paper, which is of the best quality manilla, is somewhat thicker than is ordinarily used, and is impregnated before being applied to the cable. After the lapping is complete, the covering is again impregnated, and is then taped. Over the tape is placed a layer of a bituminous waterproof material, to which the name of "Dialite" has been given. The "Dialite" is lapped with tape in the same manner as a rubber-covered



EMPIRE ROLLER BEARING FOR BRILL TRUCK.

cable, and is then vulcanised in steam. After vulcanisation is complete, the cable is finished with braiding treated with preservative compound in the usual way.

The most notable feature of Messrs. Callender's exhibits was the feeder pillar-box, for use on lighting systems, designed by Mr. J. C. Ward, late of Glasgow Corporation Tramways. The particular one shown was suitable for one feeder and four distributors, in use on a three wire system. This is shown in the accompanying illustration. Its lower portion is made to be embedded in the ground for about 18in., whilst the portion above the ground is about 4ft. 6in. high; this may be increasd by 9in. by means of a piece which can be bolted on between the portion of the pillar above the ground and that below. It has two doors on hinges, and the side panels can also be taken off. Fastened to the side panels inside are two angle irons which support petticoat insulators, and on these insulators is fixed a wrought-iron bar carrying three studs. These studs support three porcelain bases, on which are mounted clips, the porcelain bases being also petticoated underneath. The switch clips are not permanently fastened to the porcelain bases, but can be removed and fixed individually by the pressure of the fingers on an eccentric lever, which compresses a rubber buffer. Each clip carries a thimble on its under side, to which the cable is sweated, and the corresponding clip for each switch is, of course, bolted to the 'bus bar, which runs for the whole length underneath the porcelain bases. This description of the switch gear applies to both the positive and negative poles, one being placed, as may be seen by the photograph, some 9in. or 1ft. apart from the other, the two being separated by air. It will thus be seen that electrically the insulation of either pole from earth consists of two petticoat insulators, besides the petticoated bases on which the switch clips are mounted; also there are two petticoat insulators in series from pole to pole. The whole arrangement presents the appearance of the switches being suspended in air, as from the front of the box it is impossible to see how they are upheld. Another novel feature of this excellent pillar-box is that the handles of the switches can, by one simple movement, be removed, and thus, should a fuse happen to blow, there would be no damage done to the porcelain. At the bottom of the pillar-box may be seen the neutral 'bus bar and the pilot terminals. It will be seen that this



THE CALLENDER FEEDER PILLAR BOX.

feeder pillar possesses many advantages over the ordinary type, in that the switch and fuse is all in one, and any fear that may be entertained with regard to the speed of the break is groundless, owing to the force which must be exerted in removing one of the switches and thus causing it to leave the clips at a very rapid rate. The cables may be sweated into the thimbles before the clips are put in position on the porcelain, and this in itself must prove a great convenience to any workman employed in erecting the box.

Similar pillars are also made by Messrs. Callender for traction purposes, the only difference in their construction being a smaller number of switches than are used for the lighting pillar. This pillar is being erected at the present time by the Corporation of Nottingham.

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Among the exhibits at this stand of cables (which are mounted in such a way that they form part of the railing of the stand) there is a specimen of the Newcastle high tension main, which has been laid from Newcastle city to Wallsend, measuring in all some 27 miles of cable. It is working at 6,000 volts, three-phase, and is 0·25 sq. in. in section. It is a paper-insulated, lead-sheathed, galvanised steel, wire-armoured cable. Another example of Messrs. Callender's cables is one which was laid in connection with the Lowestoft lighting scheme across the harbour; it is doubly wire-armoured and sheathed in vulcanised bitumen, which is their speciality as a substitute for not only a dielectric, but also as a sheath for cables, being perfectly waterproof. Another type of this class of a similar cable is a concentric 0·05, which was laid across the River Tawe at Swansea. In this case the cable is paper insulated with lead sheathing, the lead being protected from the chemical action of the water by a vulcanised bitumen sheath outside it, the whole being braided and doubly wire-armoured. In connection with the high-tension work at Newcastle, Messrs. Callender exhibit several specimens of joint-boxes. The straight-jointer box is divided into three sections by means of partitions composed of ebonite, ½in. in thickness. Coming in at one end of the box, the cables are separated out in triangular form 2in. apart, and the joints are made by the cables being butted together in a copper sheath, and the whole run in solid metal. A long slot in the copper sheath provides the means of pouring in the metal, at the same time showing that the cables are properly put together, and thoroughly well soldered. The great feature of this box is that the joint can be made before the cast-iron case is placed in position. A similar box is also provided for a sub-station for dividing up the three core cables into three singles. A new section pillar for tramway work is shown, the cover being made of sheet steel, and takes the place of a petticoat casting at the base of a tramway pole. The panels of the section pillar are fitted round the pole, with the switches mounted on them; the whole cover can be raised by means of a portable pulley gear so that access is allowed for the workmen when connecting up, and holes are provided which are opened by a universal key through which the switches may be operated without raising the cover. The size and shape can be obtained to match the petticoat castings in use in the district where supplied. There is a water-catcher inside the cover, provided with a drain-hole letting all rain water into the centre of the post, where it can be properly dealt with below.

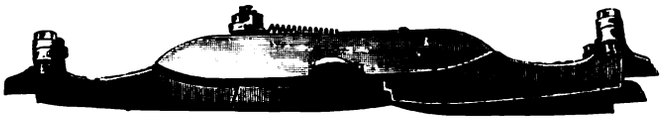
Messrs. Callender also exhibit a new house fuse box, designed by Mr. Harold Hastings, of either the double-pole or single-pole type, in which a fusible strip is bent on to a porcelain handle and is held between two end clips, which are kept in position by a porcelain base. The two poles are separated by a porcelain screen, and sealing chambers are provided top and bottom. A 50-ampere box measures 9in. by 4in., the depth being 2½in.

The four-way network box for three-core cables is shown, in which the three poles are represented by three tiers separated by ebonite insulators. The connections in the box are all disconnected by means of an insulated spanner and key, the disconnecting links being solid blocks of copper, and the copper tongues are placed by means of a gun-metal bolt which passes through the hole. The links form a circle round the centre, and are protected by diving-bell covers tested to withstand 15ft. head of water. The arrangement of this box is a universal one for single and triple concentric cables, the outside casting only being altered in each case.

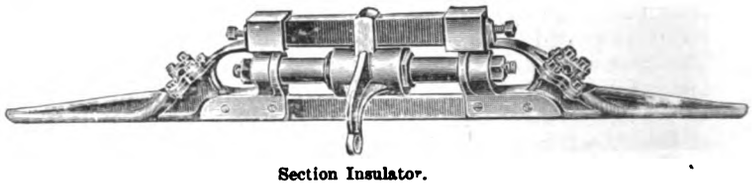
The rails of this stand are cast in solid copper, through which the cable samples pass, being stepped off at the ends, showing how they are made up. The whole is brilliantly illuminated with incandescent lights, and the reception room is one of Messrs. Callender's jointer's tents of the Post Office pattern.

One of our illustrations shows a model of the three-wire distributing-box system adopted by Messrs. Callender for Newcastle. The model is constructed to show the manner in which a three-wire distributor may be split up into three separate three-wire branches for this number of branch distributors. There are separate boxes for the positive, neutral and negative distributors, the boxes being a short distance apart.

The Electric Tramway Equipment Co., who are specialists in the manufacture of overhead line material, have an interesting exhibit with numerous samples of their insulators and fittings. Although some of the designs are still much like the types first used in America—such, for instance, as the trolley ear—yet in most instances it has been found necessary greatly to alter and improve the design to meet the more onerous conditions of English practice and requirements.

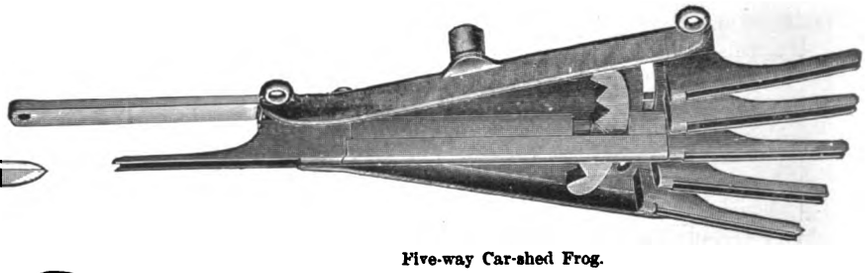


"Acme" Frog.

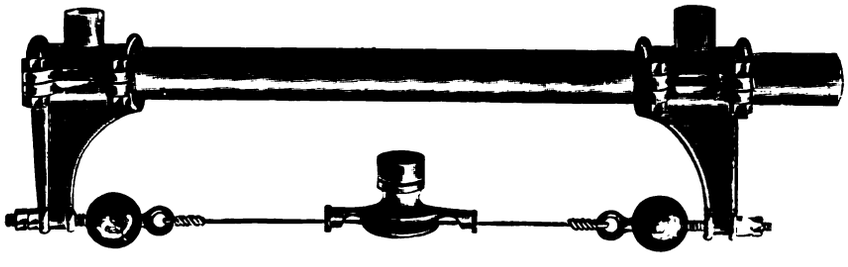


Section Insulator.

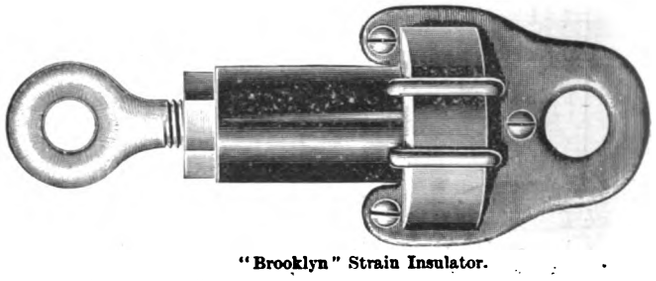
Straight Line Ear.



Five-way Car-shed Frog.



Flexible Bracket Arm.



"Brooklyn" Strain Insulator.

TROLLEY DETAILS MADE BY THE ELECTRIC TRAMWAY EQUIPMENT CO.

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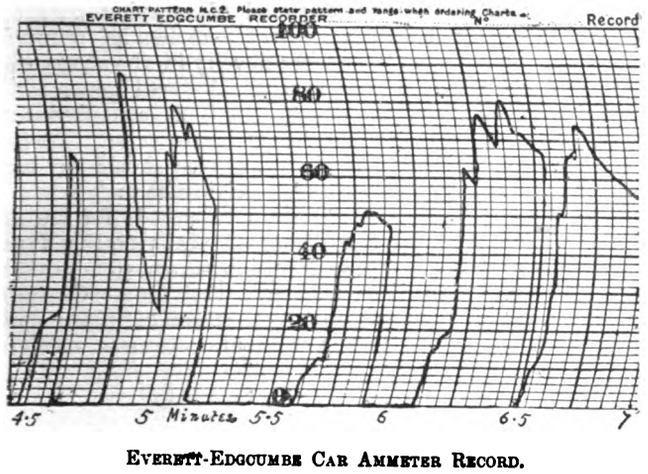
This is especially noticeable in the frogs and crossings, owing to the almost universal adoption in this country of swivelling trolley heads. We give an illustration of the "Acme" frog made by this company, by which it is possible to direct the trolley wheel as desired by a movable tongue or gate. Another very useful frog is the car shed series, which is made with either two, three, four or five "points" or "ways," and is operated by a lever placed on an indicator board fixed to the wall of the car shed. In our series of illustrations we show a five-way frog of this type in use at many of the large car sheds in the country, and by its use the wiring of the shed is greatly simplified. An important item in overhead construction is the section insulator, and in their latest pattern the Electric Tramway Equipment Co. appear to have come near to perfection. We understand that the company have in their possession some very satisfactory results of independent tests that have from time to time been made with both their "Verus" insulating material and their gunmetal fittings, and it is satisfactory to know that in recent severe competition with American and German firms for about 60 miles of line material for the Manchester Corporation the Electric Tramway Equipment Co. were successful in securing the contract. This is the more creditable, as all their material, both bronze and insulation, is made entirely at their Birmingham works. In one of the accompanying illustrations we show one method of their flexible construction which is now generally adopted by English engineers in preference to the more rigid bracket arm construction. In place of the two globe strains it is often better to use two Brooklyn strains or other forms of insulators.

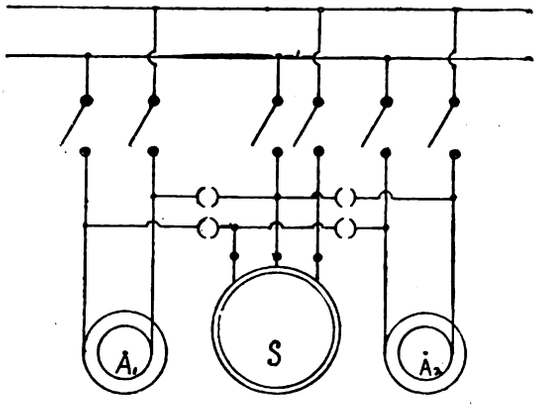
Messrs. Everett, Edgcumbe & Co. exhibit at stand No. 172 a number of recorders for use on tramcars. Several attempts



EVERETT-EDGCUMBE CAR AMMETER RECORD.

have been made to employ the ordinary recording ammeter to measure and record the current taken by a tramcar under various conditions. Messrs. Everett, Edgcumbe & Co. have designed a special recorder for the purpose, which, while similar in external appearance to their ordinary portable type, is carried on buffers, which protect the working parts from the excessive vibration to which they are subjected in working. Our illustration shows at half full-size an actual record taken on a car. The instruments are thoroughly damped—a most important point—and a special arrangement is provided, by means of which the chart speed can be varied at will from about ½in. to 4in. per minute. The charts, as a rule, last for about 30 minutes at the higher speed. A demand has lately arisen for a strong and durable ammeter which can be fixed to each car, so that the driver can see exactly what current he is taking, and thereby be enabled to bring about a considerable saving on the power used. This has been met by Messrs. Everett, Edgcumbe & Co. in an ammeter for the purpose, consisting of a round watertight case, painted to suit the colour of the car, and the cables leading in the current are brought up to it in an iron tube, passing right through the flooring of the car, so as to be protected from all possible damage. The tube is usually held either against the controller or else the front of the car, and, by means of clamps, the instrument can be raised, lowered or turned round as desired.

Now that long-distance alternating-current transmissions are becoming so common in connection with traction schemes, the new Everett, Edgcumbe rotary synchroniser will probably attract attention. So long as only small units had to be paralleled, a little skill was quite sufficient to render the ordinary synchronising lamps and voltmeters fairly satisfactory, but with the advent of larger generators and stations some more reliable system became necessary. Messrs. Everett, Edgcumbe & Co. had attacked the problem from a new direction, and we illustrate the rotary synchroniser, which is to be seen in operation at the exhibition. It consists essentially of a two-phase rotary field motor, the stator of which is fed from the 'bus bars, and the rotor from the machine to be paralleled, the split phase being produced by means of a choking coil. If the incoming machine is running too fast the hand will revolve to the left, and if too slow to the right. The correct speed, or rather frequency, is shown by the hand remaining at rest, and the precise moment for switching in is shown by the hand standing vertically and opposite a mark on the dial. Thus absolute accuracy is possible, and moreover, in order to enable the engine driver to see from a distance what is going on, a green or a red lamp is shown through holes in the dial, according to whether the alternator is running too fast or too slowly. An ordinary synchronising lamp surmounts the whole instrument, which is very compact, having a dial some 8in. or 10in. in diameter. This firm have just introduced a useful form of small direct-reading photometer set. The complete outfit, with the exception of the standard lamp, is only about the size of an ordinary cigar case, and it is claimed that accurate results can be obtained even in an ordinary room with the blinds down



EVERETT-EDGCUMBE SYNCHRONISER.

The photometer itself consists of a carefully-designed "Leeson disc," which is moved along a graduated scale ingeniously slung beween the standard lamp and the lamp to be tested.

Messrs. Nalder Bros. and Thompson, of 34, Queen-street, E.C., have an exhibit of switchboards, instruments of all kinds and circuit breakers. Amongst items of special interest there is a large station voltmeter with double illuminated dial, of which we give an illustration, and this can be turned so as to face in any direction. It is a very convenient form of instrument for central station engine-rooms. A Board of Trade panel is also exhibited containing an ammeter, voltmeter and recording instruments necessary for making the tests prescribed by the Board. A feature of novelty on this panel is a special earth automatic, provided to protect the ammeter in the event of a passage of a large current to earth. If the current exceeds the safe reading of the instrument the automatic then short-circuits the ammeter and itself, thus preventing all damage which might arise from the passage of a large current. There are several forms of switchboard panels exhibited, including a generator panel containing an ammeter, minimum reverse current circuit-breaker, field regulator and double-pole switch, also voltmeter plug for plugging on to the station voltmeter, for paralleling the in-coming machine; a

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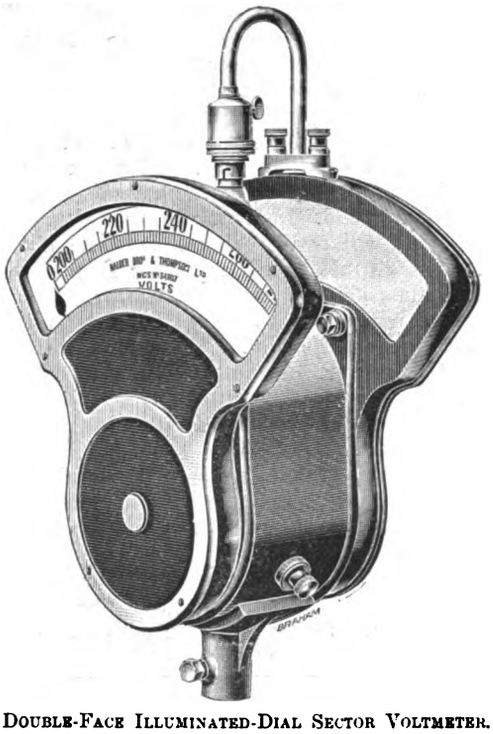
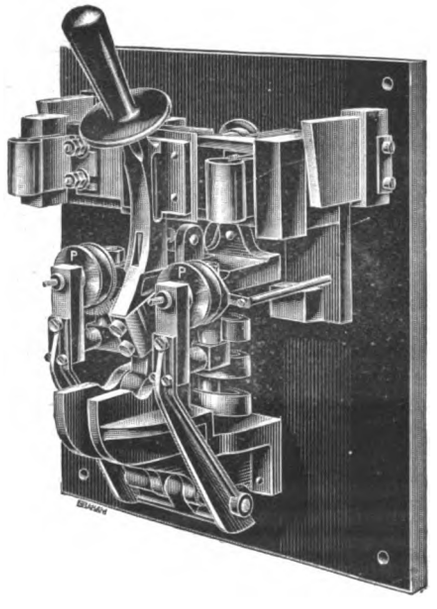
feeder panel containing ammeter, voltmeter and maximum circuit-breaker and switch; also a motor panel containing starting switch, maximum and no-volt circuit-breaker and the necessary instruments. There are, besides, numerous portable instruments, both recording and of the direct-reading type, high-tension voltmeters of various patterns, and large edge-wise illuminated instruments which can be



DOUBLE-FACE ILLUMINATED-DIAL SECTOR VOLTMETER.

made for either direct or alternating currents. A large number of circuit breakers are shown, designed for almost every possible requirement, such as plain over-load or minimum reverse-current type, over-load and under-load combined, and over-load and no-volt release. There is shown a small type of circuit breaker, of which forms are made in



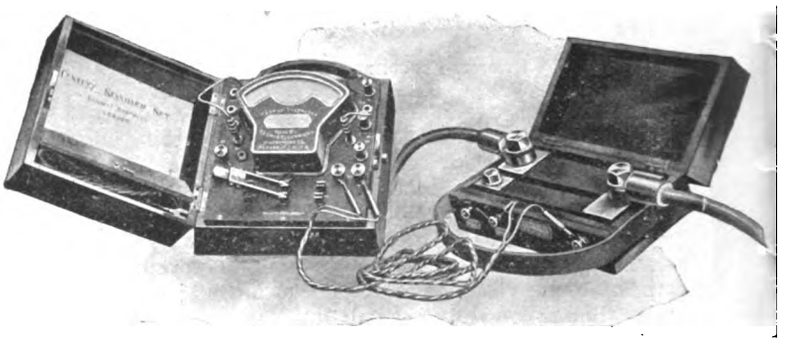
MINIMUM AND REVERSE CURRENT AUTOMATIC CUTOUT,

any of the combinations described for the larger type. A minimum cutout is shown, which breaks either at zero current or on a small reverse. It is polarised by means of the two small coils PP shown in the illustration. These are excited from the 'bus bars and are always magnetised in the same direction, the result being that if the current falls to zero, or even rises rapidly in the opposite direction, the cutout still flies off, although this current may rise to a high value in the negative direction, which, of course, it would not do were it not provided with the polarising coils.

Stand No. 37, occupied by Messrs. Elliott Bros., of 101, St. Martin's-lane, and Lewisham, probably attracts as much, if not more, attention than any other stand in the exhibition. First, there is Mr. Partridge's "Sparklet" fuse, which was fully described in our issue last week, and the numerous demonstrations given to eminent engineers and others must have been the cause of the liberation of an extraordinary amount of CO_2, to say nothing of the excellent advertisement obtained by the Sparklet Co. Current was transformed from the mains pressure of 100 volts up to 2,400 volts, and then short-circuited inside a box with coloured glass sides. A flame of about 2in. in length shot up, there was a slight report,

ALTERNATE CURRENT VOLTMETER.

the flame went out, then a sound of escaping gas, and "Sparklets" covered with hoar frost were handed round for inspection. There is also another novelty in the shape of a new speed indicator for motor cars. A small generator is coupled to the shaft of the motor, and leads are taken to a voltmeter with a scale graduated in miles per hour. There is also a recording voltmeter in circuit, so that should any luckless driver be prosecuted for furious driving he merely has to hand up a strip of paper which gives his speeds for the last 24 hours. The recorder is fixed on an anti-vibration frame which, it is said, does away with all inaccuracies due to vibration. Messrs. Elliott Bros, also show their new "Century" testing set, which is an exceedingly nice set of instruments. It affords a convenient means of making accurate measure-



"CENTURY" TESTING SET.

ments of current and pressure over large ranges, and also measurements over a considerable range of resistances. The apparatus is supplied in two portable cases. One contains an indicating instrument in the form of a Weston low-reading voltmeter, a switch for changing over the instrument terminals for the measurement of either current or pressure, the necessary series resistances for the pressure measurements, and the two smallest shunts which are employed in the measurement of current. The second case contains the two larger shunts, which, being of a certain weight, are more easily carried separately from the indicating instrument. The indicating instrument consists of a dead-beat, low reading voltmeter, having a scale of 150 divisions, and is so calibrated

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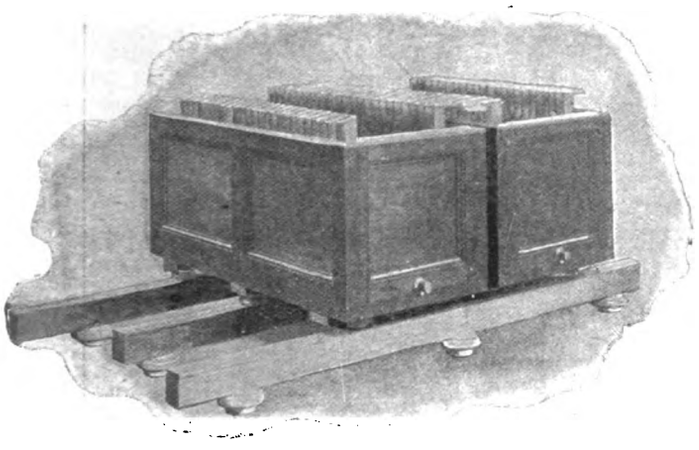
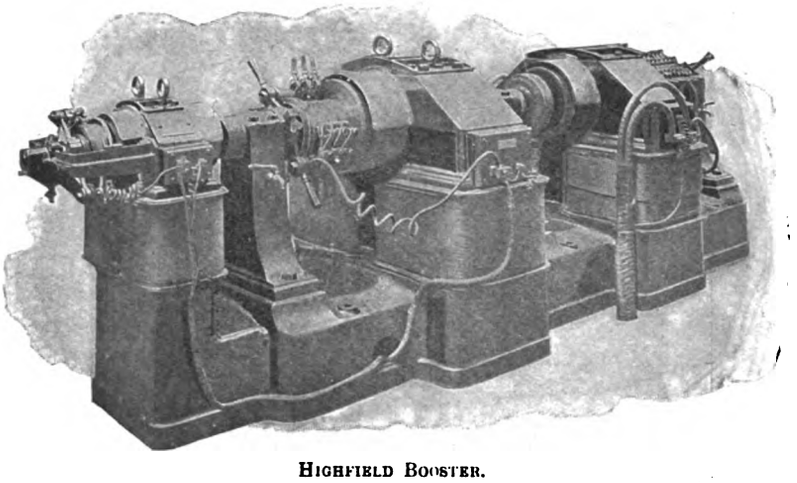
that when the instrument is used direct, by connecting the terminals marked MV to the source of current to be dealt with, an E.M.F. of 0·075 volts at the ends of the flexible leads supplied, suffices to turn the pointer to the full scale deflection of 150 divisions. From this it follows that each division is 0·0005 of a volt. The indicating instrument is arranged so that its terminals are joined to the two levers of a double-pole switch which can be turned over, either to the left for measurements of pressure, or to the right for measurements of current. Along the left-hand side of the instrument are fitted four sockets, and by attaching two wires leading from any circuit to the terminals marked "Volts," the pressure between these wires can be measured by placing the plug on the end of the small flexible cord attached to the instrument, in the hole which is marked with a pressure known to be above that to be measured. It is possible to obtain readings on this instrument from 0·006 volt to 600 volts. This instrument is extremely useful for measuring very small resistances, such as, for instance, that of the installation of a building. Another exhibit is an alternate-current voltmeter of the S.R. type. It is a small round instrument in a cast-iron case with nickeled edges, the diameter of its base being 7½in. and the radius of the pointer 8½in. There are also shown: A rail bond testing set, consisting of a direct-reading millivoltmeter with central zero, reading 20 millivolts on either side; and a multiple range ammeter for alternate work from 15 to 600 amperes by means of portable transformers. A very fine commutator board built by Messrs. Elliott Bros. for the Charing Cross and Strand Electricity Co. is also shown. It consists of 12 circuits, each of 1,000 amperes, with a recording voltmeter and edgewise ammeter for each.

The Chloride Electrical Storage Co., of Clifton Junction, Manchester, and 89, Victoria-street, S.W., have a comprehensive exhibit of accumulators and accessories. The developments of the storage battery and its adaptation to modern requirements is a subject which is not so apparent to all and sundry as, for instance, the increase in size of generators and engines for the traction systems of our large towns—because, it may be, except those whose duty brings them in contact with the large batteries which are necessitated by present conditions, the average man does not appreciate what

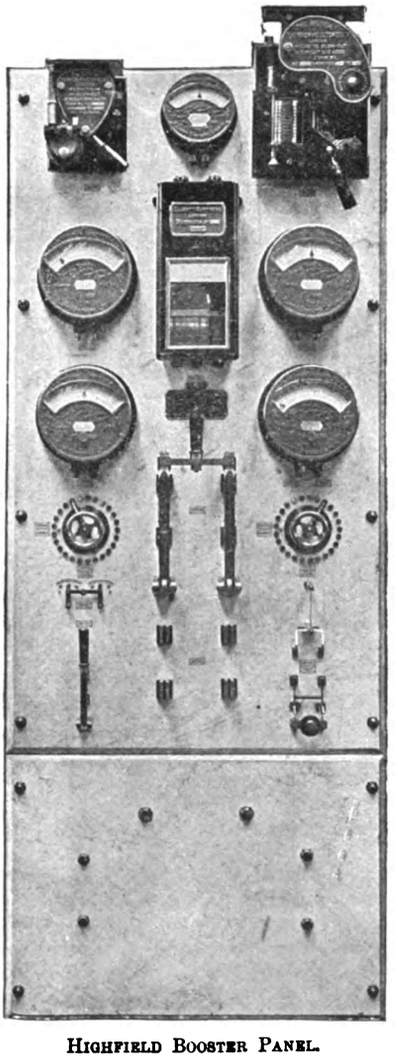


CHLORIDE "C.R." TYPE.



HIGHFIELD BOOSTER.

CHLORIDE "DOUBLE C.R." TYPE.



HIGHFIELD BOOSTER PANEL.

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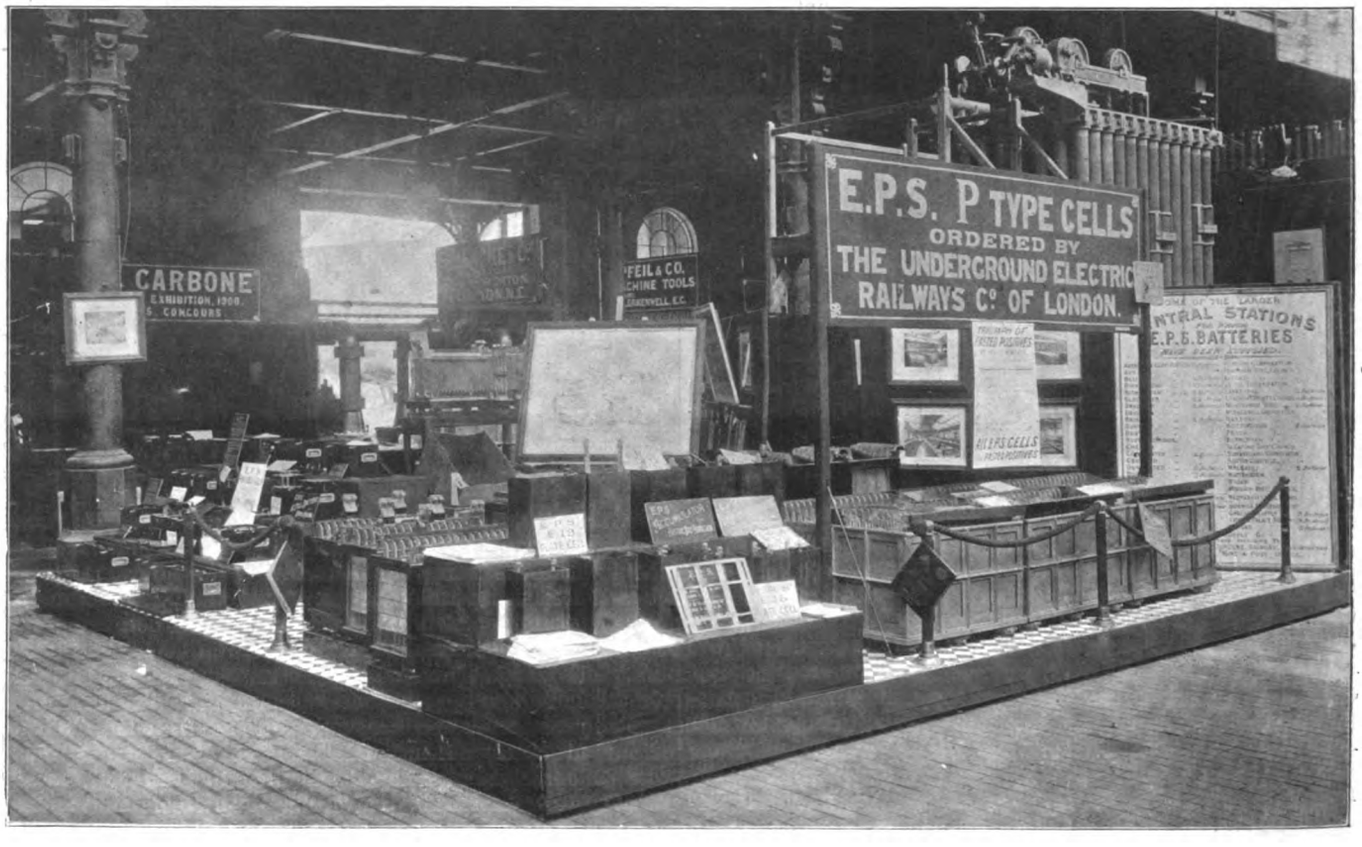
THE CHLORIDE ELECTRICAL STORAGE CO.'S STAND



THE ELECTRICAL POWER STORAGE CO.'S STAND.

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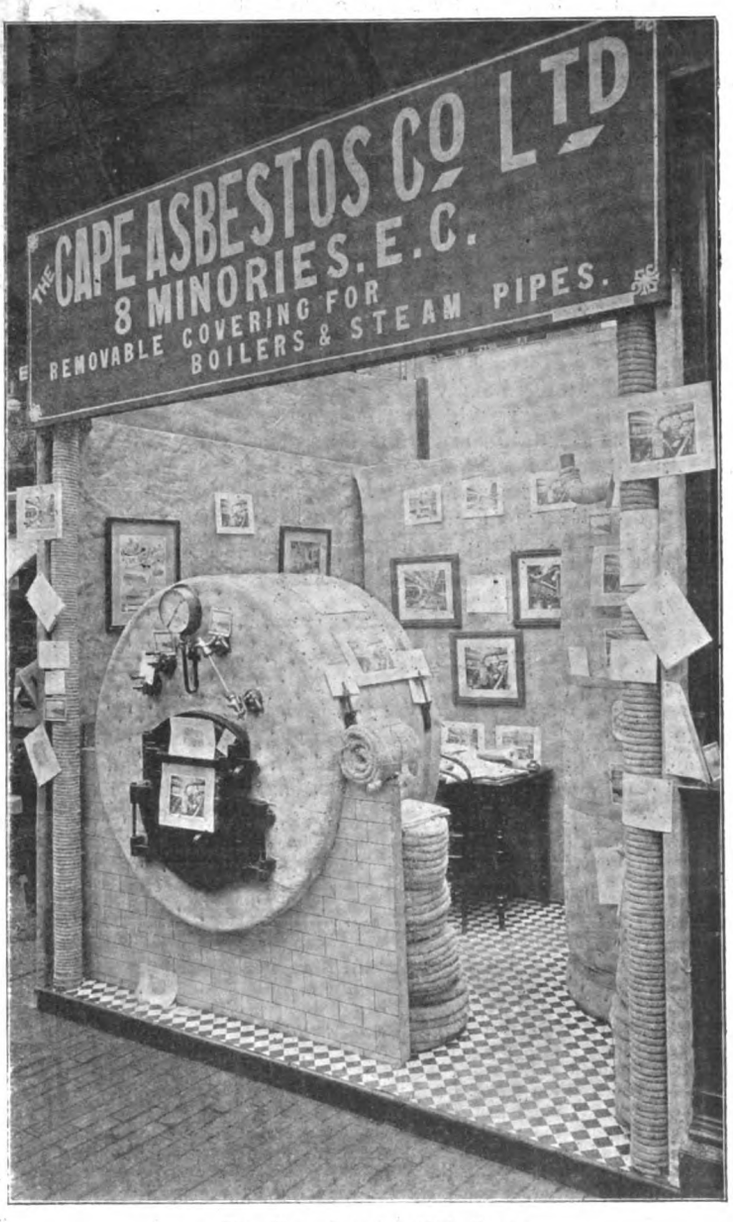
is being done in this direction, and the appearance of an accumulator contained in a tank about 8ft. 6in. deep is no doubt a novelty to many. The Chloride Company are showing a "Double C.R. type" of cell, capable of giving momentary discharges of 4,000 amperes. This type is specially adapted for situations where economy of floor space is a desideratum, the individual plate measuring 16in. by 31in., and the cell occupying only about 30in. by 24in. of floor space. The "C.R." type of plate, which is shown in both lead and lead-lined wooden boxes, measures 16in. by 15½in., and is used where the output required can be obtained without taking up an inordinate amount of floor space. In many cases batteries have to be arranged in cellars or confined spaces, where it is not possible to put them in more than one tier, and in such instances full advantage can only be taken of what space is available by employing a plate of the "C.R." or even "Double C.R." type. The demands on a battery working in conjunction with a traction or power plant are often extremely heavy and may reach the half-hour discharge rate for momentary peaks. Unless the cells are discharged through a booster to compensate for the drop in volts due to the heavy discharge, full advantage cannot be taken of the ability of the cell to withstand these high rates. Highfield's automatic booster, size "B," is shown. It is capable of dealing with peaks of 400 amperes on a 550-volt circuit. The essential differences between this machine and the old-fashioned type of reversible booster, is that by Highfield's method a constant load can be maintained on the generator, and also a constant 'bus bar voltage, with any variations of the line amperes, and the complete charging of the battery can be effected without removing the battery from its work. These advantages are not obtainable by any other method, and the benefit of smaller units, reduction of coal consumption and shorter running hours are self-evident. The simplicity of control is emphasised by a complete switchboard panel alongside the booster, and once the proper adjustments are made on the various shunts depending on the characteristic of the generator with which the booster has to work, no further regulation of any description is necessary. Examples of "C.R." type and double "C.R." type cells for large capacities and heavy discharge rates are exhibited, also samples of cells suitable for electro-pneumatic systems of control, solenoids for surface-contact systems, automatic electric signalling, lighting of car sheds and power stations, &c.

The Electrical Power Storage Co., of 4, Great Winchester-street, E.C., and Millwall, have, at stand No. 82, a very complete and interesting exhibit of the various cells manufactured by them. Of their well-known "P" type there are three large cells, each containing 74 plates. These cells have a capacity of 1,800 amperes for one hour, 900 for 3½ hours, and 540 for seven hours. The plates are arranged in two rows of 37 each, and there is a bar down the middle of the cell connecting all the plates of one polarity together, whilst those of the opposite polarity are connected by means of two bars, one on each side of the cell. This is the largest cell yet made by the E.P.S. Co., who are supplying a battery of the same type, but with 17 plates to each cell instead of 74, to the new electrical system to be used on the "Underground" railway. An interesting feature at this stand was an antimonial alloy crate, into which fitted a thin sheet-lead case, the bottom of which rests direct on a tray. It is claimed for this new type of "box" that it is lighter and much cheaper than the old form of solid crate, and that it is more durable than the lead-lined wood boxes so much in use at the present time. The newest cell made by the E.P.S. Co. is that known as the "O.K." type, and it is specially recommended for traction work. The particular specimen exhibited has 17 plates, and its capacity is 900 amperes for one hour. The plates are 19in. by 18in. by ⅛in., and the external dimensions of the cell itself are 2ft. 7½in. by 1ft. 10½in., by 1ft. 7in. Another cell, known as the "Double P" type, measures 3ft. 4in. high by 18in. by 17in., and is of great advantage when the amount of floor space is limited. Each plate in this cell consists of two "P" type plates suspended one below the other, both being burnt to the same lead strip. These cells are only manufactured in lead crates. The largest cell made for glass boxes is the "W.S. 25" type, having a capacity of 180 amperes for two hours, or 144 for 3½ hours; a specimen is being exhibited. A novel form of connecting bolt just brought out by the E.P.S. Co. is shown, and consists of an ordinary steel bolt covered with antimonial lead. The practice of permanently burning up plates to connecting bars is not always advisable in the case of a very small battery away in some country house, and this new bolt will supply a long-felt want, in that there will be no fear of corrosion, owing to the expansion of the lead covering when the nut is screwed on tight, and thus preventing any acid fumes from getting at the steel and consequently causing a portion of it to fall off and tumble into the cell. It is sometimes necessary to cut out a single cell in order to remedy a slight defect, and considerable expense is entailed in sending a fitter perhaps hundreds of miles with burning apparatus in order to perform some trifling operation which could be



THE CAPE ASBESTOS CO.'S STAND.

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equally well carried out by the battery attendant himself if only a screw connection had been adopted. It might be interesting to observe that the "P. 74" cell previously mentioned weighs about 2,600lbs. when filled with acid. Antimony lead grids are shown for placing at the bottom of the cell in order to hold the tubes in position, thus doing away with the old wooden strip formerly used. The positive plate consists of a pasted shelf grid without vertical ribs and the negative is pasted in the form of rectangular pellets. A cell known as an "E.L. 19" type for motor cars, has a perforated corrugated ebonite sheet between the plates, serving the double purpose of an insulator and also preventing any buckling; this cell is 6⅝in. long by 6¾in. by 11in. high and weighs 43lbs. when filled with acid. Its capacity is 42 amperes for 3 hours, 30 for 5, or 25 for 8 hours. There are also shown cells for X-ray work similar to those which gave so great satisfaction and which rendered such valuable service in the hospitals throughout the siege of Ladysmith.

A diagram giving results of tests on E.P.S. as compared with the new cell by Mr. Edison attracts considerable attention. The curves are plotted in watts per pound and hours, and the E.P.S. traction cell gave 2·25 watts per pound for four hours as compared with Mr. Edison's slightly less than 2·25 watts per pound for 4½ hours. This is interesting when it is known that the Edison cell is three times more costly than the E.P.S. cell taking watt-hours as a basis of calculation.

Last week we described the exhibits of the Cape Asbestos Company, whose blue asbestos removable coverings are used on the boilers and steam-pipes at so many metropolitan and provincial electricity supply and power stations, as well as abroad. This week one of our illustrations is from a photograph of this stand, the exact location of which is indicated in the panoramic view of the exhibition on page 465. Next week we hope to furnish our readers with illustrated and detailed descriptions of a number of important stands, for which we have unfortunately insufficient space this week.

(To be continued.)

DOUBLE-CURRENT GENERATORS.

The following discussion took place in connection with Mr. E. T. Ruthven-Murray's Paper on the above subject at the meeting of the Incorporated Municipal Association on July 2nd. The Paper was published in our last issue.

Mr. C. H. WORDINGHAM thought the author had done a real good service in bringing forward the merits of what were called "double-current" generators. Certainly very little was known of these in this country, and it was rather a surprise to him to find from the Paper that there were already four stations in which these machines were being put down. It would be interesting to know whether the design of these stations was English or whether they hailed from abroad. Personally, he had been very much impressed with the merits of double-current generators for some time, and it was certainly most attractive to be able to have one machine to do everything. The difficulty of reaching the distant portions of an area must crop up sooner or later, and, as Mr. Murray said, they were tempted to deal with the matter by temporary means, because it was not realised how big the thing was going to be. By putting down continuous-current plant in the early days and making provision for the slip rings, they could provide for practically everything later on. Mr. Murray appeared to assume that there was only current which it was worth while to distribute—viz., continuous, and with this he entirely agreed. He was not quite so sure, however, as to the merits of the single station. There were certainly cases in which a single station was the best that could be adopted, and in such cases it did seem to him that double-current generators were quite the right thing. Another matter upon which he would like to congratulate the author was that he seemed to have an open mind with regard to the relative merits of motor-generators and rotary converters. He did not seem to have that extraordinary prejudice which there was in this country against rotary converters, and for which he could not account, and it was useful that the Paper should have shown how much people had to pay for that prejudice—viz., a loss of 5 to 7 per cent. in efficiency, which was a very serious price to have to pay. A rotary converter would do practically everything which a motor generator could, and sometimes most of it better. There was, however, a serious difficulty in regulating the pressure when using rotary converters. If one had a transformer with a number of connections brought out so that the voltage could be varied, the switch gear and the whole arrangements became altogether too cumbersome for use, except in very small sizes. Perhaps the best solution was to keep the loss of pressure in all the lines very small, to have all the sub-stations close together, to employ a heavy distributing network, and have as few low-tension feeders as possible, and on those feeders where it was necessary to have large variation of pressure, to employ boosters.

Mr. A. B. MOUNTAIN (Huddersfield) said that he was naturally in opposition to Mr. Wordingham. The most disappointing part of the Paper was that they got two distinct currents. He would like to have one only, as in his opinion the idea of taking the currents away, and transforming them into something else, would only lead to complications and difficulties. He did not think the simultaneous generation of both alternating and continuous currents would work well, neither did he quite see how the pressure was to be regulated on either side. Supposing, in dealing with an outlying district, it was required to increase the pressure on the alternating side—they did not wish to increase the pressure on the continuous-current side as would be done if they increased the field—he would like Mr. Murray to say how this could be done.

Mr. W. B. ESSON thought a most extraordinary remark on the part of Mr. Wordingham was that continuous current was the only one worth distributing. Recent work in the North had not induced us to believe that Manchester lay in a "sleepy hollow," but this remark was worthy of an electrical Rip Van Winkle. He did not agree with that, neither did he think the remark ought to be put into Mr. Murray's mouth. His own personal opinion was that it was ridiculous to convert from alternating to continuous unless for traction purposes. The author had referred to an interesting application of the rotary converter to balance a three-wire continuous-current system, but had said nothing of balancing a three-phase system. Perhaps he had assumed that there was no distribution by three-phase, and that it was not necessary to go into the question of balancing with a fourth wire—a balancing which did exactly for the three-phase what the three wires of Hopkinson did for the three-wire system—viz., reduced the total amount of copper in the mains by 60 per cent. Induction motors had nowadays improved to such an extent that it would be found they more than compensated for any disadvantages as regards the power-factor not being unity. They could, however, be made with power-factors as high as 0·90 and 0·94, and it must also be remembered that the power-factor of synchronous motors was not always unity. He did not think Mr. Murray's proposal for regulating double-current generators a good one, for the very simple reason that it was necessary to regulate the alternating side quite independently of the continuous-current pressure, and the most obvious way was to boost up or down by passing the alternating current through the armature of a supplementary machine, and excite the field magnets of that supplementary machine so as to raise or lower the pressure at will. This method was already used for regulating the continuous-current pressure of the continuous-current side of rotary transformers. But he protested against converting to continuous current at all.

Mr. H. FARADAY PROCTOR (Bristol), referring to the following statement in the Paper—viz, "If rotatory converters or synchronous motors are to be operated from the circuits, experience shows that the maximum variation from absolutely even angular velocity must not exceed one-fourth of 1 per cent. per revolution"—asked if that law held irrespective of the number of poles or the frequency per second.

Mr. A. S. BARNARD (Hull) thought the author's statement, that the special sphere of usefulness of these machines was in the economical supply of large areas in which continuous current had to be distributed, was quite open to question. Many engineers would say that large areas where continuous current had to be distributed were best served by separate continuous-current stations; others might say that the work would be best done by separate high-tension systems. However, the method appeared to him to solve the problem of having to put down a small continuous-current dynamo and a small alternator side by side, and having to sell them after a few years as scrap. It might be possible to put down a larger machine to do the two functions at the beginning and retain it for a longer period.

Mr. ALBERT GAY (Islington) said the Paper showed that a prophecy which he made many years ago seemed to be on the point of fulfilment. He had been asked what would be the future system of electric lighting, and he had suggested that it would be a high-tension and low-tension alternating and continuous-current system, and there was no doubt in his mind that the double-current generator would have a very great effect in the future.

Mr. LEONARD ANDREWS (Hastings) asked Mr. Esson what was the gain in using a rotary booster for alternating currents over the ordinary stationary booster. Was it merely that the power-factor of the stationary booster was very low, or was there any other gain?

Mr. ESSON said that by the rotary booster system they generated another current in order to increase the pressure of the alternating current.

Mr. ANDREWS asked if the same thing could not be done with a stationary booster.

Mr. ESSON replied that he did not know that it could be done. But he had not considered it.

Mr. F. C. RAPHAEL commented on the general ignorance with regard to double-current generators. He had spoken to a municipal engineer of his acquaintance a few months ago about these machines, and he had been asked what "double currents" were, and how they generated. There was one great educational value in these generators. Up to a few years ago the younger electrical engineers did not trouble much about thinking these things out for themselves. They simply said, "I am an alternating-current man," or, "I am a continuous-current man." Then three-phase transmission with rotary converters came, and now double-current generators, with the result that the young electrical engineers were absolutely bound to think. He would deal with one technical matter in connection with the Paper. The whole point of these double-current machines was to save a machine when starting a new works. In a large area, there was a small district near the works where it was wanted to supply continuous current, and in districts further off alternating currents were required for transforming down, and this was done without having separate machines. But, if, in addition, a balancer was wanted for the continuous-current district,

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it would not have been a much greater expense to put in an alternator and a steam-driven or motor-driven balancer. No other continuous-current machine would be needed to supply the small amount of continuous current at the start. Mr. Murray had said he could use either a rotary transformer or a double-current generator for balancing on the three-wire circuit, but in his diagram he showed the thing mesh connected not star connected, and there was no middle point. Did he mean that one had to put in an extra set of transformers for this purpose,—or three choking coils? He supposed it would not interfere with the main circuit at all if these were put on to the same 'bus bars and star connected? In conclusion, he asked for some further particulars of the methods of regulating which the author intended to employ at Willesden, as he thought this was the most interesting part of the whole question.

Mr. C. F. SCOTT, of the Westinghouse Electric Mfg. Co., of Pittsburg, said that Americans had rather the advantage of the English so far as generators of this type were concerned, as they had been used in America for quite a number of years, in many stations and on quite a large scale. Neither direct-current nor alternating-current could do all that the other could do, and if they could be made to help each other it was valuable. The largest plants for supplying direct currents were alternating-currents plants, and this method was being followed in connection with the large American railways and the Edison Co. in New York. In the latter case the alternators ranged from 3,000kw. to 5,000kw. in capacity, and were something like a dozen in number. One tramway which he knew was being supplied with 600 volts directly from the machines to the trolley wire from a double-current generator, while the alternating pressure was raised up to 10,000 volts and carried to three or four sub-stations. The system was also advantageous where there was a shifting load. In a certain city in America, for instance, the load in the business part of the city disappeared about 6 o'clock, and in the residential portion it came on a bit later, and the use of double-current generators on such a load enabled the system to run on a more nearly constant load than would otherwise be the case. He had also installed small isolated plants on this method which were working quite satisfactorily. As to the efficiency of the rotary converter, this had maintained all the expectations which had been entertained in respect of it, and he was rather inclined to think that it must be somewhat through ignorance in England of the capabilities and excellence of these machines that a prejudice existed in some places aganist them. The induction motor had also been criticised on account of its lagging current. That it did have a lagging current was quite true; but for the work here proposed—viz., the running of the direct-current generator, the conditions were most favourable for making the induction motor work at quite a high-power factor. We were apt to speak of 90 and 95 per cent. load-factor as if it were a very expensive thing such as an efficiency of that mark would be. But the power-factor was not much of a consumer of energy. It was not the running cost, but the first cost which was important. It meant a little larger wire for turning the thing round, and in many cases this extra expense would be a very excellent first investment. The induction motor was the type of apparatus which was most simple and would stand abuse more than any other type of electrical apparatus. It was less likely to get out of order and give trouble, and it was less likely to cause an increase of operating expenses through breakdown. A system with a large number of synchronous motors was essentially a delicate one. If there should happen to be a lowering of voltage at one place there would be trouble, and it would probably shut down the whole plant. This was not the case with induction motors. Under the conditions which prevailed in England there appeared to be a great liking for direct current, and the double-current generator with the rotary converter ought to be of even greater value here than in America, where a large amount of distribution was done by alternating currents.

The PRESIDENT (Mr. John Rider) congratulated Mr. Murray in being what was practically the pioneer in this country of the use of double-current machines, and he wished him every success in the use of them. While he quite agreed with the principles of the author's distribution—viz., the sending out of direct currents in the immediate vicinity of the station and high-tension three-phase currents to distances, he was not altogether in agreement with him that the double-current machine was the right thing for the purpose. A double-current machine was, after all, nothing but what they all knew as a rotary converter steam driven. For a sub-station a rotary converter was hard to beat because it practically had no limit of speed, but when they came to couple this machine up with a steam engine they had another question coming in—viz., the speed at which the combination could be driven. With a 300kw. rotary quite a common speed would be 500 revs. per min., but it would not be possible to couple any engine that they knew of to that and drive it at that speed. It would probably be necessary to bring the speed down to 250 or 200 revs. per min. Then would come the difficulty that it would be impossible to get the right periodicity because the number of poles on the machine would not be sufficient. Or if the number of poles were sufficient to get a 25 periodicity without slowing the speed then they would make a bad continuous-current machine. Therefore, Mr. Murray's double-current machines were practically a compromise between a good dynamo and a good alternator, and he was afraid he would not get a good machine for either. He would have a bad dynamo because of the large number of poles he would have to use to get his periodicity—which would probably mean sparking troubles—and he would not necessarily have a good alternator. Some of the members might remember that he himself had had to tackle the question some few years ago at Plymouth, and he had used a distinct alternator and a distinct dynamo with one engine, with the result that he had the best alternator and the best dynamo, and neither interfered with the other. He also had the advantage of being able to regulate either side without affecting the other, and this was another point in which the double-current generator was liable to give trouble in. In his opinion the little expense which was entailed in putting two separate machines together, each the best of its kind, rather than to have one machine which might not be the best of its kind, was warranted.

Mr. E. T. RUTHVEN-MURRAY, replying, first of all, to Mr. Wordingham's request for the names of the four stations in which double-current generators were being installed, said he had already mentioned two—viz., the Mersey Railway and Willesden. The other two were at St. Pancras and the Trafford Park Estate power house. With regard to the latter, however, he did not know that it was working satisfactorily; he believed it was not, it being an experimental machine on the part of the firm who built it. Several speakers had raised the question of regulation, and Mr. Wordingham had seemed to think that with large transformers the contact switch arrangements would be cumbersome and complicated. But he hardly thought that this need be the case. The dial switch could be mounted on the face of the transformer itself, where it was conveniently out of the way, and the contacts be operated by a small lever on the switch-board platform. As to Mr. Mountain's request for further particulars of the regulation, he did not think it was very difficult to follow what would happen if there were a "home" district and a "distant" one to supply. If the double-current machines were regulated as continuous-current dynamos, and the voltage raised on the home feeders as might be necessary to keep the pressure on the distributors constant, the voltage on the alternate-current end would be raised at the same time, but this latter would be in a higher ratio than the continuous current, and consequently it would be probably necessary to cut down the prime ratio of the voltage on the regulating transformers at the sub-station end. But it might not even be necessary to do that, because there would be a small loss in the feeders at the sub-station end, so that a higher sub-station pressure would be required, in the same way as was necessary in the home district. He did not think there would be any great difficulties. It would be necessary at the distant stations, if working with a large line loss on the low tension, to reduce the ratio of transformation, and not to increase it at the distant end. Mr. Esson practically wished him to admit that he believed in alternating currents for distribution instead of continuous. He could not say that he did. It was very certain that what consumers wanted in this country was continuous current, and he did not think they were wrong in their wants. This had been found all over the country. The same speaker also mentioned that he (Mr. Murray) had said nothing about balancing on three-phase distribution. This subject was hardly germane to his Paper, but there was a good deal to be said upon it. Mr. Esson also thought his system of regulation bad, and preferred to regulate by an alternate-current booster. He knew that this arrangement was in use on the Berlin tramways, but he did not consider it was a good one. First of all, it was necessary to have two machines—viz., a rotary converter, which had alongside it an alternating-current booster. The expense of this was practically the same as a motor-generator, and he did not see that there were any attendant advantages over this which would not be obtained by a stationary booster. Either the arrangement which he proposed or the one which Mr. Andrews had in mind was the best. Mr. Proctor had asked for a larger permissible variation in the angular velocity; this could be allowed, and was one of the many points in favour of low over high frequency. Mr. Raphael had referred to the use of balancers, and thought that the expense attendant on the use of a separate machine rather detracted from the value of his proposals. He had also called attention to Diagram 4, and thought it did not show how it was possible to balance with that machine. It did not. The way he should balance that machine would be to use a mesh-connected primary and a star-connected secondary. It was also possible, he believed, to use a mesh-connected transformer in a similar manner; it had been done, but he did not know very much about it. At the sub-station it was a very simple matter indeed, by having a certain proportion of the rotaries arranged with star-connected transformers and simply to plug on the middle connection to these. The result was that when the machines were started up they only had to take about 1 or 2 per cent. of the full output and balancing was obtained without affecting the voltage on the outers in the slightest degree. He had been struck with the fact that Mr. Scott rather favoured the use of induction motors, and he would like to ask him as to whether his objections to the use of synchronous motors did not apply to a considerable extent to the use of rotary converters, which, after all, were synchronous machines. Could not irregularities on other portions of the system cause the rotaries to be thrown out in exactly the same manner?

Mr. SCOTT said this was so.

Mr. MURRAY finally referred to the president's remarks, which were to the effect that double-current generators would provide neither a good alternator nor a good dynamo. He was not able to stand before the meeting and say he could get this. The machines which were now being built for Willesden were designed three years ago, and the delay had not been his, but he could assure Mr. Rider that from the investigations he had made these double-current machines were good ones, both as alternators and as direct-current machines. Mr. Rider's objections were more theoretical than practical. Personally, he had no nervousness in the matter at all.

Mr. P. N. HOOPER (St. Pancras), in the absence of Mr. Baynes, desired to say that no double-current generators had been fitted in their station, for the simple reason that they could not get a maker to undertake to make a machine with 100 poles and a frequency of 50.

Mr. MURRAY said he was sorry he had been in the wrong in stating this. He was under the impression that he knew the name of the firm to whom the order had been given.

Wireless Telegraph System for Havana.—The steamship "Morro Castle," of the Ward Line, which recently sailed from New York, carried the De Forest-Smythe wireless telegraph system, which is to be installed in Havana. For several hours after sailing, the "Morro Castle" remained in communication with the De Forest-Smythe stations, at Staten Island and Coney Island.

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ANNUAL REPORT OF THE COUNCIL OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.*

During the last year there has been a large increase in the membership, which now comprises 338, made up as follows :—Committees (members), 122; electrical engineers (members), 139; associate members, 12; associates, 65.

Of these, the following 79 have been elected since the last convention :—Committees (members), 24; chief electrical engineers (members), 27; chief assistants (associate members), 6; assistants (associates), 22. Three members, one associate member and one associate have resigned; and five associates have been transferred to full membership.

Council meetings have been held in London, Birmingham, Barrow-in-Furness, Sunderland and Salford.

Repayment of Loans.—The sub-committee appointed to deal with this matter has held a number of meetings, and has also met the Council of the Borough Treasurers' Association, and, as a result of the sub-committee's report to the Council of the Incorporated Municipal Electrical Association, a special general meeting of the members was held at the Westminster Palace Hotel, London, S.W., on February 21, 1902, when the following resolutions were passed :

I. "With reference to the resolution passed by this Association at the Glasgow Convention, 1901, authorising the Council to approach the President of the Local Government Board and the Secretary of State for Scotland with the object of obtaining leave to suspend the operation of sinking fund during the first three years of the loan, and to take such other steps as may be necessary to accomplish this object, this meeting approves the action of the Council in approaching the Borough Treasurers' Association in order to ensure their co-operation, and unanimously agrees that the operation of sinking fund should be suspended for three years from the date of loan, without, however, increasing the period allowed for repayment, and that this suspension should apply also to monies borrowed for the purpose of extensions from time to time."

II. "That in the opinion of this Association, electricity supply undertakings having to be maintained in a thorough state of efficiency out of revenue, no depreciation or further writing off of capital is necessary when the period allowed for repayment of loans is not greater than 30 years, as the equated life of the works exceeds this period."

III. "That with regard to the formation of a reserve fund this Association is strongly of the opinion that such should be formed up to the full limit allowed by the provisional order before any contribution is made in relief of the rates."

Copies of these resolutions were sent to the Borough Treasurers' Association with a request that it would appoint a deputation to join a deputation from the Incorporated Municipal Electrical Association to the Local Government Board on the matter. In the meantime, there being a Select Committee of the House of Commons holding an inquiry on local loans, the Association made application to be heard, and appointed the following members to give evidence on its behalf :—Ald. Pearson, Baillie A. D. Mackenzie and Mr. A. B. Mountain. The Select Committee, however, deemed it sufficient that it had already had the municipal side of the case presented by the Association of Municipal Corporations, one of whose witnesses was the Mayor of Barrow, a member of the Council of the Incorporated Municipal Electrical Association.

Subsequently the Borough Treasurers' Association intimated that it approved of the resolutions passed at a special general meeting of the Incorporated Municipal Electrical Association subject to the following modifications :—

"*Resolution I.*—That the suspension of the repayment of the loan (by sinking fund or otherwise) should be deferred until the opening for use of the works for which the money is borrowed, or until the expiration of three years from the borrowing thereof, whichever shall be the earlier."

"*Resolution III.*—That with regard to the third resolution as to the formation of a reserve fund, the Council desire it to be made perfectly clear that, whilst agreeing with the principle of the establishment of a reserve fund, the amount thereof should be a matter entirely within the discretion of the respective local authorities, as in their opinion it depends to a very large extent upon local conditions."

adding that it would be made known to the Select Committee that the Borough Treasurers' Association supports the views of the Incorporated Municipal Electrical Association upon the subject, subject to the modifications referred to.

Presentation to Ald. Geo. Pearson.—In November last, Mr. Ald. G. Pearson was presented with the illuminated address, unanimously voted to him by the members at the annual business meeting in 1901, in recognition of his invaluable services, particularly in connection with the incorporation of the Association.

Benevolent Fund.—Since the last Convention a sub-committee has been appointed, with Mr. H. Faraday Proctor as its hon. secretary, to consider what steps should be taken to forward the objects of the fund by making it better known to the members, and as a result of the committee's report the following resolution was passed, and is to be considered at a special general meeting of the contributors to the fund, to be held immediately after the annual business meeting of the 1902 Convention :—

"That it be a recommendation from this Council to a special general meeting of the subscribers, to be held after the 1902 Convention, to discontinue the Benevolent Fund and to hand over accrued donations and subscriptions to the like fund of the I.E.E."

* Adopted at the general meeting on Saturday. Abstract.

Wiring Rules.—Mr. H. Faraday Proctor, the representative of the Incorporated Municipal Electrical Association on the Institution of Electrical Engineers' wiring rules committee, has reported from time to time to the Council of the former, the members of which have received copies of the draft rules drawn up by the Institution, and have made a number of suggestions for their amendment, following which, Mr. Proctor has circularised the engineering members of the Association, asking for their opinion on certain points, particularly on the advisability of permitting or requiring the use of switches and fuses in both or all conductors of electrical installations under different conditions. The matter will continue to receive the attention of the Council of the Association until the rules are finally approved by the Institution.

Stand-by Clause.—Mr. S. J. Watson, borough electrical engineer of Bury, having sent a copy of the "Stand-by Clause" which they had been successful in getting through the Committees of both Houses of Parliament, a copy of the clause was sent by the Association to every town clerk and electrical engineer on the list of members. The clause referred to is as follows :—

"That notwithstanding anything contained in the Electric Lighting Acts, 1882 and 1888, a person shall not be entitled to demand from the Corporation a supply of electrical energy to premises having a separate supply, unless such person shall have previously agreed to pay to the Corporation such minimum annual sum as will give to the Corporation a reasonable return on the capital expenditure and other standing charges incurred by the Corporation to meet the possible maximum demand of such person. In case the Corporation and the person demanding such supply of electrical energy shall fail to agree on the amount of such minimum annual sum to be paid by such person, the amount of such minimum annual sum shall be fixed by an electrical engineer to be appointed as arbitrator by the president of the Institution of Civil Engineers.

General Conditions of Contract.—Mr. E. T. Ruthven-Murray has represented the Association on the Institution of Electrical Engineers' committee having charge of the proposed model general conditions for electrical contracts, and copies of the draft conditions approved by the Institution have been submitted to the Council of the Association.

Series Lighting at 500 Volts.—The council has had under consideration the question of obtaining an amendment to the Board of Trade regulations necessary to allow series incandescent lighting at 500 volts, and has appointed the president, with Mr. W. A. Chamen and Mr. J. S. Highfield, as a deputation to approach the Board of Trade on the matter.

Overhead Trolley Wires.—A sub-committee has been appointed to consider the advisability of drawing up a set of rules for the use of the police in cases of emergency. These rules have been drafted and will be presented at the annual business meeting of the Association. The Council has also passed the following resolution :—

"That, in the opinion of this Association, experience has proved the use of guard wires to be a source of danger to the public, and as there are other and more satisfactory means of protecting telegraph and telephone wires, that the use of guard wires should be abolished wherever possible. This Association therefore suggests to the Board of Trade and the Post Office authorities that the proposed regulations should be modified, and that the Board of Trade and the Post Office authorities be asked to receive a deputation from the Association."

The Workshop and Factory Act.—The Council has been approached on the subject of its taking up the question of obtaining some modification of the act to suit the conditions of electric generating stations, but in view of the fact that the Institution of Electrical Engineers was also about to move in the matter, it was resolved to support any reasonable action which the Institution might take.

Vacancies on the Council.—Mr. R. C. Quin, of Blackpool, has resigned his seat on the Council on leaving municipal employ, and Mr. R. A. Chattock, of Bradford, has been appointed in his place. Mr. Councillor Worthington, of Wigan, has resigned his seat on the Council, and Mr. Ald. Potter, of Taunton, has been appointed in his place.

Parliamentary Committee.—The Council has had under consideration the advisability of forming a Parliamentary committee to keep in touch with and to obtain information as to bills before Parliament affecting electrical undertakings under municipal control, and has passed the following resolution :—

"That it is desirable to appoint a Parliamentary committee, which will report from time to time upon clauses and decisions affecting municipal electrical matters."

Generally.—The Council is pleased to find that the Association continues to receive the support of an increasing number of electrical engineers and representatives of municipalities, and takes this opportunity of expressing its appreciation of the kindness extended by municipalities and others to the members at the annual conventions.

THE "CASTELLI" COHERER AND THE "ROYAL ITALIAN NAVY" COHERER: THE END OF A SCANDAL.

BY PROF. ANGELO BANTI.

Our article (in the May number of *l'Elettricista*) on the work accomplished upon wireless telegraphy in the Royal Italian Navy has brought down upon us certain courteous observations to the effect—(*a*) That we have attributed to Castelli a merit higher than that due to the work accomplished by him; (*b*) that we have neglected to speak of the experiments executed at Spezia under the direction of Lieut. Solari; (*c*) that we have erroneously affirmed that

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the coherer adopted by Marconi in his (telephonic) transatlantic transmission was that of Castelli, while the coherer adopted by Marconi was of the type baptised a few days before by the characteristic denomination of the "Royal Italian Navy Coherer." Well, now, since the foregoing observations, however courteous, might constitute an accusation against us, we believe it needful to justify what we have done.

First of all, let us pause to inform our readers that the notes contained in the article of May last were gathered from certain official reports kindly communicated to us by the Ministry of Marine, and were compared with the extract of a memoir by Capt. Quintino Bonomo, which was contemporaneously published in the *Rivista Marittima*. Let us now examine separately the three questions.

I. *The Castelli Coherer.*—Castelli, a semaphorist, corporal in the Royal Italian Navy, was occupied on the experiments on wireless telegraphy which were executed at Livorno under the direction of Capt. Bonomo. Bonomo, in a report sent to the Ministry of Marine, and thence communicated to us, as was said, wrote as follows about Castelli :—

Faithful to the principle of never initiating new experiments before having completed those in course, and in the hope of obtaining with the Marconian apparatus other advantages over those announced, I postponed till later experimenting on telephonic methods of receiving. . . . &c.

But towards the end of January of this year (1901) the insistence of the petty officer, semaphorist Paolo Castelli, urged me to experiment earlier with this system of reception with the telephone.

Furthermore Bonomo observes :—

Castelli asserts that he had first thought of the possibility of telephonic reception in the spring of 1900, and his assertions are to be trusted, since he could not have known of the experiments of Tommasina, nor those of Popoff, since, so far as I am aware, these were only reported by scientific journals which were certainly not read by Castelli.

Capt. Bonomo himself relates the results obtained by telephonic reception, and expresses himself with respect to the Castelli coherer in the following terms :—

The sensitiveness of ordinary coherers being such as to exclude them from use in telephonic reception, recourse must have been had to self-decohering tubes of carbon powder, when *Castelli conceived the use of a tube with electrodes of carbon or iron holding two drops of mercury separated by a short cylinder of iron.* Although this tube was roughly *constructed*, the results were surprising, and on Wednesday, February 20, 1901, not only could the transmission from Palmaria be received, but one could accurately distinguish the rhythm of the oscillator at that station, so as to be able to count the component sparks.

Bonomo finishes by saying that the telephonic method of receiving by means of the Castelli coherer was completely substituted for the Marconian method of receiving. Referring now to the publication made by Capt. Bonomo himself in the *Rivista Marittima*, we find in it, confirmed and completed, what he had already communicated to the Ministry, as may be gathered from the following paragraphs, which, for the sake of precision, we will transcribe :—

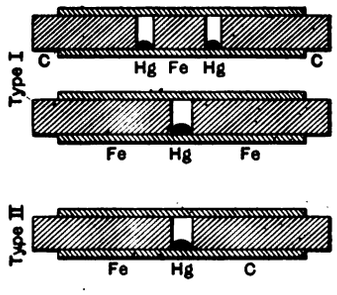
It was our intention to work out completely the studies on the Marconi apparatus before experimenting with the methods proposed by Popoff and by Tommasina, when the desire expressed by the semaphorist Castelli to experiment on telephonic reception with a tube *constructed* by him, impelled us to make some experiments independent of those in progress.

The result was excellent, and the tubes invented [ideati] by Castelli, with electrodes of *iron* or *carbon*, with *one* or *more drops of mercury*, besides presenting an extreme sensibility, decohered perfectly immediately on the cessation of the action of the electric waves, similarly to those of carbon, yet with greater constancy and precision than those possessed or constructed by us.

On page 58 of the same memoir, Capt. Bonomo repeats that the tube was *invented* [ideato] by Castelli, and *proposed* by him for telephonic reception. In conclusion, Castelli *invented* the coherer, *constructed* it, and *proposed* it for telephonic reception. *Eh, via!* Now then, what more could the poor corporal have done?

II. *Solari's Experiments.*—We were not able, in our article of May, to speak of these experiments on wireless telegraphy at Spezia by the personnel of the Royal Navy, under the direction of Lieut. Solari, for two very simple reasons :—The first, because the Ministry of Marine did not communicate to us any Solari report; the second, because Solari himself, with whom we have had opportunity to speak on divers occasions, never informed us, for reasons of military discipline, that he had carried out experiments at Spezia, still less that he had contributed to the construction of a new coherer. Certainly we could not have divined it! But, nevertheless, to-day we are in a position to refer to the studies of Solari carried out at Spezia. It is needful here only to relate that the result of the aforementioned studies was the construction of a tube consisting of two electrodes, one of iron and one of carbon enclosing a drop of mercury. With this design it is useful to call to mind that the tubes invented by Castelli were composed, as we have above related, of electrodes of iron or carbon enclosing *one* or *more* drops of mercury. The difference, then, as the annexed figure shows, between the Castelli tubes, Type I., and that of Type II., called the "Royal Italian Navy Coherer," would consist in this—that in Type I. one electrode of iron should be suppressed and one of carbon substituted. We do not wish to inquire whether the "Royal Italian Navy Coherer" is derived from the other, or whether it is quite one and the same thing as the tube of Type II., since the intelligent reader can draw his own conclusions. For our purpose it is enough to raise the following point : Let us admit that the experiments directed by Bonomo at Livorno and those directed by Solari at Spezia were made secretly and independently of one another, since, as the secrecy of military discipline certainly excludes any exchange whatever of ideas, or still more of notes, between these same officials, it must equally have prevented the experiments of Livorno from being known at Spezia, or vice versâ. For this we have nothing but to rejoice, because it demonstrates the traditional fecundity of Italian genius. But, merely for the sake of accuracy in dates, we are in duty bound to state that the experiments of Bonomo were begun in September, 1900, and yielded on February 20, 1901, the best results, thanks to the adoption of the Castelli coherer; while the experiments executed under the direction of Lieut. Solari were initiated in January of 1901, and were terminated in the summer of the same year.

III. *Coherer adopted by Marconi in the Transatlantic Transmission.*—Lieut. Solari, being sent by the Italian Government to London to acquire some syntonised apparatus, made a present to Marconi of a tube with one electrode of iron, one of carbon, and a drop of mercury interposed. Having it, Marconi asked who had invented this tube ;



Solari answered that this coherer was not invented by him, but was the fruit of the studies made by the Royal Italian Marine. From this came about the characteristic name, "Italian Navy Coherer." But this denomination, which may content Marconi and Solari in London, cannot have any consideration for us in Italy, this baptism of the coherer being a wholly personal affair between Marconi and Solari.

Since in Italy no distinction between Types I. and II. of the coherers was made, the iron-mercury-carbon tube was considered as belonging to Castelli, so much so that the news of the successful transatlantic transmission by means of the Castelli tube was learned by us *at the Ministry of Marine.*

Let us, then, correct ourselves, that the coherer adopted by Marconi ought to be called the "Italian Navy coherer" instead of the Castelli coherer; but let us, nevertheless, honestly avow that we have not published any *false* thing, but that instead there has been raised a question of "*soup and sops*"* for the purpose of concealing some manœuvres to which we are strangers.

And this suggests that . . . . ?

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Elementare Vorlesungen über Telegraphie und Telephonie." By Dr. Richard Heilbrun. (Berlin : Georg Siemens.)

"Die Telegraphie Ohne Draht." By Adolph Frasch. (Leipzig : A. Hartleben.) 5m.

"Transactions of the Académie des Sciences de l'Empereur François Joseph I." Nos. 5 and 6. (Prague : The Académie.)

"Handbook for Street Railway Engineers." By H. B. Andrews. (New York : J. Wiley & Sons). $1 25.

"Transactions of the Institution of Junior Engineers." Session 1900–1. Edited by W. T. Dunn: (London : The Institution.) 10s. 6d.

"Die Internationalen absoluten Masse insbesondere die Electrischen Masse für Etudirende der Electrotechnik. By Dr. A. von Waltenhofen. 3rd Edition. (Brunswick : F. Vieweg und Sohn.) 8m.

* Italian proverb for "a storm in a teacup."

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DOUBLE-CURRENT GENERATORS.

Two and a-half years ago we published two articles on the use and application of generators which would supply both continuous and alternating currents from one armature. At that time these machines had been utilised by the Chicago Edison Co., and had proved an excellent means of dealing with a combined urban and suburban supply district, as it enabled a choice to be made between continuous and poly-phase current for transmission to each portion of the district independently, without there being a necessity for two types of main generator. These two articles elicited from Mr. RUTHVEN-MURRAY an interesting letter, in which he pointed out that these machines had even wider applications than had been described. This letter showed that one English supply-station engineer at least was alive to the advantages of "double-current" generation, and it was with little surprise that we read a few months later, in Mr. RUTHVEN-MURRAY'S report and detailed scheme for electric lighting and traction in Willesden, that he proposed to employ generators of this class at his electricity works. Although it was eventually decided, for local reasons, to abandon or postpone the traction part of the scheme, the main features of the lighting scheme were retained, and we may reasonably hope that two 300kw. double-current generators will be running on a combined three-phase and continuous-current load by the end of the year.

Without casting any reflections on the other Papers read at the meeting of the Incorporated Municipal Electrical Association last week, all of which were well above the average, we have no hesitation in saying that Mr. RUTHVEN-MURRAY'S Paper on "Double-current Generators and their Applications" was by far the most valuable presented this year. In spite of our previous articles, alluded to above, these machines seem to have attracted little attention in this country, although, to judge by Mr. C. F. SCOTT'S remarks in the discussion on the Paper, they have been adopted on quite a large scale in the United States. Mr. RUTHVEN-MURRAY'S Paper was published in full in our last issue, and on another page of our present number we give a full report of the discussion which took place in connection with it. Had these machines been thought of 10 or 15 years ago, the uneconomical employment of the single-phase system of distribution would never have obtained the foothold which it has acquired. At that time the necessity which would arise for large excentric stations had not been realised—except by Mr. FERRANTI in his Deptford station—and the main argument in favour of an alternating-current system was that it rendered accessible those districts which were distant from the station and outside what would be the radius of economical direct continuous-current distribution. After the first partisan ardour of the alternating *v.* continuous-current controversy had subsided, it became accepted that, broadly speaking, continuous current was the thing for dense districts and alternating for "scat-

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tered" districts and large areas. Large districts such as those supplied by the Metropolitan Electric Supply Co. and the City of London Electric Lighting Co., and many large and thickly-populated provincial towns, although dense from the electrical point of view, were classified in the latter category, and endowed with distribution systems on the alternating-current transformer system; and the error in this became accentuated by the increase of lamp-density, the introduction of 200-volt lamps, and, finally, the absolute necessity for placing the supply station outside the supply area in many towns. If the double current system had been recognised at first, it would doubtless have been employed in place of the simple alternating system. The "dense" areas near the works would have been supplied with continuous currents and the more distant parts with alternating currents. This is precisely what Mr. RUTHVEN-MURRAY proposes to do, and what has been done already in the United States. Instead of the more distant areas being supplied with alternating currents directly from the step-down transformers, however, rotary converters are to be inserted, so that these sub-districts are supplied with continuous current also. Moreover, as Mr. RUTHVEN-MURRAY pointed out in the letter above referred to, the system is eminently suited to combined lighting and tramway systems; for the tramways can be supplied directly from the continuous-current side of the machine, while the lighting can be provided for on the alternating-current side through transformers and rotary converters. Finally, the possibility of dispensing with a balancer, by connecting the neutral wire of the three-wire system to the middle point of the transformer feeding a rotary converter or fed from a double-current generator, is a further advantage.

None of these matters are new, but they are not as well known as they should be. The same applies to some of the points of almost elementary theory which are included in the Paper we are discussing. A search for them among text-books will probably be successful, but they will bear repetition. If justification is needed, one need only refer to the remarks of the gentleman from St. Pancras, which appear to indicate that the St. Pancras Borough Council had hoped to obtain a double-current generator for the fairly high frequency of 50 ~ per sec. and yet suitable for driving by an excessively slow-speed engine. Perhaps, however, Mr. HOOPER was not correct in his statement, for it is hardly credible that the St. Pancras borough electrical engineer could hope to obtain what was practically a continuous-current dynamo with 100 poles.

There are many critics of these machines and many prophets of evil. The two points of attack are that, broadly speaking, a dynamo designed to supply continuous current will be troublesome on an alternating-current circuit, chiefly from the different armature reactions produced by the two classes of load; and, secondly, the necessity of running at high speed or having many poles. The first of these difficulties has already been met in the rotary converter, and has been overcome. These interesting machines gave considerable trouble at first, but the cause of their vagaries has now been traced to its source, and hundreds, if not thousands, of rotary converters are now running in daily use. Couple a steam engine to a rotary converter and you have a double-current generator, but the speeds at which rotary converters run are ordinarily greater than those of large reciprocating engines. By employing the lower frequency of 25 ~ per second, however, it is possible to employ a moderate speed and a not excessive number of poles; 250 to 300 revs. per min. is a speed at which 300kw. or 400kw. alternators, as well as continuous-current generators, are run with good results, and, as seen in Mr. RUTHVEN-MURRAY's table, this corresponds to 12 or 10 poles for the generator. We fail to see, therefore, that the particular circumstances should introduce any conditions which cannot be overcome by good and experienced dynamo designers.

Now that these problems have once more been brought to the notice of supply station engineers, we trust that double-current generators will become a feature of modern English as well as modern American electricity works, and that something more will soon be heard of the construction and working of actual machines, not only from Mr. RUTHVEN-MURRAY, but also from others who have been convinced as to their utility.

THE NORMAL SATURATION OF ALTERNATOR FIELDS.

BY R. BEATTIE.

It is usual to speak with more or less indefiniteness of the degree of saturation of the magnetic circuit of an alternator; and as so much in the regulating properties of the machine depends on the degree of saturation, it seems desirable to remove some of this vagueness by defining strictly, and once for all, what is to be understood by normal saturation.

One way toward such a definition lies in a consideration of the relationship between the voltage drop and the voltage adjustability at different excitations. By the voltage adjustability is here meant merely the power of varying the terminal pressure by altering the exciting current. The proper measure of the voltage adjustability will thus be the increment of terminal pressure per unit increment of exciting current, or $\frac{dE}{dI}$.

Now, from the point of view of regulation, one naturally considers an alternator to be good if it has a small percentage voltage drop and high voltage adjustability, but bad if it has a large percentage voltage drop and low voltage adjustability. Hence it is reasonable to take the ratio

$$\frac{\text{Voltage adjustability}}{\text{Percentage voltage drop}}$$

as a measure of what may be called, for want of a better name, the regulation efficiency of the machine.

In general, the regulation efficiency will be low at low degrees of saturation as well as at high, and for some intermediate saturation will have a maximum value. This readily suggests the adoption of *that degree of saturation which makes the regulation efficiency a maximum*, as a useful working definition of normal saturation. In most circumstances the normal saturation, as thus defined, will be the best at which the machine can be worked, though there may, in many instances, be practical reasons for preferring to work at a higher, but hardly ever at a lower value. The normal saturation for a new machine might be predicted by applying the usual methods in vogue for predetermining alternator characteristics. For small machines which can be tested under full load the normal saturation may be determined experimentally. The results of such a test for normal saturation made on one of the small alternators in the electrical engineering laboratory at Owens College may be of interest in this connection. The machine, which is of the revolving field-magnet type, has an armature ring-wound for experimental purposes with six independent phases, one only of which was utilised in making the test. The exciting current was adjusted to a suitable value, and the open circuit volts read. Then the full non-inductive load of 10 amperes was put on, and the terminal volts again read. Finally, the voltage adjustability was determined by slightly increasing the exciting current and noting the increase in the terminal voltage under load, the external resistance remaining meanwhile unaltered, so that the alternator carried its load with it during the small voltage variation.

The curves show how the regulation efficiency reaches a maximum with an exciting current of 0·45 amperes, which is, therefore, the current required to produce normal saturation. The corresponding normal voltage and normal voltage drop are respectively 210 and 9·2 per cent.

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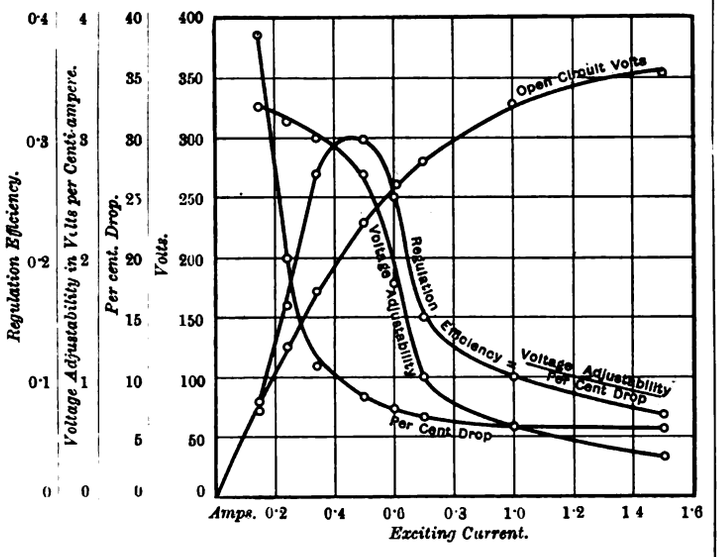
It will be understood, of course, that the regulation efficiency as above defined does not form a strict basis for the comparison of the regulating qualities of different machines; but it is a very convenient way of expressing the degree of saturation in a given machine. Thus from the curves we might say that with the exciting current at 1 ampere the machine is over-saturated to such a degree that the regulation efficiency is reduced to one-third of its maximum. It would be of much interest to know how far the regulation



efficiency of modern alternators differs from the maximum—in other words, to know precisely the degree of over-saturation at which they are worked, the present day tendency being in that direction as far as can be judged from the existing rough and ready way of expressing things.

CORRESPONDENCE.

A REMARKABLE LIGHTNING FLASH.

TO THE EDITOR OF THE ELECTRICIAN.

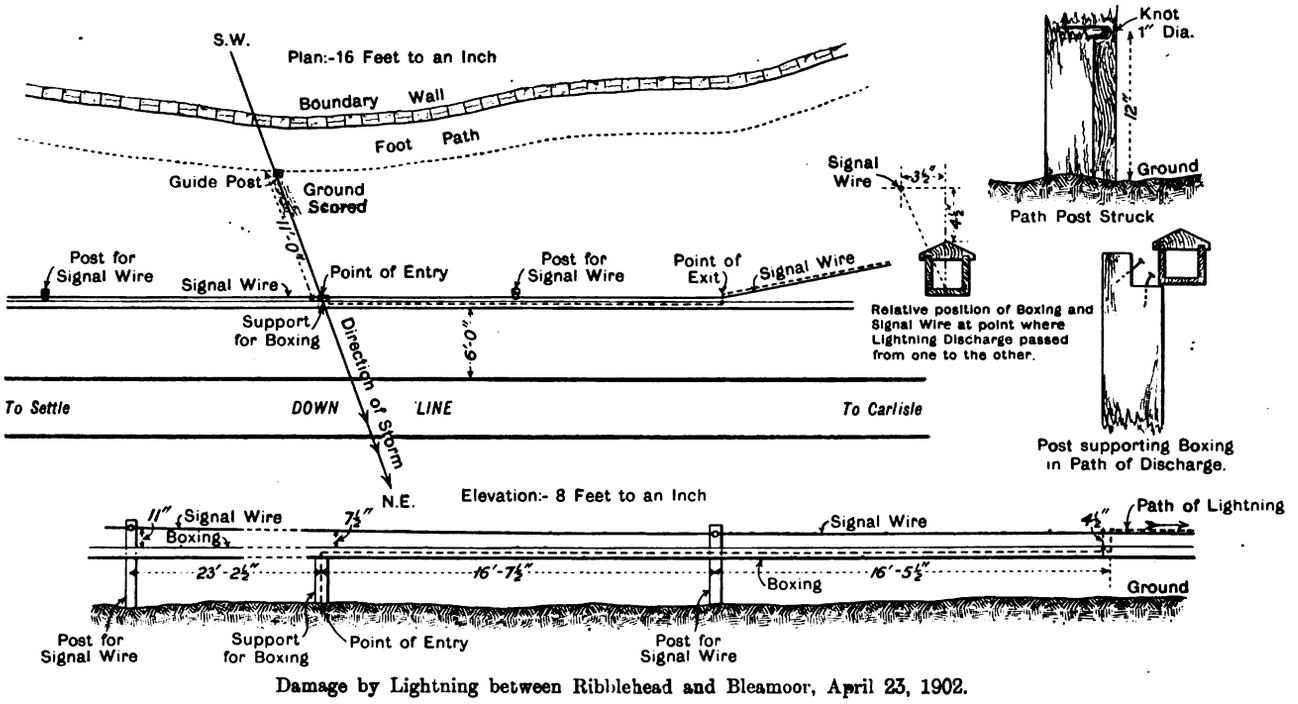
SIR: I have the pleasure to hand you herewith a statement of an interesting instance of damage by lightning.

On April 23 a thunderstorm occurred in the neighbourhood of Blea Moor, a desolate point on the Settle and Carlisle line. At this point a number of gutta-percha insulated telegraph wires, together with a "quad" paper lead-sheathed cable, traverse some wooden boxing mounted on short wooden (creosoted) pillars about 12in. above the ballast. This boxing is 6ft. from the nearest railway metal and nearly 11ft. distant from a guide post which marks the route of a footpath. Near to the boxing is a signal wire—a wire employed to mechanically operate a distant signal. This wire runs nearly parallel with the boxing and at a distance varying from 7½in. to 4½in.

It would appear that the lightning struck the guide post indicated in the plan, and which, it is worthy of notice, is the nearest to the boxing of several guide posts. About a foot from the ground line of this post is a hard knot which passes clean through the post, and is about an inch in diameter. The post would appear to have been struck on the top and shivered into fragments—one portion being hurled some 40yds. or 50yds. in the direction of the boxing, and another portion a similar distance in the opposite direction. The destruction of the guide post did not pass beyond the position of the knot in the post. Apparently the discharge then passed to the ground, the surface of which for a distance of 10ft. is scored, showing the route it followed to reach the nearest support of the boxing. This support it traversed, rending it, and entering the boxing by the nail which fastened it to the support, displacing the boxing from its bearing. The sides and top of the boxing were split open for a distance of 33ft. as though by internal force. At the extremity of the 33ft., the point at which the distance between the boxing and the signal wire is least—viz., 4½in.—it would appear that the discharge left the boxing and passed into the signal wire, which shows signs of fusion at that point. The signal wire, hence in its course, passes under railway metals, with which it is in metallic contact, affording a fairly good earth.

A careful examination of the gutta-percha insulated wires and of the lead-sheathed quad cable, as well as the felt placed over the wires to protect them from excessive heat from the sun, displays the following conditions:—The felt was blackened for about 14in. at either end of the route of the discharge. The lead-sheathed cable showed plainly the course of the current, although careful examination did not indicate that it had been pierced at any one point, nor have the wires which are enclosed in the lead sheath in any way suffered in insulation or otherwise. The impression which the lead sheath offers is that of a hot soldering iron having been applied to it for a distance of about 1½in. at the end nearest to the post which first received the charge.

Only one of the gutta-percha wires presented the appearance



Damage by Lightning between Ribblehead and Bleamoor, April 23, 1902.

of damage—a piece of the tape and percha appeared to be gouged out, but the conductor was not observable, nor has this wire failed in insulation.

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All the wires traversing the boxing in question were connected with plate lightning protectors insulated by mica at either end of the covered work. Five of the lightning protectors were put to earth; three of these were wires enclosed in the lead-covered sheathing of the cable. The lightning protectors were badly blistered—globules of metal between the plates being almost the size of a pea. It is probable that the damage to the lightning protectors was due to discharges passing along the open wires, and has no connection with the case related above, in which it is clear that the lightning discharge entered the boxing at one point and left it at another near by, which afforded a connection with "earth."—Yours, &c.,

Derby, June 27th. W. LANGDON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I herewith forward you two pieces of 200lb. copper wire that have been fused by lightning flash near Coolgardie. This is the second time wires have been fused in this way. This wire was carried on the top insulator on iron poles, and about 16ft. from the ground. The little tears of copper on this are very peculiar, and I thought you might like to see them.—Yours, &c., HAROLD DOWSON.

Western Australia, May 14.

[The copper wires in question certainly show signs of peculiar local heating, causing little globules of copper to be produced in isolated spots.—ED. *E.*]

INDUCTION MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issues of June 20th and 27th there is a very interesting discussion on the relative merits of squirrel-cage and rheostatic rotors of induction motors. Deeming that the question discussed is one of great importance, I should feel much obliged if you would publish the following few remarks:—

Mr. H. S. Meyer opposes Mr. Eborall's opinion, that squirrel-cage rotors should not, as a rule, be used beyond 5 H.P. or 8 H.P., this limit depending upon the starting load. He, on the contrary, strongly argues in favour of a more general use of this kind of rotor, preferably in connection with compensators. I may say, as Mr. Eborall has already intimated, that the difference of opinion shown in this discussion represents the difference between Continental and American practice. It is of interest to note that in the early days of polyphase working the squirrel-cage motor enjoyed the same favour on the Continent as it does now in the States. In the beginning of my (Continental) practice as designer, three phase motors, with short-circuited armature were frequently built for outputs of 20 H.P. and 30 H.P. and even higher, while nowadays such motors are only used in quite exceptional cases.

Mr. Eborall has the merit of having with great skill gathered and published the results of the best Continental polyphase practice. Now, there is scarcely any doubt that, although Americans are leading in long-distance transmission and size of machines, the design of polyphase machinery, excepting rotary converters, has been more carefully studied on this side of the Atlantic. I expect that at some time in the future, when the manufacture and use of three-phase motors is of the same extent in the States as at present in Europe, the difference in opinion concerning the form of rotor will disappear. Mr. Meyer compares the data of two 7½ H.P. motors with the two kinds of rotors, very much to the advantage of the squirrel-cage. Now, I think the two motors are not quite representative of the best practice. The slip of squirrel-cage motors should, at least for standard types, be not less than about 6 to 7 per cent. Otherwise, the starting current will be excessive at any load, the torque being too small at the same time. Polar-wound rotors should have for this output 3 to 3½ per cent. slip. In the motors described by Mr. Meyer the slip is 4·8 and 4·4 per cent. respectively. This fact explains why the efficiency is worse for the polar-wound machine. As a rule, for motors of this size, and still more for greater sizes, the contrary will be the case. In Mr. Meyer's motor the contact resistance of the slip-rings appears to be excessive, owing, probably, to the rotor currents being chosen too heavy—a fault of the design.

Influence on the System.—In this respect, the squirrel-cage motor cannot be compared with the rheostatic one, unless we do as Mr. Meyer does, and compare the one starting light with the other starting against full load. The influence of a squirrel cage motor whose capacity is one-tenth of the generator output, when starting without compensator, will, in most cases, be equal to or worse than the full load of the generator with power-factor 0·8 suddenly switched on. Such is the influence on the generator alone, not to speak of the drop in the mains. Accordingly, in bigger stations a motor of one-hundredth only of the generator output could still produce a drop of about 2 per cent. in the generator, plus a considerable drop in the transformers, mains, &c. These figures are sufficiently expressive; they show that squirrel-cage motors and lighting cannot be fed from the same generators.

Mr. Meyer emphasises the use of compensators, which, in fact, reduce the starting current considerably, but never can compare with the rotor resistances. The handling of a compensator with its switches is certainly no simpler than the starting of a rheostatic motor. The contrary is rather the case.

Now, Mr. Meyer's advocacy of the squirrel-cage motor with compensator depends chiefly upon the better efficiency he claims for it, a claim which in most cases will not hold good.

With the exception of special cases, where slip-rings are not permissible, I am inclined to say with Mr. Eborall that there is no excuse for using squirrel-cage motors with compensators where rheostatic motors can be used, as the latter easily start at any load with little current and have a *higher* efficiency. The efficiency will be equal or smaller only for motors of less than 5 H.P. This is a fact for most standard motors of good design, and in admitting this fact we quite naturally find ourselves to be on the side of Mr. Eborall.

In by far the most Continental lighting stations working on the three-phase system, all motors of 3 H.P. and upwards are required to be of the rheostatic type, and even for smaller motors the regulations are very rigorous as regards starting current. Consequently, the limits for the use of squirrel-cage motors are in this case considerably lower than even Mr. Eborall states.

Mr. Meyer further distinguishes motors (1) starting light, (2) starting with full load, and (3) against overload. My personal experience is that most motors start with overload, a smaller percentage against full load, and very few, indeed, with less than half load. To the latter belong chiefly motors driving dynamos and some kinds of fans, while shafting, tools, &c., generally require a considerable starting energy owing to the inertia of their masses.

While I find so many arguments against Mr. Meyer's recommendation of a more general use of squirrel-cage rotors, it does not mean that I under-estimate its merits in all those special cases where it should be used. I have myself designed motors of several hundred horse power without slip rings and rheostats—motors driving mining pumps and starting simultaneously with the generator. Motors of my design are installed in workshops, where all motors are started and stopped by starting or stopping of one big generator. Squirrel-cage rotors are invaluable for small motors for mining work in general (but with exceptions) and in many special cases, but they never ought to be used where a rheostatic motor presents more advantages, and this can only be decided by experience. Continental experience, which is older and more extensive than American, speaks in favour of Mr. Eborall and against Mr. Meyer.—Yours, &c.,

Alloa, N.B., July 3. ALEXANDER ROTHERT.

DOUBLE-CURRENT GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In view of the interest evoked by Mr. E. T. Ruthven-Murray's Paper on double-current generators, it may be worth while to say that in our power house here, from which electricity is supplied in bulk for distribution by the local authority, in common with the supply of power for our own works, we have two 175kw. double-current generators, one double-ended rotary converter (please do not alter the ortho-

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graphy)—a combination of two double-current machines—and one double-current battery booster.

Our three-wire system is also balanced solely by static polyphase transformers, there being no running balancer.

Our specifications for the plant were issued on June 1, 1900, the generators were ordered August 8, 1900, and were delivered to Messrs. Willans and Robinson's works in April, 1901. They were erected here in September and October, 1901, and the public supply was started December 31, 1901.

We think we can, therefore, claim to have been the leaders of this development in Great Britain at any rate.—Yours, &c.,

THE BRITISH ELECTRIC PLANT CO. (LTD.),
Alloa, N.B., July 7. W. L. Spence, Managing Director.

AN UNDESIRABLE GUEST.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As a member of the Institution of Electrical Engineers I cannot refrain from expressing my regret that so kindly and genial a past-president of the Institution of Electrical Engineers as Prof. Silvanus Thompson should have been subjected to such annoyance as was the case at the conversazione on Tuesday. It helps, however, to emphasise the point that has been a good deal in the minds of many members of recent years, and that is the desirability of raising the tone of the Institution, not only by exercising greater care in the admission of new members, but also of weeding out undesirable persons now on the membership roll. It is to be regretted that Prof. Silvanus Thompson did not ascertain who the person was who treated him in such an insulting manner. It is likely that he had some claim to be present at the conversazione, and should certainly be struck off the roll.

Col. Crompton has recently spoken strongly, with good reason, regarding certain consulting engineers, and has complained that they are a hindrance rather than a help in electrical development. It is common knowledge, too, that certain consulting engineers, members and associate members of the Institution, behave systematically as if there were no such thing as etiquette in our profession, and some of the methods adopted by this touting fraternity are most discreditable. I venture to think that good work might be done in making it impossible for such persons to have any connection with the Institution.

It has recently been suggested that the subscriptions of members should be substantially increased. Personally, I should be happy to pay considerably more than I have done hitherto if the status of the Institution could be raised by the exclusion of these undesirable persons.

In the early days of electrical engineering there was, perhaps, a good deal of excuse for laxity regarding admission to the Institution, but in these prosperous days, which we believe have come to stay, every effort should be made to raise the status of the Institution to the same level as that of the Institution of Civil Engineers.—Yours, &c.,

London, July 4. WALTER P. ADAMS.

PERSULPHURIC ACIDS.*

BY PROF. H. E. ARMSTRONG, V.P.R.S., AND T. MARTIN LOWRY, D.SC.

Although it was observed by Faraday in 1834 that "if the acid were very strong, a remarkable disappearance of oxygen took place" on electrolysing aqueous solutions of sulphuric acid,† it was not until 1878 that its disappearance was at all satisfactorily accounted for by the discovery of *persulphuric acid* by Berthelot.

Only the anhydride, S_2O_7, was isolated by Berthelot, but he concluded that the corresponding acid was formed (1) on dissolving the anhydride in water, (2) on electrolysing strong solutions of sulphuric acid, and (3) by the interaction of hydrogen peroxide and ordinary sulphuric acid. The correctness of these conclusions appears to have been regarded as beyond question after Marshall had discovered in 1891 that well-defined salts of "Berthelot's acid" could be prepared by electrolysing solutions of potassium or ammonium hydrogen sulphate. Doubt arose, however, when Caro, in 1898, discovered that if Marshall's salts were acted on by sulphuric acid, a new acid was obtained having properties markedly different from those associated with Berthelot's acid. "Caro's acid" soon acquired importance as an oxidising agent, owing to the good use that was made of it by Bamberger and by von Baeyer and Villiger.

Having found that Caro's acid liberated iodine very rapidly, whereas Berthelot's acid acted but slowly on iodides, these latter chemists were able to devise a process by which the one acid could be estimated in presence of the other. By removing sulphuric acid by means of barium phosphate, they obtained a solution containing Caro's acid and Berthelot's acid, in which they determined the amount of each of these substances as well as the amount of sulphate to which the persulphuric acids gave rise when decomposed. Their results led them to conclude that the ratio of sulphur to active oxygen in Caro's acid was

$$SO_3 : O = 1 : 1.$$

Placing the simplest possible interpretation upon this result, they assigned to the acid the formula—

$$H_2SO_5 = H_2O_2 \cdot SO_3.*$$

Meanwhile, the problem had been studied from a somewhat different point of view by Lowry and West,† who had determined the equilibrium subsisting between hydrogen peroxide and "persulphuric acid" in presence of sulphuric acid and water, and had found that the ratio which the hydrogen peroxide bore to total "persulphuric acid" was entirely dependent on the ratio which the water bore to the sulphuric acid—the ratio of hydrogen peroxide to "persulphuric acid" being ultimately the same in a mixture prepared from hydrogen peroxide and sulphuric acid as in a solution of equal strength prepared by electrolysis. The experimental curve approximated very closely to a curve deduced from an equation of the fourth order, and assuming that the chief product of interaction was a persulphuric acid of the series $H_2O_2 \cdot nSO_3$, it was to be supposed that it was the fourth term of the series—viz., $H_2O_2 \cdot 4SO_3$. But there were indications that some simpler acid was also present in small quantity.

These results applied mainly to concentrated solutions, 85 per cent. of the change taking place between the limits expressed by the formula $H_2SO_4 \cdot H_2O$ and $H_2SO_4 \cdot 4H_2O$; and virtually no peroxidation of the sulphuric acid took place below the limit expressed by the formula $H_2SO_4 \cdot 6H_2O$. Von Baeyer and Villiger, on the other hand, had dealt with a product existing in dilute solution. The different conclusions deduced from the two sets of results were, therefore, not necessarily discordant; it was possible that the product examined by Baeyer and Villiger had been formed by hydrolysis from the "higher" acid which Lowry and West's observations had indicated was present in concentrated solutions. It is also to be noted that the determination of the ratio of active oxygen to sulphur is sufficient to determine the composition of the acid only in the case of the acid being one of the $H_2O_2 \cdot nSO_3$ series: obviously, other types of "persulphuric acid" are possible.

If we consider what must be the properties of the persulphuric acids generally, it is clear that, whereas the salt of a dibasic acid of the formula H_2SO_5 would remain neutral on withdrawal of the peroxide oxygen, salts of higher acids would yield more or less sulphuric acid when decomposed. As a carefully-neutralised solution of Caro's acid becomes acid when heated, the salt originally present in it cannot be one derived directly from the acid H_2SO_5—assuming that this is dibasic. We are much indebted to Mr. A. J. Cook for having made a long series of determinations which show that the ratio of the increase in acidity to active oxygen lost is

$$SO_3 : O = 1 : 2,$$

a result which finds expression in the formula $H_2S_2O_9$ but is in direct opposition to the formula H_2SO_5; thus, supposing the calcium salt to be used:

$$2CaSO_5 = 2CaSO_4 + O_2$$

$$CaS_2O_9 + H_2O = CaSO_4 + H_2SO_4 + O_2.$$

The probability that the acids in question have the composition suggested is considerable, if the manner in which sulphuric acid may be expected to undergo electrolysis be taken into account. Strong solutions of the acid may be supposed to contain both sulphuric and disulphuric acids, and it may be expected that both would "peroxidise"; on electrolysis the former would give perdi- and the latter pertetra-sulphuric acid, thus—

$HO \cdot SO_2 \cdot OH$	$HO\,SO_2\,O$ $HO \cdot SO_2 \cdot \dot{O}$
Sulphuric acid.	Perdisulphuric acid.
$HO \cdot SO_2 \cdot O\,SO_2\,OH$	$HO\,SO_2 \cdot O \cdot SO_2 \cdot O$ $HO \cdot SO_2 \cdot O\,SO_2 \cdot \dot{O}$
Disulphuric acid.	Pertetrasulphuric acid.

An acid of the formula $H_2S_2O_9$ may be regarded as the anhydro-acid derived from permonosulphuric acid, *i.e.*—as $\left.\begin{matrix} HO \cdot O \cdot SO_2 \\ HO\,O \cdot SO_2 \end{matrix}\right\} O$.

* Paper read before the Royal Society.
† "Researches in Electricity," Series VII., § 728.

* Ber. Deut. Chem. Ges., 1901, 853.
† Chem. Soc. *Trans.*, 1900, 950.

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It is scarcely necessary to say that the interpretation now put upon the data afforded by solutions of Caro's acid will need to be verified, and cannot be accepted as final until salts of the acid have been isolated. This we are engaged in doing.

Further consideration, in the light of the facts brought forward by Baeyer and Villiger and in the present communication, of the results arrived at by Lowry and West, has served only to confirm the conclusion that the chief product of oxidation of sulphuric acid by hydrogen peroxide in presence of less than 50 per cent. of water is an acid richer in sulphur trioxide than perdisulphuric acid, and to justify the assumption on which they based the formula $H_2S_4O_{14}$—namely, that the acid is a member of the series $H_2O_2 \cdot nSO_3$. Lowry and West determined only the ratio of peroxide oxygen to persulphuric oxygen, and paid no attention to the total oxidising power of the solution. That they were justified in this course is apparent from the fact that no change in the ratio of the two forms of oxygen was observed on varying the strength of the peroxide solution from 10 to 40 "volumes," nor was any change observed as the oxydising power gradually decreased when the acid decomposed.

If the main product of the interaction had been an acid of the formula $H_2S_2O_9$, this would not have been the case, as the equilibrium represented by the equation

$$\underset{C_2}{2H_2O_2} + \underset{C_3}{2H_2SO_4} = \underset{C_1}{H_2S_2O_9} + \underset{C_4}{3H_2O}$$

would depend on the total oxidising power of the solution as well as on the proportion of sulphuric acid and water; this is seen most clearly when the equation of mass action,

$$KC_2^2C_3^2 = C_1C_4^3,$$

is transposed into the form

$$\frac{C_1}{C_2} = K\left(\frac{C_3}{C_4}\right)^2 \cdot \frac{C_2}{C_4},$$

which indicates that the ratio C_1/C_2 of persulphuric oxygen to peroxide oxygen depends not only on the ratio C_3/C_4 of sulphuric acid to water and on the concentration C_4 of the water in the solution, but also on the actual concentration C_2 of the hydrogen peroxide. The fact that the equilibrium is independent of total oxidising power can only be explained if the chief products of interaction are members of the series $H_2O_2 \cdot nSO_3$, or hydrates thereof.

As there was no sufficient evidence to justify the assumption that a third persulphuric acid was present in the solutions they examined, Lowry and West had no alternative but to regard Caro's acid as pertetrasulphuric acid, and their simpler member of the series as the acid corresponding to Marshall's salts. The determination of the ratio of sulphur to active oxygen by Baeyer and Villiger has rendered such a limitation impracticable, and we now feel not only that it is justifiable, but that we are compelled to postulate the existence of *at least* three persulphuric acids, viz.:—

Pertetrasulphuric acid	$SO_3 : O = 4 : 1$
Perdisulphuric acid	$SO_3 : O = 2 : 1$
Peranhydrosulphuric acid (Caro's acid).....	$SO_3 : O = 1 : 1$

In carrying out his experiments, Mr. Cook nearly neutralised solutions of Caro's acid by means of a carbonate, and then neutralised the liquid by means of either sulphuric acid or caustic soda, portions being taken out and tested with methyl orange. Measured portions of the neutral solution were run as quickly as possible into flasks containing a little dilute sulphuric acid to arrest decomposition; the persulphuric acids were then estimated by Baeyer and Villiger's method. Portions of the same solution were heated at 100deg. until all oxidising power was lost, and the acidity developed was estimated by caustic soda, using methyl orange as indicator.

Solution I.—This was prepared by digesting potassium persulphate at 60 to 70deg. with a solution containing only 10 per cent. of sulphuric acid. At the end of about two hours the cooled solution was diluted and neutralised with chalk. The amount of iodine liberated at once by the Caro acid present, expressed in terms of decinormal thiosulphate solution, was equivalent to 41·54 cubic centimetres; the amount of iodine liberated slowly by the perdisulphuric acid present was equivalent to 1·05 cubic centimetres. The acid liberated on warming the solution was equivalent to 22·06 cubic centimetres. The calculated amount assuming the ratio $2O : SO_3$ would be $1·05 + \frac{1}{2}41·54 = 21·82$ cubic centimetres.

—	Caro's acid.	Perdisulphuric acid.	Acid liberated.	
			Found.	Calculated.
I.	41·54	1·05	22·1	21·8
II.	38·8	5·91	26·6	25·3
III.	35·0	2·77	20·2	20·3
IV.	39·24	2·24	21·5	21·8
V.	37·3	1·56	21·5	20·2
VI.	49·8	3·43	28·7	28·3
VII.	23·3	0·71	12·2	12·4

In the subsequent experiments 15 grammes of potassium persulphate was digested with from 35 cubic centimetres to 25 cubic centimetres of concentrated sulphuric acid at the ordinary temperature during one to two hours. The solution was then diluted with ice and neutralised: in experiments 2, 3, 4 and 6 with chalk, in 5 with sodium bicarbonate, and in 7 with sodium carbonate, using phenol phthalein as indicator. In experiment 7 the solution was mixed with excess of caustic soda before warming it to decompose the per-salts, and the excess was subsequently determined. No hydrogen peroxide was present except in solution 5, in which case the amount was determined by permanganate and allowed for.

PHYSICAL SOCIETY.

At the meeting of the Physical Society on June 20th, Prof. S. P. Thompson, president, in the chair, Mr. G. F. HERBERT-SMITH exhibited the

Three-Circle Goniometer

recently constructed for the British Museum from his designs. In this form of goniometer the advantages of the earlier forms are combined; as with the two-circle or theodolite goniometer, a crystal is only once adjusted during the whole of the observations, and as with the one-circle goniometer observations are made in zones, and full advantage may be taken of the zonal characters of crystals and of the simple formulæ depending thereon. The instrument is an improved form of a similar one designed by the exhibitor in 1899. In place of the usual telescope and collimator an auto-collimating telescope is employed, and a prism is placed before the object-glass so that the line of reference is horizontal and at right angles to the axis of the telescope. In this way it is possible to obtain a reflection from a face parallel to, and on the side of, the crystal towards the vertical circle, and measurements may be made in a zone across the end of the crystal by rotation of the horizontal circle only.

Prof. EVERETT asked whether the reflection was at normal incidence. If so, was not the light very much enfeebled?

Mr. APPLEYARD drew attention to the method of reading the scales by micrometer eye-pieces, thus saving the use of verniers.

Prof. PERRY suggested that the instrument should be made of nickel steel alloy of low coefficient of expansion. This alloy is now manufactured in England, and is quite cheap.

Mr. HERBERT SMITH, in reply to Prof. Everett, said that the image obtained at normal incidence was faint, but it was much more distinct than images obtained with other angles of incidence.

A Paper

"On the Heat Evolved or Absorbed when a Liquid is brought in Contact with a Finely-divided Solid"

was read by G. J. PARKS. Pouillet discovered the fact that when a powder is put into a liquid which does not exert any solvent or chemical action upon it, there is, in general, a rise of temperature. The objects of the present investigation were to obtain a relation between the quantity of heat evolved and the area of the surface exposed, to find the rate of variation of heat evolved with temperature, and to apply to the results the laws of thermodynamics. In making any experiment on the Pouillet effect it is essential that the powder should be perfectly dry, and that it should be at exactly the same temperature as the liquid. The precipitated silica, sand, or other substance to be experimented upon was heated to a dull red heat and placed in a bulb whilst still hot. The air was then exhausted, and the bulb sealed. In making an experiment the bulb containing the powder was broken under the surface of the water in a calorimeter, and the rise of temperature noted. The average diameter of the grains of powder used was obtained by measurement with a microscope, and on the assumption that the grains were spherical the surface of the mass of the powder used was calculated. From the results of his experiments the author states that when silica, sand, or glass is brought into contact with water at approximately constant temperature, the heat evolved is proportional to the area of the surface exposed by the solid, and the amount of heat developed per square centimetre is approximately 0·00105 calorie when the temperature is near 7°C. Assuming that the phenomenon of Pouillet is reversible, and that it is due to a pressure at the surface of the powder, the author has, by the application of the laws of thermodynamics and the results of his experiments, arrived at the conclusion that at 7°C. the surface-pressure of water and silica diminishes at the rate of 158 dynes per centimetre for an increase of temperature of 1°C. Experiments made at different temperatures indicate that the heat evolved is roughly proportional to the absolute temperature. Experiments were also made which showed a fall of temperature on putting a finely-divided solid into mercury.

Prof. EVERETT said the research was a valuable contribution to our knowledge of the Pouillet effect. The results were consistent in showing a generation of heat to the amount of $\frac{1}{1000}$th of a therm per square centi-

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metre of increase of surface of contact between the water and the silica. He thought this heat must be due to diminution of volume in the water film; for extension of area of a liquid film tended to produce cold. Cold was, in fact, produced by enlargement of the surface of mercury in the concluding experiments.

Mr. J. MACFARLANE GRAY said that the Paper was to him peculiarly interesting, because satisfactory explanations of the phenomena described could be obtained by substituting the universal dynamic pressure of a corpuscular ether for the unthinkable universal attraction of matter. He gave an example to illustrate what he calls the metafilm at a surface, and pointed out that it is necessary to consider both the matter-volume and the meta-volume of bodies to get at the explanation of physical phenomena. In the author's experiments there is a diminution of meta-volume, and the ether produces heat equal to the product of the ether pressure and the volume of the cancelled metafilm, just as the heat of evaporation is reproduced when steam is condensed. The experiments were to him not a surprise, but a confirmation of his views.

Mr. R. S. WHIPPLE said that the Pouillet effect could be shown by covering the bulb of a thermometer with muslin and putting it into a steriliser. On taking it out and immediately placing it in the mouth there is a considerable rise of temperature. He had tried covering the bulb with dry muslin, and obtained a rise of 2°C. by putting the instrument into water.

Mr. J. H. GARDINER drew attention to the necessity of heating the powdered silica to red heat in order to get rid of moisture. If possible, the silica should be heated in the actual tube and sealed up whilst hot.

A Paper by Prof. R. W. WOOD,

"On a Remarkable Case of Uneven Distribution of Light in a Diffraction Grating Spectrum."

was read by the secretary. It is a well-known fact that in the spectra formed by diffraction gratings the light is unevenly distributed, that is the total light in any one spectrum will not recombine to form white light. The author has been examining a most remarkable grating in which the drop from maximum illumination to minimum occurs within a range of wave-lengths not greater than the distance between the sodium lines. In other words, the grating at a certain angle of incidence will show one of the D lines, and not the other. Experiments with polarised light have proved that these anomalies are only exhibited when the direction of vibration (electric vector) is at right angles to the ruling. The Paper gives a detailed account of the appearance of the spectra at different angles of incidence when the grating is in air and when it is immersed in different liquids. It is shown that the phenomena are not due to interference between disturbances coming from widely separated lines, and the author suggests that the matter must be referred to the form of the groove.

A Paper by Prof. R. W. WOOD,

"On the Electrical Resonance of Metal Particles for Light Waves" (second communication),

was read by the secretary. In a previous Paper the author has shown that granular deposits of the alkali metals exhibit brilliant colours by transmitted light. These colours were referred provisionally to the electrical resonance of the minute particles for light waves. The present Paper gives an account of experiments made with gold and silver films to determine whether the resonance is molecular, or whether it is an electrical vibration of metallic masses, smaller than the light waves, though of the same order of magnitude. Further investigations on the dispersion of the films and a more careful study with polarised light will doubtless throw light on the matter.

Prof. H. L. CALLENDAR showed a

"Simple Apparatus for Measuring the Mechanical Equivalent of Heat."

A cylindrical brass calorimeter is rotated by hand about a horizontal axis at a moderate speed. Unequal weights are suspended from the ends of a belt slung over the cylinder. Stability of equilibrium is secured by making the two halves of the belt of different materials and connecting the side having the smaller coefficient of friction to the larger weight. The weights are adjusted by trial to suit the friction of the belt, and may be varied within wide limits, provided that the ratio is kept nearly the same. The advantages of the methods are: (1) The friction is very nearly independent of the speed. (2) The balance is automatic; the belt immediately adjusts itself to any change of load or friction. (3) There is no change in the thermal capacity of the calorimeter with change of speed or load. (4) There is no pull or bearing-friction to introduce errors. (5) There are no forced vibrations, and no dashpot is required. (6) The actual torque may be measured statically if desired. The rise of temperature is observed by means of a bent platinum thermometer inserted through a hollow axle on one side. The external loss of heat can be eliminated by Rumford's compensation method, or by performing two experiments with different loads on the belt. The motion of the surface of the calorimeter elimiminates the effect of draughts and convection currents, so that the heat loss is much more regular than if the surface were at rest.

The society then adjourned until October 24, 1902.

THE REPAYMENT OF LOCAL LOANS BY LOCAL AUTHORITIES.

The report of the Select Committee of the House of Commons appointed to consider the subject of the repayment of loans to local authorities has just been issued. The Committee was instructed to enquire and report as to the statutory and other conditions limiting periods for the repayment of loans raised by local authorities in the United Kingdom, whether any relaxation of such conditions was desirable, and whether uniformity of practice could be secured in the matter. The following members constituted the Committee: --Mr. Bill, Mr. Brigg, Captain Donelan, Mr. William Jones, Mr. John Hutton, Mr. Heywood Johnstone, Mr. Bonar Law, Mr. Grant Lawson, Mr. A. K. Loyd, Mr. M'Crae, Mr. Charles Murray, Mr. Nannetti, Sir Albert Rollit, Mr. Runciman and Mr. Wodehouse.

From the evidence collected from all the Government departments in the United Kingdom, it appears that the policy of Parliament has been for many years to require that local loans should be repaid within a limited number of years, and each general statute conferring borrowing powers specifies a maximum period (from 10 to 60 years in England and Wales), for the repayment of the loans. Within these limits, discretion to decide the exact term for the redemption of each particular loan is, as a rule, in England and Ireland, left to the Government department specially concerned in the matter. London is an exception, however, for in the case of most of the loans raised by metropolitan boroughs the discretion is, in the first instance, exercised by the London County Council. The Local Government Board, upon whom the greater part of the work of controlling the borrowing of local authorities falls in England and Wales, has a staff of engineers and medical inspectors amongst whose duties it is to hold local enquiries into the circumstances in which the loans are required. At these enquiries the question of the probable durability and continuing utility of the work is gone into by the inspectors, who, together with the chief engineer inginspector, advises the Board as to the period for which the loan should be sanctioned. The Local Government Board and the Board of Trade examine each item of the estimates and assign to each group of items an appropriate term for the repayment. In order to avoid a multiplication of separate loans, however, it is usual to grant an equated period for the whole of the loan. This is arrived at by considering the sums required, and the term assigned to each group of items. When the groups are large, however, and the local authority expresses a preference for separate loans, these are granted. The Local Government Board, which is charged with the general supervision of local finance, in fixing the redemption period, takes into consideration the probable future condition of the localities with regard to debt, and not only the probable useful life of the undertaking.

By a Standing Order, passed in 1882, the maximum period for a loan granted by means of a private bill is fixed at 60 years. This Standing Order can be set aside by a special instruction from the House, but the Committee had not been informed of any case in which such an instruction has been moved. In the case of bills of local authorities which contain loan clauses, the Government department specially concerned prepares a report to assist the Committee to which the bill might be referred, and subsequently the Private Bill Committee had to report in what manner these recommendations had been dealt with. There is also a Standing Order (No. 172) which provides that in the case of bills whereby local authorities are authorised to borrow money for any matter within the jurisdiction of the Board of Trade or the Local Government Board, estimates showing the proposed application of the money for permanent works (excepting so far as the borrowing power is made subject to the sanction of the respective board) shall be recited in the bill, and proved before the Select Committee. The Committee are of the opinion that this Standing Order is not satisfactorily complied with in many cases.

In Scotland most public acts specify a maximum period of repayment, and within that period the local body is entitled to proceed as it pleases in the matter of raising loans. This enables them to spread, what in England would be a short loan, over the maximum period of 30 years; but from the evidence given before the Committee it appears that this is not often done.

With slight points of difference, the conditions of limiting the period for repayment of loans in Ireland are on the same principle as those in force in England.

The report then points out that the witnesses on behalf of local authorities were mainly concerned in watching over the financial interests of present ratepayers. It being found impossible to obtain the assistance of any witnesses concerned to a similiar degree in the interests of posterity, the claims of posterity were fully stated by representatives of the Government departments. The report adds—"Posterity may derive advantages of a moral and physical character from some portion of the expenditure of the present day. It is not possible to set any accurate pecuniary value upon those advantages. On the other hand, the additional sums which the ratepayers of the future will have to pay in cash if the periods for repayment of loans are extended can be arrived at with mathematical certainty."

The three principal modes of repayment prescribed by the general law and the majority of local acts are as follows:—

i. By equal annual instalments of principal, together with interest, on the sum remaining unpaid—*i.e.*, by what is called in this report the instalment system.

ii. By equal annual instalments of principal and interest combined—*i.e.*, by terminable annuity.

iii. By setting apart and accumulating, at compound interest, a sinking fund.

The report then goes on to consider the recent growth of local indebtedness due to what is sometimes called Municipal Trading, but which the Committee prefer to call Reproductive Work. It has not been thought to

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be within the terms of reference to attempt to ascertain whether, in point of fact, such work generally produces pecuniary profit.

The Committee have considered the question of the proper date for the payment of the first instalment of the sinking fund. As a general rule, such instalment should be paid within a year of the borrowing. The Committee, however, think that that requirement need not be insisted upon in the case of a loan for new works from which a cash return may be reasonably expected when they are completed; and that in that case the payment of the first instalment may be properly deferred during some portion of the time allowed for the construction of the works.

Some local authorities desire, in the case of reproductive works, not only to defer the payment of the first instalment in respect of capital, but also to pay interest during construction out of the money borrowed. This would relieve those whose representatives decide to borrow for such works from immediate liability to contribute anything in respect of the borrowing, and should not, in the opinion of the Committee, be ever permitted. During the construction of works the district has in many cases the advantage of the expenditure within it of much of the money raised by the loan, and this may fairly be taken into consideration as some compensation for the fact that nothing is being earned by the works in the interval.

The Committee recommend that the Local Government Act of 1888 should be amended by the substitution of 60 for 30 years as the maximum period for the repayment of loans under that act. This will remove the anomaly caused by the fact of the maximum period under the Public Health Act of 1875 being 60 years, the effect of which is that whereas at present an urban district council can obtain a maximum period of 60 years for the repayment of its loans raised under the Technical Instruction Act of 1899, a county borough council or town council is limited to 30 years for that purpose.

The Committee have also had their attention called by several witnesses to the maximum period of 30 years fixed by the Tramways Act of 1870 for the repayment of loans raised under that Act, and have been strongly appealed to to recommend the increase of that period. The fact that the Light Railway Commissioners are empowered to sanction—and do after full inquiry sanction—periods for repayment greatly in excess of 30 years was urged in support of this appeal. Several instances have, however, been laid before the Committee in which the money borrowed under the act has been expended on subjects which have become worn out or obsolete before the loan in respect of those subjects has been completely repaid. Even with regard to permanent way, in respect of which a period of 30 years for repayment has always been allowed by the Board of Trade, the Committee have been informed that in some instances where local authorities took over lines under their compulsory powers after 21 years, the lines were found to be partly obsolete and partly worn out, so that reconstruction with new materials was indispensable. In view of the very remarkable progress which has been recently made in methods of mechanical traction and the probability of still further developments in the near future, the Committee are not prepared to say that the periods which the Board of Trade are able under the present law to fix for the repayment of these loans for tramway lines and equipment are too short, and they do not recommend any alteration of that law.

The Committee consider that it is the duty of a department, in deciding the question of the period for repayment as apart from the question of whether any loan should be permitted, to consider more closely the durability than the desirability of the works or purposes for which the loan is required, and to use very considerable caution in fixing such period. It appears to the Committee impossible to suggest any more thorough method of arriving at the necessary calculations in the first place than the local inspections and enquiries now held by the Local Government Board and some other departments before they sanction a loan.

The Committee further recommend that the sanctioning authority should be empowered and required in all cases to fix the manner in which repayment is to be made.

Some of the witnesses who gave evidence on behalf of the larger corporations assured the Committee that a repairs or depreciation fund is provided by them in respect of most of their undertakings, but a return obtained by Sir H. Fowler in 1899 shows that over an average of five years the average annual contribution to such funds in respect of the debts which are called in that return reproductive debts only amounted to one-tenth of 1 per cent. The Committee recommend that power should be given to the sanctioning authority to make it a condition of their sanction that provision should be made for the probable annual average cost of repairs during the currency of the loan. Compliance with this condition should be in all cases enforced by Government audit.

If the recommendations contained in the last two paragraphs are adopted, the Committee are of opinion that the caution at present exercised with regard to the periods for repayment might be to some extent relaxed.

The Committee are satisfied from the evidence placed before them that there is no general demand in Scotland, apart from the question of housing, for any alteration of the statutory or other conditions limiting the period for the redemption of loans.

Finally, in cases in which loan clauses must be inserted in private bills, the Committee recommend that the Committee dealing with such clauses should either require very detailed evidence as to the exact character of the purpose to which every part of the loan is to be applied, or—in the absence of such evidence and means of testing it—settle a maximum period for the repayment of such loan, and leave the exact term within that maximum to be decided by the appropriate Government department.

The following is a summary of the Committee's recommendations so far as they may have a bearing on electrical works:—

The maximum periods for repayment of loans under the Municipal Corporations Act, 1882, Local Government Act, 1888, and the Municipal Corporations (Ireland) Act, 1843, should be extended to 60 years.

Some postponement of the payment of the first instalment should be allowed in the case of certain works.

The sanctioning authority should be empowered to fix the method of repayment in all cases, and to provide for the establishment of a repairs fund where necessary.

Private Bill Committees should, except where they undertake detailed inquiry, leave the fixing of the exact periods for repayment to a Government department.

Five years should be the ordinary maximum period for repayment of loans for the cost of promotion of private bills.

INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

MISCELLANEOUS EXHIBITS.

(*Continued from p.* 442.)

Carbons, Carbon Brushes, &c.—At the stand of Le Carbone (No. 96) is a compact and varied display of carbon brushes, carbon contacts and microphone carbons. The carbon brushes are of the types known as Z and X, which are of high conductivity make. A large number of types of tram-motor brushes is shown. In carbon contacts a number of different patterns are exhibited, suitable for switches, motor starters, controllers, &c. The carbon is particularly hard and refractory to the action of sparking. A large collection of cups, discs, pellets, powder, &c., is shown in the microphone carbon section of this exhibit.

Car Wheels, Axles, Brake Shoes, &c.—At the stand of Messrs. Miller & Co. (No. 49) there is shown an excellent assortment of chilled car wheels, axles, brake shoes, wheel presses and similar goods now used on a considerable scale in tramway and light railway car construction and working. Another firm which has a fine show of wheels and axles is the British Griffin Chilled Iron & Steel Co., whose large exhibit at stand No. 56 is an attractive display, and shows the extent to which this company can handle orders for this class of manufacture. Griffin wheels are largely used on home and colonial railways. At stand 45B the Bergish Steel Foundry, for which Mr. E. Freund, 39, Victoria-street, London, S.W., is agent, has also a good show of wheel bodies, wheel sets, &c., of special types of manufacture, together with a quantity of electrical plant, apparatus and material elsewhere described. An exhibit of electric tramcar and all kinds of railway wheels is made by Messrs John Baker & Co. (Rotherham) at stand 65, where a number of registered designs in wheels for electric tramcars is shown. At stand 85, Messrs. Hadfield's Steel Foundry Co. show special types of car wheels with cast-steel centres and fitted with rolled steel tyres. A set of Hadfield's car wheels is shown which for every $\frac{1}{8}$in. wear per side have gone a mileage of 5,000 miles, and although only half worn through have run over 35,000 miles.

Electric Drills.—At their interesting stand, No. 80, the United States Metallic Packing Co. show a portable electrical drilling machine suitable for holes up to $1\frac{1}{2}$in. diameter, which can be worked on a continuous-current circuit up to 500 volts. The motor for driving this drill is $1\frac{1}{2}$ B H P., and takes approximately 1·3 units of current per hour, the use of angle joints and flexible or telescopic shafts being dispensed with. Power is transmitted from the motor to the drill-head by means of a long shaft having a keyway into which a key fits on the inside of the hollow shaft forming part of the spur wheel running in gear with the pinion on motor. Instantaneous control is provided by a switch on the drill head. The drill is claimed to have a great range of usefulness. Drills operated by steam or air are also shown on this stand.

Fare Collectors and Checking Devices.—Messrs. J. Kaye & Sons show on stand 61 their patent fare collector, as used on the Leeds City tramways, and a cancelling punch is shown by Messrs. T. J. Whiting & Sons at stand 71. A good assortment of tramway tickets is also shown by the last-mentioned firm.

Glazing.—Several excellent exhibits are made of patent systems of glazing for car shed and depot roofs, &c. The exhibit of Messrs. Mellowes & Co., at stand '72, is particularly interesting in this respect, this system having had exceptionally hard-wearing tests for the past 20 years. The Mellowes system of glazing is perfectly water-tight, is imperishable and is unaffected by atmospheric action or by the sun's heat. At Messrs. Helliwell & Co.'s stand, G 148, the "Perfection" system of glazing is shown. A large area on this system has been erected at the leading railway stations at home and abroad. Mr. Sam. Deards, at stand G 151, shows a system of patent glazing that is claimed to be specially adapted for car sheds, electric power stations, engineering workshops, &c. This is provided with a self-locking bar, which saves the drilling of holes and obviates the presence of woodwork, rendering roofs fireproof and practically imperishable.

Insulators.—Special types of insulators for overhead trolley, telegraph, telephone and other electrical working are shown by a number of leading firms, including Messrs. Johnson and Phillips (No. 26), the General Electric Co. (1900) at stand 34, the Electric Tramway

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Equipment Co. at stand 39, the Electric Railway and Tramway Carriage Works at stands 47 and 48, Messrs. Doulton & Co. at stand 51, Messrs. R. W. Blackwell & Co. at stand 53, the Harburg India Rubber C. Co. at stand 63. This firm show a patent link and double link insulator, a new departure in overhead trolley insulators designed to keep down the weight of this article while still preserving great strength and insulation. Very large numbers of these insulators have been supplied. Messrs. Estler Bros., at stand 66, show their special types of insulators of different patterns.

Locks and Catches.—Messrs. J. Kaye & Sons show at stand 61 a number of patented locks with safety catches and patent inside and outside handles, similar to those used on most of the leading English railways, and also Kaye's patent automatic sliding door-latch for tramcar entry and exit doors, and for railway corridor carriages. Leeds Corporation have these sliding door-latches fitted to their tramcars.

Oil-cans.—At stand 61 Messrs. J. Kaye & Sons have also a display of these goods, for which their name is familiar in engineering circles and, in fact, wherever oil-cans are necessary for running machinery or for locomotives and other vehicles.

Metallic Packing.—A fine display of working models of actual packings is shown at stand No. 80 by the United States Metallic Packing Co. This company state that 140,000 packings of this class have been supplied for service upon all classes of steam engines during the past 25 years, and that in some 70 electric lighting and power stations 600 of these packings are at work. It is also fitted at some of the principal electricity generating stations on the Continent, including those at Berlin, Paris, Frankfort, Cologne, Lille, and Bordeaux.

(*To be continued.*)

PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

The Standing Orders Committee of the House of Commons, presided over by Mr. Halsey, sat on Tuesday to consider the cases of the London United Electric Railways, the Piccadilly-City, and North-East London Railway Bills, which had been reported by Mr. Campion, one of the examiners, as having failed to comply with the requirements of the House of Commons Standing Order No. 3. Mr. Greg and Mr. Bell, Parliamentary agents, appeared for the promoters, who prayed that the standing orders might, in the particular circumstances, be dispensed with ; and Mr. Cripps, of the firm of Messrs. Dyson & Co., represented the Brompton and Piccadilly-Circus Railway Co. and the owners, lessees or occupiers of houses along the streets to be traversed by the proposed railways, who urged that the report of the examiner should be upheld. It will be remembered that an agreement had been entered into by the promoters, during the consideration of the bills before Lord Windsor's Committee, providing for through bookings and fares, and for traffic facilities over the combined railways. This agreement, having only been arrived at when the bills were already before Parliament, was not covered by the notices published by the promoters in November last, as was required by the standing order. Mr. Campion, in his report to the Committee, said he regarded the point at issue not so much as a matter between the parties, or even between the promoters and the public, but as a question between the two Houses, inasmuch as the present form of the bills embodying the agreement was the result of a compromise between the competing parties, which was sanctioned by Lord Windsor's Committee. (See last week's *Electrician*, p. 443.)

The Committee, after consulting in private for three-quarters of an hour, decided that the necessary Parliamentary requirements should be dispensed with, and that the combined bills should proceed to their further stages.

THE RHONDDA VALLEY TRAMWAY BILL.

The consideration of this bill was resumed on Friday last by the House of Commons Committee presided over by Mr. Tatton Egerton.

Mr. Granville Baillie, electrical engineer, Mr G. T. Simmering, chief engineer to the railway company, and Mr. Ammon Beasley, general manager, also gave evidence against the bill.

Mr. PEMBER, K.C., then summed up the case for the Taff Vale Railway Co. He said for the first time a system of railways was proposed to be enveloped by a series of competitive tramways lying alongside the system mile for mile along their length of 20 miles. The present time was most inopportune for forcing upon a railway company an entirely new competition. The tramways should be managed on commercial principles.

On Monday, July 7, Mr. PEMBER concluded his address. He pointed out that the Rhondda valleys were extremely unattractive to strangers, and that holidays were altogether against the tramways, because the population at these times went out of the district altogether.

Mr. BALFOUR BROWNE, K.C., replying on behalf of the promoters, said that the district was an ideal one for tramways, and this was the view not only of his own witnesses but also of the British Electric Traction Co. The representatives of that company had been hovering about the committee rooms and assisting the Taff Vale Company to get the bill thrown out, because they wished to make the tramways themselves. They had already made two attempts to get into the district, and if they could make the tramways pay there was no reason why the Urban District Council should not do so. Even if the lines were constructed by a company, it should be remembered that in course of time they would revert to the local authority. The people of the district were in want of the tramways, and if the Urban District Council did not construct it a company would.

After deliberation, the CHAIRMAN said the Committee had considered the evidence very carefully, and were prepared to pass the preamble subject to a clause. The evidence showed distinctly that there was an element of uncertainty as to the tramways paying, but they considered that the Council were entitled to a preference for the construction of them in their own district. Therefore, some clause must be brought up which would require the tramways to be leased for a term of years to a company, who should make up and maintain the tramways, the amount paid as rent to be funded until it equalled the cost of the installation.

Mr. BALFOUR BROWNE : I do not know whether, under the bill, we can deprive ourselves of the power to work the tramways, as you seem to suggest. Besides, there is no company offering. Suppose we make the tramways at a cost of £290,000.

The CHAIRMAN : We think the Council ought not to spend that money.

Mr. BALFOUR BROWNE : Nobody would enter into a lease to take over a thing which is not made.

The CHAIRMAN : That is a matter for the promoters to consider.

On Wednesday Mr. BALFOUR BROWNE said his clients had framed clauses which he believed would meet the views of the Committee. The main clauses were apparently alternative, but he desired to have them both, as the Taff Vale Company might raise objections in another place later on.

The CHAIRMAN said the object the Committee had in view was this: Suppose a company like the British Electric Traction Co. built and equipped the tramways, finding the money necessary for the purpose, they would form a subsidiary company, and if the tramways did not pay the company would go bankrupt, and the rent the promoters received would disappear, and the ratepayers would have to undertake the working of the tramways. The ratepayers might not be in any better position to make the tramways pay than the company, unless there had been a certain sum accumulated from rents funded, and producing sufficient to meet the deficit.

Mr. BALFOUR BROWNE said that the Urban District Council would fund the rent in both cases, so that there would be no charge on the ratepayers. His clients had drawn up three clauses, which he wished to submit to the Committee as carrying out their decision. The first would give the Council power to lease tramways, but it would be for a longer period than 21 years, the period fixed in the Tramways Act of 1870. If the 21 years were adhered to it might be impossible to find a lessee. His second clause was :—

"The Council shall not commence the construction or laying down of the tramways, or any part or parts thereof, unless and until they have entered into an agreement with a company or person for a lease to such company or person of such tramways, or part or parts thereof, as the case may be, for such period (not exceeding 42 years), at such rent and upon such other terms and conditions as may be approved by the Board of Trade. Provided that in any such lease the amount to be paid to the Council by way of rent shall in no case be less than a sum sufficient to pay the interest on any moneys required to be borrowed for the purpose of the construction of the tramways and for the generating station and the electrical equipment of the tramways, or of the part or parts thereof, so leased as aforesaid, and also sufficient to provide the requisite appropriations, instalments or sinking fund payments, as provided by the section of this act the marginal note whereof is 'Mode of payment off of borrowed money.'

"So soon as the Council have completed the tramways, or part or parts thereof, as the case may be, so agreed to be leased, as aforesaid, the Council shall demise the said tramways, or part or parts thereof, together with such generating station and equipment as may be provided, as aforesaid, to such company or person, at the rent and upon the other terms and conditions as may be approved by the Board of Trade, and the powers of the Council to work the said tramways, or part or parts thereof respectively, shall be suspended during the continuance of such lease.

"All moneys received by the Council by way of rent shall be treated as tramway revenue, and applied as provided by the section of this act the marginal note whereof is 'Application of tramway revenue.'"

In order to avoid dealing with a bogus lessee the sanction of the Board of Trade was provided for. The third clause dealt with the construction of the tramways by a lessee, and was as follows :—

"The powers by this act conferred upon the Council of constructing and equipping the tramways shall not be exerciseable by the Council, but may be exercised by their lessees or lessee as next hereinafter provided.

"The Council on the one hand and any company or person approved by the Board of Trade on the other hand, may enter into agreements for the construction and equipment of the tramways, or any part or parts thereof, as the case may be, and as consideration for the construction of such tramway may lease any such tramways or part or parts thereof respectively to such company or person for such period (not exceeding 42 years) at such rent and upon such other terms and conditions as may be approved by the Board of Trade, and such lease may contain a clause requiring compensation to be made to the lessee on the termination of the lease on terms similar to those contained in sec. 43 of the Tramways Act 1870.

"Provided that if any company or person approved by the Board of Trade make to the Council a tender in writing to construct and equip the tramways, or any part or parts thereof, as the case may be, and to take a lease of and to work the said tramways, or such part or parts thereof, for such period (not exceeding 42 years) at such rent and upon such terms and conditions as shall, in the opinion of the Board of Trade, be adequate and proper, and such as should be accepted by the Council, the Council shall demise the said tramways, or such part or parts thereof, to such company or person at such rent and upon such terms and conditions, with or without modifications, as the Board of Trade may determine,

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"All moneys paid to the Council by way of rent in respect of such lease, as aforesaid, shall be set apart by the Council and accumulated with interest thereon as a reserve fund during the continuance of such lease, and at the termination of such lease shall, in the first place, be applied, so far as necessary, in or towards the payment to the lessee of such amounts (if any) as may be found to be due to him on the termination of such lease.

"Nothing in this section shall extend or apply to the tramways or parts of tramways authorised by the Pontypridd and Rhondda Valley Tramways Order, 1882, confirmed by the Tramways Orders Confirmation (No. 2) Act, 1882, when acquired by the Council."

Mr. FITZGERALD said he proposed the addition of the following:—"Provided in any such lease the amounts to be paid to the Council by way of rent shall in no case be less than such a sum as will, when accumulated in manner hereinafter provided, amount at the termination of the lease to a sum equal to the amount of the estimates recited in the act for the construction of the tramways and tramway purposes and generating stations and electrical equipment of the tramways and works." The sum which might be involved under these words might be too much, but they must meet the difficulty that at the end of the lease the sum in hand might be ridiculously small. He further urged that the lease should be cut down to 21 or 30 years, and that the provision for compensation to be paid by the Council to the working company at the end of the lease should be struck out.

Mr. PAGE (for the frontagers) contended that the Committee should not allow the Council to construct the tramways themselves, but should leave it to someone to be appointed by the Board of Trade.

Mr. BALFOUR BROWNE said he would undertake to alter the clauses so as to provide that the Council should not work any part of the tramways during the existence of the lease. (The clauses were amended accordingly.)

The Committee decided that the clauses as amended fully protected the ratepayers, and should be incorporated in the bill, the preamble of which they passed.

The clauses the Taff Vale Company took exception to were the provision enabling the tramways to carry parcels of 500lb. weight. The Committee decided to allow parcels up to 28lb. and passengers' luggage up to 56lb. to be carried by the tramways.

The bill will in due course be referred to the House of Commons for third reading.

OTHER ELECTRICAL BILLS.

On Wednesday the select committee of the House of Lords of which Lord Rosse was chairman had under consideration the Metropolitan District Railway Bill. This bill has already passed through the House of Commons, and its committee stage was reported in *The Electrician*, Vol. XLIX., pp. 24 and 56. It was explained that the Metropolitan District Railway and the Metropolitan Railway were going to be changed into electric undertakings. For that purpose a very large site had been bought on which to erect a generating station and the work was proceeding rapidly. Last year the promoters came to Parliament for power to lay their electric cables down certain streets. That bill passed, but it was subsequently discovered that in those streets there were certain important sewers belonging to the London County Council of the existence of which the company had not been informed. The company thought it would not be well to run any risks of interference with these sewers and therefore it was decided to use other streets. The only opponent to this proposal now remaining was the London County Council. Mr. Perke, M.P., was then called, and formally proved the preamble of the bill. In reply to counsel for the London County Council, he said the company had no objection to submitting their plans of the proposed generating station to the Board of Trade for approval and giving that department any explanatory information desired with regard to the station. Part of the land required for the generating station was used as a private roadway, by which access was obtained to buildings, some of which the County Council owned and some of which the company were about to acquire. Witness agreed that in erecting the generating station they would not build on the half of the road next the County Council premises, thus allowing access to those premises and preserving their light. In the King's-road and Fulham-road there were sewers belonging to the County Council. The company were willing to come under an absolute provision that their cables and wires in that road should be laid at a depth of not less than 4ft. 6in. below the surface in order to clear the mains of the Council. The Committee allowed the bill, amended in these particulars, to proceed.

The North Metropolitan Tramways Bill, which has already passed the House of Commons (see *The Electrician*, May 2, p. 66), came before the House of Lords on Tuesday as an unopposed measure.

In the House of Commons on Thursday last week, the Lords' amendments to the Halifax Corporation Bill were agreed to, and on Friday similar amendments to the Kent Electric Power Bill were also agreed to.

On Monday the Huddersfield Corporation and the Manchester Corporation (General Powers) Bills were read a third time in the House of Lords and passed. In the House of Commons on the same day, the Hastings Tramways, Mexborough and Swinton Tramways and Saddleworth and Springhead Tramways Bills were read a second time.

The Tyneside Tramways and Tramroads Bill was read a third time in the House of Commons on Tuesday, and the Swansea Corporation Bill a second time.

The Wigan Corporation Bill was read a second time in the House of Commons on Wednesday.

The North Staffordshire Tramways Bill was listed yesterday for consideration by a Select Committee of the House of Commons, Mr. Ashton presiding. The measure, which has already passed through the House of Lords, is intended to empower the North Staffordshire Tramways Co. to work their tramways by mechanical or electrical power, and to confer further powers upon that company and the Potteries Electric Traction Co. with regard to their respective tramways, No appearance was put in by the opposition, and the further consideration of the bill was adjourned until Tuesday or Wednesday.

PATENT LAW AMENDMENT BILL.

Mr. GERALD BALFOUR, in the House of Commons on Friday last, in moving the second reading of this bill, said he intended to introduce amendments into the bill in the Committee stage which he thought would prove satisfactory to the community generally, and might be accepted as a reasonable solution of what was undoubtedly a somewhat difficult problem. He proposed to amend the clause relating to compulsory licences so that if any existing industry or the establishment of any new industry was prejudiced by the failure of the patentee to work his patent or to grant licences, the reasonable requirements of the public should not be held by the Court to have been satisfied, and the patentee might be required to grant licences. He proposed to retain the principle of granting compulsory licences as the basis of the amended clause, but to give the Court in certain extreme instances the power to revoke the patent. But this was subject to a proviso that no order should be made before the expiration of three years or if the patentee gave satisfactory reasons for his default. This was a reasonable compromise between extreme views; it would not work harshly upon the poorer patentees, while it would render difficult or impossible a patent being taken out to prevent production in this country. In accordance with the recommendation of the Committee the High Court was substituted for the Board of Trade as the tribunal to decide whether a compulsory licence should be granted. It was, no doubt, a serious matter to entrust to an executive department of the Government the decision of a case in which enormous pecuniary interests might be involved, but an objection to the substitution of the High Court was the length to which proceedings might be carried by appeals. He proposed, therefore, that the tribunal should be the Judicial Committee of the Privy Council, with no appeal. This Committee had a right—which, however, had never been exercised—to determine the duration of a patent in the public interest, and this constituted a precedent for making the Committee of the Privy Council the tribunal for dealing with this matter. The last point on which he proposed to amend the clause was in reference to cases where there was *prima facie* evidence that a patent was being used only to prevent manufacture in this country. In such a case he proposed that the onus of proving that public interests had been reasonably met should be with the patentee.

Mr. CALDWELL said the right hon. gentleman had not mentioned clause 1, which made most important changes in patent legislation. The examiner was charged with the responsibility of examining specifications over a period of 50 years. Upon this report it might be necessary for an applicant to amend his specification, and there appeared to be no limit to examination and amendment. The hon. member further objected to the period for lodging a complete specification being reduced from nine to six months, and regretted that the tribunal to decide on the question of compulsory licences was to be changed from the Board of Trade to the Judicial Committee of the Privy Council.

Sir W. HOULDSWORTH disagreed with these objections. The object of the first clause of the bill was to provide that the tabulated information at the disposal of the Patent Office should be carried further and made available to anyone who came forward and desired to take out a patent. It would be a great pity if the records in the office were not made available on behalf of the patentee. The appeal which was provided was for the protection of the patentee, and the power of revocation of a patent, if it was not utilised within 12 months, had been very strongly recommended to the Committee which considered this question, among others by Sir Edward Fry. He had permission to say that those with whom he was acting, who included all those in the country who were personally interested in the matter, were very well satisfied with the clause as now proposed, and, though it did not fulfil their ideal, it went a long way in the direction in which they wished to go.

Sir R. REID agreed that nothing could be more absurd than that a foreign patentee should come here and get a patent, which, instead of encouraging the industries of this country, was so used as to prevent our own people doing what otherwise they would do. In regard to the question of the tribunal to determine as to compulsory licences, he was satisfied that the Privy Council was far and away the ablest and most satisfactory that could be found.

The ATTORNEY-GENERAL said that the evil which the first clause was intended to deal with was most serious. Any steps that could be taken to restrict the number of patents which investigation subsequently proved to be invalid would undoubtedly be a benefit to trade and commerce. He thought that the second clause also was most valuable. A patent was supposed to be granted for the encouragement of manufacture in this country. But under the existing law a large number of patents were taken out by foreigners solely for the purpose of preventing manufactures in this country, and such was the state of the law that there was no means of grappling with the evil. He thought the Judicial Committee of the Privy Council was the proper body to refer proceedings to under the clause, as the matters at issue involved consideration of the rights of property, and it was desirable also that there should be a unanimous current of decision.

Mr. CALDWELL asked whether the Judicial Court would take evidence as a Court of the first instance.

The ATTORNEY-GENERAL said that of course evidence would be taken.

Mr. WHITLEY regretted that the bill was not more drastic. He had hoped that the Board of Trade, after its many years' consideration of the matter, and the pressure put upon it by the commercial community, would have been more bold and have gone a little further in the reform of the

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patent laws. He was prepared to support the establishment of a skilled department of the Board of Trade to deal finally with all questions of patents.

Sir J. LAWRENCE considered that the principle of compulsory licences would not suffice. He desired rather to see the introduction of the Belgian law, which required compulsory working after three years. The clause in the bill, if amended as suggested by the President of the Board of Trade, while stopping short of an absolute acceptance of the principle of compulsory working, still gave a liberal measure of relief. He believed that, although the bill was not an ideal measure, it was capable of being made into a very useful measure of patent law reform.

Sir J. LENG wished that more could have been done for patentees who were too highly taxed already, and also that British and Colonial patents should be recognised throughout the whole of the British dominions.

Mr. PLATT-HIGGINS hoped sub-section 1 of the second clause would be strengthened, for it was now thrown on any person interested to prove a negative—that the reasonable requirements of the public had not been satisfied—not as regarded himself, but the public generally.

Mr. CRIPPS considered the objection of the last speaker was met by the amendments to be proposed in Committee.

Sir W. ALLAN said the American system enabled a working man, however humble his position, to lay his model before the Patent Office and obtain his patent, unless the office declared it was not a valid invention. In this country it was just the opposite. The Patent Office took a man's money, but would not say if a patent was valid or not. The patent laws of this country should follow the principle of charging the inventor the lowest possible terms and giving him the longest possible time. There should be a committee of search, whose duty should be to investigate the validity of an invention before taking the money for a patent. The present system gave no encouragement to inventive working men. The present bill was too wordy and not practical; there should be a simple statement of the charge and the time, and the inventor should be left free to settle his other business arrangements.

The bill was then read a second time.

Mr. GERALD BALFOUR next moved that the bill be referred to the Standing Committee on Trade, and, after a short discussion and a division, this was agreed to.

The following 15 members have been added by the Committee of Selection to the Standing Committee on Trade for the purposes of this bill:—Sir W. Allan, Mr. Bousfield, Mr. Brigg, Sir John Brunner, Mr. Cawley, Mr. Cripps, Col. Denny, Mr. Fielden, Sir J. Lawrence, Mr. Moulton, Mr. O'Mara, Mr. Platt-Higgins, Mr. Randles, Sir Robert Reid and Mr. S. Roberts.

LEGAL INTELLIGENCE.

Bunce v. W. A. S. Benson & Co. (Ltd.).

In the King's Bench Division, on Wednesday, Mr. Justice Ridley and a special jury heard an action for alleged libel, brought by Mr. E. G. Bunce, trading as Bunce & Co., electrical engineers, against Messrs. W. A. S. Benson & Co. (Ltd.), and seeking damages. From the statement of claim it appeared that plaintiff was employed by a firm of estate agents to wire a house at Gloucester-place, London, W., and prior to the completion of the work defendants were called in to make a report on the work being carried out by the plaintiff. This report contained certain statements as to the way in which the work had been carried out by plaintiff to which he took exception, and brought the present action. After the opening statement of Mr. R. A. McCall, K.C., for the plaintiff, and the plaintiff's evidence had been taken, counsel engaged in the case were able to inform his lordship and the jury that it had been agreed that the record should be withdrawn, and that the plaintiff should pay to the defendants half their taxed costs in the action on the defendants making a statement that the plaintiff was not personally to blame for any of the defects reported to exist in the installation. On plaintiff's behalf it was admitted that defendants were employed to make a report, and that they were justified in stating what they did on the facts then existing. For defendants Mr. Eldon Bankes, K.C., said his clients had never laid any blame on plaintiff personally.

His lordship agreed that nothing had been said against plaintiff personally by defendants, and the record was then withdrawn on the terms stated.

Tramway Regulations.

In the King's Bench Division on Tuesday a Divisional Court was moved on behalf of the National Carriage and Horse Owners' Accident Insurance Union and Mr. R. Wiseman, a ratepayer of Manchester, for a mandamus requiring the Manchester Corporation to comply with sec. 44 of the Manchester Corporation Tramways Act, 1900, which provides that within six months from the time of taking over any section of the tramways the Corporation should make bye-laws in respect of such section, regulating the distance at which cars using the tramways should be allowed to follow one another. Counsel for the plaintiffs said that on June 6, 1901, the Corporation took over the first section and substituted electric for horse traction. Since then a number of other sections had been taken over, but the regulations had not been made. The Insurance Union was a company which insured owners of horses and carriages against risk caused by accidents in the streets, and in addition to that one of the objects of the company was to procure the amendment or repeal of bye-laws and regulations of local authorities which might prejudicially interfere with the convenience of their clients.

After hearing counsel on both sides, Mr. Justice CHANNELL thought no rule should be made. Although he did not say a mandamus could not be granted calling upon the Corporation to perform the duty imposed on them by the act, the granting of a mandamus was discretionary. The Corporation had the preparation of these bye-laws under consideration. The making of regulations was a matter of some trouble. The Corporation were continually taking over fresh sections, and if they performed the duty imposed upon them by the statute literally they would have apparently, to make a separate set of bye-laws every six months. If anybody chose to set the law in motion by indictment he might do so, but he did not think such an indictment would be met favourably by any grand jury.

Mr. Justice Jelf concurred, and the application was refused.

Tramway Bye-Laws.

At Brentford (Middlesex) Police-court, on Monday, during the hearing of an action brought by the London United Tramways against a passenger for having travelled on one of the company's electric cars without paying his fare, the evidence showed that when the fare was demanded defendant tendered a ticket which had been issued on another car belonging to the company earlier in the day. The question raised by the defence was whether a tramway journey could be broken and the same ticket be used for the subsequent completion of the journey. Counsel for the Tramway Company (Mr. Hanson) said it was peculiar that this point had been entirely overlooked by all the tramway companies in formulating their bye-laws. It was the intention of the London United Company to have the matter put right by at once making application for a bye-law regulating the matter.

Defendant, who had been in custody for more than a week, was then discharged.

Taff Vale Railway Co. v. Amalgamated Society of Railway Servants and Others.

In the King's Bench Division on Wednesday, Mr. Justice Wills granted an application for the postponement of this action (to recover damages for picketing) until next sittings.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Belfast Library and Technical Instruction committee require a chief lecturer in physics and electrical engineering and also a chief lecturer in mathematics. An advertisement contains further particulars. Applications to the Principal (Mr. F. C. Forth), Municipal Technical Institute, Belfast, by July 21.

A lecturer in electrical engineering and physics is required for the Halifax Municipal Technical School. Applications to the principal by July 16. See advertisement.

Erith District Council require an electrical engineer to act as clerk of works during erection of electricity works. Applications to the clerk (Mr. Charles H. Fry) by 10 a.m. July 16. See advertisement.

A teacher is required for teaching magnetism and electricity and electric light and power at the Harris Institute, Preston, for two evenings a week. Applications by July 28. Further particulars from the secretary, Mr. T. R. Jolly. See advertisement.

A junior assistant, with mechanical and electrical experience, and a jointer are required for the Wakefield electricity works. Applications by July 18 to manager, electricity works, Calder Vale-road, Wakefield. See advertisement.

The Stepney (London) Guardians require an engineer for their Childrens' Homes at Stifford, Essex. Applications to clerk by July 23.

Mr. H. Collings Bishop, engineer and manager of the Wigan Electric Lighting and Tramways department, has been appointed borough electrical engineer and tramways manager at Newport, Mon.

Mr. G. W. Keats has been appointed chief assistant electrical engineer by the Woolwich Borough Council. Mr. T. M. Colson has joined the Council's electrical staff as station engineer at Plumstead, Mr. H. Walker (Mr. Colson's assistant with the Woolwich District Electric Light Company) has been appointed station engineer at Woolwich, Mr. S. H. Penning distribution engineer, and Mr. B. Beatty is appointed assistant distribution engineer. These appointments and re-arrangements of staff have followed the acquisition of the Woolwich Co.'s undertaking by the Woolwich Borough Council.

Mr. O. R. H. Bury, M.Inst.C.E, late general manager of the Buenos Ayres and Rosario Railway, and previously general manager of the Entre Rios Railway, has been appointed general manager of the Great Northern Railway.

Mr. Walter Harris, M.A., Ph.D., F.C.S., of the County School, Northampton, has been elected head master of Sutherland Institute, Longton.

Mr. J. W. Williams has been appointed shift engineer at the Kelham Island power station of the Sheffield Corporation.

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Mr. E. B. Foster, M.Sc, has been appointed head of the engineering department at the Brighton Municipal Technical School.

Mr. F. H. Corson, of Bolton, has been appointed generating station superintendent at Blackburn at £175 per annum.

EDUCATIONAL NOTICES.

Glasgow and West of Scotland Technical College.—Plans for the extension buildings of this college have been approved by the Dean of Guild Court. On the ground floor of the new buildings the department of natural philosophy is to be accommodated, the second floor will be devoted to natural science, the third floor to architecture and building construction, and on the fourth floor chemistry and technical chemistry will find their home. A building running parallel to this section will contain three blocks, the first being devoted to the electrical engineering department, the remainder of this department being housed in the second block. The department of prime movers, mathematics and metallurgy will find accommodation in a wing connecting the three blocks.

Northampton Institute, London, E.C.—The day courses in mechanical, electrical and horological engineering commence on Monday, September 29th, the entrance examination being fixed for Wednesday and Thursday, September 24th and 25th. Some further information is given in an advertisement on another page.

Alleged Conspiracy to Defraud.—At the Central Criminal Court, on Wednesday, Mr. Charles Bright, who was indicted for having committed a misdemeanour under the Debtors Act, and Messrs. J. F. Moreno and R. G. Fudge, indicted for aiding and abetting the first-named defendant to cheat and defraud his creditors, were acquitted.

In his defence Mr. BRIGHT gave an absolute denial to the charge. He was under cross-examination when the jury intimated that they were of opinion that there was no case upon which they could convict.

The COMMON SERJEANT (Mr. Bosanquet) concurred, and said, in his opinion, the bankruptcy was obtained on a mistaken affidavit whilst Mr. Bright was in the Argentina, and was premature and a great hardship upon him. Defendants were then discharged.

Ascot.—The Ascot and District Electric Supply Co. are applying for a provisional order for Ascot, Windlesham, and Bagshot.

Ashford.—The gas manager (Mr. Morton) has canvassed the town to ascertain the demand for electric current for lighting, and has reported to the Council that the probable consumers would take about 85,000 units per annum at the outset. The County of Kent Electrical Power Co. have been asked their terms for supplying current. A company has given notice of applying for a provisional order in the ensuing season.

Ashton-under-Lyne.—The charge for electric current for street lighting has been fixed at 2½d. per unit; to Corporation departments (except for public lighting) 3½d.; to private consumers 4d. for lighting, or alternately 1s. per 8 c.p. lamp fixed per quarter, and for power 1½d. per unit. The Board of Trade have been requested to grant an extension of the period for the commencement of the construction of the tramways.

Asylum Lighting.—The Fife and Kinross Asylum Board have resolved to put down electric lighting plant at the asylum.

Auckland.—A committee is to report on the question of erecting joint electricity supply and refuse destructor works.

The County of Durham Electrical Power Distribution Co. will apply for a provisional order for this district.

Barking.—An inquiry was held here last week into the application of the Council to borrow £11,744 for additional plant and mains to meet the increasing demands for electric current.

Belfast.—The Corporation have applied for a loan of £20,000 for extensions of the electric lighting mains. The Local Government Board are asked to postpone the application of the sinking fund for the first two years. The city electrical engineer (Mr. Victor A. H. McCowen) has submitted a lengthy report in the Lorain surface-contact system of traction.

Bexhill.—Consumers taking over 800 units of electric current per quarter are to be charged 7d. per unit for the first hour and 1½d. after.

Birkdale.—The formal opening of the electricity works takes place on Aug. 1, when the switching-on ceremony will be performed by Mrs. Weld-Blundell.

Brentwood.—The Provincial Electric Supply and Traction Co. intend to apply for a provisional electric lighting order.

Brighton.—The accounts of the electricity department for the year to March 31 were submitted to the Council last week. The loans sanctioned amounted at that date to £824,893, of which £410,352 remained unborrowed, the total debt being £399,780. 9s. 8d. The total expenditure for the year was £42,273. 3s. 10d., against £33,011. 8s. 11d. for the year to Dec. 31, 1900; £24,277. 3s. 7d. was carried to net revenue account, against £19,600 in 1900. Revenue amounted to £66,550. 7s, including £50,254. 9s. 9d. from private lighting, £11,960. 7s. 2d. from public lamps, £1,799. 6s. 10d. from tramways, and £2,462. 12s. from meter rents and sundries. Interest and sinking fund charges were £24,445. 12s. 6d., leaving a deficiency of £168. 8s. 11d. In 1900 £107. 15s. 2d. was carried to next account. The reserve fund showed a credit balance of £3,420. 11s. 3d. 5,685,435 units of current were generated, of which 4,860,430 had been sold and 360,066 used on works, the total quantity accounted for being 5,220,496 units. Of the amount sold 809,350 units were assigned to public lamps and 264,693 to tramways, and 3,786,387 were supplied to private consumers.

Councillor HOLLOWAY moved the adoption of the report and accounts, and said that no profit had been made on the supply of current to the tramways department. Assuming the undertaking to have belonged to a company the profit would have amounted to £24,287. 3s. 7d., equal to about 5¾ per cent., but as it was a municipal undertaking sinking fund and interest absorbed rather more than the whole of the profit. Three years ago they reduced the cost of current from 1½d. to 1d. per unit, which they had no right to do. Last year they had a reserve of about £5,000, but during the year they had had extraordinary expenditure to meet—they had to replace two dynamo sets at £1,400, wood paving cost £433, and £272 was expended on change of voltage. The strike in the coal trade cost them £1,000, and they anticipated they would save as much as that on the next contract. The only thing that troubled him was the reserve. For an undertaking of over £400,000 to have a balance of only £3,420. 11s. 3d. was ridiculous. In the case of an explosion at the works, he did not know what they would do; they would have to come on the rates. He was not proposing they should raise the price of electricity, but if they went on at the same rate they did not anticipate a profit next year.

The accounts were severely criticised by Ald. Sendall.

Councillor BLAKER urged that the large amount that had been paid off in the shape of redemption on the electricity undertaking was an adequate reserve fund.

Councillor CARDEN congratulated the Council upon the satisfactory character of the balance-sheet. About £28,000 had been spent on the new generating station, and they had also started repaying the capital on it two years before they would come into possession of the station. But for that a profit of £1,000 on the year would have been shown. Then they had paid £15,000 for fuel, against £11,000 in the previous year. There was a satisfactory increase in the revenue of £14,000 on the previous year. That was over 20 per cent. on an undertaking that had been in existence only 11 years, and if it increased at the present rate, in 10 years' time the revenue would be over £150,000 a year. They were repaying their capital at a much faster rate than other towns. Glasgow was only redeeming at 1¼ per cent., while Brighton was repaying at the rate of 3 per cent.

The accounts were ultimately adopted.

Burnley.—The Council have authorised extensions of the electricity generating plant at an estimated cost of £1,997.

Burslem.—The Potteries Electric Traction Co. intend to apply for a provisional electric lighting order.

Bristol.—The accounts of the electricity department for the year ended March 31 have been issued.

The number of consumers on March 25 was 1,790, an increase of 283 for the year. The total connections to the mains were equivalent to 149,146 30-watt lamps (compared with 119,615 last year), 19,520 were taking energy at power rate, 124,385 at lighting rate and 5,241 represented street lighting, an aggregate increase equivalent to 29,531 lamps—viz., power connections 10,131, private lighting 19,400. The number of units sold was—private 1,965,794, public lighting 480,776, power 310,054, total 2,756,624, an aggregate increase of 565,065. The use of electric current for power had continued to increase, and the sale of current had more than doubled. Total receipts were £44,882.12s.3d., expenditure £26,848.7s.11d., leaving gross profit £18,034. 4s. 4d. available towards payment of interest (£10,946. 8s. 6d.) and repayment of loans (£8,063. 16s. 11d.), or a deficit of £996. 1s. 1d. on the year. The total capital expenditure to March was £384,776. 15s. 3d. The mortgage debt was £373,623. 6s. 6d. The balance to credit of reserve fund was £4,509. 2s. 6d., and to credit of depreciation account £1,236. 16s. 3d. The city electrical engineer (Mr. H. Faraday Proctor) also reports that the total number of sub-stations now constructed is 55, and the mileage of cables laid is 159, having 550 miles of conductors. Although the heavy expenses in connection with capital charges, amounting to considerably over 1½d. per unit sold, and much of which capital has not even yet become remunerative, has prevented a net profit, Mr. Faraday Proctor estimates that the working of the department during the next financial year will enable a further sum to be placed to credit of reserve. The revenue for lighting last year was £33,955., compared with £27,695. and £22,769 in the two preceding years, and for power £1,910, against £872 and £425.

Carnarvon.—A scheme is being promoted for the erection of generating works for supplying electric current throughout Carnarvonshire. The inception of the scheme is due to Sir Wm. Preece, K.C.B., and to Mr. C. H. Rees, of Carnarvon. It is proposed to introduce electric lighting and electric tramways into the populous centres of the county, and to seek the co-operation of quarry owners with the view to substituting electricity for steam as motive power. The movement has met with considerable support. An influential county meeting is to be held at Carnarvon on 14th inst., when Sir William Preece will explain his views, and give details of the project.

Chard.—The Council have resolved to promote a bill for electric lighting and other powers. The Electric Supply Corporation's application for a provisional order will be opposed by the Council.

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Clacton.—Mr. Whitcher, at the last meeting of the Council, moved a resolution for putting the Council's provisional electric lighting order in force. He thought they could establish electricity works without being a burden on the rates, and as they were threatened with applications by companies for electric light powers they could only retain their powers by taking steps to comply with the terms of their order. The matter was adjourned for a week.

Colchester.—The Electric Light and Power committee have been authorised to substitute 150 Nernst electric lamps for 150 gas lamps.

Dartmouth.—For public electric lighting the Council have decided to erect 10 arc lamps for the principal thoroughfares, with incandescents for the remainer of the streets.

Denton.—The Council have applied for an extension of time for constructing electric tramways under their 1901 provisional order.

Electric Illuminations.—Some smart work was carried out by the Electric Lighting Boards Co. at the Crystal Palace on the occasion of the great Empire ball last week. The installation comprised 2,200 lights in various devices, the lights and festoons being covered with artificial flowers. Some 2 miles of cable was used in this work, the whole of which was executed in three ordinary working hours by a small staff. We are informed that the installation is to be taken over *en bloc* by a firm of caterers.

Exhibition.—It is proposed to hold an exhibition of electric light fittings, heating and cooking apparatus, motor-driven domestic machinery, &c., in the Grand Aquarium, Brighton, from Oct. 4 to 18 next. The exhibition is to held under the auspices of the Corporation, and firms desirous of exhibiting should apply to the engineer and manager of the Electricity department, Mr. John Christie, North-road, Brighton, who has been appointed hon. sec. Such an exhibition in this popular town will attract a large gathering both of visitors and residents.

Failsworth.—The Council have decided to transfer their provisional electric lighting order to the Manchester Corporation for 21 years, subject to Board of Trade approval.

Fire.—In the fire which occurred on Saturday at the Mexborough electric lighting works the generating plant entirely escaped damage.

Grantham.—With regard to the agreement between the Town Council and the Urban Electric Supply Co., undertakers for the supply of energy under the Grantham Electric Lighting Order, 1900, the Board of Trade has refused to sanction a condition that the Company must render an account to the Corporation of the waste electric energy.

Llanberis.—The Gwyrfai Rural Council, as well as the Llanberis and other Parish Councils, will support the application of Mr. Assheton Smith, proprietor of the Dinorwic slate quarries, for a provisional electric lighting order for the rural districts between the quarries and the sea at Port Dinorwic.

Helensburgh (N.B.).—Two companies will shortly apply for electric lighting powers in this district.

Kilburn (London).—An arrangement has now been come to between the Willesden District and Hampstead Borough Councils in regard to the electric lighting of High-road, Kilburn, which lies on the boundary of the two districts. 22 arc lamps are to be erected in that thoroughfare.

Inverness.—A company is applying for a provisional electric lighting order. The Council will oppose. The Council's order was obtained in 1899.

Kensington (London).—An important addition was made last week to the public electric lighting of this borough, when 98 further arc lamps were brought into use.

Kroonstad (Orange River Colony).—This municipality has allocated £10,000 for electric lighting.

Leigh.—An agreement is to be made with the South Lancashire Tramways Co. for the construction of further tramways within the borough. The company offers to pay £200 per annum for the first five years from the opening of the new lines, £300 per annum for the next five years, £400 for the next five years, and £500 after.

Leven (N.B.).—A company is applying for a provisional electric lighting order.

Light Railway.—The Board of Trade have, after modification, confirmed the Holmfield and Southowram Light Railway Order, 1902.

London County Council.—On Tuesday, on the recommendation of the Highways Committee, it was agreed to expend £500 in the purchase of additional electric testing plant, consisting of an alternator and motor, for the Council's electricity meter-testing station on the Victoria Embankment.

Lytham.—The Board of Trade have agreed to defer consideration of revocation of the Council's electric lighting order for 12 months.

Maidenhead.—The Council have decided to apply for a provisional order to extend their area to include all districts within a radius of 4 miles from the town hall.

Mexborough.—On Wednesday the Council authorised the laying of distributing mains in several additional streets. Application has been made for a loan for an additional 100kw. set. The chairman of the Electric Lighting committee (Mr. Carruthers) said they were now supplying the equivalent of 1,598 8 c.p. lamps for private and 1,250 8 c.p. for public lighting, and that this was within 160 lamps of the station capacity.

Municipal Telephony.—At the meeting of Manchester City Council on Wednesday the special Telephones committee presented a long report describing the results of the visit of a deputation to the Glasgow municipal telephone system. It stated that the number of subscribers to the Glasgow municipal telephone service is 7,206, of whom 5,302 are actually connected. Further applications for connection were being received at the rate of 300 per month, and connections were being made at the rate of 480 per month. About 40 per cent. of the subscribers at Glasgow were also subscribers to the National Telephone Company's system, the company having about 8,000 subscribers in the Glasgow area. The National Company's charge for unlimited user was £10 per subscriber, and the Corporation's charge for a similar service £5. 5s. The balance-sheet of the Glasgow Telephone committee to May 31 would shortly be issued. The figures would show a small profit for the eight months during which the system had been in operation. It is claimed by Glasgow Corporation that telephone subscribers in Glasgow are being saved £25,000 per annum in reduced telephone charges. The Manchester committee submitted a recommendation to the effect that it was advisable that the applications to the Postmaster-General for concurrent licences to carry on telephone exchange business by the Corporations of Manchester, Salford and Stockport should be proceeded with. The committee further recommended that regulations be drawn up and submitted to the Board of Trade to safeguard the public against the danger of telephone wires falling on the trolley wires of the municipal tramways.

The adoption of this report was moved by the chairman of the committee (Mr. Ald. Southern), who said that in view of the Glasgow experiment they could ask the Council with renewed confidence to approve the principle of municipal telephony. With the example of Glasgow before them he did not think they would be running any practical risk.

Mr. J. Wilson said he was not quite in accord with the view that the time was opportune for the adoption of municipal telephony. It might be well that they should ask themselves whether they could not make a better arrangement with the National Company. He thought he had authority for saying that the National Company would be prepared to enter into an agreement with the Council on the basis of a 5 per cent. profit, together with 2½ per cent. sinking fund and a 25 years' lease. They might reckon that a quarter of a million would be at stake if they transformed the service into a municipal undertaking. Another thing which should cause the Council to pause was that in the near future wireless telephony might be something that would have to be reckoned with; and, again, the telephonic question might become a matter of State control. Telephone users also would be compelled, while the municipal system was growing, to use both systems, and thus be put to additional expense.

Mr. Heenan also opposed the motion, and moved an amendment—"That before approving of an application to the Postmaster-General for a licence to carry on telephone exchange business, Sir William Preece, K.C.B., be requested to furnish an estimate of the probable cost of establishing a system of 20,000 subscribers' lines in the Manchester telephone area."

After discussion the amendment was lost, and Mr. Smethurst then moved a further amendment that the further consideration of the question be deferred until the committee had ascertained whether the National Company would guarantee a more efficient service, and what, if any, reduction they were prepared to make in the annual charge. This amendment was lost by 29 to 25, and the original resolution was then put and carried.

In connection with municipal telephony matters at Manchester, a letter has been forwarded to the members of the Council, signed by the Manchester, Salford and District Property Owners' Association and a number of leading firms and private persons, asking that a vote of the ratepayers in Manchester may be taken before any definite scheme of municipal telephony is put forward.

The Council has decided to renew its application to Tunbridge Wells Corporation for the extension of the municipal telephone service to the town.

Offenbach-Frankfort Transmission Line.—An error occurred in a note appearing on p. 448 of our last issue in reference to the plant erected at the Frankfort Exhibition by Messrs. Lahmeyer & Co. in connection with the electric transmission line from Frankfort to Offenbach. The date should, of course, have been 1891 and not 1901 as stated.

Penge.—The Blackheath and Greenwich District Electric Light Co. will apply for a provisional order for this district.

Perth.—The charge for current for public lighting has been fixed for the current year at £12 per arc and £3. 10s. per incandescent lamp.

Rubber and Gutta Percha in German New Guinea.—Rather more than two years ago the German Colonial Society offered a prize of £150 for the discovery of a plant in the German colonies to furnish rubber and gutta percha suitable for use in the manufacture

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of all kinds of electric cables. It is stated that information has reached Berlin from German New Guinea that gutta percha and rubber have both been found in that colony in considerable quantities.

St Helens.—The Council have given notice to Messrs. F. W. Smith & Co. to terminate the existing arrangements for the "free" wiring of consumers' premises.

Sheffield.—The accounts of the Corporation Tramways department show that, during the year ended March, 49,176,631 passengers were carried, compared with 34,370,763 in the preceding year. Renewals, maintenance, &c, cost £19,846. The electric traction portion of the Corporation's undertaking shows receipts £175,575, compared with £108,300. The gross expenditure totals £106,299, leaving a profit of £69 275, an increase of £21,699. After paying interest and sinking fund (£36,655) there was a net profit of £32,610. Since the tramways have been in the hands of the Corporation £27,000 has been handed over for relief of rates, and there is an accumulated surplus of £78,787. These accounts were approved by the Corporation on Wednesday.

The Electric Light committee recommend that the salary of the engineer and manager of the electric lighting department (Mr. S. Edgar Fedden) be increased from £600 to £700 per annum as from June 1.

Southgate.—The Council are applying for a provisional electric lighting order.

South Shields.—The Electrical committee have received a communication from a consumer to the effect that if they allow new customers to have electric current free during May, June and July he would decline to pay his next quarter's accounts in order to test the legality of the Council's action. A letter has also been received from the solicitor of the South Shields Gas Co. asking to be allowed to examine the books of the electric lighting department, to ascertain the orders received for electric lighting under the offer of the Corporation to give a free supply of current to new consumers during May, June and July. This request has been refused.

Stepney (London).—An addition to the public arc lighting system was made last week, when the mayor (Mr. Edward Mann, J.P.) switched on 50 arc lamps erected along the Mile End-road.

Teignmouth.—The Gas committee have come to terms with Messrs. Crompton & Co. in regard to the erection of electricity works, and the general principle of their scheme was approved by the Council on Tuesday. The company will pay up to £200 for the cost of obtaining the provisional order and £30 as a yearly rental. The option of purchase at the end of 14 or 21 years is reserved by the Council. Two other companies have notified intention to apply for electric lighting powers in this district.

Walker.—For some time past there has been friction between the Walker and Wallsend Union Gas Co., and the Council in regard to the Supply of electric current in the district. It has now been agreed that the company are to supply electricity to Messrs. Armstrong, Whitworth & Co., Messrs. Wigham, Richardson & Co. and Messrs. Dobson & Co., for 42 years, and in return the company waive their right to supply gas for public lighting in perpetuity, and also pay the cost of the dispute to date.

Wells.—Messrs. Crompton & Co. have submitted terms to the Council for the erection of electricity supply works.

Workhouse Lighting.—Swindon Guardians have approved a scheme, estimated to cost £1,862, for the electric lighting of the workhouse.

Worthing.—A special meeting of the Council to-day (Friday) consider a recommendation of the Parliamentary committee to apply to the Light Railway Commissioners for authority to construct a system of tramways in the district.

Yarmouth.—The accounts of the electricity department for the year ended March 31 were submitted on Tuesday. After meeting all expenses, including interest and sinking fund, there was a net profit of £279. The total revenue was £8,441, annual expenditure £4,990, interest £1,413, and sinking fund instalment £1,602. 418,021 units of current were sold, compared with 356,882 in 1901, and the average price per unit for private lighting was 5·11d. and for public lighting 3·06d. The Council offer to supply current to the Naval Hospital at 4d. per unit for lighting and 3½d. for power.

Sports.—The annual sports of the British Electric Traction Club were held at Shepherd's Bush, London, W., on Saturday last, the judges being Messrs. Dade, Devonshire, Drummond, Greer, Hilton, Raworth, and Sellon, and the referee Mr. Sydney Morse. The winners of the numerous events were Messrs. S. Humphrey, H. A. Stagg (hon. sec. of the club), H. Kingsbury, B. H. Malaher, W. S. Wreathall, C. W. Francis, J. Tegetmeier, A. H. Paul, A. Toms, A. W. Grist, T. Bower, F. J. Cursons, and W. L. Hird. In the tug-of-war the engineers beat the secretarials. The sports were held in fine weather, and a large gathering was present. The prizes were presented by Mrs. Garcke.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Tenders are required for boilers, wrought-iron smoke stack, high-speed engines, single-phase alternator, exciters, surface condenser, main switchboard, transformers, mains, &c., for the King Electric Lighting and Cold Storage Co. (Ltd.), King William's Town, South Africa. Plans and specifications from the London agents (Messrs. A. E. Booth & Co.), 16, New Union-street, Moorfields, E.C., to whom tenders by August 7. See advertisement.

The *Metropolitan Asylums Board* invite tenders for supply of builders', engineers', smiths', plumbers', gasfitters' and miscellaneous ironmongery and electrical accessories for their several institutions. Forms of tender at the offices, Embankment, London, E.C., where tenders by 10 a.m. July 16. An advertisement contains further particulars.

Malvern Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work), engines, alternators exciters and switchboard, high and low-tension concentric cables and transformers. Specifications, &c., from the engineer and surveyor (Mr. H. P. Maybury), Council House, Malvern. Tenders (addressed chairman of the Gas, Water and Electricity committee) by Aug. 23. An advertisement contains further particulars.

Manchester Electricity committee invite tenders for the supply, delivery and erection at their Stuart-street works of condensing water pumps, pipework and tanks, storage feed-water tanks, and circulating pipes over the workshops. Specifications, &c., from the secretary (Mr. F. E. Hughes), and may also be inspected at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, London, S.W. Tenders to chairman by noon, July 22. See advertisement.

Manchester Electricity committee require tenders for three electric locomotives for their Stuart-street works. Tenders by noon July 17.

Accrington Electricity committee invite tenders for Lancashire boiler, steam and other piping. Specifications from the borough electrical engineer (Mr. H. Gray), and tenders, addressed to chairman, by noon of July 21. See advertisement.

Epsom District Council invite tenders for a semi-marine dry-back boiler, with fittings, &c.; ejector condensers, circulating pumps and pipework; spray cooling ponds; steam feed and drain pipes, &c.; and a 150kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, &c. Tenders to clerk by noon July 18.

Gillingham Urban District Council invite tenders for water-tube boilers, steam and exhaust piping, condenser, cooling tower, three high-speed engines, 250kw. tri-phase alternators, switchboard, underground cables, arc lamps, crane and well. Tenders to clerk by 3 p.m. July 17.

The Visiting committee of *Devon* County Asylum, Exminster, invite tenders for wiring alterations and additions, 2,000 lamps, booster dynamo and motors, switchboard, replacing of battery of 120 700-ampere-hour cells, &c. Tenders to clerk to County Council, Exeter, by noon July 23.

Wigan Electric Light and Tramways committee require 1,500yds. of 0·1 sq. in. lead-covered paper-insulated cable. Tenders to town clerk by July 14.

Pontypridd Urban District Council invite tenders for cables and dust destructors. Tenders to chairman of Electric Lighting and Tramways committee by July 31.

Truro Electric Lighting committee invite proposals for the electric lighting of the city, which must be sent to the town clerk (Mr. Robert Dobell) by 31st inst. See advertisement.

Barking District Council invite tenders for rails, fish plates and bolts, and permanent way construction. Tenders by 5 p.m. July 31.

Finchley District Council invite tenders for the erection of engine-house, &c., buildings. Tenders by 4 p.m. 21st inst.

Pemberton District Council invite tenders for cables. Tenders by July 23.

Mexborough District Council invite tenders for a 100kw. steam dynamo. Tenders by July 19.

Tenders are invited for the electric lighting of Meynell-street Wesleyan Mission Hall, *Leeds*. Tenders by 15th inst.

Bradford Corporation invite tenders for the wiring of Nelson-street fire station. Tenders by 17th inst.

Dublin Lighting committee invite tenders for construction of cast-iron subway under the Grand Canal Dock. Tenders by noon July 29.

Amsterdam Municipality invite tenders for 150km. of three-phase and 70km. of direct-current cable and 25km. of test and telephone cables. Tenders by Sept. 8.

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Tenders are required for the supply of hand-drawn copper wire (15,800 metres of 6·9mm. and 15,800 metres of 8·2mm.) to the *Christiania* electrical works. Resistance of wire to be not more than 17 ohms per km. and sq. mm., and to be delivered in 1,000 metre lengths. Tenders at per 1,000 kilogs (stating date of delivery and tensile strength of wire per sq. mm.) to "Electricitetsverkets Kontor Tordenskjoldsgade 7II." by 15th inst.

TENDERS RECEIVED AND ACCEPTED.

The tenders of Messrs. Cramer & Co, recently accepted by the London County Council, for wiring and supply of fittings for the electric lighting of Battersea and Camberwell fire stations and the Battersea Park-road and Battersea river sub-stations have been withdrawn. This is the third instance in the last few months in which accepted tenders have been withdrawn under similar circumstances, and the General Purposes committee are to consider what course is advisable to prevent the practice. The Fire Brigade committee recommend that the tender of Messrs. Mossop & Co. be accepted for the Battersea Park-road sub-station for £58. 11s., and in the other cases the tenders of Messrs. Jackson Bros. be accepted, the total being £377. 3s.

Penang Municipal Commissioners have accepted the following tenders for the supply of plant in connection with their electricity supply scheme :—

Penang Foundry Co. (boilers)	£1,517	19	1
Ditto (condensers)	646	8	3
W. H. Allen, Son & Co. (engines and dynamos)	2,660	0	0
General Electric Co. (switchboards)	635	17	0
Electrical Power Storage Co. (storage battery)	1,052	9	2
Callender's Co. (cables)	5,258	18	9
Crompton & Co. (arc lamps)	1,032	0	0

In connection with the extension of the engine-house at the Valley-road electricity works, Bradford, the following tenders have been let by the Corporation :—

Thomas Obank & Sons, mason's work.
Bradford and District Joiners' Works Department, joiners' work.
H. E. Hodgson & Co., smithy and iron foundry work.
R. Townend, plumbers and glaziers' work.
T. H. Hewitt, painters' work.

The Premier Electric Lamp Co. (Ltd.), notify us that contracts for the supply of incandescent lamps have recently been placed with the company by H.M. Office of Works, H.M. War Office, London United Tramways, Portsmouth Tramways, Mersey Docks and Harbour Board, Brighton Corporation Tramways, St. Helens Tramways, Manchester Tramways, Liverpool Overhead Railway, Southend Tramways Queen Anne's Mansions (London), and Hyde Park Court (London)

The Mountstuart Shipbuilding, Graving Dock and Engineering Co., Cardiff, have placed a contract with Messrs. Crompton & Co. for the complete electrical equipment of their works at Bute Docks. The contract will include the supply of 50 arc lamps, 14 electric motors, ranging from 15 H.P. to 50 H.P., a 25-ton electric crane, an electrically-driven centrifugal pump, capstan, &c. Current will be taken from Cardiff Corporation mains.

Dudley Corporation have accepted the tender of Messrs. Rhodes and Webster for electric motors up to 5 B.H.P., and that of Messrs. Mather and Platt for motors above 5 B.H.P. The tender of the Brush Company has been accepted for incandescent lamps and that of the Vacuum Oil Co. for oils.

Rotherham Council have accepted the following tenders for extensions to the tramway plant :—

W. T. Glover & Co. (feeders, &c.)	£6,726	1	6
W. H. Allen, Son & Co. (generating set)	2,721	0	0
Hawksley, Wild & Co. (boilers)	1,774	0	0

Manchester Corporation have accepted the tender of Messrs. Rowland Carr & Co. for the whole of the cast-iron troughing required by their electricity department for the next 12 months.

St. Helens Council have accepted the tender of Messrs. Armstrong, Addison & Co. for poles to carry the overhead wires for supplying energy to the works at Ravenhead.

Messrs. Willans and Robinson have received an order, through Messrs. Dick, Kerr & Co., for the Wigan electricity works for a 700 H.P. compound central-valve engine.

Barking District Council have accepted the tender of Babcock and Wilcox for pipe work and lagging ; that of Norton Bros. for chequer plating, &c. ; and that of Bergtheil and Young for motors for auxiliary plant.

Ealing Town Council have accepted the tender of the British Electric Transformer Mfg. Co. for supply of transformers, and that of Messrs. Siemens Bros. & Co. for jute mains.

Glasgow Parish Council have accepted the tender of Messrs. Lowdon Bros. & Co. for supply of generating plant and for wiring the asylum at £1,995.

The tender of Messrs. Willans and Robinson has been accepted by Southend Town Council for the supply of a 225kw. steam dynamo, at £2,477.

Bootle Town Council have accepted the tender of Callender's Company for feeders and distributors at £6,930. 10s ; that of Messrs. Mather and Platt for an electrically-driven boiler feed-pump at £167, and that of the Union Ironworks Co. for a bunker and feeding apparatus at £128. 10s.

Dewsbury Town Council have accepted the tender of Messrs. Cowans (Ltd.) for the supply of a traction switchboard, and that of Messrs. Chadwick & Sons for a cooling pond at the electricity works.

Lincoln Council have accepted the tender of Messrs. W. Gregory & Sons for wiring the abattoirs at £56. 3s. 4d.

Worcester Corporation have accepted the tender of Messrs. Morris. Jones & Co. for wiring the Tybridge-street generating station, at £165,

Nuneaton and Chilvers Coton District Council have accepted the tender of Babcock and Wilcox for the supply of a water-tube boiler and pipe work at £570. Eight tenders were received.

An order has been placed with Messrs. Willans and Robinson, through Messrs. Crompton & Co., for three 100 H.P. compound engines for the Camberwell (London) infirmary.

BUSINESS NOTICES.

Mr. Saml. Buckley, of St. Paul's-square, Birmingham, has acquired the business of Messrs. Bohler Bros. & Co., Sheffield, and continues the manufacture of ingots, billets and finished bars which that company has manufactured for many years past at their Sheffield works. Mr. Buckley is also the manufacturer of the patent Buckley lifting jack, specially designed for lifting tramcars when obstacles of any kind become jammed beneath these vehicles.

Mr. Albert Barron, formerly manager of the fittings department of the Electrical Co. has entered into partnership with Mr. J. J. Smith, 47, Holborn Viaduct, and 48 and 49, Farringdon-street, London, E.C. The title of the new firm is J. J. Smith & Co.

Messrs. James Gordon & Co., 52, Lime street, London, E.C., have been appointed sole British and colonial agents for Leffel turbines. Messrs. Gordon have, we learn, several installations of these turbines in hand in this country.

We are informed that Mr. Ernest H. Nelson has retired from the firm of F. McNeill & Co., manufacturers of patent felts and slag wool, &c., and the business will henceforth be carried on by Mr. George A. Nelson under the same style.

BANKRUPTCIES AND LIQUIDATIONS.

Alex. Pollock, electrical engineer, 22, Dunning-street (formerly of 95, Albert-road), Middlesbrough, has been adjudicated bankrupt.

In the bankruptcy of David Roberts, electrical engineer, &c., 30, Macklin-street (formerly of 3 and 5, Whiston-street), Derby, the first meeting of creditors will take place on 11th inst. at 47, Full-street, Derby, and the public examination on 15th inst. at the Court House, Derby.

F. H. Wynn, electrician, &c., 14, Westmoreland-street, and Mowbray-square, Harrogate, has been adjudicated bankrupt. First meeting of creditors on 18th inst. at Red House, Yeovil, and public examination on Aug. 1 at Courts of Justice, York.

Electrites Limited is to be wound up voluntarily. Mr. F. B. Lacy, Red Cottage, Pinner, is liquidator.

Plant, &c., for Sale.—An art metal works business (including electric light and gas fittings) is for sale as a going concern in the city of Bradford. An advertisement contains further particulars. Cards to view from Messrs. Butterfield and Hartman, C.A., 2, Darley-street, Bradford, or 3, North-parade, Manchester.

Norwich Electricity Co., in order to make room for larger sets, offer for sale some Willans engines direct-coupled to Laurence-Scott shunt-wound dynamos. Inquiries to the Company, Duke-street, Norwich, where the plant is running. See also advertisement.

The Metropolitan Electric Supply Co. (Ltd.), 16, Stratford-place, London, W., have two Brown's patent steam feed-water heaters for sale. The plant can be viewed by appointment. See advertisement.

An electric launch, a Crompton motor, dynamo and other plant, are advertised to be sold by auction on Friday, July 18. The plant is at Morecambe, and can be seen and particulars obtained from the auctioneer, Mr. J. Nicholson, Lake-road, Bowness, or from Mr. J. Gibb, 6, Skipton-street, Morecambe.

A Crompton-Howell battery, in fair condition, is for sale. Offers to general manager, Gloucester Railway Carriage and Waggon Co., Gloucester. See advertisement.

Some excellent plant, suitable for mill lighting or for a complete installation of 500 lights, is advertised for sale on another page.

Land for Sale.—The Land Company, 68, Cheapside, London, E.C., announce in an advertisement that they have for disposal eligible plots of freehold land at Herne Bay, Southend, Westcliff, Minster, Walton-on-the-Naze, &c.

Capital Required.—The owners of a small electric lighting station, operated under provisional order, advertise in another

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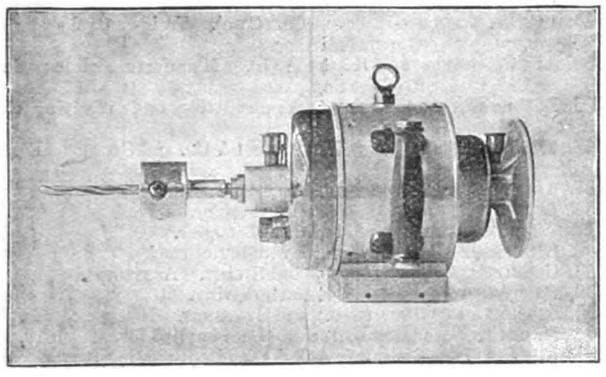
column that they are prepared to consider proposals to enlarge the company to meet an increasing demand for electric current.

Automobilists' Repair Kit.—Messrs. Shippey Bros., 14, King-street, Cheapside, E.C., are placing on the market a new type of repair kit for motor vehicles.

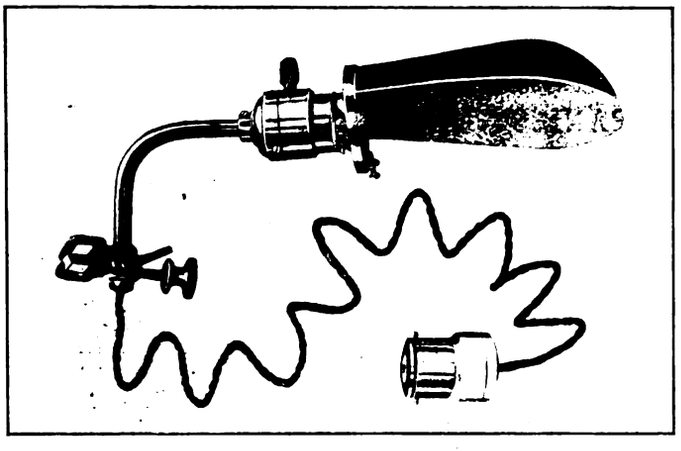
Portable Electric Drills.—Messrs. O. Berend & Co., Basinghall-avenue, London, E.C, have issued a new price list of "Oberon" portable electric drills. A special feature in the design of these drills is the light weight of the motor drill, its compactness, high efficiency and simple form of speed regulation. The drills are supplied with or without reduction gear. This gear is completely enclosed, as shown in the illustration. Speed regulation is obtained



"Oberon" Drill, with Reduction Gear.

by a three-way combined regulator and starting switch, and the motor can be started at slow and be gradually increased to full speed. A device actuated by a small lever attached to the motor can be supplied, by means of which the drill may be run with or without the reduction gear. The weight of the largest size of these drills is 23lb.

Desk-Lamp Fixtures.—The British Thomson-Houston Co. have introduced a compact and convenient device for supporting an incandescent lamp on or over a desk. This is shown in the illustration.



B.T.H. Desk Lamp Fixture.

A joint in the fixture permits it to swing sideways so that a roll-top desk may be closed over it without interfering with the lamp. The fixture is made up of a key socket, shade holder, shade, attaching plug and a length of silk cord, and can be clamped in any convenient position.

Catalogues.—We have received from Messrs. Isenthal & Co., 85, Mortimer-street, London, W., a copy of a bulky catalogue in German relating to the physical apparatus manufactured by Max Kohl, of Chemnitz, Germany, whose sole agents for Great Britain and the Colonies Messrs. Isenthal have been appointed. The volume is one of the most complete catalogues of physical apparatus for lecture and laboratory purposes that we have seen, and should be useful to the teachers and assistants at technical schools and colleges.

A new catalogue of Maxim electric incandescent lamps is issued by the Sir Hiram Maxim Electrical and Engineering Co, and among special points which the company desire to place before users of incandescent lamps are the following :—

(1) All the filaments in the Maxim electric incandescent lamp are treated, and, in the case of double filament lamps, both filaments are mounted upon a glass bar stem before the treating takes place, which ensures the filament retaining the same shape in the bulb as it did while undergoing the above process. As a result of this method both filament being treated in series are equalised and run at the same efficiency.

(2) The different voltages of traction lamps from 24 volts, as used for train lighting, up to 250 volts for running in series on a 500-volt tramway circuit. A curve is given showing the exceptionally good manner in which the candle-power is maintained throughout the life of the lamp.

The Pulsometer Engineering Co. are issuing a well-arranged catalogue, very fully illustrated, and showing the uses to which Pulsometer pumps can be put in connection with water supply. The new catalogue is a very complete publication, the illustrations being particularly informing.

A sheet illustrating the latest types of "Sunbeam" high-voltage lamps is issued.

We have received from the American Circular Loom Co., of Boston, Mass., whose British agency is at 27, Chancery-lane, London, W.C., a catalogue of flexible conduit for electric wiring. Certain advantages are claimed for this type of flexible conduit over other types of conduit.

From Messrs. Arthur Lowcock (Ltd.), Shrewsbury, we have to acknowledge a well-got-up catalogue of fuel economisers, made throughout at the company's Shrewsbury works. Some excellent illustrations are given.

Oil and gas engines of the latest design of the Campbell type are treated in a set of sectional parts of the main catalogue issued by the Campbell Gas Engine Co. The engines listed, illustrated and described are many of them designed specially for electric lighting work. Particulars are included of a special type of self-starting apparatus for large engines. Combined engines and pumping plants are also dealt with, and a special type of mining pump and general water supply is included.

The recent disastrous conflagrations have called attention to the necessity for improved fire-fighting apparatus, and a new list published by Messrs. Shand, Mason & Co., London, is, therefore, interesting in this connection.

Messrs. Cresswell's Asbestos Co. (Ltd.) have ready a compact catalogue of a large variety of rubber, gutta-percha, mica, asbestos, fibre and leather goods for engineers, including a large assortment of beltings and belting sundries, tubing, hose, insulating fibres, jointings, sheetings, &c. A good list of sundries is also given.

From the Christensen Engineering Co. of Milwaukee, U.S.A., we have received a list of electrically operated stationary and portable air compressors designed to be operated from any electric railway, power or lighting circuit. These are claimed to be complete specially-designed self-contained units of electric plant in the most compact form. The working parts operate in a bath of oil, and the details are interchangeable.

Messrs. Monté Callow & Co , 6, Ludgate-broadway, London, E.C., have now ready the "Polyphase" section of their catalogue of Perfector resistance apparatus.

Imports of Electrical Goods.—The value of the electrical goods imported into this country during June was £71,709, against £54,367 in June, 1901, and £86,171 in June, 1900. The total value for the six months ended June 30 was £355,411, compared with £552,966 and £420,253 in the corresponding periods of 1901 and 1900 respectively.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 2 to 8, with the ports of destination :—

Africa—Alexandria, £426 ; Cape Town, £1,199 (including £317 telegraph material) ; Durban, £1,018 (including £132 telegraph material) ; East London, £250 ; Port Elizabeth, £31 ; Sierra Leone, £3,342 (telegraph material). *Argentina*—Buenos Ayres, £2,413 (including £1,080 telegraph material). *Australasia*—Brisbane, £30 ; Melbourne, £349 ; Perth, £230 ; Sydney, £586. *Azores*—£390 (including £190 telegraph instruments). *Brazil*—Rio de Janeiro, £2,035 (telegraph material). *Canada*—Halifax, £555 (telegraph cable). *Ceylon*—Colombo, £17. *Channel Islands*, £63. *Denmark*—Copenhagen, £30. *Gibraltar*, £50. *Holland*—Amsterdam, £123. *India*—Bombay, £80 ; Calcutta, £104. *Japan*—Yokohama, £412. *Malta*, £35. *Portugal*—Lisbon, £77. *Russia*—St. Petersburg, £1,417 (telegraph material). *Spain*—Carthagena, £28. *Straits Settlements*—Singapore, £6. *U.S.A.*—New York, £140. Total £15,436, against £21,474 in the corresponding week last year (July 3 to 9).

Niagara-Toronto Power Transmission.—Contracts have been let for part of the plant needed for the transmission of electric current from Niagara Falls to Toronto. The distance is 90 miles, and the transmission is to be effected at a pressure of 60,000 volts. The generating plant will consist of 10,000 H.P. units, generating current at 11,000 volts, step-up transformers being used to raise this to the line potential. It is hoped that by July next year the first of these units will be at work.

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

May 5, 1902.

10,269. VERITYS LIMITED and W. R. RIDINGS. Birmingham. Arc lamps.
10,271. H. SCOTT. Bradford. Automatic supply of electric power to mechanism.
10,302. J. LANDON. Watford. Apparatus concealed by doormat which completes a circuit when trodden on.
10,309. F. C. F. KNAAK. Plate, die, printing and metal presses by electric-kinetic power.
10,329. E. LESPAGNOL. Secondary batteries.
10,335. A. H. MIDGLEY. Dynamo-electric machinery.
10,342. T. H. MURPHY. Armature windings and producing same.*
10,357. M. S. LOMBARDO. An electric tinder-box.

May 6, 1902.

10,369. J. C. MACALESTER. Glasgow. Electric light switch.
10,387. J. REYNOLDS. Plymouth. Adjustable trolley.
10,444. C. BERZ. Electric measuring instruments.
10,452 J. E. EVANS-JACKSON. Wireless telegraphy. (De Forest Wireless Telegraph Co., U.S.)*
10,457. J. REDDING, L. D. LOTHROP and J. W. DEERING. Storage batteries.*
10,459. H. J. HADDAN. Controllers. (D. Bergmann, Sweden.)
10,460. T. J. MURPHY. Trolley controllers.

May 7, 1902.

10,466. J. GARVIE. Electrical working of pile drivers.
10,437. G. DAVIS. Glass globe for glow-lamps.
10,512. G. W. JONES. Electric conduit.
10,528. C. COOK. Galvanic batteries for shot firing in mines.
10,529. J. WATSON. Overhead electric trolley traction systems.
10,532. L. BRISTOL. Portable secondary batteries.*
10,533. O. ZERKOWITZ. Jacquard card-punching machines.
10,534. F. DESSAUER. Liverpool. Röntgen tubes.
10,538. C. STOLL. Trolleys for overhead conductors.*
10,541. W. E. PALMER. Electric clocks.*
10,546. J. G. LORRAIN. Electric conductors, and attaching devices. (H. A. Macdonald, France.)

May 8, 1902.

10,565. STEEL, PEECH AND TOZER (LTD.), and H. E. BOWDEN. Sheffield. Liquid resistance switch.
10,581. W. R. WYNNE. Lamps of Nernst type.
10,590. G. SWEETSER. Incandescent lamps.
10,594. V. W. RILEY and H. W. ROWING. Cleats.*

May 9, 1902.

10,672. R. MÜLLER and R. D. BOWMAN. Electric ignition gear.
10,695. J. C. FULLER, G. FULLER and D. FULLER. Attaching metallic connections to plates of batteries.
10,701. A. A. GUEST. Incandescent lamp fittings.
10,710. J. YOUNG. Switchboard for telephonic intercommunication.
10,733. W. STOCKMEYER. Automatic regulating systems.

May 10, 1902.

10,755. J. H. TUCKER. Birmingham. Electrical switches,
10,758. A. E. BAILEY. Plymouth. Trolley-wire catcher.
10,788. C. E. WISNER. Liverpool. Wireless telegraphy.
10,800. S. Z. DE FERRANTI. Electrostatic instruments.
10,811. A. E. CARTER. Brighton. Rotary carbons for arc lamps.

May 12, 1902,

10,822. H. CRACKNELL, J. W. CRACKNELL and C. T. PHILLIPS. Leeds. Overhead wires for traction.
10,826. F. COLLINS. Liverpool. Clockwork-operated electric switches.
10,837. T. HARRISON and G. A. SMITH. South Shields. Starting switches.
10,841. C. T. A. HENSHAW. Edinburgh. Fittings insulator.
10,856. M. NORDEN. Switchboards for illuminating electric lamp signs and automatically actuating the same.*
10,881. W. A. CROOK and E. MINES. Liverpool. Incandescent lamps with rare earth filaments.
10,888. L. CERBOTANI and A. SILBERMANN. Electromagnetic devices.*
10,889. W. C. RUNGE. Telephone receivers and transmitters.
10,890. W. C. RUNGE. Telephone systems and apparatus therefor.
10,899. S. Z. DE FERRANTI and C. C. GARRARD. Electric circuit protecting devices.

May 13, 1902.

10,934. J. D. F. ANDREWS and ELECTRICAL PRODUCTIONS (LTD.). Arc lamps.
10,938. W. WHITE. Electric switch. (F. Rohr, Spain.)
10,943. E. GAGNE and P. BONNEAU. Trolley guards.*
10,952. E. R. MÄNNELL. Clockwork electric alarms.*
10,957. F. LUX. Electricity meters.
10,971. F. W. LE TALL. Arc lamps. (H. Brener, Germany.)

May 14, 1902.

11,018. J. W. LEA and J. H. PERRINS. Birmingham. Lamp holders.
11,021. R. KENNEDY. Leeds. Electricity meters.
11,044. J. B. GIRDLESTONE and C. F. G. THORKELIN. Arc lamps.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

5,172. CHARLTON and BARTON. Thermal working of switches, registering apparatus, &c.
5,427. DOVER. Manufacture of cables.
6,615. BREMER. Arc lamps.
9,781. QUIN and SMITH. Insulator for overhead trolley.
9,925. NEWTON and WRIGHT. Working apparatus with alternating or pulsating currents.
10,188. JACOBS. Indicators for sectional telephone circuits.
10,206. CRUVELLIER. Electric railways and tramways on the surface-contact system.
10,374. MORDEY and STELJES. Step-by-step telegraphic apparatus.
10,655. BELL and BELL. Electrolytic cells.
10,734. BRITISH THOMSON-HOUSTON Co. (Case). Train-control systems.
10,793. POLYBLANK. Electric indicators.
10,869. ABEL (Siemens and Halske A.G.). Manufacture of incandescent bodies for electric lighting.
11,003. BLOCHMANN and BICHEL. Transmitting and receiving electric signals.
11,242. SIR W. G. ARMSTRONG, WHITWORTH & Co. and STUART. Electrical primers.
11,857. ARNOLD and COLLISCHOUN. Armature windings.
12,134. LEE. Arc lamps and electrodes therefor.
12,217. WATSON. Coin-actuated medical batteries.
12,342. SCHÄFFER. Electromagnetic winding of clocks.
12,552. CROMPTON & Co., HODGSON and EWART. Arc lamps.
12,739. POTT and WILLIAMSON. Electric driving.
12,835. STOTHERT AND PITT (LTD.) and STOTHERT. Electric cranes.
12,975. MADDEN. Secondary batteries. (Date applied for, March 19, 1901.)
13,139. EDMONDSON. Resistance switches and automatic cutouts.
13,256. SCHARF. Transferring several telegrams in both directions by a single wire.
13,266. JEVONS and OFFORD. Automatic line switches.
13,732 ABEL (La Soc. Anon. pour la Transmission de la Force par l'Electricité). Electric traction on tramways.
14,237. GIRDLESTONE and THORKELIN. Arc lamps.
14,751. TOSSIZZA. Electro-metallurgic treatment of ores.
15,155. HIRST and BOYES. Conduits for electric conductors.
15,833. WISE (A.G. "Magneta" (Electrische Uhren ohne Batterie und ohne Contacte)). Armatures for electric clocks.
15,918. MARILLIER. Electrical distribution for traction.
17,039. CROSSE. Rifle range telephones.
18,830. BREWSTER. Automatic electric fire alarm.
20,561. MCGILLVRAY and CARR. Feeder or junction box.
20,834. RITZER. Variable-pressure electric current transformer. (Date applied for, March 11, 1901.)
21,942. NAUHARDT. Electrolytic treatment of tin.

COMPANIES' MEETINGS AND REPORTS.

Electric Construction Co. (Ltd.).

The ninth annual general meeting was held on Thursday, under the presidency of Mr. JAMES WILLIAM BARCLAY.

The SECRETARY (Mr. David Willock) read the notice convening the meeting and the auditors' report,

The CHAIRMAN then said: Gentlemen, the net profit of the year is £20,496. 19s. 11d., but to this has to be added the balance brought into the account from last year, £2,853. 18s. 2d., and the total available for distribution is thus brought up to £23,350. 18s. 1d. This sum your Directors propose to appropriate in payment of the fixed dividend on the preference and of 6 per cent. on the ordinary shares, and in adding £2,000 to the general reserve—the balance of £3,504. 6s. 1d. being carried forward to the credit of next year's profit and loss account. The general results of the year's business are similar to those of last year, and coupled with the figures of previous years go to show that we have a steady going business, while at the same time our position from year to year becomes more firmly established. You have no doubt noted that our general reserve is now £32,000, while the depreciation fund, made up exclusively from revenue amounts to £43,000. This is the ninth annual report, and if we go on accumulating at the same rate for another nine years, the Company will be in a very comfortable position indeed. I have much satisfaction in referring to the handsome increase in the net receipts from the Madras Tramways; it is no less than 33 per cent. over that of last year, and the gross receipts for 1902 so far show every promise of even a larger increase in the current year. There is thus great promise that this will prove a highly profitable undertaking, but, as I told you on a previous occasion, we intend to restrict ourselves to our manufacturing business, and shall, therefore, avail ourselves of a favourable opportunity, which we look for soon to dispose of the tramways in whole or in part. The shares of other companies consist almost entirely of holdings in the Electrical Power Storage Co. and in the Crystal Palace District Electric Supply Co. You may recollect that the Electrical Power Storage Co. was a subsidiary company formed to take over the accumulator branch of the old Company's business. The Storage Company has, under the present able management, proved a success, for it holds the premier position among electric storage companies. The development of electric traction is opening up a great future for such manufactures, and I am glad to say that the profits of the Company show a large increase in the year just ended. The expenditure side of our account

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shows increases in some items, but these are of an exceptional character, and a considerable reduction in expenses is anticipated during the current year. Our Managing Director (Mr. Gray) maintains a close supervision of all outlays, and sees that we get full value for our money. I am glad to inform you that the compensation for accidents to workmen during the year is only £36. 13s. 3d., which is less than one-fourth of what we would have to pay an insurance company for the risk. This seems to me a very good test of the skill and carefulness of the men. I do not know whether many of you have been to the Wolverhampton Exhibition, but if so, I am sure you would be well satisfied with the display of electrical plant made by the Company, and I can assure you that the machines are quite as effective as they look, for I am told they provide a large share of the power required by the exhibition and actually supplied the whole on the day the exhibition was opened. The relations between the management and all classes of the employés continue to be thoroughly cordial, and your Directors have much satisfaction in recommending the distribution among them of the usual bonus in token of your appreciation of steady and zealous service. This bonus is determined by the rate of dividend, the wages paid to each man, and his industry and regularity during the year. We believe the money is well spent. It encourages the men to steady industry, interests them in the prosperity of the Company, and tends to the growth of confidence between employer and employed. Competition between the manufacturers of electrical machinery has been and still is very keen, but we maintain our position. Our works, plant and tools are all modern and of the best, and in size capable of turning out the largest machines that may be required. We have reason to be satisfied with the abilities of our staff and the skill and industry of our artisans, who recognise that if they are to earn a bonus they must do, at least, as well as others. So fully equipped in every respect, I think we have every reason to have confidence in the future of our Company. I now move the adoption of the report and accounts.

The Chairman having replied to sundry questions, the resolution was carried unanimously.

The retiring Directors and Auditors were then re-elected.

A SHAREHOLDER inquired if the Chairman could explain why the shares of the Company stood so low. He presumed that the Company had representatives in South Africa.

The CHAIRMAN replied that he could not explain the low price of the shares—that must be sought for on the Stock Exchange, but these things were sometimes inexplicable. He knew of no reason why the shares should be so low, except that people were not pleased with the return. They had always had very able and efficient agents in South Africa, who were looking after the Company's interests there. They had a considerable number of orders in hand from that quarter.

A cordial vote of thanks to the Chairman and Directors terminated the proceedings.

Electrical Power Storage Co. (Ltd.).

The thirteenth ordinary general meeting was held on Thursday, under the presidency of Mr. J. IRVING COURTENAY.

The SECRETARY (Mr. David Smith) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: Gentlemen, the balance-sheet shows that the net profit for the year is £10,913. 13s. 8d., making, with the balance brought forward, £11,346. 2s. 9d. Out of this sum we have transferred £5,000 to reserve and £1,000 to contingent fund; and we recommend a dividend of 5 per cent. upon the paid-up ordinary capital of the Company, leaving £854. 14s. 9d. to be carried forward. The reserve will now stand at £15,000 and the contingent fund at £5,000. We believe shareholders will approve of this cautious policy, which will greatly strengthen the position of the Company. The steady increase in the contingent fund also, must, we feel certain, convince customers of the Company's ability to fulfil its obligations under the maintenance contracts. The factory has been maintained in thorough repair and condition at a cost of £2,102. 18s. 3d., and £956. 17s. 7d. written off for depreciation The works are furnished with the latest types of labour-saving machinery, and everything is being done to ensure the safety and comfort of the men and to increase the efficiency and productiveness of the establishment. The workpeople are provided with coffee before starting in the morning, and this is much appreciated. Owing to the continually increasing demand for cells of the Company's larger central station types, the forming accommodation has for some time been taxed to the utmost, and a contract has, therefore, been entered into for the erection of an additional floor in the main building of the factory, which, when completed, will enable us to substantially reduce the time necessary for delivery. I am glad to be able to point to the figures for the year as evidencing that it has been an exceptionally prosperous one for this Company. This is all the more gratifying as the returns on analysis prove that it is due to a general increase of business in all directions; orders for lighting and power stations, for private installations, and for traction purposes all showing an increase over previous years. Our turnover during the past year has been larger than ever before, in addition to which we are in the satisfactory position of starting the new financial year with orders ahead to an amount which is considerably in excess of that of any previous year. Among the larger contracts we have completed during the year have been the following:—Aberdeen, Alloa, Garston, Birmingham, Birkenhead, Horsham, Worksop, Sutton Coldfield, Nottingham, Colchester, Ayr, Harrow, Newcastle-on-Tyne, Leamington Spa, Great Yarmouth, Stockport and Liverpool. Among those contracts on which we are at present engaged I may mention one for the Underground Electric Railway Company of London (Ltd.)—the company which is carrying out the change to electric power on the Underground Railway—as well as contracts for the following towns:—Liverpool, Broughty Ferry, Cleckheaton, Walsall, Birkenhead, Newcastle-on-Tyne, Norwich, Dublin and Hornsey. In this connection it is specially interesting to notice that many of these are "repeat orders"; that is to say, they are for towns where there are already one or more of our batteries in use—such towns, for example, as Aberdeen, Birmingham, Nottingham, Liverpool, Walsall, Birkenhead, Newcastle-on-Tyne and Norwich. We are still continuing our experiments in batteries for electric traction, and although our laboratory has tested a very large number of cells manufactured in this country, on the Continent, and also in America, we have not yet found anything which is superior to the cell we are now manufacturing and selling in large quantities to the City and Suburban Electric Carriage Co. The latter, as far as we can ascertain, is the only company in this country which is doing any considerable business in electrically-propelled vehicles. I may say, further, that the results which we have obtained from experiments with our own vehicles specially kept for experimental use, point to the fact that the supply and maintenance of batteries for these vehicles is not nearly so expensive as the public imagine, and we have now a project under consideration which will enable the purchasers of vehicles to hire batteries at a very reasonable rate. For the last two years there have been more or less persistent rumours of an accumulator invented by Mr. Edison which will, we are told, revolutionise electric traction. Mr. Edison is undoubtedly an exceedingly able man, and the science of electricity owes much to him, but I can assure the shareholders that it is quite too early to place reliance on statements which, in many instances, bear on the surface evidence that they are circulated by irresponsible parties, and do not emanate from the inventor. Although we have followed Mr. Edison's figures closely, we cannot find that even his own statements show that he is able to make a battery which is more than 10 per cent. lighter than the special battery we manufacture for traction purposes, and as Mr. Edison's battery must be at least two or three times as expensive to manufacture as our own, it will have to last a very long time indeed before it can come into successful competition with those which we are now selling. If, moreover, we judge from our own laboratory experience and the experience of our technical staff, we think it may probably be found that Mr. Edison is still far from being in a position to make a commercial success of his invention. The experience of the E.P.S. Co., extending over 20 years, shows that there has been no radical alteration in principle resulting in a signal commercial success since Camille A. Faure introduced the mechanical application of a salt of lead to the lead grid or support. It must not be forgotten that the excellent results of the year's working which we have before us have been obtained in the teeth of the severest competition, and it is largely due to the gradual improvement in detail made by our staff and works that we are able now to compete so successfully, both in regard to price and quality. As I have explained to you in previous years, this Company has never been tempted to enter into what I may justly call a ruinous competition; that is, to sell a cheap article which would in the long run bring discredit on the Company. On the other hand, you may be perfectly well assured that wherever you find a battery manufactured by this Company, it is the best, and in the end will prove the cheapest that can be produced for the money. In furtherance of this continual improvement in detail, we are now introducing a new form of negative plate, under the name of "Carzonode," which, after exhaustive tests extending over three to four years, we find is vastly superior to those at present in use, and will enable the Company eventually to materially reduce its maintenance rates, thus increasing our power of meeting a certain class of competition which, in the past, we have felt to be somewhat severe. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded the motion.

Mr. J. W. BARCLAY, after congratulating the directors upon the result of the year's operations, said: Every now and again we see some alarming statement in the newspapers—alarming from the shareholders' point of view—that Mr. Edison or someone else has discovered an accumulator which is going to do ever so much more than has been done in the past—and then we do not hear anything more about the matter until some other invention is mentioned. It is curious, as you have said, that there has been really no new invention radically affecting the storage of electricity since that made by M. Faure, and all the improvements and developments that have taken place since are principally in workmanship and details. By careful attention to workmanship and details, the accumulators are made to last longer. Their efficiency is increased, and I do not know that there is very much more to hope for, except in that direction, from the storage of electricity. A point which ought to be kept in view by the shareholders and by others who are interested in electrical storage is, that a battery which passes a successful laboratory test may prove very unsuccessful on a commercial scale. I believe I am right in saying that it requires two or three years of constant action and reaction to test an electric cell in order to be able to determine what its value is in the commercial world, and whether it is a success or not. If, then, we should see accounts of the discovery of some new or improved battery or method of storing electricity, we may very safely withhold our judgment for a year or two, because that time must elapse before it can be determined whether the new battery is a success or not.

The resolution was then carried unanimously, and the auditors having been re-appointed, the proceedings terminated.

Rand Central Electrical Works (Ltd.).

The annual meeting was held on Tuesday, Sir C. RIVERS WILSON, G.C.M.G., C.B., presiding.

The SECRETARY (Mr. H. Rogers) read the notice calling the meeting and also the report of the auditors.

The CHAIRMAN said: Gentlemen, after a long period of anxiety, and trouble and loss we have at last emerged into a period of peace and prosperity. You naturally cannot expect after the occurrences of the past year, that the working which we can lay before you should show

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very favourably. At the same time it is not altogether unsatisfactory to remark that, although we only worked four months of the year 1901, eight months of it being entirely idle, yet we earned within £9,500 of our working expenses. In 1900—when we worked for the whole year, but not at all up to the full capacity—we had a small sum in excess of our working expenses. Of course, our working expenses could not be diminished so much as we might have hoped for, because it was necessary to keep our staff together to maintain the works in proper condition, and we employed them as much as we possibly could during that period of enforced idleness. The balance-sheet, prepared on the same lines as that laid before you last year, does not call for much explanation. You will observe, on the debit side, the item of sundry creditors, £4,647, which contrasts favourably with the amount of £15,326 in the previous year. This amount of £4,647 is made up of unpaid invoices of Siemens and Halske, £1,255, which are almost, if not entirely, liquidated at the present time, and ordinary trading accounts at Johannesburg, £3,392. On the credit side, you will be able to calculate that the construction of works and mines installations accounts, &c., which in 1900 amounted to £206,895, have been increased slightly to £208,566. The cause of that increase of capital expenditure arises mainly from the necessity of supplying a telephone installation, at a cost of about £1,500, the want of which was felt in the past, especially when mishaps have happened to the plant in outlying districts of our system, and the difficulties of communication have caused delay which this installation will obviate. Water supply, line construction, material, &c., are practically unchanged and require no comment. Sundry debtors mainly consist of amounts due for the supply of current to various mines, and to the Johannesburg town and railway, prior to the British occupation, in respect of which £2,400 has since been paid by the mines and the amount due for the Johannesburg town and railway supply—namely, £1,920—is considered safe by the Directors. The item in suspense—£1,460—represents the indebtedness of the late Transvaal Government for power supplied in connection with the Robinson gold and slimes plant. Then we have Imperial Government claims. Under this heading is the expenditure, to Dec. 31, 1901, for repairs to plant damaged by the Boers, amounting to £2,358, the cost of expenses for military protection £1,285, sundry incidental items £100, and £1,500 deposited with the late Transvaal Government as caution money. I say nothing as to consequential damages which we have suffered, as that may or may not be a question which may be entertained by His Majesty's Government. Before leaving the balance-sheet I must call attention to the fact that we stand in the position of having an accumulated deficit which amounts to £25,231. As some set-off against that we have a small special reserve, which accumulated a considerable time ago, before the guarantee arrangement came into effect with Siemens and Halske, and it now amounts to £4,722. If that special reserve is applied to the reduction of the deficit, which we think is a proper appropriation to make of it, we shall thereby reduce the deficit to £20,509. But bear in mind in considering these figures, that in each year we have continued the policy of making a very liberal allowance for depreciation. As regards contracts with various customers, we have contracts for 2,400 H.P. running for various periods. Contracts for 900 H.P. expire this year, but we have no doubt that we shall be able to dispose of that to the old or to new customers. We also are under arrangement to supply 860 H.P. to various companies as a temporary supply, and on favourable terms, and we are under an engagement to supply 200 H.P. additional to the Johannesburg Municipality within the course of about six months. Our customers consist of, first, the town of Johannesburg, and then two important stations on the railway—Elandsfontein and Johannesburg. We supply power to 10 mines, and, in addition, we also supply various minor interests, such as chemical works and industries of that description. We have every hope that, as the contracts with our old customers run out from time to time, we shall be able to renew them on favourable terms, but, failing that, I think there can be no sort of doubt that we shall be able to place the whole of our power, and, I hope, on advantageous terms. We have felt it absolutely necessary to modify the old tariff and to put ourselves more into conformity with the system and the action of the mines out there. Since we started business in South Africa there have been enormous developments and improvements in everything relating to electrical machinery. The consequence is that the mines which at that period, six or seven years ago, would have been unable, except at excessive cost, to supply themselves with their own power, and which, therefore, would naturally have recourse to us as a matter of necessity, are now, I think Mr. Gorrissen will tell you, in view of the various improvements I have alluded to, able to supply themselves on much more economical and favourable terms. That in itself made it indispensible for us to reconsider our position in this matter, and I think that the tariff, as it has been now framed, and as we believe it will work out, will give us at least as good, and certainly a more sure revenue than we might have expected to have obtained under the old system, as being better adapted to the requirements of our customers. As to the question of labour, which, perhaps, you may think has given us trouble and anxiety, I may say that we do not anticipate much trouble on that account. As a matter of fact, we only employ 80 to 100 natives, which is only a very small number compared with the thousands employed at many of the mines, and, from the latest advices which have reached us, I think we shall have no trouble on that score. As regards our prospects, what can I say? We have passed through a very severe ordeal, and we look forward with confidence to the future. In conclusion, I must say again, what I have had the pleasure of saying on former occasions, how much we are indebted to our local Directors and staff in South Africa. They have continued to apply themselves to their work with a self-denial and energy beyond praise, and that the Company has such a favourable future before it now, and that the works out there, in spite of the trials we have gone through, and the accidents which have befallen them, are in such excellent condition is entirely due to our local Board and staff. I now move the adoption of the report and accounts.

Mr. GORRISSEN seconded, and said the Company's re-arranged tariff would provide for their running customers paying 6d. a unit for the first two hours, with a minimum of 30s. a month for each kilowatt installed, and for each additional hour 1d. a unit. This system of tariff is very generally adopted by electrical supply companies at the present time.

The retiring Directors and Auditors were then re-elected, and a hearty vote of thanks to the Chairman and Directors terminated the proceedings.

Callender's Cable and Construction Co. (Ltd.).

The sixth ordinary general meeting was held on Friday last, Mr. HENRY DRAKE presiding.

The CHAIRMAN, in moving the adoption of the report, said: We hope you will consider the results of the past year's working satisfactory. Competition in our business continues as keen as ever—indeed, seems to become more keen. You will see from the accounts that the profits last year were the largest the company has yet made. The amount at credit of profit and loss is £71,978, and after paying interest on debentures, dividend on preference shares, writing down plant and machinery and furniture, and carrying £3,000 to machinery renewal fund, we have an available balance of £58,621. 16s., including the amount brought forward. We propose to deal with the amount in this way: We have already paid £22,500, or 15s. per share, and we propose to pay now a special bonus of 5s. per share, and to carry forward £28,621. 16s. We are thus paying 20s. per share, equal to 20 per cent., for the year. You will see from the accounts that the reserve fund now stands at £100,000, and we have thought it better not to carry this balance of £28,621 to reserve, but simply to carry it forward. A reserve fund of £100,000 is a respectable figure, and for the present we think it should remain there. Since we last met we have increased our purchase of land at Erith by 16 acres. We get a long frontage to the river, and we now have 45 acres of land at Erith. An additional advantage in buying this land is that it not only increases the value of what we already possess, on account of giving us the longer river frontage, but we are also able to keep off other factories which might have been erected there, and might have endangered the safety of our works. The ordinary capital has been increased by £25,000. That is not a large amount, and our capital is not sufficient for the growing requirements of our business. We have already sent out notices to the debenture stockholders to consider the issue of £110,000 further debenture stock, to rank pari passu with the existing £90,000, all of which will go in the ordinary working of the company. The circular issued with the report informs you that the negotiations for amalgamation with the W. T. Henley's Telegraph Works Co. (Ltd.) have fallen through, and I venture to think that the accounts now submitted to you will prevent any feeling of disappointment on the part of the shareholders on this account. I will now ask Mr. Callender, our managing director, to make his usual statement as to the business of the company, and will conclude by moving the adoption of the report and accounts.

Major W. M. MACKENZIE seconded the resolution.

Mr. T. O. CALLENDER said: During the year, in spite of very serious competition, not only among English manufacturers but also on the part of our foreign friends, we have been enabled to hold our own, to make a not unsubstantial progress, and to present the balance-sheet which I think you must consider satisfactory. In the balance-sheet the items referring to the property owned by the company represent very fairly the value of those properties which with the plant have been thoroughly well maintained, and we have been charging more than the full amount usually charged for upkeep and maintenance from the year's revenue. We do not, of course, like this keen competition from abroad; at the same time, I have no doubt we shall be able to hold our own, and give a good account of ourselves against any competition. The amount of work we have had is very satisfactory. We have, of course, suffered, like most other cable makers, from the serious fall that has taken place in the price of copper, but I am glad to say this was not so serious to us as it might have been. Naturally, the upsetting of business arrangements by a fall in copper from £80 to £50 per ton was very serious; but, in spite of all this, the position of the company at the present time is a most excellent one. I ought to take this opportunity of expressing our appreciation of the loyal support we have received from our excellent staff. One of the difficulties the company works under is the necessity of having such a large number of men all over the country. The total number at present in our employment is between 7,000 and 8,000, scattered over some 100 towns and places in this country and abroad. The result of this is that we have to have a considerable number of trained engineers, most of whom must of necessity be young men, and we have been singularly fortunate in picking out a very excellent lot of men, who have done admirable service for the company.

In reply to remarks, Mr. Callender further observed that he considered the company had adopted a very conservative policy in regard to the amounts written off for depreciation. As to the expenditure, this would tend to increase in view of the severe competition. The company had now to pay in charges and expenses for every £100 of orders at least double the amount they had to pay three or four years ago. This was the tendency, not only in electrical business, but in all branches of the engineering trade. With regard to the breakdown of the negotiations for the amalgamation with Messrs. Henley's, he could only reiterate the words of the chairman of the latter company—"the door had not been slammed, but only closed." They had parted friends and, in view of any possible renewal of the negotiations, the least said the better.

The report was adopted unanimously.

Mr. GEORGE ALLAN said he had understood that some of the employés of the company, heads of departments and others, were led to expect some acknowledgment of their long services to the company if the amalgamation with Henley's had been consummated. He suggested that it would be unwise to disappoint them, and whilst desirous of not committing the

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directors to any details, he suggested that the board should do something to reward the faithful services of the employés.

After discussion it was arranged that the matter should be left in the discretion of the directors.

The retiring directors and auditors were re-elected, and a vote of thanks to the chairman, directors and staff terminated the proceedings.

EDMUNDSON'S ELECTRICITY CORPORATION (LTD.)—At the meeting last week the managing director (Mr. F. E. Gripper), who presided, said the profit for the year, after paying debenture interest, and with the balance from last year, amounted to £30,962, £6,000 more than last year. The dividend recommended in the report would require £10,452, leaving £6,179 to be carried forward. During past year £100,000 of new capital has been issued and £40,000 debenture stock, which had been principally required for extension of existing works and for carrying out new works in connection with the Urban Electric Supply Co., their largest subsidiary company. The Urban Company had made satisfactory progress during the year, and the works at Twickenham, Weybridge, Godalming, Stamford, and Hawick have already commenced to supply current. All their shares in subsidiary companies had been taken at cost price, excepting those in the Woolwich Company, which they had taken at par value. Woolwich Council had entered into an agreement to purchase their Woolwich undertaking, and they had been working it on the Council's behalf until the necessary parliamentary powers could be obtained and other formalities could be completed. Those were now practically finished. They anticipated that the return upon the £1 shares would be considerably over £2. Since their last meeting they had opened a new station at Newport, I.W., and had obtained powers for lighting Ryde and Cowes. They had been in negotiation for erecting electric lighting works for several local authorities on the terms of the authority finding the necessary capital, and afterwards leasing the works to them for a term of years, and they had entered into contracts on those lines at Hamilton, N.B., and Dorking, and two or three other places would be settled shortly. The directors' report was adopted.

NEW COMPANIES, STATUTORY RETURNS, &c.

JOSEPH BAKER & SONS (LTD.)—Reg. July 2, capital £200,000 in £5 shares (20,000 preference), to acquire the business of engineers, patentees, manufacturers and merchants carried on in London, South Australia and Canada as Joseph Baker & Sons, and to carry on the business of mechanical and electrical engineers, electricians, boiler makers, &c. The first directors are J. A. Baker (chairman), W. K. Baker, G. S. Baker (manager) and P. B. Baker. Reg. office, 58, City-road, E.C.

BEVERIDGE LIMITED.—Reg. in Edinburgh on July 3, capital £3,000 in £1 shares, to acquire the businesses carried on by Beveridge & Co. and Walker Bros., Lindsay & Co., Glasgow, and to carry on the business of electrical and gas engineers, &c. The subscribers are W. K. Beveridge, electrical engineer, W. Walker, electrical engineer, A. Lindsay, electrical engineer, J. Chalmers, J. Hendry, J. Fellar and D. Caldwell. The first directors are W. K. Beveridge, W. Walker and A. Lindsay. Reg. office, 11, Jamaica-street, Glasgow.

BRITISH RAILWAY TRAFFIC AND ELECTRIC CO. (LTD)—Reg. July 4, capital £100,000 in £1 shares, to acquire, manufacture and deal in railway plant, cars, carriages and waggons, locomotives, motors, motive or motive power, including electricity, the construction and equipment of light and narrow-gauge railways, and to carry on the business of electrical, mechanical and general engineers and contractors, dealers in wires, cables and electrical and other motive or illuminant materials and apparatus, &c.

GENERAL ENGINEERING CO. (COVENTRY) (LTD.)—Reg. July 3, capital £500 in £1 shares, to acquire the business carried on at Coventry as the General Engineering Co., and to carry on the business of mechanical and electrical engineers, suppliers of electric light and motive power, machinists, metallurgists, moto-car builders and dealers, &c. The first directors are J. W. Mills and W. H. McLauchlan. Reg. offices, 37, Earl-street, Coventry.

STOTHERT AND PITT (LTD.)—Reg. July 2, capital £145,750 in £1 shares (£25,000 preference), to acquire the business of Stothert and Pitt, and to carry on the business of mechanical, hydraulic and electrical engineers, agents, manufacturers of and dealers in steam engines, boilers, cranes, lifts, hoists, machinists, &c. The first directors are W. Pitt, P. K. Stothert, A. K. Stothert, D. Carmael and T. R. Gill. Reg. office, Newark Foundry, Bath.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The return to May 21 gives the capital as £220,000 in 16,000 ordinary and 6,000 preference shares of £10 each, all of which have been taken up and paid for in full. Mortgages and charges nil.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—In return to May 14 the capital is £450,000 in 18,000 shares of £25 each, 17,000 of which have been taken up and paid for in full. Mortgages and charges nil.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The return to March 13 states that the capital is £300,000 in 30,000 ordinary and 30,000 preference shares of £5 each, of which 29,884 ordinary and 30,000 preference have been taken up. £5 per share has been called up on 17,922 ordinary and 20,000 preference, and £2 per share on 11,000 ordinary and 6,250 preference shares, and £239,901 has been received, including £15,791 paid in advance. £23,560 considered as paid on 962 ordinary and 3,750 preference. Mortgages and charges £116,400.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—According to return to May 14 the capital is £2,445,630, in 200,000 ordinary, 34,563 first preference, and 10,000 second preference shares of £10 each, of which 88,321 ordinary, 34,563 first preference and 4,669 second preference have been taken up. £1,275,530 considered as paid. Mortgages and charges £80,000.

WESTERN TELEGRAPH CO. (LTD.)—In return to May 28 the capital is £2,500,000 in 250,000 shares of £10 each, of which 207,930 have been taken up. £10 per share has been called up on 130,000, and £1,300,000 has been received. £779,300 considered as paid on 77,930 shares. Mortgages and charges £578,145.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The return to May 20 gives the capital as £132,520 in 53,008 shares of £2 10s. each, of which 45,008 have been taken up. £2. 10s. per share has been called up on 8 shares and £20 has been received. £112,500 considered as paid on £45,000 shares. Mortgages and charges £170,000.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver $24\frac{9}{16}$d. per oz. (July 10). Consols (2¾ per cent.) $95\frac{15}{16}$—$96\frac{1}{16}$ for money, $96\frac{1}{16}$—$96\frac{3}{16}$ for account; 2½ per cent. 96—96½ (July 10). Consols Pay Day Aug. 7; Stocks and Shares Continuation Days, July 28 and Aug. 12; Ticket Day, July 29; Pay Days, July 11 and 30; Mining Share Carry-over Days, July 25 and Aug. 11.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—An interim ordinary dividend at the rate of 7 per cent. per annum for the half-year ended June 30 has been declared.

CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.)—An extraordinary meeting is to be held to approve the increase of capital of this company by £500,000 in £5 shares, of which 20,000 shares are to be issued to shareholders forthwith to provide capital for additional plant and materials to meet the growing demand for electric current in Calcutta.

CHILI TELEPHONE CO. (LTD.)—The directors' report for the year to March 31 states that the aggregate number of subscribers at all centres was 4,981 compared with 4,723 in 1901, a gain of 258 for the year. The gross revenue in Chili was $759,139, compared with $683,170 in the previous year, an increase of $75,969. Expenditure in Chili was $365,776, compared with $347,413, an increase of $18,363, leaving the net income in Chili from all sources $393,362, against $335,757, an increase of $57,605. The average rate of exchange was 14·85d., compared with 16·65d., a decrease of 1·80d., making the sterling figures of net income in Chili £24,340, against £23,290, an increase of £1,050. The liquid assets and liabilities in Chili on March 31 were valued at 13¾d., the current rate of exchange on that day, compared with 17d. on the corresponding date last year. The decrease due to this fall in exchange amounts to £986, which has been charged to reserve. The balance to credit of revenue (including £2,680 brought forward) is £21,720, of which £7,986 has been carried to reserve for depreciation and renewals. The directors recommend a dividend of 5s. per share, tax free (at the rate of 5 per cent. per annum), absorbing £11,000, and leaving £2,733 to be carried forward. During the year capital outlay in sterling was £948. The increased mileage of lines for the year was 162 miles 1,739yds.

EASTERN TELEGRAPH CO. (LTD.)—Subject to final audit, the accounts show, after payment of interest on 4 per cent. mortgage debenture stock, the 3½ per cent. preference dividend stock to March 31, and the interim dividend of £1. 5s. per cent. on the ordinary stock to Dec. 31 last, a balance available sufficient to pay a final dividend of £1. 5s. per cent. and a bonus of £2 per cent., both tax free, on the ordinary stock, both payable on 23rd inst., and making, with previous payments on account, a total distribution of 7 per cent. on that stock for the year to March 31. The transfer books will be closed from 16th to 23rd inst. inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended March 31 of 2s. 6d. per share, tax free, payable 15th inst. The share register is closed from 7th to 14th inst. inclusive.

ELECTRICAL CO. (LTD.)—The balance-sheet for 1902 has been passed at the annual general meeting, when a dividend of 15 per cent., the same as last year, was declared, and a substantial amount added to reserve, &c. Owing to the extension of the company's business, it has been found necessary to increase the capital by £100,000, making it £200,000 in all. It has been further decided to establish works in this country, and negotiations for the acquisition of a suitable site have been commenced.

D.P. BATTERY CO. (LTD.)—The results of the past year's working enable the company to pay a dividend of 15 per cent. besides nearly £800 in debenture interest, writing off £1,200 for various items and carrying forward £1,000. It will be remembered that about a year ago the company decided to concentrate their works at Lumford Mills, Derbyshire.

GREENWOOD AND BATLEY (LTD.)—At the meeting on Saturday the chairman (Mr. Arthur Greenwood) congratulated the shareholders upon the year's satisfactory working. The various departments had, excepting the textile machinery department, been fully employed, and steady progress was being made in the extension and development of the electrical department, which fully justified anticipations. In close connection with this development of their business was the introduction of the De Laval steam turbines. The machine-tool department had been and continued busy. They were now well employed generally, and the prospects for the present year were distinctly good. The £5,000 sanctioned last year for the completion of the central electric station was being rapidly spent, and he hoped by the end of the present year the company would have a model generating plant to show buyers.

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NATIONAL TELEPHONE CO. (LTD.)—Subject to final audit the following dividends are recommended for the half-year ended June 30:—At the rate of 6 per cent. per annum on the first and second preference shares, at the rate of 5 per cent. per annum on the third preference shares, at the rate of 6 per cent. per annum on the preferred stock, and at the rate of 4½ per cent. per annum on the deferred stock, being equivalent to 5 per cent. per annum on the ordinary shares, less tax in all cases, carrying £70,000 to reserve and about £8,000 forward. The transfer books will be closed from 18th to 31st inst. inclusive.

SOUTH-WEST WIRELESS TELEGRAPH SHIP CO. (LTD.)—Under this title a prospectus has been issued in which shareholders of this new company are promised "a monopoly with every prospect of a substantial dividend." The company is a Liverpool concern, and has a capital of £25,000 in £1 shares, of which 18,000 have been offered for subscription this week. As an example of prospectus compilation the document is an extraordinary one. The company will work under the Marconi patents, and also acquires the patent rights of a ship-mooring arrangement of Capt. W. M. Walters (4,194 of 1901), and the benefit of an agreement between the Marconi International Marine Communication Co. and Capt. Walters. Under this patent and agreement it is proposed to

"establish a floating station on the high seas in latitude 49deg. 40min. N., and 8deg. 00min. W., primarily for the purpose of acting as a floating postal and telegraph ship, giving sailing vessels and steamers their orders, reporting vessels, supplying vessels requiring provisions, stores, &c., and generally acting as a maritime outpost to the British Islands and Western Europe. The vessel will be moored about 110 miles W., ¾ S. of the Lizard, with which point she will be connected by Marconi's system of wireless telegraphy, which is guaranteed by the above company to be effective up to 195 miles."

To remove any doubt of the saneness of this proposal a certificate is set out in the prospectus signed by a number of nautical experts, and this certificate states that the signatories of the certificate are of opinion "that the scheme is thoroughly feasible both from a nautical and commercial point of view, and will supply a long-felt want of the shipping community." The qualifications of the signatories to certify as to the commercial feasibility of the scheme is not so apparent on the face of the document as may be their testimony to the feasibility from the nautical aspect. The Marconi Company takes a royalty of 25 per cent. of the gross receipts, and, in return, grant the holders of the agreement

"a monopoly of the use of any or all their appararus—Marconi or otherwise—and any improvements thereon, for the purposes aforesaid, for the full duration of their patents, and further guarantee not to enter into similar agreement with any other person or persons in regard to any floating station in the Chops of English, Irish and Bristol Channels within the area bounded by the one hundred fathom line of soundings, other than Trinity or Irish lightships or vessels under weigh fitted with the apparatus, and to check all opposition as far as lies in their power during the continuation of this agreement. They also undertake to transmit all messages to and from their station at the Lizard and the floating station free of charge, put same upon Post Office wires, and provide on shore all necessary tuition free for the operators on the floating station. As regards passengers' messages, it has been arranged that where such messages are collected by the station launch, by flag, signal, &c., 75 per cent. of the gross proceeds accrue to this company and 25 per cent. to the Marconi Company; but where they come from vessels fitted with wireless apparatus, and this station simply repeats them—perhaps automatically—to the Lizard (the Marconi Company thus having two sets of instruments and operators at work) this company takes 25 per cent. of the gross proceeds and the Marconi Company 75 per cent."

The prospectus proceeds:—

"As regards the possibility of so many vessels being eventually fitted up with the wireless apparatus as to render this station useless, it may be pointed out that though electricity on board ship has been in vogue for many years, is economical and safe, and is saving of time by enabling cargo to be worked by night, yet not 5 per cent. of existing steamers are fitted with it, so it is scarcely likely that more will be fitted with the wireless apparatus, which costs about half as much, and calls for a skilled operator to keep it in order. As regards privacy, if necessary the upright wire at the ship can be syntonysed with the wire at the Lizard so that no one outside can read the messages. Syntonysing also disposes of any inconvenience that might arise from a multiplicity of messages at the same moment."

The estimated annual revenue from this single vessel (located in a somewhat dangerous position, necessarily in the track of shipping, and moored on an untried principle) from a variety of sources is put at £23,000. Of this the Marconi Company are given about £4,500; £3,500 is put as the outside working expenditure, leaving 60 per cent. for the shareholders. These figures (the prospectus proceeds) "are, perhaps, optimistic, but if they are divided by two there is still a handsome dividend." A considerable revenue is anticipated from vessels "dropping a bag or bottle of telegrams to be picked up by the station boat, which is to be specially built to perform this service in almost any weather, so that the station will start taking money immediately on installation." Provision has been made for rendering the ship practically unsinkable, and, in addition to the ordinary riding lights, it is

"to be lighted by a vertical electric beam of great power, which, playing on the under surface of the clouds, and rendered distinctive by the motion of the vessel, should, of a dark cloudy night, be seen at a great distance. It is proposed to fit powerful search lights so that signals may be read and answered almost as easily by night as by day, and a powerful automatic fog signal will be fitted. Seeing that the business is, as far as can be seen, an unassailable monopoly, that the vessel can hardly be done without when once started, that she can scarcely be sunk, and, humanly speaking, cannot be driven from her moorings, and in any case will be covered by insurance, it is considered that the venture is one of the most promising ever put before the public, and is of international importance; *but the public must always remember that it is not more than a venture.*" (The italics are ours.)

The investing public will, perhaps, be more deeply interested in the sequel. Capt. Walters (who is the promoter) obtains for his concession from the Marconi Company and the purchase by the South-West Company of his mooring patent (with the right to take out foreign patents), £7,000 in fully-paid shares, and is to act as manager at a salary of £300 per annum. The company will proceed to allotment only if 66 per cent. of the 18,000 £1 shares now offered are subscribed. We fear our readers will not be in time to secure an allotment of this first issue, as the list closed yesterday (Thursday), but there will probably be a subsequent opportunity for those desirous of sharing in the venture.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange committee to appoint a settling day in and to grant a quotation to £400,000 £1 shares of the *Cape Town Consolidated Tramways and Land Co. (Ltd.)* and £150,000 4 per cent. debenture stock of the *Isle of Thanet Electric Tramways and Lighting Co. (Ltd.)*, and to allow 14,500 ordinary £5 fully-paid shares of *Edmundson's Electricity Corporation (Ltd.)* and 60,000 ordinary £10 fully-paid shares of the *London United Tramways (1901) (Ltd.)*, to be quoted in the official list.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)—The transfer books are closed from 7th to 15th inst. inclusive, preparatory to the payment of an interim dividend of 12s. per share.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a).
		£	£		£	£
Aberdeen Corporation...	July 5	1,177	+ 335	5	5,126	+ 1,317
Ayr Corporation	„ 5	374	...	7	2,202	...
*Birmingham Tramways.	„ 5	4,831	− 58	26	124,029	+30,392
*Blackburn Corporation..	„ 4	930	+ 242	27	19,428	+ 3,189
Blackpool Corporation...	„ 3	1,491	+ 391	14	10,066	− 423
Blackpool and Fleetwood	„ 5	763	− 22	1	763	− 22
Bolton Corporation	„ 6	1,664	+ 55	14	22,904	+ 1,712
Bradford Corporation ...	„ 5	3,591	+2,444	14	45,855	+31,370
Brighton Corporation ...	„ 6	934	...	33	20,649	...
Brisbane Tramways.....	May 21	2,326	−1,197	21	48,865	+ 4,318
*Bristol Trams & Carriage	July 4	5,065	+ 193	26	112,661	+ 4,295
*Buenos Ayres & Belgrano	June 8	2,903	+ 47	...	...	...
Burnley Corporation ...	July 5	730	+ 234	‡14	9,880	+ 3,493
Calcutta Tramways Co...	„ 5	R24,529	+R4,125		R 21,529	+R 4,425
Cardiff Corporation	„ 5	1,563	...	...	...	...
Carlisle Tramways Co....	„ 5	286	+ 11	†27	4,151	+ 91
Central London Railway	„ 5	7,196	+1,117	1	7,196	+ 1,117
City & South London Ry.	„ 6	2,821	− 849	1	2,821	− 849
Cork Elec. Tramways Co.	„ 3	804	+ 160	§26	12,231	+ 637
Devonport & Dist. Trams	June 27	494	+ 53	25½	10,345	+ 53
Doncaster Corporation..	...	...	...	...	...	...
Dover Corporation	July 5	262	+ 7	14	3,048	− 62
Dublin & Lucan Railway	„ 6	120	− 23	1	120	− 23
Dublin Southern Dist....	† „ 4	543	− 27	†1	543	− 34
Dublin United	† „ 4	2,268	− 7	†1	2,268	
Dudley—Stourbridge ...	June 27	996	+ 311	25½	17,819	+ 2,637
*Dundee Corporation ...	July 2	819	+ 118	...	...	...
East Ham Council	„ 5	489	+ 21	2	1,177	+ 238
Gateshead & Dist. Trams	June 27	1,146	+ 454	25½	17,521	+ 2,216
Glasgow Corporation ...	July 5	12,411	+ 57	5	61,095	+ 1,837
Greenock & Port Glasgow	June 27	822	+ 614	25½	11,485	+ 6,740
Hartlepool Tramways ..	„ 27	483	+ 232	25½	5,797	+ 642
Hull Corporation	July 5	1,789	+ 63	14	21,120	+ 893
Isle of Thanet Co.	„ 5	893	− 112	...	...	...
Kidderminster & Dist....	June 27	183	+ 41	25½	2,821	+ 78
Leeds Corporation ...	„ 28	6,655	+2,276	...	...	...
	July 5	6,120	+1,574			
'Liverpool Corporation...	June 28	15,032	+5,398	26	243,602	+21,960
Liverpool Overhead Rly.	July 6	1,535	− 137	‡1	1,595	− 137
Manchester Corporation	„ 5	5,322	+3,604	§56	135,471	...
Merthyr.....	June 27	290	+ 61	25½	5,102	− 648
Middleton	„ 27	442	...	13½	4,209	...
Newcastle-on-Tyne Corp	July 5	2,635	...	...	...	...
Oldham, Ashton & Hyde.	June 27	738	+ 240	25½	12,815	+ 376
Perth (W.A.) Elec. Trams	July 4	1,070	+ 240	¶26	28,592	+ 5,642
Poole & Dist.....	June 27	304	+ 11	25½	5,745	− 86
Portsmouth Corporation	„ 28	3,291	+2,364	...	...	...
Potteries	„ 27	1,765	+ 357	25½	35,350	+ 1,563
Salford Corporation ...	July 7	2,720	+ 744	14	35,739	...
*Sheffield Corporation ...	„ 6	4,516	+ 920	1	4,516	+ 920
Southampton Corporat'n	„ 3	1,569	+ 888	...	...	...
Southport Tramways ...	June 27	452	+ 276	25½	5,448	+ 1,780
*S. Staffordshire Trams...	„ 27	1,009	+ 234	25½	19,505	+ 750
Sunderland Corporation.	July 6	1,320	+ 116	14	16,203	+ 1,803
Swansea Trams.....	June 27	883	+ 428	25½	11,392	+ 1,293
Taunton Trams.....	„ 27	90	...	25½	1,509	...
Tynemouth & Dist.	„ 27	652	+ 191	25½	5,998	+ 479
Wigan Corporation	July 3	343	+ 142	...	...	...
Wolverhampton District	June 27	195	+ 140	25½	3,689	+ 2,379

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 3 days.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, July 2.		Price Wednesday, July 9.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 9	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½	⅝	½	⅝	..	...	...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100	104	100	104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11	12	11½	12½	5 12 0	...	12½	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	10	11	4 1 10	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101	104	101	104	4 6 7	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9	⅝	9	9⅛	4 4 3	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9⅜	9	9⅛	3 13 8	March and September	...	...
(2),000	5	3 6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8⅛	9½	8⅛	9⅜	3 3 2	...	9⅜	8⅜
10,000	5	3/4 3/10	Do (Nos. 20,001-30,000)	8½	9⅜	8⅛	9⅛		...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	107	105	107	3 15 2	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	10	9	10	5 0 0	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	..	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	5⅝	5⅛	5⅜	3 18 3	,, ,,	...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	106	...
44,426	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5	5⅛	⅝	⅞	2 12 2	March	5⅜	...
£180,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8	9	8	9	5 5 7	February and August	8⅛	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	11⅛	12⅜	11⅛	12⅛	4 13 0	January and July	.	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	121	126	121	126	4 0 8	June and December	128½	...
£300,000	Stock	4½%	* Do. 4½% 2nd Deb. Stock Certs. (all pd.)	101	104	101	104	4 6 7		103	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	7½	8⅜	8	9	4 9 0	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12	13	11½	12⅞	4 16 0	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	108	111	108	111	4 1 1	...	...	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	⅝	6¼	⅝	6¼	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10	11	10	11	4 10 11	...	...	...
10,000	5	6¾	Do. 6 per Cent. 1st Pref.	6½	6¾	6½	6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104	107	104	107	3 14 11	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1½	1⅝	1½	1⅝	..	...	...	...
25,560	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	...	...
£150,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	94	99	94	99	4 0 10	Mar., June, Sept., Dec.	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16	17	16	17	3 16 6	April and October	17⅜	16 1/16
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	109	113	109	113	3 19 8	June and December	109	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	98	101	98	101	3 10 0	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary	14	15	14	15	4 0 0	March	...	...
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	99	102	99	102	3 18 1)	...	...	...
300,000	1	...	Rand Electric	1 3/8	1 5/8	⅞	1	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 6 9	April and October	...	...
40,000	5	9.6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	15½	...
20,000	5	3/6	Do. 7 per Cent. Preference	8⅝	9⅜	8⅝	9⅛	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97	100	97	100	3 10 0	...	100	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛	..	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	..	South London Electric Supply Ordinary	2⅛	3⅛	2⅝	3⅛	...	...	...	...
110,000	5	5 6	Westminster Electric Supply Ordinary	11	12	11	12	4 7 6	March and September	11⅜	11½
28,141	5	1/3	Do. 5 per Cent. Cum. Pref. (£2. 10s. paid)	3½	3⅝	⅛	3⅛	...	...	3⅜	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4⅛	4⅜	4⅛	4⅜	4 11 5	April and October	4½	4⅜
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	30	125	130	4 12 2	...	127	...
20,000	10	6/0	Barcelona Tramways Ordinary	8	9	8⅛	9⅛	3 3 2	...	9¼	...
10,000	10	5/0	Do. 5% Cumulative Preference	8⅛	9⅛	8⅛	9⅛	5 5 3	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½	14½	13½	14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3⅜	4⅛	3⅜	4⅛	...	...	4	3⅝
75,000	5	2/6	Do. 5% Cum. Pref.	4⅜	5	4⅜	5	5 0 0	...	4 1/16	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	102	105	102	105	4 5 9	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21	22	21	22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures xd	105	107	105	107	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7⅛	7	7⅛	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9⅜	10⅛	9¼	10	5 0 0	May and November	9 9/16	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102⅝	104⅞	102⅝	104⅞	4 6 9	...	103	103
100,000	10	12/0	British Electric Traction Ordinary	12	13	12	13	6 18 6	...	12⅝	12⅜
100,000	10	6/0	Do. 6% Cum. Pref.	12	12⅜	12	12⅛	4 16 0	February and August	12⅝	12 1/16
£300,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	126	124
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅜	1⅞	1⅜	1⅞	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅜	5⅛	4⅜	5⅛	5 14 3	...	...	...
27,500	5	10/0	Do. "B"	5	5⅜	5	5⅜	5 9 1	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	102	105	102	105	4 15 3	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	95	98	95	98	5 2 0	...	...	...
25,000	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	...	...	...	...	2 0 0	...	...	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	106	108	106	108	4 3 7	...	108	106¾
480,000	1	1/2⅞	Cape Electric Tramways Shares	2⅜	2⅝	2⅜	2⅝	3 16 2	...	8⅛	...
£1,810,014	Stock	4%	Central London Ordinary Stock	106	109	106	109	3 13 5	June and December	109	107⅝
£494,093	Stock	4%	Do. 4% Preferred Stock	103	109	107	110	3 12 9	...	108	106⅞
£494,993	Stock	4%	Do. Deferred Stock	103	106	104	107	3 14 8	...	1 4½	104
£698,201	100	4%	Do. 4% Deb.	117	120	117	120	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	4¾	5¼	4⅜	5⅛	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	2½%	City and South London Railway Con. Ordinary	73	76	74	76	2 13 10	February and August	76	74⅛
37,500	10	1/0⅛	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	,, ,,	...	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	...		...		...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1861)	128	133	128	133	3 15 5	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	128	131	128	131	3 17 8	...	130	...
£150,000	Stock	...	Do. (1901)	122	126	122	126	...	...	125	124½
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	...	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅜	12⅛	11⅜	12⅛	3 16 11	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14⅜	15⅜	14⅜	15⅜	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4¼	4⅝	4¼	4⅝	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	102	99	104	4 18 0	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8	9	8	9	3 6 8	...	⅝	...
30,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	13⅝	13½	13⅝	4 7 3½	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture xd	108	110	108	110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½	5	4½	5	...	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4 1/8	4 1/16	4 1/8	4 1/16	3 0 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅛	11	10⅛	11	4 11 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture xd	97	99	99	101	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	1⅛	11	10½	11	4 10 11	...	1 1/16	10⅞
30,999	10	2/3	Do. (£7. 10s. paid)	8	8½	8	8½	...	...	...	...
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	105	107	107	109	3 13 3	...	108⅜	106½
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	79	81	81	83	...	...	...	...
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	115	119	115	119	4 5 7	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y Str'rl'g 6% Mort. Debs. (1908)	104	106	104	106	4 14 9	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	104	106	104	106	4 6 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3⅛	4⅛	6 13 4	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93	98	93	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	99	103	100	103	4 17 5	...	...	...
13,334	10	8/0	Potteries Electric Traction Ordinary	9	10	8⅝	9⅜	4 4 3	...	...	...
20,000	10	5.0	Do. 5 per Cent. Cumulative Preference	10	11	9⅝	10⅜	4 15 2	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	107	110	107	110	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...		...		...	...	...	...
[6],182	1	...	Do. 6% Preference (12/0 paid)	...		...		...	April and October	...	...
[8]3000	1	...	Do. 6% Preference (fully paid)	...		...		...	,, ,,	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 2.	Price Wednesday, July 9.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 9. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£32,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98 102	98 102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3½ 4½	3½ 4½	...	June and December	...	...
£119,700	100	....	Do. 5 per Cent. Debentures	70 80	70 80	...	...	...	...
£7?8,840	Stock	12/6	Anglo-American	45 48	43 49	5 17 3	Feb., May, Aug., Nov.	47	...
£3,105,580	Stock	25/0	Do. Preferred	88 90	90 92	6 7 1	" "	91	89
£3,105,580	Stock	2/0	Do. Deferred	6¾ 7¼	7 7⅛	1 6 8	" "	7⅛	7
$12,333,300	$100	$12	Commercial Cable Capital Stock	170 180	165 175	4 8 11	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	94 96	95 97	4 2 6	" "	16½	...
16,000	10	4/0	Cuba Submarine Ordinary	4½ 5¼	4½ 5½	7 5 6	February and August	6⅜	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½ 13½	12½ 13½	7 8 2	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2½ 3½	2⅝ 3½	5 14 4	April and October	2½	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	8½ 9¼	7⅞ 8½	5 17 8	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞ 103⅞	99⅞ 103⅞	4 7 8	January and July	...	...
60,710	20	3/0	Direct United States Cable	9½ 10⅛	10 11	5 18 2	Jan., Apr., July, Oct.	10½	10½
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99 102	99 102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200] (red.)	120 130	120 130	5 7 8	Jan., Apr., July, Oct.	125	122
£1,255,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	88 91	88 91	3 17 8	" "	9 1/8	89
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	107 111	107 111	3 12 2	May and November	109	...
300,000	10	6/6	Eastern Extension	12 13	12 13	5 7 8	Jan., Apr., July, Oct.	12 7/16	12 7/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	103 113	108 113	3 11 4	February and August	109	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100 103	100 103	3 19 0	February and August		
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100% 103%	100% 103%	3 18 3	May and November	102¾	100
150,000	10	5/0	Great Northern of Copenhagen	25 27	25 27	5 11 1	January and July	...	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos.	99 102	99 102	4 8 1	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	37 41	37 41	6 1 11	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100 104	100 104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99 102	99 102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3½ 4½	3½ 4½	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	100 103	100 103	4 18 5	March and September	101	...
30,008	2½		West Coast of America	⅛ ⅜	⅛ ⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97 100	97 100	4 0 0	January and July	98¼	...
88,321	10	...	West India and Panama	⅜ ⅝	⅜ ⅝	...	May and November	⅜	...
34,563	10	6/0	Do. 6 per Cent. 1st Pref.	5½ 5¾	5½ 5¾	10 8 8	" "	5	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅜ 4⅜	3⅜ 4⅜	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99 102	99 102	4 18 0	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	11⅛ 12⅛	11⅛ 12⅛	5 16 4	Mar., June, Oct., Dec.	12⅛	1 ⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	101 104	101 104	4 16 2	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	97 100	97 100	4 0 0	...	...	...
			TELEPHONES.						
44,000	£5	5 0	Ohili Telephone (fully paid)	¼ ½	¼ ½	5 18 0	August	3⅛	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6 2/6	1/6 2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛ ⅜	⅛ ⅜	5 0 0	November	...	...
86.492	1	1/0	Do. 5 per Cent. Preference	⅜ 1	⅜ 1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95 99	95 99	6 1 3		97	93⅝
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	4⅜ 4⅞	4⅜ 4⅞	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	54 58	54 58	7 15 2	...	55	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12 14	12 14	4 5 9	February and August	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12 14	12 14	4 5 9	" "		...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞ 5⅛	4⅞ 5⅛	4 17 6	" "	4⅛	...
£2,000,000	Stock	3½	* Do. Debenture Stock 3½ per Cent. (red.)	93 96	93 96	3 12 11	June and December	95⅛	9⅛
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102 106	102 106	3 15 6	...	104½	103⅛
171,504	1	0/8½	Oriental	1 1 1/16	15/16 1 1/16	5 12 11	April and October	...	...
58,000	5	2/6	United River Plate	5 5½	5 5⅛	6 7 3	July	...	...
40,000	5	2.6	Do. 5% Cumulative Pref.	4⅛ 5	4⅛ 5	4 15 3	June and December	...	...
£179,247	Stock	5	* Do. 5 per Cent. Debenture Stock (red.)	101 104	101 104	4 16 2	June and December	...	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅝ ¾	⅝ ¾	5 14 3	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅜ ½	⅜ ½	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜ ½	⅜ ½	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7⅛ 8½	7⅛ 8½	5 17 8	July and February	...	...
70,000	5	...	Do. 6 per Cent. Preference	5⅛ 6	5⅛ 6	5 0 0	January and July	6⅛	...
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	100 103	100 103	4 7 7	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	5⅞ 6⅛	5⅞ 6⅛	4 18 0	...	6 1/8	6
105,731	2	...	Brush Electrical Engineering	1⅛ 1⅜	1⅛ 1⅜	...	March	1⅛	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅛ 2⅛	1⅛ 2⅛	...	March and September	1⅝	1⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101 104	101 104	4 6 7	March and September	102	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	99 99	94 99	4 10 10	January and July	...	...
80,000	5	10/0	Callender's Cable Construction Ord.	16 17	16 17	4 8 3	" "	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛ 6	5⅛ 6	5 0 0	" "	6	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109 113	101 113	3 19 8	November and May	111	...
450,000	1	0.9⅜	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	4 16 0	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	93 98	95 100	4 11 9	...	97½	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	8 0 0	March	...	...
[85,000	3	1.9⅜	Crompton and Co. (Nos. 1 to 54,000)	3 3½	3 3½	6 8 6	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	104% 106%	104% 106%	4 14 4	...	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜ ⅝	⅜ ⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1⅜ 2⅜	1½ 2⅛	...	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	73 77	76 78	5 3 0	June and December	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	...	76 81	6 3 5	...	79	...
35,500	5	2/6	Edmundson's Electricity Corporation Ord.	6⅛ 6⅝	6⅛ 6⅝	5 3 3	Half-yearly	6 9/16	...
33,000	5	3/0	Do. 6% Cumulative Preference	5⅞ 6⅛	5⅞ 6⅛	4 16 0	...	6 3/16	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107 110	107 110	4 2 9	...	109	108½
112,100	2	1/2½	Electric Construction Co.	1½ 1⅝	1½ 1⅝	6 17 2	January and July	1⅝	...
31,390	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅜ 3	2⅜ 3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 102	99 102	3 18 11	January and July	101½	...
122,985	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 7 per Cent Cumulative Preference	¾ 1⅛	¾ 1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	9⅜ 10⅛	9⅜ 10⅛	4 17 7	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98 101	98 101	3 19 3	...	100½	...
35,000	5	5/0	Henley's Telegraph Works Ordinary	16 17	16 17	4 8 3	February and August	17	16½
35,000	5	2/3	Do. 6% per Cent. Preference	5⅛ 6	5⅛ 6	3 15 0	" "	5⅛	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 115	111 115	3 18 3	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 10 11	" "	21 7/16	21
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	15½ 16½	15½ 16½	6 1 8	July	...	...
37,350	12	36/0	Telegraph Construction and Maintnce.	34 37	35 38	6 6 5	March and July	36½	35
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101 104	101 104	3 16 11	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	...	...	5 14 3	...	...	...
50,000	5	2/6	Do. 5 per Cent. Cumulative Preference	...	...	4 3 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	...	...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	...	...	...	" "	...	...
			FINANCIAL, INVESTMENT, &c.						
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5½ 5⅝	5½ 5⅝	5 9 1	...	...	...
180,227	10	2/6	Globe Telegraph and Trust	8 9	8 9	5 16 8	Jan., Apr., July, Oct.	9	8⅝
110,043	10	3/0	Do. 6 per Cent. Preference	12½ 13½	12½ 13½	4 8 11	" "	13⅛	12⅝
11,339	8	4/0	Reuter's	6⅝ 7½	6⅝ 7½	5 6 8	April and October	...	...
3,303	£100 Cert.	6%	Submarine Cables Trust	110 120	110 120	5 0 0	...	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE resignation by Lord SALISBURY of his post of Premier in the political arena—a post which he has filled with honour and distinction for an almost unbroken period of 17 years—recalls to our mind the lively interest which the noble Marquis has ever evinced in electrical matters. For a long period he has carefully followed the development of electrical science, and when that science took a practical turn he was foremost amongst his exalted peers in introducing electrical appliances into his country residence at Hatfield and upon his estate. Electric light and power for domestic and other purposes early found a place in the halls and workshops of Hatfield Hall, and even in the fields and parks around it. Nor did practical applications altogether wean Lord SALISBURY from pursuit of electrical science; indeed, so well recognised in scientific circles were his lordship's studies during infrequent leisure hours, that he was invited to become President of the British Association for the Advancement of Science at its Oxford meeting in 1894. We sincerely wish Lord SALISBURY many years of the leisure which he has earned so well, and we trust he may long continue to derive pleasure from his study of the fascinating science of electricity.

WE are glad to be able to report that the House of Commons has passed on to their Committee stage the group of electric "tube" railways which have already received the sanction of the Upper House. Whatever may be said in favour or against these schemes, either individually or in correlation, the time to weigh evidence was not when the Bills came up yesterday for second reading. Considering the extreme care which has been expended on these Bills in their passage through the House of Lords, it would have been most unjust to have thrown them out without the opportunity of detailed discussion in Committee. We shall endeavour, as heretofore, to give our readers prompt and full reports of the Committee stage of these highly important Bills.

Now that peace and safety reign in South Africa, as in many parts they never reigned before, it is to be hoped that British engineers will employ every fair and honourable means to secure a large share of the contracts which are surely impending. We learn from the Johannesburg correspondent of *The Times* that he has been informed by the British Trade Commissioners, Messrs. MORGAN and JENKINS, that large orders will shortly be going for electrical and mining plant in Johannesburg. The merchants wish to give British manufacturers preference, but British prices generally must be considerably reduced. Owing to excessive freights, the machinery must be made lighter, and quicker deliveries must be effected in order to enable British firms to meet American and German competition. The largest electrical tramway system in the world will shortly be laid down in Johannesburg, and merchants are emphatic in stating that it is only by attention to the above points that they can hope to secure for British manufacturers a fair share of the orders. American and German houses, the *Times* writer states, have been very active, and recently booked several orders at remarkably low prices in order to secure a firm footing in that market. English machinery is preferred, but prices and weights must be reduced. We trust that British electrical manufacturers and contractors will pay heed to this sound advice from the best-informed quarters without delay.

"ELECTRIC UNDERGROUND" shares are an increasingly popular investment, and it is expected in financial circles that the two leading railways—viz., the "Twopenny Tube" and the City and South London Railway—will steadily improve, both as regards dividend distributions and market values, for some

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time to come. For several weeks past there has been vigorous inquiry for these shares on the Stock Exchange, but very few have changed hands owing to the tightness with which their present sagacious holders retain them. As regards the "Two-penny Tube," the recent nominal decline from 109 to 107 was due merely to enforced inactivity in this market, and we believe that not even the fall of ½ on the brief breakdown last Saturday induced any real business. With regard to the City and South London Railway, the dividend announcement of which was postponed until Tuesday, there was considerable speculation as to what the announcement would be, forecasts varying between 2½ and 3½ per cent. The declaration of the highly satisfactory dividend of 3 per cent. on the ordinary shares will probably lead to a greater activity in these shares, as holders desirous of realising immediate profits will now give way to investors who are anxious to buy City and South London Railway shares for the steady improvement in market value which must result from the increase in traffic receipts, consequent upon extensions of the railway.

Lieut.-Col. R. E. Crompton replies this week to our criticisms on his previous letter on the subject of tramways versus electric omnibuses. We are glad to publish his letter; but we fail to see that it throws much useful light on the question, or that it weakens in any way the position of his critics. The strongest position of these critics lies in the practical non-existence of the type of omnibus which Lieut.-Col. Crompton champions. We have asked him to tell us where the accumulator omnibus is to be found doing public service on a commercial scale. In reply he admits that he "referred to privately-owned cars, and not specially to omnibuses." So far as concerns the main question, he might as reasonably have pointed to clockwork toys. We have no wish to speak discouragingly of the accumulator vehicle—it has its proper place, and in that place it has great uses. But our readers will judge for themselves whether it is not ridiculous to point to a few "privately-owned cars" as evidence for the abolition of the electric tramway.

On the question of "overtaking power," Lieut.-Col. Crompton evidently believes that the mere fact of a vehicle running on rails reduces its overtaking power, as compared with vehicles running on the road. It is difficult to follow the argument. Lieut.-Col. Crompton would hardly apply it to railways, or even to light railways, yet these are in the same circumstance as tramways in regard to overtaking power. As a matter of fact, in a well-managed tramway system cars going the same way would gain nothing by being able to get past one another—save in the event of a breakdown. Lieut.-Col. Crompton asserts that "it is this want of overtaking power which causes electric tramways to have such a much smaller carrying capacity than would seem to be theoretically possible." We do not know how much is theoretically possible, but we do know that it is the almost universal rule in practice that the introduction of electric tramways vastly increases the carrying power of a road.

It is surprising that so practical an engineer as Lieut.-Col. Crompton should base his conclusions upon such doctrinaire arguments and theoretical assumptions as he has done in these two letters. Anyone can test the accuracy of his amazing statement that "the point-to-point speed of the vehicles on the tramways is in most cases no greater, and in many cases less, than that of horse-drawn omnibuses running on the plain road surface." On a Bank holiday, or on any ordinary day—it matters not which—let Lieut.-Col. Crompton mount a horse-drawn public omnibus at Shepherds Bush or Hammersmith and travel for a few miles beside the London United Tramways Co.'s lines. Let him count the number of electric tramcars he will overtake. It will be a negative quantity.

Early in 1898, E. Goldstein described certain rays which were observed to emanate from a perforated or "canalised" cathode. They proceeded, however, in a direction opposite to the cathode rays, and formed, in fact, their prolongation backwards. Their discoverer called them "canal rays," and maintained that they were not deflected by a magnet. We know now that they are simply the positive particles coming from the anode or from the intervening gas, and the Paper we publish to-day, by W. Wien, gives us some interesting further information with regard to the aspect they present from the point of view of the electron theory. We learn that these canal ray particles, identical, probably, with the particles constituting polonium rays, are discharged from a glowing carbon filament charged to +8,000 volts, even in a practically complete vacuum. Their mass varies from 250 times to 2,700 times that of the negative electron, and they may very well be the remnant of the atom left after the negative electron has been split off. Whether this beautifully simple conception is true or not, it deserves to be true at all events, and will, probably, turn out to be so.

Mr. Henniker Heaton, writing in *The Times* last Monday, is greatly disturbed at what naughty Prof. Silvanus Thompson has been saying about Mr. Marconi. "The professor's attack opens with a glowing compliment to the genius of Marconi. It is accompanied by a deadly insult to Marconi. We are reminded of the Oriental method of a bow and a blow." But Mr. Heaton's excitement—it becomes clearer as we read on through his letter—is less concerned with Mr. Marconi than with the "prospect" of 6d. telegrams to New Zealand, and *inter alia* emancipation from the submarine cable:—

> The fact seems to be that Marconi's "vertical wire" is the missing link without which Lodge's "coherer" is useless. For Prof. Lodge's wireless telegram sent 200yds. compares poorly with Marconi's sent 2,000 miles. Before the professor's gets up to 400yds. Marconi will be giving us a service to New Zealand, 12,000 miles, at 6d. a word. The one is a pretty experiment, fit for a lecture to children at the Polytechnic; the other a grand development of the power of man, lifting him a little nearer to the angels. . . . . I should not care if Mr. Marconi were proved to be a full-blooded Huron or Liberian. The fact remains that he has devoted his youth to working for England. Every one of his 130 patents benefits the Empire. Take the famous boast of our enemies that in case of war our cable communications will be cut at once. How foolish that coast looks now, since Mr. Marconi's achievement!

Prof. Silvanus Thompson's reply, which we print below, is a characteristic piece of writing, which should show Mr. Heaton the danger of hitting at people whose strength he has not previously measured:—

> Mr. Henniker Heaton's belated letter of July 3rd, published only to-day in your columns, shows how an able man can miss the point. He rejoices

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in the "exposure and shattering" of an accusation which he attributes to me, an accusation which I have never made, and which I have myself exposed and shattered in *The Times* of July 5th. When he ventures on technical grounds he is equally unfortunate. He refers to Sir OLIVER LODGE'S early success of 1894, which he compares with Signor MARCONI'S Newfoundland experiment of 1902. As the latter was made with telephonic apparatus not patented by Signor MARCONI at all, the comparison is—well, interesting. What Mr. HENNIKER HEATON says is this:—"Prof. LODGE'S wireless telegram sent 200yds. compares poorly with MARCONI'S sent 2,000 miles." Granted. But that is not the point. The point is, Which of the two was the first to send a wireless telegram? Was it LODGE in 1894, or MARCONI in 1896? That which has apparently shocked Signor MARCONI'S supporters and roused some of them to fury is the discovery that LODGE actually did invent and exhibit wireless telegraphy by ethereal waves in 1894. What on earth has distance to do with the matter? STEPHENSON invented a locomotive that would run 200yds.—or more. Is a later engineer who makes a locomotive run 2,000 miles to be lauded to the skies as the inventor who, in Mr. HENNIKER HEATON'S own words, has "lifted man nearer to the angels"? Is the pioneer who did the hard work, and had the brain to invent, to be belittled as merely having devised "a pretty experiment fit for a lecture to children"? Mr. HENNIKER HEATON is in this a little less than just.

Says Mr. HENNIKER HEATON:—"The fact seems to be that MARCONI'S 'vertical wire' is the missing link without which LODGE'S 'coherer' is useless." This is very interesting as an *obiter dictum* of a politician; but how does it pan out in view of the fact that Signor MARCONI did *not* patent the vertical wire, and did patent all manner of detail about coherers? Mr. HENNIKER HEATON must try again.

BY-THE-WAY, we noticed in yesterday's *Times* that Mr. MARCONI has had the honour of entertaining H.M. the CZAR and KING OF ITALY with an exhibition of wireless telegraphy on board the "Carlo Alberto" at Kronstadt. On the after-deck a Marconi receiver was set up, messages being sent from a transmitter on the fore-deck of the same vessel. A telegram, we are assured, "was received from the fore-deck before their Majesties' eyes." Would not Mr. HEATON consider this "a pretty experiment, &c."?

THE annual report of Mr. A. A. VOYSEY, the electrical engineer to the Corporation of London, summarises the progress in electricity supply in the City during 1901. Since 1895 the average price charged to consumers has fallen from 7·56d. to 4·45d., while the number of consumers has risen from 2,740 to 10,618. The total consumption for the year was 11,526,951 units sold, for an aggregate lamp connection equivalent to 549,175 8 c.p. lamps. There have been 508 arc lamps in use for public lighting, which have worked so satisfactorily that only 277 "failures" were observed, as against 1,496 "failures" in 1897. A "failure," however, is often a transient extinction and quite a trifling affair. On the interesting subject of the purchase of the City electricity undertakings by the Corporation, Mr. VOYSEY observes:—

> It may be thought that, as the Corporation will be able to take over the whole of the City undertakings, it is not necessary to pay any attention to the position of the rest of London in the matter, but a broad view of the question does not lead to this conclusion. . . . There are, no doubt, many difficulties to be overcome before complete and successful co-operation satisfactory to all parties could be established, and chief among those difficulties is the want of uniformity in the methods of supply. If such a co-operation were established, it would probably be found possible to close some generating stations entirely, and others during a part of each day, and also to convert others into transforming stations. If a reasonable spirit did but actuate all parties, great benefit might thus accrue, not only to the City of London, but to all parts of the metropolis.

A Wonderful Law.—Writing in a contemporary on "The Cyclone Theory of Magnetism," Mr. H. E. P. Cottrell states that: "By a fourth law, all magnetic substances, when under the influence of a magnet, acquire magnetic properties, while non-magnetic substances remain unaffected." How very curious.

Durham College of Science, Newcastle-upon-Tyne.—Complete courses of instruction are provided at this college for students of both sexes proceeding to degrees in science, &c. The matriculation and exhibition examinations begin September 29th, lectures, October 7th. An official announcement gives some further particulars.

Additional Power Development at Sault Ste. Marie.—The Clergue Syndicate at Sault Ste. Marie, Ont., is about to let contracts for the digging of its third canal to utilise the waters of Lake Superior for the development of electrical power. Several years will be required for constructing the canal, and it will be necessary to remove about 400,000 cubic yds. of earth and 600,000yds. of stone. It is estimated that, with the acquisition of the new power, the company's total capacity will reach 110,000 H.P. A large metallurgical plant, for the treatment of ores by electricity, and a paper mill will be installed to utilise the power.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Bolama	April 19, 1902 ...	—
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Mozambique—Majunga (Madagascar)	June 19, 1902 ...	July 11, 1902
Santa Cruz—Teneriffe	July 7, 1902 ...	—
Puerto Plata—Martinique	July 10, 1902 ...	—
Cap St. Jacques—Haiphong	July 12, 1902 ...	—

Earthing Secondary Distributing Circuits.—Mr. S. Bingham Hood, in an article dealing with the above subject in the *Electrical World and Engineer* of New York, says that, from personal experience with a system having a connected load of over 40,000 lamps, he is convinced that it is absolutely necessary to earth the secondary in order to ensure the safety and reliability of the system. He states that a 1in. galvanised pipe driven 6ft. into the earth will give a resistance varying from 20 to 80 ohms, according to the soil and weather; this increases in the course of a few years to over 200 ohms, and it is therefore necessary to see that an efficient earth is obtained. Above all, it is necessary to have conductors, both primary and secondary, in first-class condition and to keep them so.

Edison Storage Battery Patent.—An additional patent on his "Reversible Galvanic Battery" has just been issued to Thomas A. Edison. The original application, filed on March 1, 1901, was divided and the new application filed on June 20, 1901. The patent covers chiefly the composition of the active material for the depolarising element of the Edison nickel-iron cell. The material consists of an electrolytically active oxide of nickel, having more oxygen than Ni_2O_3. Intimately mixed with the oxide is an inert flake-like conducting material, such as flake graphite. Other parts of the battery are the alkaline electrolyte, which remains unchanged during all conditions of working, the depolarising conducting element carrying the active material, and the second element carrying an insoluble oxidisable material.

Electrolysis of Gas Mains.—To prevent electrolysis insulated joints have been inserted on the high-pressure gas main of the North Shore Gas Co., of Waukegan, Ill. The main in question parallels a trolley line for 13 miles, and tests show that the pipe line was returning about 25 per cent. of the entire current to the power houses, which are about 10 miles apart. The pipe line has a rubber-packed Dresser expansion joint every 1,200ft. It was thought that 90 per cent. of these joints entirely broke the conductivity of the pipe, but this was deemed insufficient. The pipe was therefore cut in two places and a break of 10ft. secured by inserting insulating couplings with rubber packing. Such joints, as nearly as could be determined under the fluctuating current, diminished the return current through the pipe by from 50 to 75 per cent.

Electric Express Line between Rome and Naples.—A committee of electrical engineers has been appointed by the Italian Government in order to come to a conclusion regarding

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the scheme for an entirely new line connecting Rome with Naples. This line will be double tracked throughout and electrically equipped on the third-rail system. The speed of the trains will be regulated so that the whole distance between the Italian capital and Naples will be covered in less than two hours. The terminal stations will be built at the centre of the cities, so that practically the two towns will be in very intimate communication. The country between Rome and Naples is the most rich and fertile of the whole peninsular, and, especially now that important drainage works are going on, that part of Italy will certainly become a field of wealth. Regions which at present are almost isolated will be recalled to a new era of agricultural progress.

The Telegraphone.—Our readers will remember the beautiful electromagnetic phonograph, known as the Poulsen telegraphone, which excited so much interest and admiration at the Paris Exhibition of 1900. The record is made on a steel wire or ribbon by the alteration of its internal magnetisation by the passage over it of an electromagnet in connection with a telephone transmitter into which the message is spoken, so that the instrument may be set up in an office to receive and record telephone messages in the absence of a clerk, or to receive confidential messages for a principal, remaining locked up in his desk until he returns and reads them off by connecting the instrument with his telephone receiver. *Electrical Investments* for Wednesday last states that Herr Pedersen, of Copenhagen, has recently obtained a patent for a very important improvement in this instrument, making it possible to read a number of messages on a single steel wire or strip, and to reproduce each message without interference from the other, thereby materially lessening the size of the drum and the length of wire or ribbon required. This addition will considerably increase the practical utility of this instrument.

Electric Voting Machine for Congress.—Among the methods proposed for installing an automatic voting system in the House of Representatives at Washington is an electrical device which, the *Western Electrician* believes, will meet all the requirements. It consists of a transmitter on each member's desk, which is connected electrically with a single printing receiver for printing in three columns alphabetical lists of names of members voting "Aye," "No" and "Present," and three totalisers arranged so as to be readily observed by the members for giving the totals of the three classes of votes. Each transmitter comprises a small ornamental casing about 4in. square, with a Yale lock in its front face; also two push buttons, one marked "Present" and the other "Mistake"; and an opening above the lock disclosing the letters "O.K." When a member desires to vote he inserts the key into the lock and turns it to the right if he wishes to vote in the affirmative, or to the left if in the negative. This movement draws the letters "O.K" from the opening above the lock and brings to view the words "Aye" or "No," as the case may be. Provision is also made for changing a vote by operating the "Mistake" button.

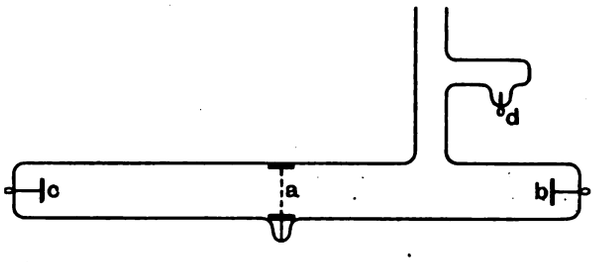
Personal.—Mr. Dane Sinclair, engineer-in-chief to the National Telephone Co., is resigning this position to take up the post of general manager to the British Insulated Wire Co. Mr. Sinclair has been in the service of the National Telephone Co. for the past 20 years, and has held his present position of engineer-in-chief exactly 10 years. During this time he has worked up the engineering side of the National Telephone Co.'s system to its present high state of efficiency, and the directors of the company, as well as its staff, have reason to regret the loss of one of its very ablest and most popular officials. We understand that the company parts with Mr. Sinclair in the friendliest possible spirit, and their good wishes—and we would add our own also—go with him. Mr. Sinclair is being succeeded by Mr. F. Gill. Mr. Gill was district manager of the National Telephone Co. for some years prior to 1896, when he was appointed superintendent for Ireland to the Company. He is also local secretary for the Dublin section of the Institution of Electrical Engineers.

We understand that Mr. Philip Dawson, M.Inst.E.E., is joining the firm of Messrs. Kincaid, Waller and Manville 29, Great George-street, Westminster, and that the title of the firm will now be Kincaid, Waller, Manville and Dawson.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Fluorescence due to Canal Rays.—W. Wien has already shown that the fluorescence of glass produced by canal rays depends upon the gas in the tube and upon the magnetic deflectibility of the rays. He has since found that canal rays produce fluorescence in metallic oxides obtained by combustion, but not in oxides prepared in the wet way. He supposes that the former are higher oxides than the latter, and that they give off oxygen when positive electrons impinge upon them. Magnesium oxide fluoresces red, zinc oxide a bright green, while alumina shows patches of various colours. If the cathode itself is oxidised, it also shows fluorescence where the cathode rays originate. A tube was provided with three aluminium



electrodes *a*, *b*, *c*, and an anode *d*, of which *c* was oxidised in an oxy-hydrogen flame and *a* was perforated. If *a* was the cathode, *c* showed mixed blue and brown fluorescence. On making *b* the cathode, *c* fluoresced blue under the cathode rays. If *c* was the cathode, it showed brown fluorescence at the origin of the cathode rays. But no brown fluorescence was produced by the impact of cathode rays, and *b* only began to show any fluorescence after its surface had become oxidised.

[W. Wien, *Physikal. Zeitschr.*, July 1, 1902.]

Ions from Hot Wires.—The curious fact that the negative ions discharged from hot wires and from the arc move more slowly than the positive ions still awaits an explanation. C. D. Child supposes that the negative electrons are more easily loaded with neutral particles than the positive ones, and backs up this view by an experiment in which several turns of heated platinum wire were placed between pieces of wood about 1·5cm. apart and 10cm. long. The air arising from these wires was passed between two sheets of tin kept at a potential difference of 100 volts, in order to deprive it of any ions produced by the platinum. The air so cleared was unable to produce a discharge between two metal plates. But when a flame was substituted for one of the plates, a discharge took place without heating the wire at all, owing to the ionisation within the flame itself. On heating the platinum wire, the rate of discharge was reduced by 50 per cent. when the flame was positive, and by 83 per cent. when the flame was negatively charged. Now, discharge occurs from positive platinum wires at a lower temperature than from negative wires. It is, therefore, reasonable to suppose that neutral platinum has a greater attraction for negative ions than for positive ions. Hence, the negative ions would be more easily "loaded" than the positive ones when platinum particles are present.

[C. D. Child, *Phys. Review*, May–June, 1902].

Unifilar Magnetometer.—P. Schulze discusses the comparative value of the bifilar and unifilar suspension of a magnetometer needle, in view of the fact that the latter type is now the most popular in terrestrial magnetic observations. The author shows that if, with a unifilar suspension, the needle is twisted out of the magnetic meridian into a new position of equilibrium, the oscillations about the new zero are unsymmetrical, the greater elongations being on the side towards which the twist has taken place. In ordinary operations the deflections are of greater importance than the oscillations, but the author shows that a similar lack of symmetry is shown in the deflections produced by equal couples. The errors thus introduced may easily be of practical importance, as is shown by a simple calculation. The author gives an equation by means of which the true scale values may be calculated for

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positions near the zero, and also a method of correcting the readings for considerable deflections. These corrections have hitherto been neglected in magnetic observations.

[P. SCHULZE, *Ann. der Physik*, No. 7, 1902.]

Gas Spectra in a Magnetic Field.—The Zeeman effect has hitherto been studied chiefly in metallic vapours, as its production in the spectra of the more permanent gases appears to be very difficult. G. Berndt has, however, studied the general behaviour of gas spectra in a magnetic field, and some of his observations are interesting. The spectra were those obtained from a vacuum discharge through the gas filling a constriction in a vacuum tube, which was introduced between the poles of Du Bois half-ring electromagnet giving a field of 20,000 units. Line spectra suffered only little change, whereas band spectra were almost always replaced by the spectrum of mercury. The general behaviour of the spectrum is as if the resistance of the gas increased in the magnetic field, which, considering the strong force exerted by the field upon the electrons conveying the discharge, is not surprising. In most of the gases, whether simple or compound, the Zeeman effect is barely perceptible, but helium shows the phenomenon to great advantage in a field of about 10,000 units, about six polarised doublets being discerned with the discharge parallel to the lines of force. With stronger fields, the spectrum loses in luminosity and distinctness. The author used an echelon spectroscope.

[G. BERNDT, *Ann. der Physik*, No. 7, 1902.]

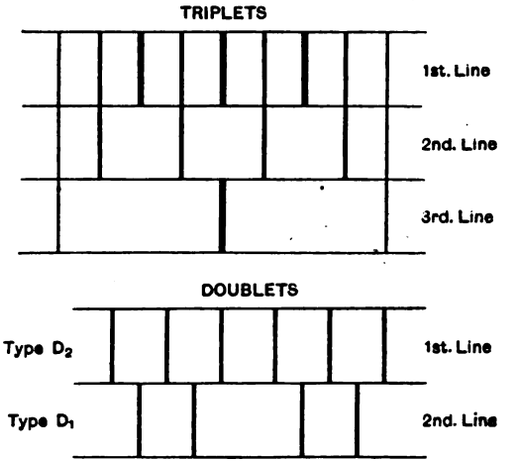
Hall Effect in Gold.—Von Ettingshausen and Nernst found that the Hall coefficient in certain bismuth-tin alloys depended on the strength of the magnetic field employed, this change extending in some cases even to a reversal of the sign of the effect. Kundt, in his work on the Hall effect in iron, cobalt, and nickel, showed incidentally that the coefficients for gold and silver remained constant even to fields of 21,500 C.G.S. units. Under these circumstances W. C. Baker has examined the behaviour of pure metals in very weak magnetic fields, to see if there existed in that region any reversal similar to the one quoted above for bismuth-tin alloys. The author operated upon a sheet of dentists' gold with copper connections made by a new method, which gives a permanent contact of low resistance, and prevents the solution of the gold in the hot solder. A copper comb was placed on the gold foil and drops of solder were put on the tip of each tooth. The drops being spherical they did not tend to draw away the gold by their surface tension. The experiments showed a linear increase of the Hall effect in a magnetic field rising from 0 to 700 units. Taken together with Kundt's result, it means that the Hall coefficient for gold is absolutely constant at least up to fields of 21,500 units.

[W. C. BAKER, *Phil. Mag.*, July, 1902.]

Magnetostriction.—H. Nagaoka and K. Honda, of Tokyo, have completed a lengthy investigation of the connection between the magnetisation and the mechanical deformation of the ferro-magnetic metals. In reversible nickel steel, such as is used for scales on account of its small expansion, mechanical elongation in the direction of magnetisation produces an increase of magnetism. On the other hand, the same substance stretches on being magnetised, especially when it is annealed instead of being hard-drawn. Iron, steel, nickel and nickel-steel increase in volume by magnetisation, but cobalt shows contraction. The greatest volume change was observed in a nickel steel containing 29 per cent. of nickel, in which it is, in a strong field, 40 times that of iron. As regards the Wiedemann effect, the twist produced by the combined action of circular and longitudinal magnetisation in iron, nickel and nickel steel increases with the longitudinal field strength, and reaches a maximum, whence it decreases gradually as the field is further increased. The sense of twist in iron and nickel steel is opposite to that in nickel. The transient current produced by twisting a longitudinally-magnetised wire, and the longitudinal magnetisation caused by twisting a circularly-magnetised wire are reciprocally related to the twist produced by longitudinal and circular magnetisations.

[NAGAOKA and HONDA, *Phil. Mag.*, July, 1902.]

Zeeman Effect.—The detailed study of the Zeeman effect is likely to give us very intimate information concerning the structure of metallic atoms and the physical properties of the metals. It is, therefore, encouraging to find that the unravelling of the complicated effects of a magnetic field upon the various spectrum lines is steadily proceeding. We know from the work of Paschen, Runge, Kayser, and Rydberg, that every spectrum may be split up into "series" of lines obeying certain laws. It is usual to distinguish a main series and two subsidiary series. In addition, there are "doublet" series—*i.e.*, a series for each component of a set of doublets—and "triplet" series, resulting from the arrangement of all the first, second, or third lines of a set of triplets in a series. This series system has received a striking confirmation from the Zeeman effect. It is found, according to C. Runge, that (*a*) lines belonging to the same series are split up in an exactly similar manner, the differences of frequency produced being the same in each case, and (*b*) in different elements lines of the "corresponding" series are split up in the same manner. Thus, the Zeeman effect is the same in each line of the first triplet series of the mercury spectrum. There are six different triplet series, and each series shows a different type of Zeeman effect, but



the type is the same for every line of the same series. Again, the second triplet series of Mg, Sr, Zn, Cd and Hg all show the same type, and so do the doublet series of Cu, Ag, Al and Tl. The two doublets of the main series observed in copper and silver show the same splitting as the two D lines. Exactly the same splitting is shown by the lines of the second "subsidiary" series, but in the opposite succession, and this is a brilliant confirmation of Rydberg's assertion that the second subsidiary series is the inverse of the main series. These laws offer a valuable auxiliary in the allocation of lines to certain series. Thus, the author makes out that the two calcium lines H and K in the solar spectrum correspond exactly to the two D lines. Moreover, there is a simple numerical connection between the differences of frequency produced in the components of triplets and doublets. The author gives a diagram illustrating the Zeeman effects shown by the first, second, and third line of each triplet respectively. The first line of each triplet is separated into nine components at equal intervals u, the second line into six components at $4u$, $3u$ and u at each side, and the first into three $4u$ apart. In the doublets there is a corresponding division into intervals v, and it appears that $8v = 2u$.

[C. RUNGE, *Physikal. Zeitschr.*, July 1, 1902.]

Telephones on Trains.—A train telephone has been installed on the Overland Limited train on the Chicago and North-Western Railway, which runs from Chicago to San Francisco in 2 days 21 hrs. 25 min., said to be the fastest long-distance train in the world. The telephone is connected to the central office at any town where the train stops by means of a cable attached to a tripod on the roof. An operator at the station is detailed to make this connection when the train stops.

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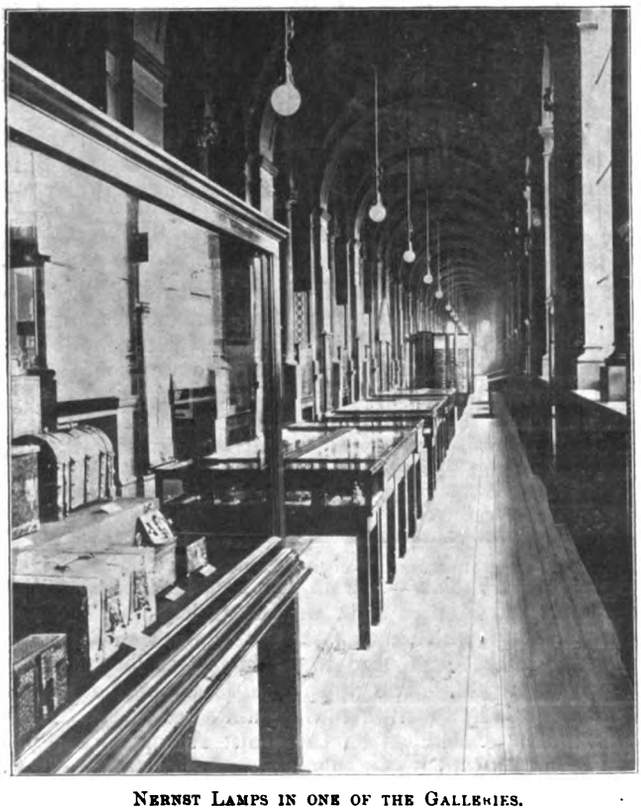
THE ELECTRIC LIGHT IN THE EDINBURGH MUSEUM OF SCIENCE AND ART.

EDINBURGH MUSEUM OF SCIENCE AND ART: ARC LAMPS IN ONE OF THE GREAT HALLS.



NERNST LAMPS IN ONE OF THE GALLERIES.

REFLECTED ARC LIGHTING.

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THE ELECTRIC LIGHT IN THE EDINBURGH MUSEUM OF SCIENCE AND ART.

The accompanying illustrations are typical views of a large electric lighting installation which has recently been completed at the Edinburgh Museum of Science and Art to the specification and under the supervision of Messrs. Buchan and Hogarth, of Edinburgh, who are the electrical advisers to H.M. Board of Works, Scotland.

No less than four distinct methods of lighting have been adopted, the arrangements being specially designed to suit the requirements of the various parts of the building. The illumination of the great halls, shown on one of our illustrations, is by 10-ampere arc lamps, of which 92 are employed, suspended from the roof on specially-designed brackets, made by Messrs. Mackenzie Bros., of Edinburgh. These lamps, although of a more ornamental design, are similar to those used on the street lighting circuits at Edinburgh. The brackets upon which the Museum lamps are hung can be swung round on to the gallery in order to facilitate cleaning, &c. The gas ring seen near the roof of the great hall is to be removed. The floor lighting of these halls is supplemented by 32 inverted arcs, placed under the first floor galleries, and another 40 light the main floors of the east and west wings of the building. The light from these lamps is directed upon a concave reflector 4½ft. in diameter, and the resultant effect is absolutely free from shadow. In addition, there are some 600 incandescent lamps in the workshops, stores, offices and police service.

Besides the lighting of the building, arrangements have been made whereby many of the valuable machinery models may be put in operation electrically. Connections have also been made for the operation of the workshop machinery, and for the heating of the electric urns for use on the occasion of receptions and conversaziones.

The most interesting portion of the installation, however, is the employment of 50 of the 1902 pattern of Nernst lamp, which is, we believe, the first public utilisation of this type in this country. These lamps are distributed throughout the corridors and library, and a view of one of the former is given in our second illustration.

Current is supplied by the Edinburgh Corporation through two 3-pole services for lighting (besides those necessary for motors and heating) to main distributing boards, whence it is distributed to 13 sub-distributing boards. Some 10,000 gas burners, giving approximately 40,000 c.p., have been replaced by an electrical installation of more than double that capacity, at about half the annual cost. The arc lamps were supplied by Messrs. Crompton & Co., and the installation carried out by the National Electric Wiring Co. Nearly 16 miles of wiring have been employed, carried in 12 miles of conduit tubes.

THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

(*Continued from page 474.*)

The stand of the Simplex Steel Conduit Co. in the entrance arcade is worthy of careful inspection. The general arrangement of the exhibits is shown in the accompanying photograph. They consist of the "Simplex" steel conduit system for electric wiring with the "Simplex" special fittings and accessories. Six grades of conduits are manufactured. Grades 1 to 4 are for socket junctions; grades 5 and 6 are for screw junctions. The conduits are made in eight sizes, having the following external diameters—viz., ½in., ⅝in., ¾in., ⅞in., 1in., 1¼in., 1½in. and 2in. The lengths vary from 13ft. to 14ft. They are suitable for all conditions of wiring work, and are evidently manufactured with the greatest care. The accessories are made in three classes—viz., ordinary, inspection, and split, and can be had ordinary enamelled, screwed enamelled and galvanised. With the exception of normal and half-normal bends, the fittings are made of malleable cast iron and the inspection fittings are supplied with light steel covers. Normal and half-normal bends are made from heavy gauge brazed tube. Besides the usual conduit fittings, junction boxes, reducing nipples, &c., the company show switch boxes, ceiling rose boxes, special "looping-in" ceiling roses, pendant fittings (horizontal and vertical), split and stiff pendant fittings, corridor, subway and emigrant fittings, watertight switches, lamp-holder fittings (ordinary and flanged), distributing switch and fuse boards, brackets and arc lamp brackets, stocks and dies, hack saws, tape reamers, &c.

The exhibit of the British Westinghouse Electric and Mfg. Co. is somewhat varied in character, owing to the vast field of power engineering covered. The apparatus exhibited is of the most modern type, and is intended to show the trend of the times as indicated by the most recent work on traction and power engineering installations. The machinery is practically all in operation, and that not merely as exhibition models, but as actual full-sized commercial machinery. The main exhibit can well be treated and described as a complete combined electric tramway and street lighting system. The generating station consists of a section isolated from the rest of the exhibit, and includes a 112 H.P. gas-driven unit receiving its supply from the public gas mains. The engine of this set is of the three-cylinder type. The three vertical cylinders are placed closed together side-by-side, and are all counterparts of each other, both as to size and valve arrangements. They are each single acting, of 13in. in diameter and 14in. stroke, working on the Otto cycle.

An important feature of the gas engine is the unique system of governing. The air and the gas are always admitted to the cylinders ready mixed, and as a mixture of the exact proportions for securing the maximum power from the gas. The air and gas come together in a separate box, or mixing chamber, from which the engine draws its supply into the cylinders through a valve, the orifice of which is regulated by a very sensitive revolving governor. The principle, therefore, resembles somewhat the throttle governing of steam engines. The gas engine exhibited is direct-coupled to an electric generator of the Westinghouse standard railway type. The armature of this machine is practically built direct on an extension of the engine shaft. It is of the slotted-core type, the conductors being formed and insulated before being placed in the slots. They are of such a shape that they drop easily into position without force or bending; thus the insulation is preserved and ready access afforded to any individual coil for inspection or renewal. The magnetic circuit consists of the usual cast-steel ring, built in halves and bearing internal pole-pieces of assembled soft steel stampings. The field is compound wound, and each pole-piece carries a portion of the series and shunt windings. The series coils and the shunt coils are wound on separate formers, which slide into position on the pole-pieces. The capacity of the generator exhibited is 75kw. at a pressure of 500 to 550 volts. The current generated passes direct to the main switchboard, the white marble panels of which bear the switches, instruments and various devices, all of Westinghouse standard types manufacture, necessary for the control of the generating machinery and the distribution of the current as required. The greater part of the output is utilised for the operation of the length of tramway shown in one of our illustrations. The total length of the track is 310ft. The space between and around the rails is made up to the level of the rail-head and forms a slightly elevated promenade from one end of the hall to the other, a large luxurious car running regularly from one end of the promenade track to the other. The car body was built by Messrs. Milnes, of Birkenhead. The motor equipment consists of four Westinghouse No. 49B tramway motors, each axle being driven by a motor through single reduction gearing in the usual

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manner. The car is one of those recently ordered of the British Westinghouse Company for the Tyneside tramways.

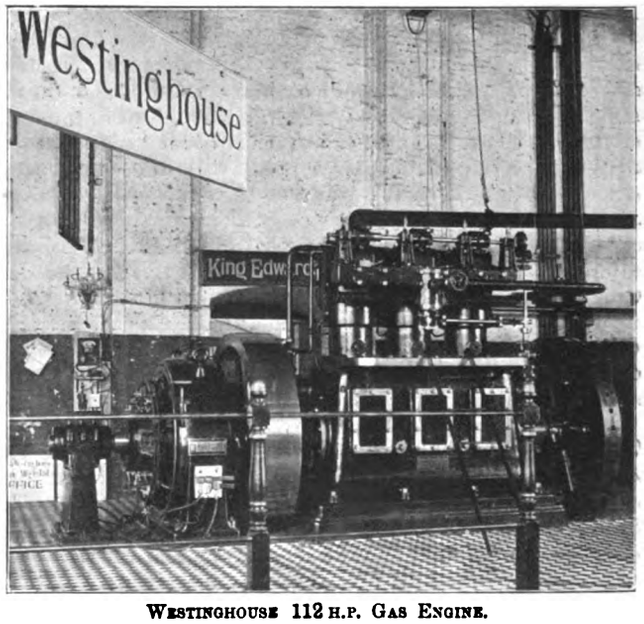
The Westinghouse No. 49B tramway motor, also exhibited, is of a type designed more particularly for city tramway working. The enclosing shell forms the yoke of the magnetic circuit, and is horizontally divided, each half bearing two internal pole pieces. The halves are hinged together on the side farthest from the wheel axle, so that by opening the motor and dropping the lower half all the internal parts of both armature and field are readily accessible. A feature of this motor is the small diameter of the armature, which introduces many advantages, such as reducing the centrifugal stress on the armature conductors and reducing the losses of the system owing to the small amount of momentum and inertia

Simplex Steel Conduit Co.'s Stand.

to be overcome at stopping and starting comparatively light rotating parts. An interesting feature to engineers are the car controllers with which the running car is equipped. There is one No. 412 Westinghouse controller at each end of the car, each of which controls by the one main lever all the four motors of the tramcar. This new controller is an adaptation of the well-known double-equipment type, and is just as effective and reliable in practice as that has long proved itself to be. Of very great importance also is the Westinghouse magnetic brake with which the car is stopped in its journeys backwards and forwards over the route. This brake is quite a recent invention, and is designed expressly for use on city and suburban electric tramways. It combines the advantages of axle braking, wheel rim braking and slipper braking. A unit of the magnetic brake consists of a horseshoe electromagnet suspended, poles downwards, by spiral springs immediately over the track-rail head. The magnet poles are fitted with iron slippers. A flow of current round the coil of the electromagnet causes it to be drawn downwards, the slippers in the poles gripping the rail by magnetism. A moving car is, therefore, braked by the drag of the magnet on the rail, the frictional resistance depending upon the strength of the magnet—*i.e.*, upon the strength of

Westinghouse Working Tramway Exhibit.

the current flowing round the magnet coil. The body of the magnet is coupled by a system of simple levers to the brake blocks of the car wheels on each side of the magnet, by which the drag of the slippers on the rail is transmitted to apply lateral pressure to the brake shoes on the wheel rims. The proportional braking effect on track and wheels is definitely adjusted, so that whilst the wheel-braking effect is a maximum the pressure on the wheels is never sufficient to cause skidding.



Westinghouse 112 h.p. Gas Engine.

Adjustments are provided whereby the proportional braking effects may be regulated once and for all to suit the weight of the car and the gradients of the track, and so always to secure the greatest safety and the maximum braking effects. Current for exciting the electromagnet is drawn from the car motors, which are driven as generators by the momentum of the moving car.

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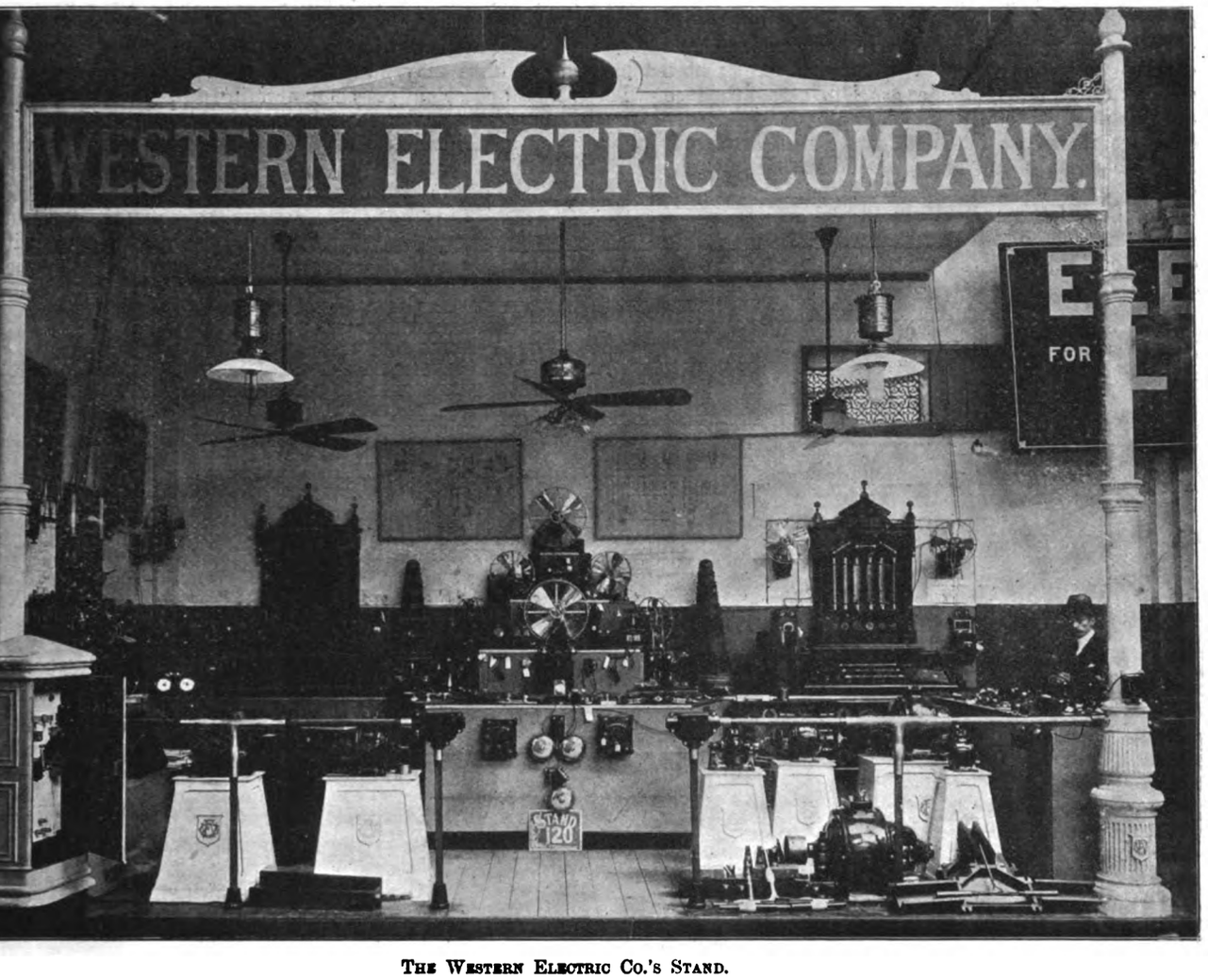
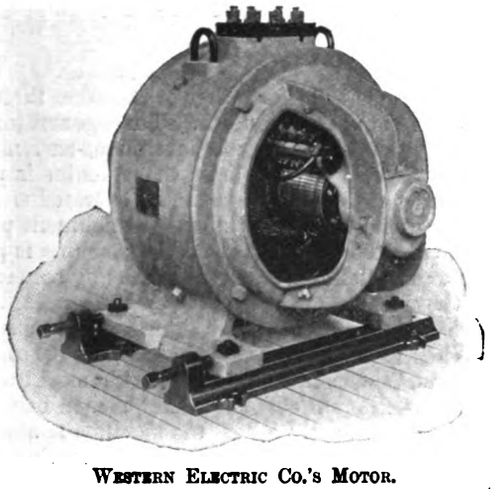
The Western Electric Co., of 171, Queen Victoria-street, E.C., had a stand (No. M120) in a corner of the small hall. They exhibited various telephones, motors, fans, traction material, arc lamps, cables, &c. Specimens of the new telephones used by the Post Office authorities, and a small exchange panel were features of a varied and interesting show. The motor, of which we give an illustration, is a 3 H.P. semi-encased 220-volt machine, and is built with a bipolar frame up to 5 H.P. and 6 H.P., owing to this method of construction being

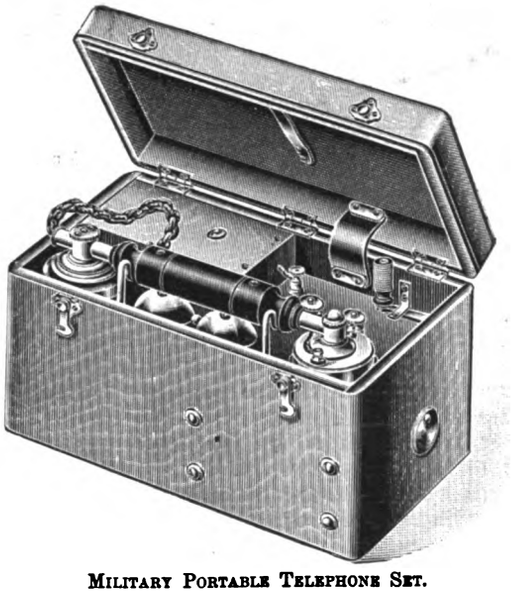


THE WESTERN ELECTRIC CO.'S STAND.



WESTERN ELECTRIC CO.'S MOTOR.

less expensive for small motors. There is also less chance of flashing round the commutator on a 500-volt system than when a multipolar machine is used, owing to it being possible to keep the brushes further apart. These machines are standardised, and all parts are interchangeable. The ventilation is exceedingly good, and they are built to run at three different speeds. We also give an illustration of a new military portable telephone set, which consists of a very compact four-magnet



MILITARY PORTABLE TELEPHONE SET.

generator, ringer, induction coil, battery of two dry cells and micro-telephone and cord. The whole is contained in a polished mahogany or teak case measuring 11in. by 6¾in. by 6in., and

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weighing 13lb. complete. The Western Electric Co. also exhibited a portable telephone for use on electric tramways. The transmitter and receiver, consisting of one piece, are carried in a small box together with a cord and plug. If the driver of a car desires to communicate with the generating station, he merely has to insert the plug in sockets provided in the section pillars which immediately rings up the station, and then conversation can be carried on. A ceiling fan exhibited has a sweep of 60in., and its blades are 8¾in. across the face. These fans are also made with an electrolier attachment beneath. There were also exhibited on this stand new types of very cheap telephones for office and domestic purposes. The transmitter is of the improved Hunning-Delville pattern. having a perforated aluminium disc protecting the carbon diaphram. The disc is provided with a lip on the under side, which, together with the pair of springs projecting over the upper side, enables the receiver to be clipped to the face of the transmitter when not in use. The springs also act as an automatic switch, cutting the bell out of circuit, and putting the receiver and transmitter in circuit when the receiver is removed. The latter has an alumiuium case with an ebonite ear-piece. The bell push is fitted to the face of instrument above the transmitter. All the above details are mounted on a new insulating material resembling ebonite. This mounting only measures overall 4⅞in. by 4in., depth 1⅛in. The above instrument is common to all the sets, being mounted in japanned metal frames, designed for use as either wall sets with bell, desk sets or inter-communication sets. The bell is very compact, and so arranged that the hammer strikes the edge of the gong on the under side. On the inter-communication sets, selective ringing and speaking is obtained by means of a hollow plug which fits over pegs mounted on face of the metal frame.

The exhibits of Ferranti Limited are always of great interest to both traction and lighting engineers, and those at stand No. 30, though not numerous, answered the purpose admirably. We give an illustration of the high-tension sub-station switchboard for use on a three-phase system, showing the arrangement of the 'bus bars, switches and fuses. Provision has been made on this board for the primaries of three static transformers, delta-connected for sub-station working, and for two in-coming feeders. It will be observed that the switches are of the well-known Ferranti patent quick-break type, and the fuses may be seen both above and below, consisting of solid porcelain vessels containing oil, in which the fuses are immersed. This board comprises a very compact and easily operated gear, and is absolutely safe as regards danger of shock. All live parts are placed at the back of cells, and are out of reach of the attendant. Great care has been taken to provide a separate cell or compartment for each phase, so that short-circuiting between the phases is impossible. It will also be seen that a panel is provided for a fourth transformer, which can be used as a substitute for either of the other three in case any one of them should break down. Three generator panels, forming a section of a low-tension continuous-current switchboard, were exhibited. One pole of the machine is provided with a combination switch, which can be operated either as a hand release switch or by an automatic attachment placed in the panel below. The other pole of the machine is provided with a knife or paralleling switch, a paralleling contact being provided in the panel.

The above panels have been designed to be operated as follows:—When it is required to put a machine on to the 'bus bars, the automatic switch is first closed, the machine is then run up to voltage, the knife or paralleling switch being placed on the paralleling contact. When the machine is at the same voltage as the bars this switch is finally closed. Should there then be any fault in the circuit, the automatic switch at once opens. It will be seen that with the above arrangement no plugging devices are required, and that the possibility of the switchboard attendant making mistakes is reduced to a minimum. The machine ammeter is placed above the switches.

Messrs. Ferranti Limited's Stand.

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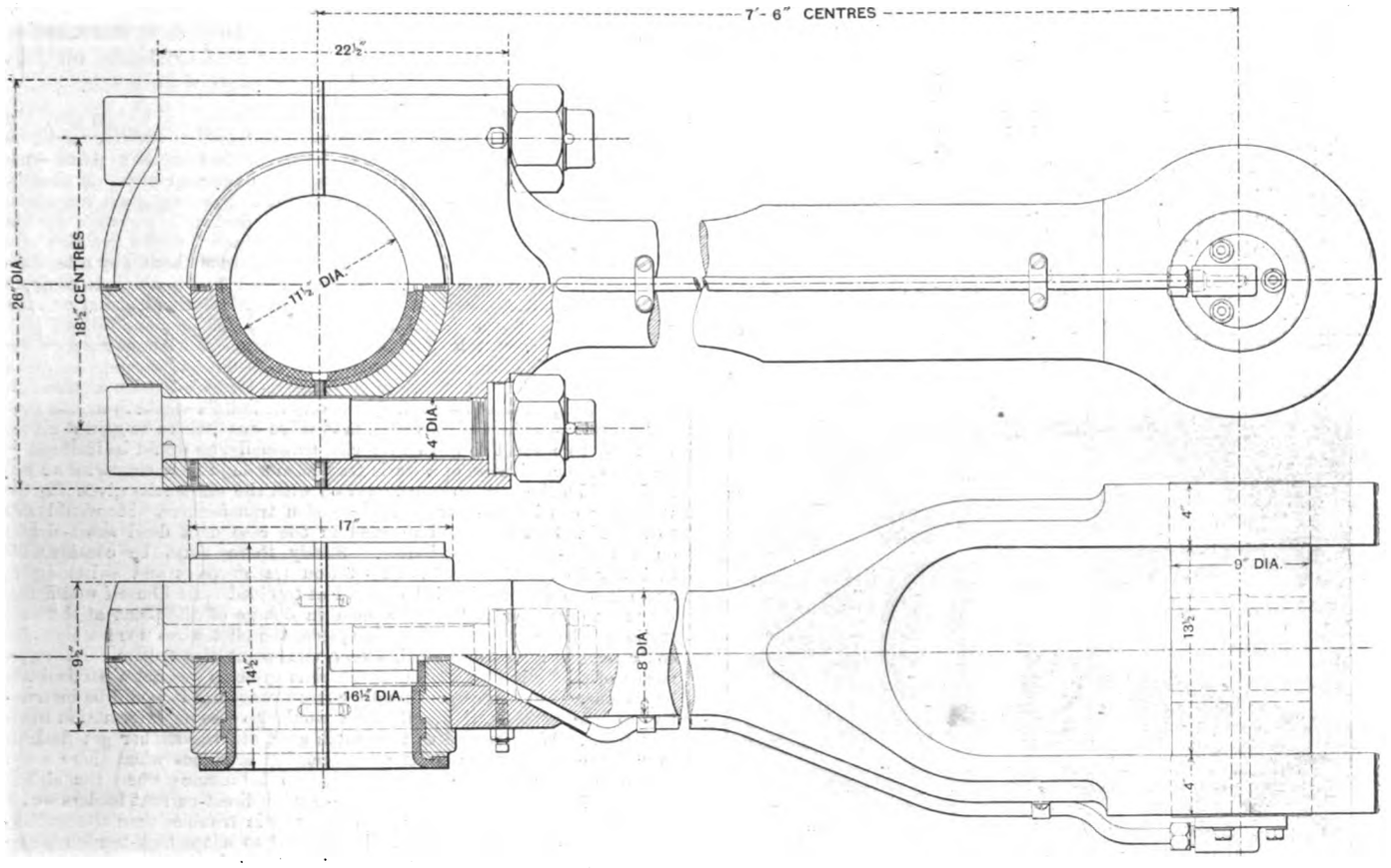
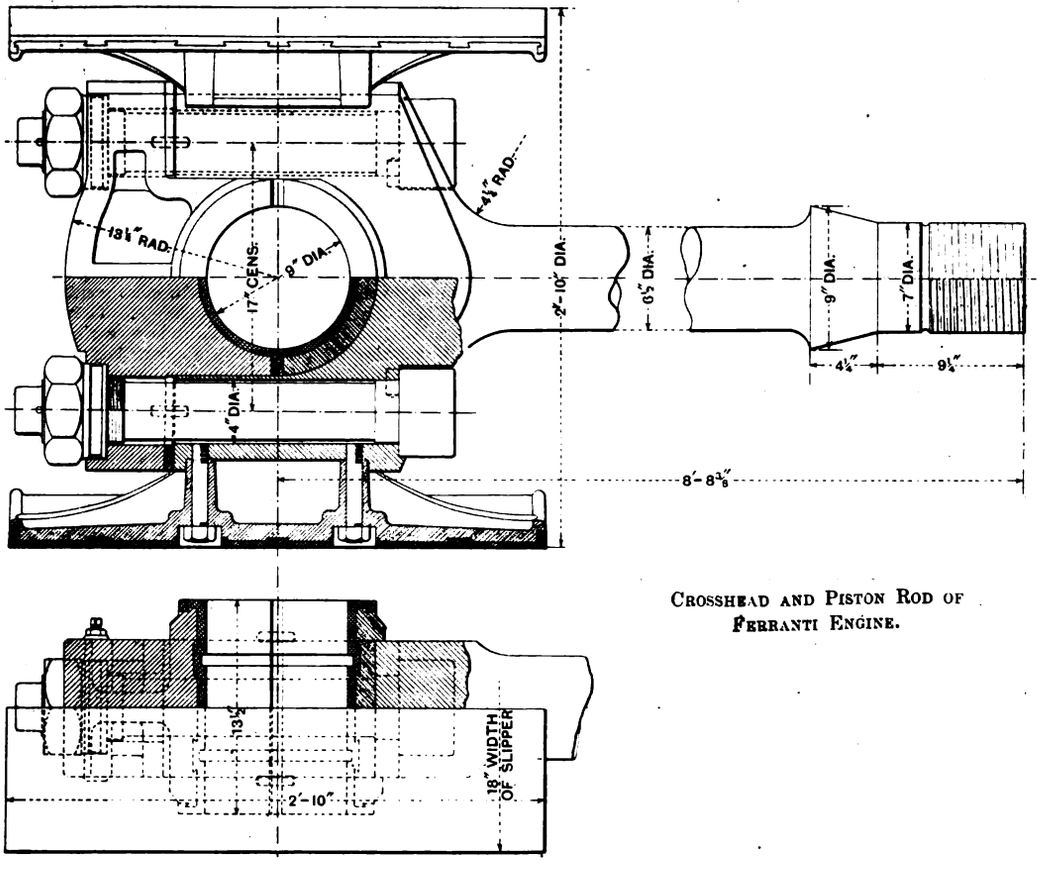
A fuse may also be used if required, and is placed below the knife switch.

Among the other exhibits on the stand were two rheostats of the Ferranti open type, in which the regulating switch and rheostats are combined in one apparatus. No bunching of connections whatever is necessary with a rheostat of this type.

Various types of Ferranti oil-break fuses were also exhibited, one being a multi-break oil fuse for use on systems up to 10,000 volts, and consists of several porcelain cylinders about 12in. in height and 3in. in diameter containing oil. The connections are brought up from the bottom of the cylinders with a hook, and the fuse wire fastened on so that it bridges across



CONNECTING ROD OF FERRANTI ENGINE.



CROSSHEAD AND PISTON ROD OF FERRANTI ENGINE.

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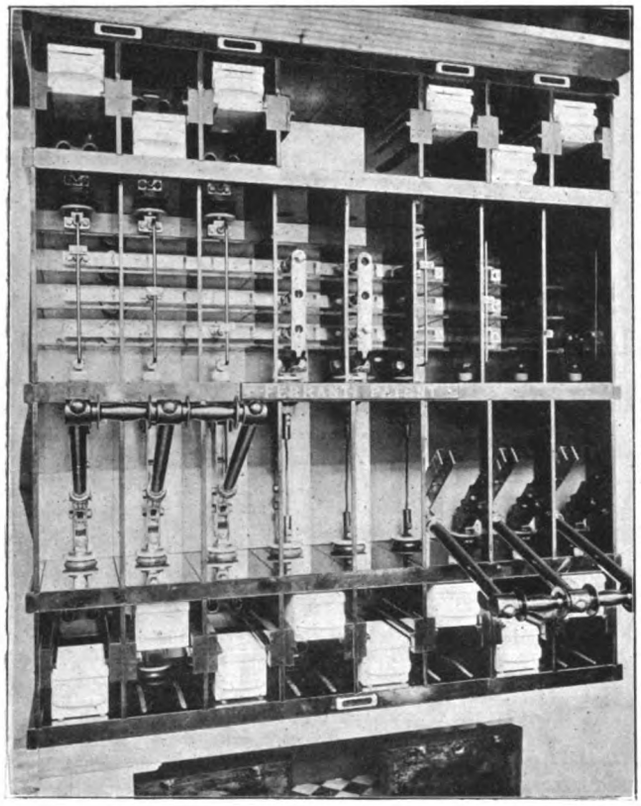
from one cylinder to the next. There were eight cylinders on the specimen exhibited, and, therefore, four fuses in series. In the event of these blowing, the connections are immediately pulled down into the oil by means of powerful springs. The piston rod, crosshead, and connecting rod, of which we give drawings, have been made for one of the four 2,500 I.H.P. engines they at present have in hand for the London County Council Tramways. Both rods are of the marine type. The crosshead is formed on the end of the piston rod, and fitted with a cast-steel cap and bearing step. The slippers are of cast iron, securely held to the crosshead, and babbitted on their working faces. The piston rod forging was made by the Portland Forge Co. (Ltd.), of Kilmarnock, and is to Admiralty requirements. The ultimate tensile strength, as taken from actual test pieces, was 34 to 34·7 tons per square inch, with 35 to 40 per cent. elongation in 2in. The crosshead pin is shrunk into its position in the jaws of the connecting rod.



FERRANTI HIGH-TENSION SWITCHBOARD.

The crank pin bearing steps are of cast-iron, very strong, and well supported. Both the crosshead pin and crank pin bearings are lined with white metal. The forging for the connecting rod was obtained from the Parkhead forge of William Beardmore & Co. (Ltd.).

A Ferranti edgewise ammeter in insulated case, intended for use on boards with pressure up to 10,000 volts, was also exhibited. The main coil of this instrument is outside the case, and entirely insulated from the moving parts of the instrument. There were also exhibited by Messrs. Ferranti several of their meters, which are too well known to need any description here.

(To be continued.)

The Metric System.—An article by Mr. H. E. P. Cottrell, entitled "A Short Cut to the Metrical System," appears in the current number of *Feilden's Magazine*, and contains the statement that the United States of America have paved the way to the adoption of the metrical system by decimalising the inch and the ton, and even our own colonies have been taking steps to attain the desired object. It is suggested that we should retain the names of the units at present in vogue and let them signify metrical values as nearly as possible equal to those which they at present denote.

HIGH-TENSION CONTINUOUS CURRENT SYSTEMS.

The following discussion took place in connection with Mr. A. S. Barnard's Paper on the above subject at the meeting of the Incorporated Municipal Electrical Association on July 9th. The Paper was publised in our issue of July 4th.

Mr. J. F. C. SNELL (Sunderland) said that it seemed to him that the only object of the high-tension direct-current system—which might be taken as the alternative at the present time of multi-phase systems—was the fact that wages at the sub-stations were dispensed with. If that be the principal advantage—as he understood it to be—very grave consideration would have to be given by an engineer designing a system for the supply of a big town, before he committed himself to the erection of a number of sub-stations fitted with running plant without any attendant to look after them constantly. He himself had had occasion to consider this question quite recently in connection with Sunderland, and after carefully weighing up the vital questions of cost, efficiency and reliability of supply, had deliberately put aside high-tension continuous-current for this reason. Mr. Barnard's prices for the high-tension three-phase plant were not accurate. Taking the author's figures for high-tension continuous-current plant, it seemed that there was very little difference between the two, and on this point he was convinced that there was little to be gained either way. With respect to the efficiencies, personally, he would be inclined to say that the efficiencies of a static transformer and rotary converter at full load would make very good comparison with the efficiencies given in the Paper for continuous-current high-tension transformers. He would like to ask Mr. Barnard what happened in the case of a dead short-circuit on his low-tension distributor. Surely there must be considerable difficulty in starting up his sub-station transformers and switching in again if such a short-circuit happened at top load. He himself would feel very much happier if he had a man in charge of the plant at the sub-stations. There were also in this system the pilot wires upon which the controlling switches depended, a very vital point of a system. His experience of pilot wires on continuous-current systems was not a particularly happy one. They were continually going wrong, and it would be instructive to him, at least, if Mr. Barnard would give some information upon that point. With regard to the switch gear, did the author get flashing over at the commutator on the high-tension machines when there was a rise of pressure on the primaries due to inductance when the circuit was open? He thought that the high-tension direct-current feeders would be much more likely to suffer from electrolytic troubles than alternating-current high-tension primaries. If one had to adopt high-tension transmission at all there could be little doubt that alternating was the best. Coming to Mr. Barnard's costs, he asked what was the price of coal per ton during the last year, and also whether the assessment committee rated the machinery at the sub-stations or whether they took this as part of the necessary distributing apparatus. There was also another very important point which he thought was germane to the Paper. Why was it that there was a station at Sculcoates-lane, Hull, which was high-tension continuous-current and another station supplying the tramways, but entirely separate from the lighting station? He had made a careful study of the Hull costs. Mr. Barnard was most unfortunately suffering from an extremely poor load-factor, one of the worst in the kingdom—viz., 8¼ per cent. Surely, if the two stations had been combined a considerable increase in the load-factor would have resulted, and he himself was of the opinion that the deficit which everyone deplored at Hull last year—and a good deal of which he knew was due to extraordinary causes—would at any rate not have been so heavy. This was, therefore, a good opportunity for Mr. Barnard to explain why the two stations had been separated. If it was due to engineering reasons, it was a most conclusive argument against the use of high-tension continuous currents. The author had not referred to the capital cost at Hull, but, taking last year's figures, it was £73 per kilowatt. Considering that there was a great deal of plant installed at the station which was not working usefully, this was not a bad figure. There were a good many stations which were temporarily showing a capital cost of over £100 per kilowatt, so that the total cost of the installation of Mr. Barnard's system was by no means to be put on one side. Turning to the cost of generation, he said the reason why he had asked for the cost of coal per ton was that he noticed the cost of coal last year at Hull was 0·84d. per unit, which was extremely high unless the price of coal was high. Mr. Barnard was working condensing, so it was not on the steam side. Was it due to the electrical side—*i.e.*, to the large proportion of units which were unaccounted for? He believed not, as a matter of fact. This would also be a good opportunity for Mr. Barnard to say what was the efficiency of the distribution—what was the ratio of the units sold to the units actually generated at the station. The total engineering costs and managerial charges were 2·35d., and, considering the extremely poor load-factor, he should say this figure was an extremely good one, subject to the explanation as to the price of coal. But the sinking fund and interest came out at nearly 4½d. No wonder there was a deficit when the average price received was only 3·3d. Probably this deficit was only a temporary one, which would be wiped away during the next year or two.

Mr. A. WYLLIE (Walsall) emphatically supported the Paper. He had seen the station at Hull working on two or three occasions, and he knew how well it did work. He also himself had had considerable experience with this type of plant. With regard to the general efficiency of the plant, with transformers of smaller size than those mentioned in the Paper, he could get quite as good results. It should also be remembered that in the tables given by the author the feeder losses were included, so that the figure represented the efficiency between the low-tension side of the transformers and the high-tension side of the switchboard at the generating

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station. The efficiency, therefore, was good and the reliability of the plant was good. Mr. Snell had questioned this latter, but after having worked with such a plant now for considerably more than seven years he (the speaker) could only say that in general the plant turned out very reliable indeed; in fact, thoroughly reliable machines at from 2,000 to 3,000 volts were now to be had. Mr. Ruthven-Murray, in his Paper on double-current generators, had made a remark regarding commutators, and suggested that 3,000 volts would be found the limit on account of these. He was able, however, to say that with ordinary care and attention there was no difficulty whatever with commutators. A commutator at 2,000 volts would work just as well as one at 200 volts, and without any more difficulties. With regard to sub-station wages, in his own case they were not even so high as those suggested by Mr. Barnard. In Walsall there were nine sub-stations, and he found it perfectly satisfactory on each shift to have simply one man in charge of them, and intelligent junior labour for the work was quite satisfactory. Further, during the daytime, when the load was very small, the sub-station attendant was available for other work, such as fixing meters and attending to small jobs generally outside, the sub-stations being quite safely left to themselves. Mr. Snell had asked some questions about starting up again in case of a secondary short-circuit. He presumed Mr. Snell was referring to a temporary one, and this would simply take out the nearest transformer, the others taking up the load, and the man at the switchboard, seeing he had lost one, could safely close the circuit again as long as the high-tension switch was in. He had never experienced any difficulty with pilot wires if they were properly put in. The author said three, but he had found only two necessary. He could assure Mr. Snell that to start up again after a high-tension short-circuit was not at all a difficult matter. The man at the generating station had such perfect control that he could start up again without any assistance from the outside man. With reference to the splitting of the tramway and lighting load at Hull, he said at Walsall they were using larger machines than those referred to by Mr. Barnard, and one of them was running on a portion of the Walsall tramway circuit, and was performing very well indeed. It was rated at 105kw., and the load was varying constantly from nothing to 50 per cent. overload, but it was running without any batteries or other regulating apparatus. The generating plant used to drive it was only that originally installed for lighting. He had been much interested in the reference of the author to the long-range switch. The performance of that switch was really admirable, and in the case of the failure of the pilot-wire the man at the switchboard merely saw he could not get his long-range switch in, and he had the sub-station attendant at hand somewhere to send round and put it in. The machines were so reliable at Walsall that they were always started up without any attendant at the sub-stations. In some cases the pilot wires were not even joined across the secondary of the machine. He had never experienced any difficulty with the breaking of the high-tension switches nor had he known of a case where the breaking of these switches had caused any damage whatever to any of the machines by reason of a rise of E.M.F. at the switch. In conclusion, he emphasised the closing remark in the Paper, and, without wishing to pass any absolute opinion on the system whatever, thought that any engineer who failed to consider the possibilities of high-tension continuous-current when wishing to work at from 2,000 to 3,000 volts would certainly be neglecting a most excellent opportunity.

Mr. C. E. C. SHAWFIELD (Wolverhampton) endorsed what the author had said with regard to the switch gear. At the Wolverhampton works the system originally put down was a high-tension continuous-current one, and he was bound to say that a great deal of trouble was experienced with it from causes which at the time they were really quite ignorant of. But he had since come to the conclusion that the type of switch gear employed was very largely responsible for these accidents. They used the Ferranti oil type of switch which gave a very rapid break under oil, and the result was that a very large E.M.F. had momentarily generated owing to the breaking of a negative circuit which broke down the stationary machines. There was another trouble which he noticed in connection with the system, and he would be rather glad if Mr. Barnard would say whether he had had any experience of this himself. In the case of a short on a high-tension system —for instance, a fault occurring in the armature of a high-tension transformer—had he found that the other transformers on the system came out at the same time? He himself had always found this to be the case. The reason for this he believed to be simply due to the momentum of the armatures of the other transformers which generated a considerable back E.M.F. and caused a heavy current to flow through the short, which was, of course, in parallel with them. As regards starting up after breakdown, he endorsed what Mr. Wyllie had said, that there was no difficulty in doing this. He was sorry to say that he had had to start up very frequently through this cause at Wolverhampton, and the result was that he had learned how to do it. On one occasion he had had to start up after a severe short-circuit on the low-tension mains ultimately found to be due to a spanner left in one of the street boxes. He started all the generators at about quarter voltage, and kept the transformers running slowly, so that they were only giving about 30 or 40 volts on the low-tension side. He put the long-range switches in at that E.M.F., and gradually ran the pressure up until the spanner was melted away. Mr. Snell had seemed to query the possibility of running a fluctuating load from this type of plant. There was little difficulty from this because he had had for a short time at Wolverhampton a circuit which gave even worse fluctuations than were given by a tramway load. It was a motor running at a stamping press in an enamelled tinware works, and as there was neither a flywheel on the motor or press, the fluctuations were very great indeed. But there had been no ill effects.

Mr. A. B. MOUNTAIN (Huddersfield) thought that most men would agree that almost any system properly worked out would give very good results. He did not think they at all wished to pledge themselves to one particular system, but supposing they did, chairmen of committees would no doubt agree that the financial results obtained by any undertaking would be a measure of the success of the system. Mr. Snell had stated that the cost at Hull was £73 per kilowatt. He had just been looking into the Huddersfield figures, and although the plant there was put down many years ago, the capital cost was £65 per kilowatt, and the cost of producing energy at these works was 1·53d. per unit, as against 2·4d. in Hull. He thought it very plucky indeed for a man with figures as high as that to come and talk to the single-phase advocates about costs. A good deal had been introduced into the discussion about transformers. In alternate-current systems, transformers were about the most perfect part of the whole. As a matter of fact, the engineer himself never went near the sub-station. The transformers were absolutely reliable, and instead of costing £4. 10s. per kilowatt, they only cost 30s. A consumer could afford to sacrifice 5 per cent. in motor efficiency if he could get 10 per cent. reduction in the cost per unit.

Mr. H. R. BURNETT, of Barrow, thought one of the great disadvantages of the high-tension continuous current was that if the transformer load-factor was to be kept up to anything like a reasonable amount—say 75 to 100 per cent.—they must be comparatively small, and consequently the number would have to be large. Again, to control these tranformers each had to have a separate feeder laid for it, and, in addition to this, Mr. Barnard even went so far as to have three pilot wires to each transformer. Each transformer also meant an amount of switch gear, and all these things ran up the cost of the installation. There was one very important point which the author, to his mind, was a little bit apt to overlook. The curve of efficiency in the Paper was the efficiency of the machine only, and did not include the mains. This showed an efficiency of 92 per cent. at full load, but his experience was that, as the load decreased, so did the efficiency. The average load-factor of the transformers might be taken at something like 75 per cent., and then the efficiency of the distribution fell to about 80 per cent. or something less. The governing effect of the transformers upon the voltage he did not think was so apparent as the author made out, because any advantage in this respect was more than counterbalanced by the drop in the motor armature and generator armature of the transformer. A very considerable drop was experienced with a varying load which would not be so when supplying on the ordinary direct-current system. He had not had much experience of starting up after a dead short-circuit or a breakdown, but the way he liked to do this was to run up quietly on the low-tension plant he had at the station.

Mr. W. A. CHAMEN (Glasgow), referring to the question of the rise of voltage when the circuit was broken, said that no one, so far as he could recollect, had mentioned what kind of mains were connected—viz., single or concentric.

Mr. S. Z. de FERRANTI said the Paper was interesting, because very little was generally written or spoken upon the subject. The question of high-tension transmission and low-tension distribution was one which had fascinated some very able inventors in the very early days. Some of them would no doubt recollect the installation which was put up by Marcel Deprez some 20 years ago near Paris, when high-tension continuous-current was distributed to several centres, and there converted down by means of motor generators to feed the low-tension network in the city itself. This was, of course, in the very early days when little was known about the practical working of electricity, and when the people working it were confronted with every possible difficulty. Strangely enough, we had to-day high-tension continuous-current tranmission, but in the early days it really amounted to extra-high pressure. In the Marcel Deprez apparatus several machines were coupled in series, each being separately insulated. The receiving apparatus also consisted of several machines or several armatures separately insulated and coupled in series and mechanically driven. It would be seen, therefore, that a start had then been made in quite the most difficult part of the problem—viz., extra high tension instead of high tension. Another very able inventor, M. Thury, of Geneva, took up the problem, and put up an installation there. In this case 6,000 volts were employed, generated by 2,000-volt continuous-current machines coupled up in series. The next thing of the kind which he remembered coming across was in Paris again, where the Popp Company were, 20 years ago, supplying compressed air for motive power in the city, which was used at sub-stations for conversion into low-tension continuous current. All these systems had gradually disappeared. They started under very great difficulties. They were very ambitious, and taught present-day engineers a great deal which was very valuable. Really what they came back to to-day was that good electrical distribution was possible on almost any system; but he thought the adoption of continuous current in this country was very largely due to the dangers which surrounded alternating high-tension current when it was first introduced, when fairly faulty transformers were put into each house. He could recall a case of six fires occurring simultaneously on one system. They had got upon a certain track, and the public was learning to demand a certain article, and whether it would ever demand another article was a matter of very great doubt to him. Personally he had often expressed the opinion that he could see no reason for going in for continuous current rather than alternating. Perhaps the only real necessity for continuous current was for lifts - requiring, say, 3 per cent. of the total energy. But the time must be looked to when electricity must be distributed at very much lower costs than at present, and with this being forced upon them more and more, he thought it would cause a unification of all the various systems. The eventual thing which would decide all these problems was one purely of cost to the consumer, and it would be a very good thing if electrical distribution could be done in one way instead of so many, as at present. Standardisation, not only of article, but also of systems, would undoubtedly bring matters down to the condition of lowest possible cost to the public.

Mr. C. H. WORDINGHAM thought Mr. Barnard was in the position of champion of a lost or losing cause. He believed that high-tension continuous current would not be employed, because it was not possible to go nearly as high in pressure as with alternating currents. He believed it was not practicable to transmit by this means at a higher

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pressure than 3,000 volts, and in this the author seemed to agree. If they were going in for high-pressure at all with all the costly and troublesome and complicated arrangements of transforming plant, they might just as well "go the whole hog," and put in plant for 6,000 or 10,000 volts. Most of the speakers had rather handicapped the continuous-current high-pressure system by assuming that it must be done with the particular switch which Mr. Barnard and others use. He could not see that there was any inherent reason for controlling the transformers from the generating station. But how did Mr. Barnard get on with the Board of Trade with respect to the high-pressure transforming stations? The Board of Trade specified that a trained man should be in attendance unless the stations were very small. He did not see any necessity for all this complicated control from the generating station.

Mr. Barnard, who will reply in the Association's *Journal*, was accorded a hearty vote of thanks at the conclusion of the discussion.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"The Steam Turbine." By R. M. Neilson. (London: Longmans Green & Co.) 7s. 6d.

"General Index to the Journal of the Iron and Steel Institute." 1890-1900. Vols. XXXVI. to LVIII. Edited by Bennett H. Brough. (London: E. and F. N. Spon.)

"Transactions of the American Institute of Electrical Engineers." June and July, 1901. (New York: the Institute.)

"Die Elektrizität in Gasen." By Dr. Johannes Stark. (Leipzig: J. A. Barth.) 12m.

"Proceedings of the Royal Society." No. 462. Vol. LXX. (London: Harrison & Sons.) 2s. 6d.

ELECTRICITY WORKS ACCOUNTS.

Hastings Municipal Electric Supply Works.

A cursory glance at the analysis we give of the accounts of this undertaking for 1901 certainly induces a feeling of disappointment. A more complete knowledge of the circumstances of the working serves, to some extent, to relieve—but does not wholly extenuate—the indifferent results obtained.

It is to be feared that the situation of this place precludes the possibility of a moderate fuel item being ever shown. Mr. Andrews says that during 1901 the average price paid for coal was 1s. per ton higher than in 1900, on account of the large proportion delivered under that year's contract. Both the stores and the wages items have dropped to more reasonable figures, but the repairs at the station and on distribution plant show increases. The increase in the former costs is attributed chiefly to the rough usage of the plant during building alterations and in the latter to transformer breakdowns.

An unsatisfactory feature of the costs column are the increased management charges. They were high enough in 1900.

Making some allowance for the probable high price of fuel at this place and, of course, for the public lighting costs, it would appear that the total costs are still quite 0·5d. per unit too high.

With regard to the financial results shown we find that the mean capital expenditure bears rather too high a relation to the output for good results to be possible. As a matter of fact, after payment of capital charges amounting to about 6·7 per cent. on the mean capital there was a net loss for the year of £1,949.

The last three years included in the table below were the first under municipal administration:—

Year.	Output.	Equiv. lamp connections.	Load-factor.	Revenue per unit sold.	Total costs per unit sold.	Working profit.	Dividend under company.
1895	265,846	9,667	..	5·76d.	4·64d.	£1,246	nil
1896	283,100	10,064	12·6%	5·92d.	4·37d.	1,894	nil
1897	338,705	13,418	12·5%	6·30d.	3·86d.	3,426	6%
1898	363,678	14,817	12·7%	6·76d.	4·58d.	3,302	7½%
1899	404,866	19,423	12·8%	6·94d.	3·95d.	5,046	...
1900	524,830	23,664	12·1%	5·38d.	3·60d.	3,896	...
1901	703,814	29,428	13·7%	5·05d.	3·15d.	5,565	...

Hove Electric Lighting Co. (Ltd).

The Hove accounts for 1901 indicate a more than maintenance of the satisfactory results of 1900. It will be noticed that the load-factor has diminished, but notwithstanding this, and a great increase in the rates and taxes, the total costs were reduced from 2·92d. to the creditable figure of 2·83d. per unit. Thus it is that the working profit of 1900 was improved upon last year, although the total revenue per unit was lower. Out of the gross profit there was paid in capital charges about 3 per cent. of the mean capital as well as an ordinary dividend of 8 per cent., leaving £454 carried forward.

The amount of £600 annually set aside for repairs and maintenance, in accordance with the contract with the Hove Commissioners, has again proved insufficient to meet the necessary outlay on this account during the year. The excess of £187 (£316 in 1900) we have shown as a minus quantity in the net revenue account, as it was provided out of the maintenance reserve account, leaving therein a balance of £759.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 1900
Ayr (Municipal)	Oct. 11, 1901	Kens'gton & Knightsbr'(Co.)	Apr. 11, 1902
Barnsley (Municipal)	June 27, 1902	Kingston-upon-Hull (Mun.)	July 13, 1900
Bath (Municipal)	April 30, 1900	Kingston-on-Thames (Mun.)	June 20, 1902
Bedford (Municipal)	Aug. 3, 1900	Lancaster (Municipal)	Feb. 15, 1901
Belfast (Municipal)	Oct. 18, 1901	Leeds (Municipal)	June 27, 1902
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 26, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal	Oct. 4, 1901	Leyton (Municipal)	Nov. 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Sept. 13, 1901
Bristol (Municipal)	Aug. 30, 1901	Morley (Municipal)	June 14, 1901
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	July 11, 1902	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	July 11, 1902	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Nov. 29, 1901
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 16, 1901	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 28, 1900	Richmond (Company)	June 29, 1900
Crewe (Municipal)	July 11, 1902	Salford (Municipal)	Jan. 24, 1902
Croydon (Municipal)	Nov. 22, 1901	Scarborough (Company)	Dec. 20, 1901
Crystal Palace District (Co.)	Sept. 13, 1901	St. Helens (Municipal)	Jan. 10, 1902
Derby (Municipal)	Jan. 26, 1900	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. Pancras (Municipal)	July 5, 1901
Dover (Company)	May 2, 1902	Sheffield (Municipal)	Feb. 1, 1901
Dundee (Municipal)	Dec. 6, 1901	Shoreditch (Municipal)	Jan. 31, 1902
Eastbourne (Municipal)	Mar. 14, 1902	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Edinburgh (Municipal)	Dec. 6, 1901	South London (Company)	May 16, 1902
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 4, 1902
Folkestone (Company)	May 2, 1902	Southampton (Municipal)	Feb. 8, 1901
Glasgow (Municipal)	Sept. 27, 1901	Southport (Municipal)	Jan. 17, 1902
Gloucester (Municipal)	Aug. 20, 1901	Stafford (Municipal)	Aug. 16, 1901
Great Yarmouth (Mun.)	Dec. 13, 1901	Sunderland (Municipal)	Oct. 18, 1901
Greenock (Municipal)	Aug. 30, 1901	Taunton (Municipal)	June 16, 1899
Guildford (Company)	Oct. 19, 1900	Tunbridge Wells (Mun.)	Nov. 1, 1901
Halifax (Municipal)	Dec. 27, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hammersmith (Municipal)	Nov. 15, 1901	Walsall (Municipal)	May 23, 1902
Hampstead (Municipal)	Nov. 22, 1901	Wandsworth (Company)	May 9, 1902
Hanley (Municipal)	Aug. 9, 1901	Westminster (Company)	April 4, 1902
Harrogate (Municipal)	Jan. 25, 1901	Whitehaven (Municipal)	Feb. 8, 1901
Harrow (Company)	Dec. 21, 1900	Winchester (Company)	June 20, 1902
Hast'gs & St. Leonards (Mun.)	July 12, 1901	Windsor and Eton (Co.)	July 19, 1901
Hereford (Municipal)	Jan. 17, 1902	Woking (Company)	Dec. 22, 1899
Hove (Company)	May 10, 1901	Wolverhampton (Municipal)	Jan. 24, 1902
Huddersfield (Municipal)	May 23, 1902	Woolwich (Company)	May 31, 1901
Hull (Municipal)	July 4, 1902	Worcester (Municipal)	April 18, 1902
Isle of Wight (Company)	Dec. 20, 1901		

REMARKS.

HASTINGS.—*a* By company. Municipally controlled since the beginning of 1899. *b* Inclusive of £54,800 consideration money for purchase of undertaking under contract of July 23, 1897, and £6,548 amount paid to company for new machinery and plant, alterations of buildings, extension of mains, transformers, &c., by company subsequent to date of contract. *c* Over-expended. *d* Engineers' department £309, accountant and clerical staff £112, collectors £148. *e* Insurance £161. *f* Or £15 per kilowatt demanded plus 1½d. per unit. *g* Or 10s. per 8 c.p. lamp (maximum demanded) plus 1½d. per unit. *h* Being from 253,150 units at 6d. £6,329 and 255,472 units at 1½d. £1,597, and the lamp charge (see *g*) £2,547, less £36 bad debts *i* 195,192 units at 1½d. plus £1,260 for current, interest and sinking fund on capital expended on lamps, posts, &c., £556, and repairs, carbons, trimming £661. *j* Consulting engineer £53, engineers' department £694, account collector £105, clerical staff £124, proportion of general office salaries, £97. *k* Law £34, insurance £156.

HOVE.—*a* Inclusive of premiums, £10,688. *b* Over-expended. *c* Distribution, wages and repairs and maintenance costs are included in the corresponding generating items; the wages (£1,036) include £389 pr portion of salaries of engineers, superintendents and officers and £656 in 1900 and £782 in 1901 wages and gratuities at generating station. *d* Includes £450 to directors. *e* Insurance £130, auditing £16. *f* Paid out of maintenance fund. *g* Includes £119 income tax. *h* Wright system. *i* Premiums £12,550. *j* Includes land.

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	HASTINGS.		HOVE.	
Undertaking Worked by	Hastings Corporation.		Hove Electric Lighting Co. (Ltd.).	
Date of Commencement of Supply	1883.[a]		November, 1892.	
System of Supply	Alternate-current transformers.		3-wire continuous-current, with batteries.	
Chief Engineer	L. Andrews.		C. B. Smith.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	687,503	867,622	625,828	—
„ **SOLD (TOTAL)**	**524,830**	**703,814**	**539,208**	**629,427**
„ sold to consumers	401,830	508,622	539,208	629,427
„ sold for public lighting, &c.	123,000	195,192	nil	nil
„ sold for traction	nil	nil	nil	nil
„ used on works	—	—	26,776	27,891
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**24·2**	**22·9**	**15·3**	**16·7**
Actual maximum supply demanded	495 kilowatts	584 kilowatts	605 kilowatts	734 kilowatts
Load factor	12·1%	13·7%	10·2%	9·80%
Number of public lamps	53 (15-amp.) arc	103 arc, 100 glow	nil	nil
Number of consumers	484	604	801	924
Connections to mains in 8-c.p. lamps at end of year	23,864	29,428	52,913	61,366
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	**735**	**1,235**	**1,203**	**1,203**
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	£123,333 / £99·8	£150,000 / £125	£150,000 / £125
Share	— / —	— / —	100,000 / 83·0	100,000 / 83·0
Loan (including Debenture charges)	— / —	123,333 / 99·8	50,000 / 41·6	50,000 / 41·6
RECEIVED (TOTAL)	£104,789 / £143	108,439 / 87·8	92,226[a] / 76·7	99,534[i] / 82·7
Share	— / —	— / —	56,538 / 47·0	61,984 / 51·5
Loan (including Debenture charges)	104,789 / 143	108,439 / 87·8	25,000 / 20·8	25,000 / 20·8
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	14,894 / 12·1	68,462 / 56·9	63,016 / 52·4
Share (unissued)	— / —	— / —	43,462 / 36·1	36,275 / 30·1
Share (uncalled)	— / —	— / —	— / —	1,741 / 1·45
Loan (including Debentures)	— / —	14,894 / 12·1	25,000 / 20·8	25,000 / 20·8
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	5,273 / 7·18	9,210 / 7·46	17,038 / 14·2	21,150 / 17·6
DEPRECIATION FUND	— / —	— / —	946 / 0·786	759 / 0·631
EXPENDED (TOTAL)	102,256[b] / 139	123,406 / 100	100,523 / 83·5	109,739 / 91·2
Lands and buildings	— / —	— / —	9,447 / 7·85	12,420[j] / 10·3
Plant	— / —	— / —	44,263 / 36·8	47,767 / 39·7
Mains	— / —	— / —	45,836 / 38·1	48,517 / 40·3
Miscellaneous	— / —	— / —	977 / 0·812	1,035 / 0·860
BALANCE OF CAPITAL ACCOUNT	−2,533 / −3·45	−14,967 / −12·1	−8,297[b] / −6·89	−10,204[b] / −8·47
REVENUE—	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.
TOTAL	£11,774 / 5·384d.	£14,799 / 5·050d.	£13,841 / 6·164d.	£15,519 / 5·920d.
Revenue from supply	8,667 / 3·964d.	10,557[h] / 3·603d.	13,069 / 5·820d.	14,846 / 5·661d.
„ meters, &c.	412 / 0·188d.	545 / 0·186d.	753 / 0·335d.	631 / 0·240d.
„ public lighting	2,650 / 1·210d.	3,697[i] / 1·261d.	nil / —	nil / —
„ supply for traction	nil / —	nil / —	nil / —	nil / —
„ miscellaneous sources	44 / 0·020d.	— / —	18 / 0·008d.	42 / 0·016d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£7,878 / 3·602d.	£9,236 / 3·150d.	£6,561 / 2·921d.	£7,422 / 2·830d.
TOTAL WORKS COSTS	6,700 / 3·064d.	7,444 / 2·540d.	4,500 / 2·003d.	5,090 / 1·941d.
Generation of electricity	*6,398* / *2·924d.*	*6,568* / *2·240d.*	—[c] / —	—[c] / —
Fuel (including cartage, &c.)	4,624 / 2·114d.	4,530 / 1·546d.	2,479 / 1·104d.	3,005 / 1·146d.
Oil, waste, water, stores	497 / 0·227d.	393 / 0·134d.	69 / 0·031d.	137 / 0·052d.
Wages at station	885 / 0·405d.	918 / 0·313d.	1,036[c] / 0·461d.	1,161[c] / 0·442d.
Repairs and maintenance at station	393 / 0·180d.	728 / 0·248d.	916[c] / 0·408d.	787[c] / 0·300d.
Distribution of electricity	*95* / *0·043d.*	*206* / *0·070d.*	—[c] / —	—[c] / —
Wages, &c.	10 / 0·005d.	25 / 0·008d.	—[c] / —	—[c] / —
Repairs, renewals of mains, &c.	85 / 0·039d.	181 / 0·061d.	—[c] / —	—[c] / —
Public lighting	*207* / *0·095d.*	*670* / *0·229d.*	— / —	— / —
Attendance	207 / 0·095d.	670 / 0·229d.	— / —	— / —
Renewals			— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,178 / 0·539d.	1,792 / 0·612d.	2,061 / 0·918d.	2,332 / 0·889d.
Net rents	*42* / *0·019d.*	*27* / *0·009d.*	*249* / *0·111d.*	*298* / *0·114d.*
Rates and taxes	*255* / *0·117d.*	*244* / *0·083d.*	*184*[g] / *0·082d.*	*498* / *0·190d.*
Management	*881* / *0·403d.*	*1,521* / *0·519d.*	*1,628* / *0·725d.*	*1,536* / *0·585d.*
Salaries	569[d] / 0·260d.	1,072[j] / 0·366d.	1,102[d] / 0·491d.	1,104[d] / 0·421d.
Stationery, &c.	43 / 0·020d.	68 / 0·023d.	75 / 0·033d.	108 / 0·041d.
Establishment charges	88 / 0·040d.	190 / 0·065d.	285 / 0·127d.	158 / 0·060d.
Law charges &c.	181[e] / 0·083d.	191[k] / 0·065d.	166[e] / 0·074d.	166[j] / 0·063d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£3,896 / 4·30%	£5,565 / 4·93%	£7,280 / 7·50%	£8,095 / 7·70%
Sum carried to Depreciation Fund	— / —	— / —	−316[f] / −0·326%	−187[f] / −0·178%
Sum carried to Reserve Fund	2,306 / 2·55%	3,795 / 3·36%	2,250 / 2·32%	2,250 / 2·14%
Net interest on loans (incl. Debenture charges)	3,331 / 3·68%	3,719 / 3·30%	1,011 / 1·04%	1,082 / 1·03%
Net profit for the year	1,741 / 1·92%	−1,949 / −1·73%	4,335 / 4·45%	4,950 / 4·71%
BALANCE FROM LAST ACCOUNT	253 / 0·28%	−1,488 / −1·32%	346 / 0·356%	272 / 0·259%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	4,681 / 4·82%	5,222 / 4·97%
Deficit	*1,488* / *1·64%*	*3,438* / *3·05%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	8% / —	8% / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	66·9%	62·4%	46·4%	47·8%
Expenditure per mean kilowatt capacity	£11. 6s. 7d.	£9. 7s. 7d.	£5. 16s. 8d.	£6. 3s. 5d.
REVENUE PER MEAN KILOWATT CAPACITY	**£16. 18s. 10d.**	**£15. 0s. 5d.**	**£12. 6s. 2d.**	**£12. 18s. 0d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	10s. 11d.	11s. 1d.	5s. 8d.	5s. 5d.
Price charged for lighting, per unit	6d.[f]	6d.[g]	7d. to 1d.[h]	7d. (1 hr.) to 4d.[h]
Price charged for power, per unit	[plus 1½d. unit. £15 per kw. demanded]	[plus 1½d. unit. £15 per kw. demanded]	3d.	3d.
Price charged for public lighting			—	—
Receipts per unit for private supply	4·96d.	4·98d.	5·82d.	5·66d.
„ „ public lighting	4·76d.[l]	3·72d.	—	—
„ „ traction	—	—	—	—

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STEAM TURBINES FOR POWER STATIONS.

The Paper on "Steam Turbines," by Mr. S. E. FEDDEN, the electrical engineer to the Corporation of Sheffield, possesses one salient feature in common with Mr. E. T. RUTHVEN-MURRAY'S Paper on "Double-current Generators," upon which we commented last week, inasmuch as in either case the Paper represents the convictions upon which a practical and experienced engineer is prepared to stake his professional reputation. These are no doctrinaire Papers; no essays based on speculative theorising; no irresponsible compilations of the labours of others. They express what their authors are prepared to do, and what, to a large extent, they actually have committed themselves to, in the power-station practice over which they have exercised control. Strikingly original and, to a considerable degree, defiant of the usual practice of their professional confrères, as these two engineers have shown themselves to be, it cannot be urged against them that their novel practice is rash. Neither of them is a novice; each has had long and varied experience in the design and management of central stations. Their views therefore command the attention and merit the careful study of every electric power engineer in the United Kingdom.

Mr. FEDDEN certainly has made a bold stroke in deciding upon the equipment of his new Sheffield electricity works with units so novel and so large as 1,500kw. steam turbo-alternators. But we fully support him in this venture, and are as confident as he is that the history of what steam turbines have done in recent years, and are doing to-day, is ample justification of his decision. Indeed, we expect to find that ere long recognised and common practice will sanction not merely 1,500kw. units, but turbo-alternator sets capable of developing double or treble this power. The steam turbine, speaking apart from incidents of manufacture, is a better engine the larger the size in which it is built. Whether, for electricity supply purposes or for electric traction it is likely to exceed some 5,000 H.P. it is too early to say; but, in the utilisation of steam turbines in the naval and mercantile marine, it is not unlikely that larger turbine engines even than this immense size of unit will be built before many years have elapsed. It stands greatly to Mr. S. E. FEDDEN'S credit that he has had the courage of his convictions, and has led the way in this important *renaissance* in steam practice—for the very first steam engine, the text books tell us, was a turbine.

Notwithstanding the brevity of his Paper, Mr. FEDDEN has managed to compress within its compass most of the arguments in favour of the turbine type of steam engine, though they have inevitably suffered somewhat in the process of compression. We do not suggest that they have been distorted; far from that—but one or two of the major arguments have been compressed too much. For instance, we should have liked to have heard more about the use of superheated steam in turbines. In a brief paragraph near the close of the Paper Mr. FEDDEN tells us that "tests show that with 50°F. of superheat

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there is 8 per cent., and with 100°F., 12 per cent. economy in steam consumption." Some remarks are added with a view to show how much better than a Sulzer engine is a steam turbine, when supplied with superheated steam, as regards steam economy. It may fairly be assumed that the indicated economy of the Sulzer engine is the record point for reciprocating engines, though the slow-going Sulzer engine is beaten by some of its more fast-speed rivals in brake economy. But Mr. FEDDEN has not made the most of the superior economy of the turbine; nor does he insist with sufficient emphasis, we think, on the importance of superheating for this class of engine. Not only in mere steam economy, but also—and far more to the point—in heat economy, and thereby in money economy, superheating has the advantage over dry saturated steam. Wetness in steam is a source of loss and trouble in reciprocating engines, but it is far more troublesome and wasteful in a turbine, especially in that particular class of steam turbine which Mr. FEDDEN describes. No steam engine supplied with dry saturated steam can work without liquefaction occurring in the working steam chambers. Even a steam jacket does not get rid of this form of wetness. But little drops of water in a cylinder are not half so mischievous as they can be in the devious and narrow passages between the vanes of a turbine. It is on this account that superheating tells to such marked advantage in a turbine.

The merits of steam turbine practice in electric power stations do not rest alone upon the superior economy of heat. Money is saved besides in other ways; and in addition to numerous direct financial gains, there are the savings indirectly resulting from the fostering of confidence in the public, owing to reduced risk of breakdown and the promptitude with which an accidental interruption of service can be remedied. Dividing these various good points into two classes, according as they severally belong to capital or revenue economies, we may notice that Mr. FEDDEN'S Paper enumerates several merits in each class. Economy of capital results from the adoption of the steam turbine, partly on account of its compactness and small weight, and partly because of the absence of those reciprocating movements, which in any ordinary steam engine, involve the construction of costly foundations. Floor space and the cost of land are economised by the small size; building costs are cut down on account of the small weights to be carried on the beams and columns; auxiliary plant is economised, because of the compactness and simplicity of the station; and so on. Economy of revenue also is a consequence, not only from the saving in fuel, but also of lubrication, wages for attendance, cleaning and repairs, &c. In every important department, therefore, the adoption of the steam turbine in power stations, even for the largest units, is to be commended.

The question naturally arises: Why, if all this be true, are steam turbines not in more general use? It is difficult to give a wholly satisfactory answer to this question. There are but few distinctive types of steam turbine as yet on the market, and, of these, only the Parsons engine has been extensively adopted in this country. But even the number of Parsons engines in use is much below what might reasonably have been anticipated from the performance of this engine. It will be remembered by our readers that H.M. QUEEN VICTORIA was graciously pleased to extend the master patent for this engine, on the completion of the 14 years' period, on the usual grounds of exceptional merit and lack of adequate remuneration. Since that time the steam turbine certainly has been somewhat more *en evidence* than formerly, but even nowadays it is the exception rather than the rule to come across an engine of this type. Mr. FEDDEN'S explanation that all this is due to the "inherent conservatism to which British engineers are only too liable," may contain a germ of the truth, but it is very far from being the complete explanation. Doubtless, some of the apathy of British engineers towards steam turbines is due to lack of energy in bringing these engines before public notice. If the merits of the turbine were to be more prominently and more persistently brought before the notice of the public and the profession, we believe that this engine would frequently be adopted where at present its advantages are unknown. Be this as it may, the fact remains that the steam turbine is not used one-tenth as much as it deserves to be. Sooner or later it must have its deserts.

THE EFFECTS OF SELF-INDUCTION AND CAPACITY IN ELECTRIC TRANSMISSION.

BY G. H. BAILLIE.

The self-induction of a transmission line is a quantity rarely taken seriously by engineers in England; the capacity has received more attention, which has always taken the form of abuse. The neglect of the one and the abuse of the other are the outcome of existing conditions in England—namely, supply at a power-factor of unity or nearly unity. A line supplying an induction motor load with low power-factor works under very different conditions, and it is known that then self-induction may become a decided nuisance, and that capacity may present some redeeming features. As the various power distribution schemes will probably bring about an extended use of induction motors, it may be useful to consider to what extent self-induction and capacity should be taken into account in practical work. Their effects have been fully worked out in the case of some long overhead lines in America and Canada, but the original Papers are not always accessible, and generally give formulæ dealing with natural logarithms, electrostatic units and the square root of -1, which are far from inviting.

A collection of formulæ applicable to the different systems of transmission, and more in accordance with slide-rule requirements may prove of use.

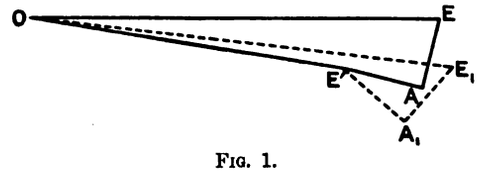

FIG. 1.

Self-induction.—The way in which the drop due to self-induction depends on the power-factor is clear from a diagram. If OE′ is the pressure at the end of the line, E′A the resistance drop, and AE the self-induction drop, at right angles to the current, then OE is the generator pressure. So long as the lag is small AE is nearly at right angles to OE′, and OE differs little from OA; but if the lag be large, as shown by dotted lines, the self-induction E.M.F. is more in line with OE′, and appreciably increases OE.

It is worth notice that self-induction diminishes the angle of lag between the pressures at the two ends of the line, and makes the power-factor at the generator end less than that at the receiver end.

Single-phase Line.—In Fig. 2 OA is the current C′ lagging behind the receiver pressure OE′ by an angle ϕ.

$E'B = 2RC'$ is the resistance drop.

$BE = 2pLC'$ is the self-induction drop, R and L being the resistance and self-induction per wire.

OE is then the generator pressure, and $E^2 = E'^2 + C'^2(4R^2 + 4p^2L^2) + 2E'C'\sqrt{4R^2 + 4p^2L^2}\cos(\phi - \theta)$, where $\theta = \tan^{-1}\frac{pL}{R}$.

This unwieldy expression can be much simplified. If there were no self-induction, E would be OB, or practically equal to

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OC in numerical value, E'C being the resistance drop due to the *effective* current C (or C' cos ϕ); with self-induction, E is practically equal to OD in numerical value, DC being the self-induction E.M.F., and equal to $2pLC'$ sin ϕ or $2pLC$ tan ϕ.

For practical purposes, therefore, the formula becomes $E = E' + 2RC + 2pLC \tan \phi$, the three terms being respectively receiver pressure, resistance drop, and self-induction drop. C is the effective current, or the component of current in step with the pressure. For practical cases the formula is correct to $\frac{1}{10}$ per cent

Three-phase Line.—The three wires are usually placed at the angles of an equi-lateral triangle, and then the magnetic field due to one wire will not affect that due to the other two. The fields due to these two differ in phase by 60deg., and their resultant is, therefore, $\sqrt{3}$ times the field due to each wire. The effect of self-induction in each wire is, therefore, $\frac{\sqrt{3}}{2}$ times that in each wire of a single-phase line.

To transmit the same power, the current in each wire is $1/\sqrt{3}$ times that in the single-phase, and, consequently, the

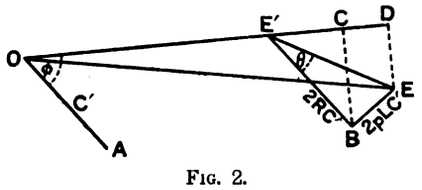

Fig. 2.

drop due to self-induction in a three-phase line is half that in a single-phase line. It is true that the wires will have half the section in the three-phase line, and therefore a higher self-induction, but the difference is only some 7 per cent. If the wires be arranged in a plane, the self-induction will be somewhat larger, owing to the influence of the third wire, but the increase is always negligible, and, as far as self-induction is concerned, it is immaterial how the wires are arranged.

Two-phase with Four Wires.—If AB and A'B' represent the wires of the two single-phase circuits, and the wires be arranged in the corners of a square as in Fig. 3, the field in the loop AB is the resultant of that due to all four wires. The combined effect of A'B' on the loop is a fixed amount equal to 0·00022 henrys per mile of circuit, at right angles to the main field. The resultant field in AB is in no practical case appreciably increased by the presence of A' and B'. Comparing with the single-phase system to transmit the same

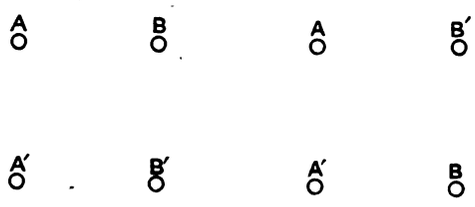

Fig. 3.

Fig. 4.

power the current in any wire is one-half, and the wires are half the section. The drop due to self-induction is then about 8 per cent. more than half that in the single-phase system. In the arrangement shown in Fig. 4 the drop in AB is increased by that due to 0·00022 henrys per mile of circuit, which, in the case of cables may be a large percentage of the whole self-induction drop. Fig. 3, therefore, shows the better arrangement. For the same reason, if arranged in a plane, the order A, B, A', B' is better than A, A', B, B', which again is better than A, A', B', B.

Two-phase with Three Wires.—In this, the field between either outer wire and the middle is due to the current in the outer, plus $\sqrt{2}$ times this current in the middle, combined at an angle of 45deg. The self-induction, therefore, must be taken as 2·24 times that due to each wire with the current in the outer wires, and its effect in this system is somewhat greater than that in the two-phase with four wires or the three-phase system.

Value of Self-induction.—The self-induction of two parallel wires in millihenrys per mile *per wire* is $0{\cdot}7416 \log_{10} 2a/d + 0{\cdot}08$, where a = distance between wires and d = their diameter.

Fig. 5 is a curve giving the henrys per mile for different ratios $2a/d$.

This is applicable to a single-phase or two-phase four-wire line. For a three-phase line, multiply by $\frac{\sqrt{3}}{2}$ or 0·866 to get the effective self-induction per mile of wire. For a two-phase, three-wire line multiply by 2·24 to get the effective self-induction per mile of each of the two circuits, considering the current in the outers.

The above formula also gives the self-induction of concentric cables, if a represents the radius of the outer conductor (vide W. H. Everett, *Electrical Review*, Vol. XLVII., p. 731). This, however, is negligible, except for high-tension cables, and then the effect of the self-induction is negligible.

The value of the drop of pressure due to self-induction is best expressed as a percentage of the resistance drop, for, as both are directly proportional to the current and to the length of line the percentage depends only on the size and distance apart of the wires.

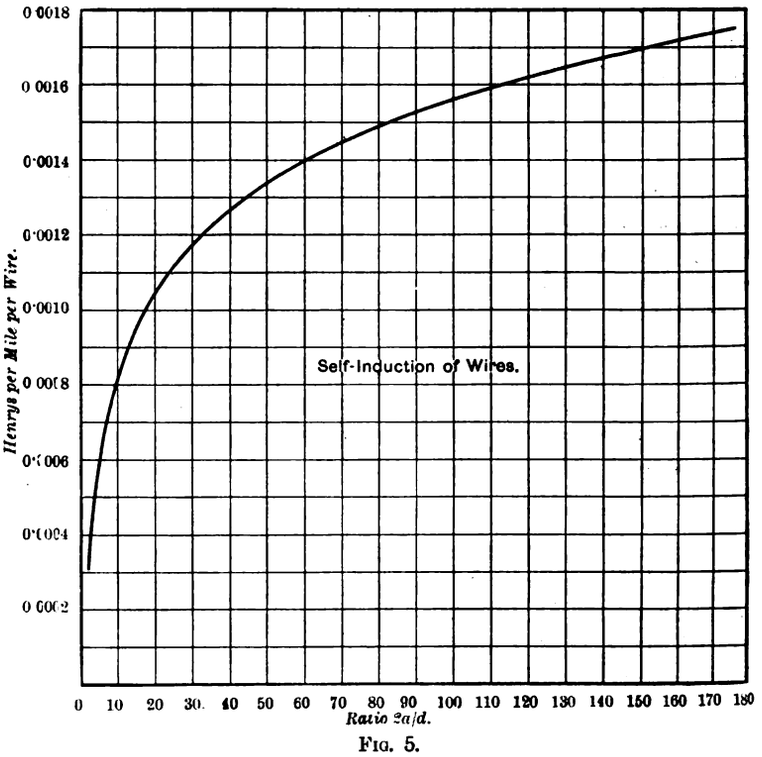

Fig. 5.

In a single-phase line, the percentage is $100 \frac{2CpL}{2CR} \tan \phi = 100 \frac{PL}{R} \tan \phi$, and in a three-phase line $100 \frac{\sqrt{3}CpL}{\sqrt{3}CR} \tan \phi = 100 \frac{PL}{R} \tan \phi$, and the percentage holds equally for a single-phase, three-phase and, of course, two-phase four-wire line. In a two-phase line with three wires the expression for the resistance drop with a low power-factor is so complex that the self-induction drop cannot be simply expressed in the same way. With a low power-factor the percentage may be more than twice that for single-phase.

The expression for the self-induction drop in per cent. of the resistance drop, may be written

$$0{\cdot}465 \frac{n}{R} \tan \phi \log \frac{2{\cdot}56a}{d}, \text{ or } 8{\cdot}5 \frac{d^2}{n} \cdot \tan \phi \cdot \log \frac{2{\cdot}56a}{d},$$

where R is the resistance per wire, n the frequency, and d the diameter in inches, and ϕ the angle of lag at the end of the line. (These and the following logarithms are all to the base 10.)

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The second expression is applicable only to solid wires; for stranded cables it gives a value slightly too high.

In Fig. 6 are curves showing the drop of pressure due to self-induction in per cent. of the resistance drop for overhead lines. The abscissæ represent distances apart of the wires. Three curves are given for conductors—0·6in., 0·36in. and 0·2in. diameter, representing, roughly, 37/14, 19/15 and 19/19 cables. The first and last may be taken as maximum and

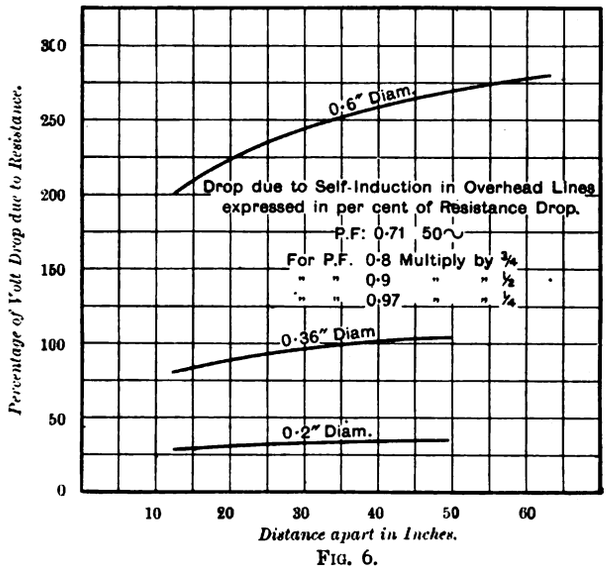

FIG. 6.

minimum sizes for overhead lines, while the 0·36in. is an average size, corresponding to No. 00 wire. The curves are calculated for a power-factor of 0·7 and a frequency of 50~. For power-factors of 0·8 and 0·9 (accurately 0·895) the values must be multiplied by ¾ and ½ respectively. The maximum drop likely to occur in overhead lines due to self-induction is about twice the resistance drop at 50~ and a power-factor of 0·7, and the minimum about one-third of it. In an average

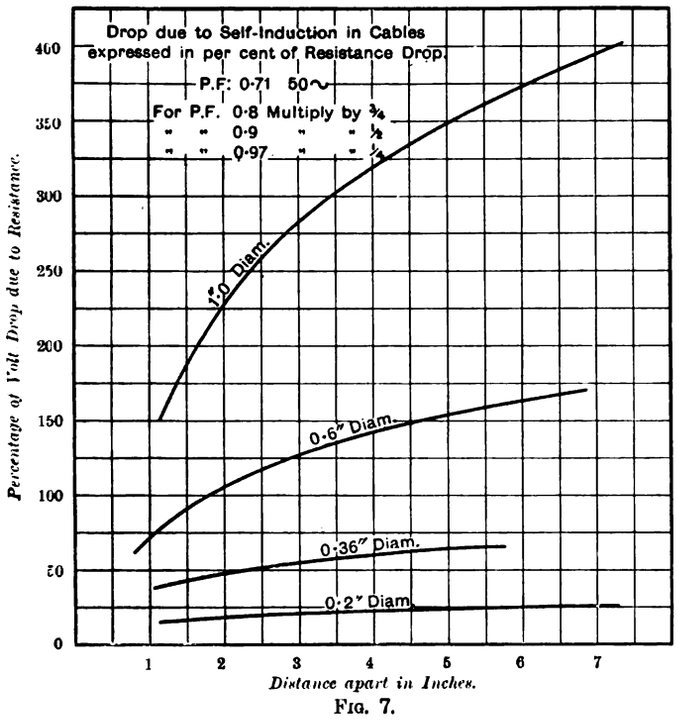

FIG. 7.

line the drop will be doubled by reason of its self-induction. It may be noticed that, although the self-induction itself diminishes as the size of conductor increases, the drop due to it, expressed as a percentage of the resistance drop, increases rapidly as the size. For this reason the self-induction drop in cables, often considered negligible, may be an important factor in the regulation of pressure. Fig. 7 gives the corresponding curves for cables of the same size, with the addition of a 1in. cable. In this the self-induction drop is very large; its minimum value, allowing ¼in. insulation between the cables, is 160 per cent. of the resistance drop, and in the case of single cables drawn into ducts it may amount to three times the resistance drop. With a 0·6in. cable (0·21 sq. in.) the minimum is about 70 per cent. of the resistance drop, and, run in ducts, the self-induction may more than double the drop.

On lighting circuits the effect of self-induction is negligible; in the secondary the power-factor is unity, and in the primary, though the excitation of the transformers can produce a large lag at low loads if no transformers be cut out of circuit, yet the high-tension mains are comparatively small, and so have a negligible self-induction drop. As an extreme case, may be cited one of the St. Petersburg lighting companies, where the power-factor of the primary is as low as 0·53 at low loads, but even then the presence of a self-induction drop would tend to assist regulation rather than hinder it. But on power circuits supplying induction motors the case is very different. A 100 H.P. induction motor, built by the General Electric Co, had a power-factor varying from 0·43 at quarter-load to 0·76 at full load, and though by use of a very small air-gap the full-load power-factor may be increased to 0·9, yet a power-factor of 0·7 is not too low an average to assume on a power circuit; the figures given above for the self-induction drop are then applicable, and show that both in overhead lines and in cables the self-induction calls for some attention. Of course, on power circuits good regulation is not so important as on lighting circuits, but this fact is generally discounted by allowing a larger drop in the line. Before leaving the subject of self-induction, it should, perhaps, be pointed out that the loss of pressure is not accompanied by a loss in power, for the reason that the power-factor increases along the line.

(To be concluded.)

AN IMPROVED FORM OF LABORATORY RESISTANCE FURNACE.

In our issue of May 30th we gave some details of a recent determination of the melting point of manganese, in a new form of electric resistance furnace constructed by Herr W. C. Heraeus, of Hanau, Germany. This furnace may, doubtless, prove of value to some of our readers, since by its aid tem-

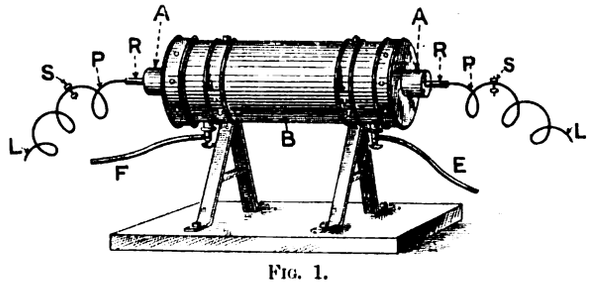

FIG. 1.

peratures ranging up to 1,500°C. can be attained with a control so perfect, that the successive increases in temperature need not exceed 5°C., if so desired; and we, therefore, abstract a recent article describing the furnace contributed by Herr W. C. Heraeus to the *Zeitschrift für Elektrochemie*.

The general external appearance of the furnace is shown in Fig. 1. It comprises: An inner heating tube of porcelain, R, around which is wound a spiral of thin platinum foil, the terminals of which are shown at E and F; an asbestos tube, A, enclosing the porcelain tube and its spiral; and a sheet-iron drum, B, filled with powdered glass or quartz in order to minimise losses by radiation.

The chief feature of the furnace is the platinum resistance spiral. In the original form of furnace this was constructed of wire, but it was found that only imperfect contact with the inner tube could be obtained, and that loss of heating effect and destruction of the spiral speedily occurred. The later furnaces are, therefore, constructed with spirals of very thin platinum foil. The contact between the spiral and tube

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with this thin foil can be made so intimate, that complete transference of the heat from the foil to the tube occurs when the current is passed through the apparatus. The foil used is only 0·007mm. thickness, and 4 to 5 grammes suffice to provide the heating spiral for a furnace having an inner tube 1in. in diameter and 15in. in length. The spiral is, of course, connected in circuit with a resistance box, and the temperature is regulated by increasing or diminishing the resistance in the external circuit. A Chatelier thermo-couple is employed to determine the temperature in the interior of the porcelain tube with this furnace, and, as in the case of the manganese melting point determination, the substance can be heated in any desired atmosphere. Another form of the resistance furnace suitable for heating crucibles is shown in Fig. 2. In this case the platinum spiral, the terminals of which are shown at SS, is wound upon a porcelain cylinder, R, slightly larger in internal diameter than the crucible which is to be

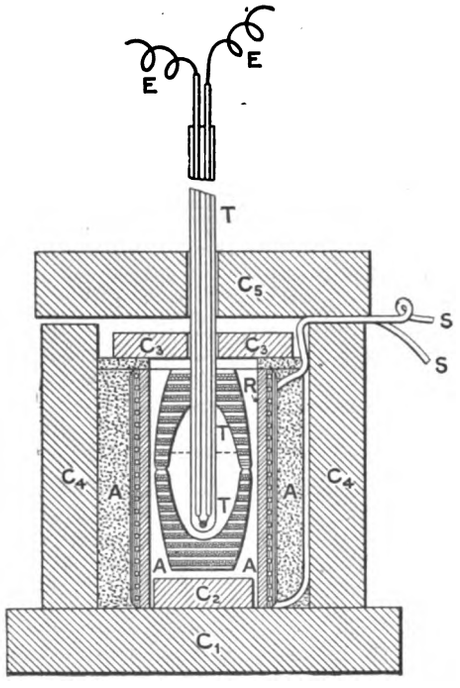

Fig. 2.

heated. The spiral is covered on the outer side with asbestos sheet, and the space A between this and the outer furnace walls, C_4, is filled with powdered quartz or glass. The thermo-couple used for determining the temperature in the interior of crucible is shown in position at T.

A MAGNETIC DETECTOR OF ELECTRIC WAVES, WHICH CAN BE EMPLOYED AS A RECEIVER FOR SPACE TELEGRAPHY.*

BY G. MARCONI, M I E.E.

The present note bears upon the special manner in which a core or rod of iron or steel placed in a varying magnetic field is affected by high-frequency oscillations transmitted from considerable distances. The magnetisation and demagnetisation of steel needles by the effect of electrical oscillations has long been known, and has been noted especially by Prof. J. Henry, Abria, Lord Rayleigh, and others. Mr. E. Rutherford also has described a magnetic detector of electric waves, based on the partial demagnetisation of a small core composed of fine steel needles, previously magnetised to saturation, and placed in a solenoid of fine copper wire connected to exposed plates. By means of a magnetometer Mr. Rutherford succeeded in tracing the effects of his electrical radiator up to a distance of ½ mile across Cambridge.†

The detector which I am about to describe is, in my opinion, based upon the decrease of magnetic hysteresis which takes place in iron when, under certain conditions, it is exposed to the effect of high-frequency or Hertzian waves. As employed by me up to the present, it has been constructed in the following manner:—On a core or rod consisting of thin iron wires are wound one or two layers of thin insulated copper wire. Over this winding insulating material is placed, and over this again, another longer winding of thin copper wire contained in a narrow bobbin. The ends of the winding nearest the iron core are connected to the plates or wires of the resonator, or, as is the usual practice in long-distance space telegraphy, to earth and to an elevated conductor; or they may be connected to the secondary of a suitable receiving transformer or intensifying coil, such as are now employed for syntonic wireless telegraphy. The ends of the other winding are connected to the terminals of a telephone or other suitable receiving instrument. Near the ends of the core, or in close proximity to it, is placed a magnet, preferably a horseshoe magnet, which by a clockwork arrangement, is so moved or revolved as to cause a slow and constant change, or successive reversals, in the magnetisation of the iron core. I have noticed that if electrical oscillations of suitable period be sent from a transmitter according to the now well-known methods, rapid changes are effected in the magnetisation of the iron wires, and these changes necessarily cause induced currents in the windings, which induced currents in their turn reproduce on the telephone with great clearness and distinctness the telegraphic signals which may be sent from the transmitting station. Should the magnet be taken away, or its movement stopped, the receiver ceases to be perceptibly affected by the electric waves, even when these are generated at very short distances from the radiator.

This detector has been successfully employed for some time in the reception of wireless telegraphic messages between St. Catherine's Point, Isle of Wight, and the North Haven, Poole, over a distance of 30 miles, and also between Poldhu, in Cornwall, and the North Haven over a distance of 152 miles, of which 109 are over sea and 43 over high land. It has also been ascertained that signals can be obtained over these distances with the new detector when employing less power at the transmitting station than is necessary if a reliable coherer be substituted for the magnetic detector. I have had occasion to notice, however, that the signals audible in the telephone are weakest when the poles of the rotating magnet have just passed the core and are increasing their distance from it, whilst they are strongest when the magnet poles are approaching the core.

Very good results have also been obtained by keeping the magnet fixed, and using an endless iron rope or core of thin wires revolving on pulleys (worked by a clockwork arrangement), which cause it to travel through the copper-wire windings, in proximity to a horseshoe magnet, or, preferably, two horseshoe magnets with their poles close to the windings, and with their poles of the same sign adjacent. In this case the copper-wire windings are separated from the iron by means of a stiff, thin pipe of insulating material in order to prevent chafing of the wires. With this arrangement the signals appear to be quite uniform in strength.

There appears to be a certain magnetic force which gives best results, but different qualities of iron require different values. There would also appear to be a particular speed of revolution for the magnets employed which is more suitable than any other. I have obtained good results when causing the magnets to revolve at the rate of one revolution every two seconds, or, when using a moving core, by causing it to travel at a speed of about 30cm. in four seconds. Either iron or steel can be used for the cores or revolving rope, but I have observed that by far the best effects are obtained when using hard-drawn iron wires or iron wire that has been considerably stretched or twisted beyond its limits of elasticity prior to its employment. I have used cores generally consisting of about 30 hard-drawn iron wires of approximately 0·5mm. in diameter, with a winding on them made up of a single layer of silk-covered copper wire 0·019cm. in diameter and of a total length of 2·4 metres. The other winding, connnected to the telephone, has consisted of similar wire, and I have been in the habit of employing a sufficient number of turns of it to give a resistance about equal to that of the telephone used.

It would, no doubt, be possible to obtain the signals by causing the iron core to act directly on a telephone diaphragm, and in this case the secondary winding on the core could be omitted. The length of the electric waves used in the experiments between St. Catherine's Point and North Haven was about 200 metres. If longer waves are employed it is desirable that the length of the winding nearest the iron should be increased.

This detector, as I have already stated, appears to be more sensitive and reliable than a coherer, nor does it require any of the adjustments or precautions which are necessary for the good working of the latter.

Further advantages in its use become apparent when it is employed in connection with my syntonic system of space telegraphy. According to this system, electrical syntony between the transmitter and receiver is dependent on the proper electrical resonance of the various circuits of transformers used in the receivers. With certain coherers one difficulty has been that it was not always possible to restore them by mechanical tapping to the same electrical resistance which they

* Paper read before the Royal Society, June 12th.

† See *Phil. Trans.*, A, Vol. CLXXXIX. (1897), pp. 1-24.

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possessed before being affected by the transmitted electric waves, the result being that the secondaries of the receiving transformers were at certain times open and at other times closed by a variable resistance, thus causing an appreciable variation in their natural period of electrical oscillation.

The magnetic detector which I have described possesses, on the other hand, a practically uniform and constant resistance much lower than that of a coherer in its sensitive condition, and, as it will work with a much lower E.M.F., the secondaries of the tuning transformers can be made to possess much less inductance, their period of oscillation being regulated by a condenser in circuit with them, which condenser may be much larger (in consequence of the smaller inductance of the circuit) than those used for the same period of oscillation in a coherer circuit, with the result that the receiving circuits can be tuned much more accurately to a particular radiator of fairly persistent electric waves.

The considerations which led me to the construction of the above-described detector are the following :—It is a well-known fact that after any change has taken place in the magnetic force acting on a piece of iron, some time elapses before the corresponding change in the magnetic state of the iron is complete. If the applied magnetic force be either subjected to a gradual increase followed by an equally gradual diminution, or caused to effect a cyclic variation, the corresponding induced magnetic variation in the iron will lag behind the changes in the applied force. To this tendency to lag behind Prof. Ewing has given the name of magnetic hysteresis. It has been shown also by Gerosa, Finzi and others that the effect of alternating currents or high-frequency electrical oscillations acting upon iron is to reduce considerably the effects of magnetic hysteresis, causing the metal to respond much more readily to any influence which tends to alter its magnetic condition. The effect of electrical oscillations probably, is to bring about a momentary release of the molecules of iron from the constraint (or viscosity) in which they are ordinarily held, diminishing their retentiveness, and, consequently, decreasing the lag in the magnetic variation taking place in the iron.

I therefore anticipated that the group of electrical waves emitted by each spark of a Hertzian radiator would, if caused to act upon a piece of iron which is being subjected at the same time to a slowly varying magnetic force, produce sudden variations in its magnetic hysteresis, which variations would produce others of a sudden or jerky nature in its magnetic condition. In other words, the magnetisation of the iron, instead of slowly following the variations of the magnetic force applied, would, at each spark of the transmitter, suddenly diminish its magnetic lag caused by hysteresis. These jerks in the magnetic condition of the iron would, I thought, cause induced currents in a coil of wire of strength sufficient to allow the signals transmitted to be detected intelligibly on a telephone, or, perhaps, even read on a galvanometer. The tests to which I have referred above confirm my belief that the magnetic detector can be substituted for the coherer for the purposes of long-distance space telegraphy.

THE EFFECT OF DAYLIGHT UPON THE PROPAGATION OF ELECTROMAGNETIC IMPULSES OVER LONG DISTANCES.*

BY G. MARCONI, M.I.E.E.

During some long-distance space telegraphy tests carried out towards the end of February last between a transmitting station situated at Poldhu, on the coast of Cornwall, and a receiving station on board the U.S. s.s. "Philadelphia" travelling from Southampton to New York, I had the opportunity of noticing, for the first time in my experience, considerable differences in the distances at which it was possible to detect the received oscillations during daylight, as compared with the distances at which the effects could be obtained at night.

Before describing the results obtained, it may be useful if I give a brief description of the nature of the apparatus used at the transmitting and receiving stations. The transmitter at Poldhu was similar in principle to that used by me in previous work,† but the elevated conductor at the transmitting station was much larger, and the potential to which it was charged at the peak of each electrical oscillation very much in excess of any that had been previously employed. The transmitting elevated conductor consisted of 50 almost vertical naked copper wires, suspended at the top by a horizontal wire stretched between two poles each 48 metres high and placed 60 metres apart. These wires were separated from each other by a space of about 1 metre at the top, and, after converging together, were all connected to the transmitting instruments at the bottom. The potential to which these conductors were charged during transmission was sufficient to cause sparking between the top of the said wires and an earthed conductor across a space of 30cm.

The general engineering arrangements of the electric-power station erected at Poldhu for creating the electric waves of the frequency which I desired to use, were made by Dr. J. A. Fleming, F.R.S., who also devised many of the details of the appliances for producing and controlling the electric oscillations. These, together with devices introduced by me and my special system of syntonisation of inductive circuits, have provided an electric wave generating plant more powerful than any hitherto constructed.

At the receiving station on the ship, one of my receivers, as described in the Society of Arts Paper above referred to, was employed, and the signals were recorded on the tape of a Morse recording instrument. A receiving transformer accurately tuned to the period of the electrical oscillations radiated from the transmitting station at Poldhu was connected to the coherer in the usual manner. The receiving elevated conductor was constituted of four almost vertical wires sustained in position by the ship's mast, the summit of which wires was about 60 metres above the sea level. At their lower end they were all connected to the receiving instrument.

My assistants at Poldhu had received instructions to send a succession of "S's" and a short message at a certain prearranged speed every 10 minutes, alternating with 5 minutes of rest, during the following hours :—From 12 to 1 a.m., from 6 to 7 a.m, from 12 to 1 p.m. and from 6 to 7 p.m., Greenwich mean time, every day from Feb. 23 to March 1 inclusive. On board the "Philadelphia," I did not notice any apparent difference between the signals received in the day and those received at night-time, until after the vessel had reached a distance of 500 statute miles from Poldhu. At distances of over 700 miles, however, the signals transmitted during the day failed entirely, while those sent at night remained quite strong up to 1,551 miles, and were even clearly decipherable up to a distance of 2,099 miles from Poldhu.

It is interesting to note that at the time of the year at which these experiments took place, daylight at Poldhu was rapidly increasing between the hours of 6 a.m. and 7 a.m., and on the "Philadelphia," I noticed that at distances of over 700 miles from the sending station, the signals at 6 a.m. were quite clear and distinct, whereas by 7 a.m. they had grown weak almost to total disappearance, their strength thus apparently diminishing in proportion as daylight increased at Poldhu. No such weakening of the signals was noticeable between the hours of 12 midnight and 1 a.m.

With a view to further tests in this same connection, I carried out other experiments between the station at Poldhu and a receiving station (in all respects similar to the one on the "Philadelphia") situated at the North Haven, Poole, Dorset. The distance between the North Haven and Poldhu is about 152 statute miles, of which 109 are over sea and 43 over high land. It was found that the signals from Poldhu could be perfectly well received at the North Haven during the night when four vertical wires 12·1 metres high were used in connection with the receiving instruments, whilst, all other conditions being the same, during the day the height of the wires required to be 18·5 metres in order to receive the same signals with equal clearness.

The cause of these observed differences in the effects obtained by night, as compared with those noticed by day, may be due to the diselectrification of the transmitting elevated conductor, operated by the influence of daylight. The electrical oscillations in the transmitting elevated conductor may thus be prevented by the discharging influence of light from acquiring so great an amplitude as they attain during darkness. The diselectrification of negatively-charged metallic bodies by light has been noticed by many observers,* and as each alternate half-oscillation in the transmitting elevated conductor must necessarily charge it negatively, the dissipating effect of light on each alternate oscillation of the electrical wave in the transmitting wire may be sufficient to cause a material decrease in the amplitude of the oscillations. Other tests were instituted with the object of ascertaining whether the illumination of the spark-gap of the transmitter had any effect upon the impulses transmitted, and accordingly the ball dischargers were enclosed in a box opaque to light. No perceptible difference, however, was noticed in the strength of the signals received, whether the spark-balls were or were not exposed to daylight.

It would be interesting to ascertain whether the same effects are to be observed when using transmitting elevated conductors covered with insulating material opaque to ordinary light. I have never noticed any appreciable difference in the distances over which signals are obtainable during the day and the night respectively in the course of all the other numerous experiments which I have carried out with installations not designed for very long distances, and in which the electrical power used at the sending station has been small compared with that used at the Poldhu installation. Probably the much higher potential to which the elevated conductor at Poldhu was charged may have greatly increased the facility with which losses might occur, due to diselectrification through the influence of daylight. I hope to be able to make a complete study of the effects described in this note in the course of further long-distance tests which are likely to be undertaken shortly.

* Paper read before the Royal Society, June 12th.

† See *Journal* of the Society of Arts, Vol. XXIX, pp. 506—517.

* See Papers by Messrs. Elster and Geitel in *Wiedemann's Annalen*, pp. 38—40, also p. 497; also remarks of Prof. Righi in *Comptes Rendus*, Vol. CVII., p. 559.

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STEAM TURBINES.*

BY S. E. FEDDEN.
(City Electrical Engineer, Sheffield.)

The technical details of the steam turbine have been very prominently placed before engineers lately, in numerous able Papers, that the author does not consider it necessary to go over this ground again. Suffice it to say that the construction of the steam turbine is simplicity itself, as it consists only of a hollow drum revolving in a stationary drum or cylinder, each with teeth or vanes attached, and so arranged that they clear each other. The two cylinders are steam packed, and, of course, the thrust guides require careful adjustment so that the veins do not clash. Of late years this turbine engine has been meeting with signal success, and many engineers are now considering whether it is not destined to revolutionise the means of obtaining power from steam both by land and by sea. The author suggests, however, that engineers and inventors should turn their attention towards bringing to perfection gas turbines now that cheap gas is available, and the ideal engine, combined with the most economical way of obtaining electrical energy from coal, may then result.

The fundamental principle attending all methods of electrical working is implied by the word "velocity," a requirement eminently possessed by the dynamo, motor and rotary converter, owing to the entire absence from these machines of reciprocating parts. This requirement, however, is not possessed by the prime mover—the modern reciprocating engine. Velocity was first obtained on the dynamo by means of belts or ropes, but this method of driving was soon discarded; it took up too much available floor space, and was an unsatisfactory and inefficient arrangement at the best. The attention, therefore, of the most prominent engineers in the world was directed towards increasing the speed of the engine, so as to adapt it for direct coupling to the high-speed dynamo or alternator. The efforts of these engineers were attended with very great success in Britain, and they were able, not only to couple their new high-speed engines to the dynamos, but they also obtained those qualities of economy and reliability of working claimed for the slow-speed engine with its belt drive, and the market now supplies high-speed engines of moderate sizes and of British manufacture, which are second to none in the world.

The demand for electrical energy for all purposes has, however, increased by leaps and bounds, and has thus called for larger generators and larger engines with heavy reciprocating parts; therefore, more strain and wear, bringing increased engine troubles. High-speed engines are now being built with pistons considerably over 2 tons weight. Such a piston will have to start and stop from 400 to 500 times per minute. When this enormous weight, making so many reversals per minute, is considered, it will not be difficult to imagine the steam-hammer effect obtained if the least thing goes wrong with the valve setting or the compression. On account of the increased engine troubles with high-speed engines, manufacturers are now falling back to moderate speeds, and many to slow speeds, although this is attendant with an increased cost of the plant.

Taking into consideration the large demands for electrical energy which must be made in the near future, it seems probable that the size of the generator and slow-speed engine will become unmanageable, also great difficulties will be experienced in shipping and erecting the same. The aim of all engineers should be simplicity, and the modern reciprocating engine, with its numerous complications, cannot by any means be considered the embodiment of this principle of simplicity. The great number of its moving parts, which require watching and adjustment, increases the cost of maintenance and attendance. Engineers who have had charge of power stations of from 6,000 H.P. to 10,000 H P. are fully aware of the laborious and never-ending work and watchfulness required to maintain their reciprocating engines in fair running order; the station calls, incident to the taking up of brasses, repairs and adjustments to valves, gland packing, cylinder lubrication, automatic governors, trip valve gears, and many other things, are items that go to build up the daily and nightly experience of the present-day station engineer.

Engineers laying down new plant have to consider the increased cost of building, the larger floor space required, the longer lengths of steam and exhaust piping, valve-opening gears, and heavy cranes for lifting, which are required in the case of large reciprocating engines, as against the requirements of a station laid out with steam turbines. The massive nature of foundations, the time required for delivery and erection of large plants, are items which often seriously delay the speedy completion of contracts. It was owing to these and similar reasons that the author's attention became directed towards the steam turbine offering a possible solution of the difficulty, and a short experience with generators of this type has since formulated his belief that progress in the generation of electrical energy lies in this direction.

The failure of the steam turbine to secure earlier appreciation was probably due in great measure to that inherent conservatism to which British engineers are only too liable. Two years ago the author had the opportunity of going through the country to inspect all the larger turbine installations, and the conclusions then arrived at were:—(1) It was inadvisable to put down a steam turbine to exhaust to atmosphere; (2) it was inadvisable to put down a steam turbine of a small size; (3) it would be policy to instal steam turbines from 200kw. to 300kw. and upwards either for alternating or continuous-current generation for lighting or power, provided there was a plentiful supply of cold water available for condensing purposes, and also provided that surface condensers were used, all the water being returned to the boilers.

From the year 1885 until 1890 nearly all the turbines manufactured were non-condensing and of comparatively small type. They were not economical—in fact, many engineers called them steam eaters; but great improvement, both in construction and design, has since been made in them, and this has lead to a very much smaller steam consumption, so that there is now on the market a steam turbine which, in the larger sizes, and in the matter of steam consumption, is capable of holding its own against any triple expansion engine yet produced. Even in the early days, when they were considered steam eaters, their smooth running and general adaptability to the driving of electrical machinery was the subject of much comment. The author, however, wishes to call the attention of the members to a few of the advantages which the adoption of the steam turbine, when running under ordinary conditions for working in a power station, has impressed upon his mind.

As many members are no doubt aware, a steam turbine of 500kw. capacity, 100 cycles single-phase, was brought from the Paris Exhibition into the Sheffield station about 18 months ago, and was running on the town load within three days of the time of its arrival at the station doors, and within about three weeks of the date of the order by telegram. It was simply dropped down on the station floor without any preparation in the way of foundations, and has since, over the period stated above, run more or less continuously, and during longer hours than any other plant in the station. It runs in parallel with alternators both of the iron and copper type, with engines of the triple and compound type, and can be brought up to speed to meet the demands of a sudden load much more quickly than any other of the neighbouring plants.

Boiler priming or wet steam simply causes momentary slackening of speed until the turbine clears itself of water. Other advantages are as follows:—(1) Absolutely steady nature of turning moment. (2) Entire absence of cylinder lubrication, which, therefore, allows of all the condensed steam being returned to the boilers. The saving in this one item alone materially assists in the reduction of station costs. (3) The time occupied in cleaning down is brought to a minimum, and is about one-sixth of that required with a reciprocating engine of similar capacity. (4) The entire absence of rubbing surfaces and packed glands within the steam chamber will permit of the use of superheated steam without fear or injury. The turbine specially lends itself to the use of superheat of a high temperature, and in this respect possesses a considerable advantage over a reciprocating engine. (5) Exceedingly small costs for attention and repairs and great reliability of working. These last items bring home to the engineer more forcibly than anything else the advantages of a purely rotary, as opposed to a reciprocating, motion.

When considering the laying down of a steam turbine plant, the main factors to be considered are:—

First.—Good vacuum in the condenser. This is even more necessary than with an ordinary engine as the makers claim that the turbo expands the steam right down to the vacuum of the condenser. The following table of actual tests taken on a 500kw. set illustrate how important it is to obtain a high vacuum:—

Consumption of 500kw. Turbo-alternators, Running at 2,500 revolutions with 140lb. Steam Pressure at the Stop Valve and no Superheat.

Vacuum constant from full load to no load.	Consumption per kilowatt-hour.			
Inches of mercury.	Full load.	Half load.	Quarter load.	No load.
29	...	...	...	1,500
28	22·2	25·6	32·4	1,700
27	23·1	26·9	34·5	1,900
26	24·0	28·2	36·6	2,100
25	25·1	29·7	39·0	2,300
24	26·2	31·2	41·2	2,500
23	27·5	32·9	44·8	2,700
22	28·9	34·7	46·3	2,900

Second.—Arrangements for high superheat, as tests show that with 50°F. of superheat, there is 8 per cent., and with 100°F., 12 per cent. economy in steam consumption. From the tests taken on the 1,250kw. steam turbine sets, which are now working satisfactorily at Elberfeld, in parallel with Sulzer engines, where the speed ratio is something like 16 to 1, it was shown that there was a gain of 12 per cent. with 55°C. superheat, and that every inch of vacuum improves the steam consumption by 4 per cent. It was

* Paper read before the Municipal Electrical Association, July 3rd.

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also shown that the steam consumption in the turbines, other things being equal, decreased constantly with increasing loads, whereas the Sulzer engines showed a less economy over three-quarter load.

The steam consumption in a turbine closely follows the right line law, or is proportional to the load added to a constant quantity which represents the consumption of steam at no-load.

The new 1,500kw. turbo-alternators which the author is installing at Sheffield power station will, with their own condensers, only occupy the space of 730ft. The foundations will be of the simplest description, and the general compactness of the sets and the ease of erection are expected to effect a considerable saving of time and money. The appearance of the station will be improved by the absence of ugly lengths of steam piping, or cylinders poised up in mid-air to obstruct the lighting of the building; and altogether the author hopes that there will be a general absence of that complexity of moving parts which, to the trained eye of a station engineer, offers so many possibilities of failure.

The author has been severely criticised for starting a large power house with steam turbines, but time may show whether this criticism is deserved. At present, however, he feels quite confident, after considering the problem from all points, that the steam turbine stands in a most favourable position, when compared with reciprocating engines of large powers, for the supply of electrical energy.

INVESTIGATIONS OF THE ELECTRIC DISCHARGE IN RAREFIED GASES.*

BY W. WIEN.

In my last Paper I showed that the magnetic deflection of the positively charged canal rays occurs, in contradistinction to the negatively charged cathode rays, in quite an irregular manner, even if pure gases are used for filling the tubes, and if the potential is constant. The following experiments were made to further clear up this peculiar behaviour.

The repetition of the magnetic and electrostatic deflection seem to offer difficulties even to observers† who are used to work with discharge tubes. I shall, therefore, describe in some detail the conditions which must be observed in order to obtain the effects described in an undisturbed manner. For the magnetic deflection it is necessary to employ an iron screen such as described by me, and to make sure of its efficiency, otherwise the magnetism so strongly affects the discharge that the magnetic deflection itself is completely masked. The tube with the iron cylinder must be made so strong as not to be crushed by the strong magnetic tensions acting upon the iron core. Further, the tube must be fastened in special holders, since otherwise the forces acting upon the iron core pull the tube into the magnetic field between the poles of the electromagnet. To fill the tube, pure hydrogen is specially suitable, since the canal rays are less absorbed in it, and, therefore, a more intense fluorescence is obtained on the glass for the same potential at the electrodes than when the tube is filled with air. As we shall see, the portion of the canal rays produced in pure hydrogen which can be deflected by a magnet is more intense than in the case of air. Even with a field of 500 C.G.S. units, the magnetic deflection is easily observed in hydrogen, while in air the fluorescence of the deflected portion is very weak. The observation of the electrostatic deflection has no difficulty in proper tubes. With the tube described in paragraph 3, a constant voltage of 250 suffices to produce a distinct electrostatic deflection.

In these observations a good earthing of the cathode is essential. If a spark-gap is introduced, or mercury vapour is used for filling, electric oscillations arise which produce changes in the potential of the cathode even when the earthing is good. This produces differences of potential even on the side of the tube where the canal rays emerge, and here also discharge effects are obtained which bring about a mixture of cathode rays and canal rays. To recognise the canal rays, it is not only necessary to observe their fluorescence on glass, since that is even not clearly to be distinguished from the fluorescence produced by cathode rays. The simplest means of separating them from any cathode rays that may be present is the magnetic deflection, which is of different orders of magnitude in the canal rays and the cathode rays. The former are not sensibly deflected by an ordinary horseshoe magnet, while the cathode rays are strongly deflected by it. Besides, the magnetic deflection is in the opposite direction in the case of the canal rays. Another means of recognising the canal rays is offered by the electrostatic deflection. The canal rays are attracted by the negative electrode. Finally, the positive electricity transported by the canal rays is another test.

Goldstein has put the question whether the spark-gap inserted in my arrangement might not possibly have influenced the magnetic deflection. This point is very simply disposed of by the fact that in these experiments on the magnetic deflection no spark-gap at all was introduced. Also, the opinion of Goldstein that the spark-gap should produce the negative rays emerging at the anode is contradicted by the fact that one always obtains magnetically-deflected negative electricity there, even when employing an influence machine, a high-tension machine, or a high-tension accumulator without a spark-gap. We shall see, later on, that already at a discharge potential of 30 volts, with an incandescent cathode, negative electricity emerges at the anode in a diffused manner. I now pass to the description of the various experiments.

1. *Experiments in an Extreme Vacuum.*—It is known from Hittorf's experiments that, with an extreme vacuum, the discharge no longer passes through the tube. This does not necessarily mean that the discharge cannot pass at all, but only that it does not suffice to completely take up the current furnished by the source of electricity. To determine how the negative and positive electricity is distributed, I have devoted the greatest care to the preparation of an extreme vacuum. The tube used is shown in Fig. 1. All the electrodes were aluminium; a and a' were aluminium discs 2cm. in diameter; b was a disc of aluminium, perforated and attached to the wall of the tube; c was an aluminium pencil. The greatest difficulty in the preparation of a very high vacuum is offered by the gases occluded in the metals. Long heating and subsequent transmission of strong discharges are the well-known methods for expelling the gases. But it was seen during the heating that the vacuum could not be driven to the limit of the capacity of the pump. I have heated a tube without interruption for four weeks up to 250deg., and yet perceptible gas bubbles were always formed in the course of a few hours. But, of course, it is just possible that some gas may have diffused through the heated platinum wires. In any case, the limit up to which heating the tube is any use is already obtained after 24 hours. After that the same amount of gas collects in the same time. But then, as soon as the discharge is put through, new quantities of gas again appear, and this process is only finished after several days. Then it is possible to obtain such a condition that the pump does not bring out any gas bubbles from the cold tube for several days.

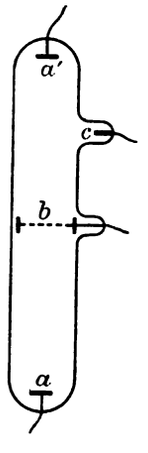

FIG. 1.

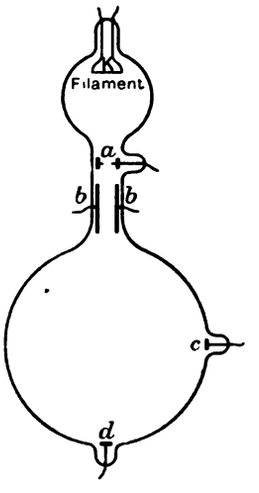

FIG. 2.

The tube above described, after having been brought to this condition, was melted off. It was then passed through the wall of a large zinc box, in which were the induction coil and the accumulators. The electrode b was joined to the wall of the box, and the latter was put to earth, while the electrode a was connected with a Dolezalek electrometer, having a sensitiveness of 40,000 volts per scale division. If, then, a' was brought to a high negative potential, a negative charge suddenly appeared at the electrometer when the discharged gap was 2·5cm., though not a trace of charge was obtained at a lower voltage. On further increasing the discharge, the charge obtained at the electrometer increased, so that with a discharge gap of 3cm. the electrometer went beyond the scale. At the same time there was no visible discharge in the tube. But if a' was brought to a high positive potential, no sign of positive electricity was seen even with a spark-gap of 10cm.

It follows from this that the canal rays are totally absent in the extreme vacuum, although cathode rays may yet be detected. It is not improbable that these are not derived from the remnant of gas but from the metal of the electrode.

According to the well-known experiments of Hittorf, a passage of electricity may be obtained even with a very small difference of potential and a very high vacuum, when the cathode is white hot. Now it is the question whether the current is transmitted when the vacuum is driven to the extreme limit. For these experiments I used three different tubes. In the first the glowing electrode was a

* Translated from *Annalen der Physik*, 8, 2, pp. 244-266, 1902.

† *Cf.* Goldstein, *Verh.*, Deutsch. Physikal, Gesellschaft, 3, p. 211, 1901.

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straight carbon filament of a Siemens glow lamp, brought to a white heat by a current of 15 amperes. To this was fixed a tube (Fig. 2) with a copper diaphragm *a*, provided with a slit 2mm. wide. The diaphragm was connected to earth. The side electrodes *b* were aluminium strips 5cm. long and 5mm. broad, and *c* and *d* were aluminium discs 1cm. in diameter. The tube was first exhausted, then heated for a length of time, and again exhausted to the extreme vacuum. Then the electrode K was joined to three insulated accumulators and an electroscope, and brought to a white heat. The electrometer then showed a positive charge of about 1,000 volts. At the same time it was seen that gas collected in the pump. On further pumping and glowing, the spontaneous charge disappeared more and more and finally became imperceptible. If, then, the glowing electrode was charged to a positive or negative potential of 10 volts, then about equal qualities of positive and negative electricity appeared on the electrodes *c* and *d* on the other side of the earthed diaphragm. If the glowing electrode was charged to 3,700 volts by means of a high-tension machine, a good deal of gas was developed, which was only slowly got rid of. A further quantity of gas was produced on connecting with an induction coil. But the tube was so empty that even with the cathode at a white heat the sparks constantly passed over a spark-gap 5cm. long, connected in parallel. In spite of the brilliant light of the glowing thread, the fluorescence produced by the cathode rays on the glass wall was distinctly visible, even when the carbon thread was a cathode.

Now, in order to protect the parts of the tube beyond the diaphragm from direct electrical actions, I used a second tube. In this case the glow lamp was contained in the zinc box above mentioned. It was cemented into a brass tube, A, with a double wall (Fig. 3). A diaphragm, *a*, was soldered into the interior of this brass tube. On the other side, the remaining portion, with the electrodes *b*, *c*, *d*, was cemented in. The projecting inner part of the tube A fitted exactly in a brass tube joined to the wall of the box. The space between

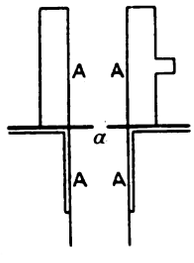

Fig. 3.

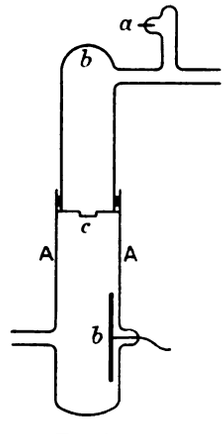

Fig. 4.

the double wall was filled with ether, so that no perceptible heating of the cement could be produced by the glowing of the carbon filament. In this manner the space containing the glow lamp was completely separated from the external space but for the small slit in the diaphragm. This tube showed exactly the same phenomena as the first. On glowing and electrifying the carbon filament at the same time, it gave off gas for weeks without showing any exhaustion. But the voltage up to which the filament had to be charged in order to produce electricity on the electrodes *d* and *c* was higher and higher. If the glowing filament had a negative charge, negative electricity appeared at *d* and *c*, and if positively charged, positive electricity appeared there. This quantity of electricity was always imperceptible below the limiting voltage, and suddenly acquired a high value. The maximum tension finally obtained was 800 volts in the case of a negative, and 3,000 volts in the case of positive electricity. The quantities of electricity reaching *c* and *d* were smaller when a horseshoe magnet was pushed over the tube. The magnetic influence was stronger in the case of negative electricity than in the case of positive, and there was also a considerable effect due to the tension of the glowing filament. At 70 volts, the transport of electricity to the electrodes *d* and *c* was completely stopped by the magnet, at 400 volts it still reached 30 per cent. When the electrode *b* is brought to a difference of potential of 40 volts, there is also a considerable diminution of the transport of electricity to *d*. But this diminution is less at higher tensions. But even after two months pumping I did not succeed in preventing the diffuse propagation of electricity, although the remnant of gas given up by the glowing electrode had become very small. The quantity of electricity reaching *c* or *d* was always pretty equal, and real measurements could, therefore, not be carried out. The third tube was similar to the second, except that the carbon filament was replaced by a platinum wire. The phenomena were essentially the same. The platinum wire also discharged gas continuously, until it had been entirely disintegrated.

According to these observations, the passage of a current through a tube with a glowing electrode does not differ from the ordinary passage of electricity; here also both electricities deviated from the path of the current proper. The quantitative difference is based upon the higher conductivity of the gases produced by the glowing electrodes, and specially upon the continual evolution of conducting gases from the glowing electrode.

To determine whether electricity issues under all circumstances from an electrode, whether it be an anode or a cathode, I made the following experiment. A tube (Fig. 4), to which a thinner tube with a side electrode *a* was fused, was provided with a metallic cap having an opening of 2mm. This opening was closed by a thin aluminium window which contained a very fine perforation, as I ascertained with the help of a lamp. After some trials I found a piece in which the perforation was so small that the pump could remove the air streaming in to such an extent that the cathode rays issuing from *c* showed green fluorescence at *b*. Now, if an electroscope was placed near the plate *c*, its leaves collapsed at once when a discharge passed through the tube, both when *c* was anode and when it was cathode, and independent of the exhaustion between the glow-light stage and the highest attainable vacuum. For these experiments I used a high-tension accumulator, a high-tension machine or an influence machine and induction coil. This means that influences issue from the perforation which impart a conductivity to the outer air, whether *c* is an anode or a cathode. If another tube, A, provided with an electrode *b* was fitted over the first tube, the new tube could be brought to any exhaustion by means of a second pump. When the tube A contained air of the ordinary density, no current could be discovered in a galvanometer connected with *b* and with the earth. With increased exhaustion I obtained a current which continually increased. A current of negative electricity arose when *c* was an anode and a current of positive electricity when *c* was a cathode. This happened even at slight discharge tensions, and, indeed, whenever a visible discharge passed through the tube.

2. *Fluorescence produced by Canal Rays.*—The fluorescence produced by canal rays upon the glass wall has repeatedly been described by Goldstein. In his last communication he draws special attention to the green fluorescence of the glass and a second fluorescence which does not originate in the glass, but in the gas itself, and which may sometimes appear in a different place and be distinguished by its colour. This separation he ascribes, after Helmholtz, to a refraction in the glass wall, and he ascribes the luminosity to glowing sodium vapour. With an ordinary gas filling I could only confirm the observations of Goldstein. I have observed the two fluorescence effects produced by the canal rays from the first, but did not pay special attention to them, as I observed great irregularities in these colourations which I could only partly eliminate lately. The colour described by Goldstein as blue and yellow often appeared to me as greenish-yellow, often again as brownish-yellow, or, again, salmon colour, while using the same glass for the tube. The green fluorescence of the glass was sometimes stronger and sometimes weaker, and occasionally seemed to be entirely absent. Now, I have found that these differences are caused by differences in the gaseous filling. On using perfectly pure hydrogen, ordinary air, pure oxygen, or mercury vapour, I obtained fluorescence effects on the same glass which differed much from each other on the first appearance, even when the material of the electrode and the discharge tension were the same. But it is necessary for these experiments to pay the greatest attention to the purity of the gas. Already in the well-known work of Wüllner on the spectra of pure gases, the difficulty of obtaining a perfectly pure gas in the tube made itself felt. It was then seen that all greased joints must be avoided, and that mercury vapour must also be excluded. In investigating the fluorescence colours produced by canal rays, a great sensitiveness to impurities also is noticed. Even when the spectrum of the gases is already perfectly pure, the fluorescence colours show changes which disappear on further increasing the purity of the gas. Under these circumstances the working with perfectly pure gas is an extraordinarily lengthy process. To get rid of the various gases included in the electrodes to such an extent that no impurities arise from them usually takes weeks. It appears, indeed, that a complete elimination of occluded gases from the electrodes is altogether impossible. One has to be content with purifying the electrodes to such an extent that, during a single observation, the discharge does not change the gas contained in the tube. I must here draw special attention to the fact that a diminution of the gaseous pressure during the discharge, as found in the so-called hardening of Röntgen tubes, is no proof that no gases diffuse out of the electrodes. On the contrary, a gradual change of the gas is produced, probably due to the fact that part of the gas is absorbed by the electrodes but another gas diffused out in its place. It is evident that an arrangement in which cement or greased joints are used is quite useless for such observations. Mercury vapour must also be got rid of. It is also impossible to fuse the tubes of the pump and then use them for observations, since the gas contained in them always degenerates after a little while.

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Now, in order to carry out the observations in different gases, I have used four tubes at the same time; three out of the four were as far as possible identical. The cathode was a perforated piece of aluminium foil, which completely closed off the tube, and the anode was a small disc of aluminium. At *a* strips of aluminium 5cm. long and 5mm. broad were fused in at a distance of 5mm., in order to observe the electrostatic deflection (as in Fig. 5). One of the tubes was connected with the apparatus for eliminating mercury vapour and producing electrolytic hydrogen, which I described in my last Paper, and also with a pump by means of a tube which could be closed by a barometer valve. The continuous current of hydrogen was made to flow through the tubes of the hydrogen apparatus for a fortnight preceding the experiment. The other tubes were directly fused to the pump. One of them could be closed by means of a barometer valve. It could be filled with air by breaking off the fused point of a long and very fine glass thread. A third tube contained a drop of mercury. A fourth tube, with a copper electrode, also served for observations on mercury vapour. The tubes having been freed from gas by several days' heating to 250deg., and passing the discharge for the same time, were all filled with air, and exhausted until a spark-gap connected in parallel showed a spark length of 1cm. The canal rays appearing in the tubes showed just the same fluorescence—a green and brownish-yellow colouration on the glass. The electrostatic deflection considerably displaced the green fluorescence at 800 volts, but only displaced the brownish-yellow fluorescence very little. At 250 volts the displacement of the green fluorescence was still distinctly visible, but not that of the brownish-yellow. The deflections were not uniform. The fluorescence is drawn out into a long band which gets more and more narrow, which means that the deflected rays are the more central and less diffuse.

When the first tube was exhausted to the utmost, and filled with pure hydrogen, the fluorescence at the same tension showed a different appearance. It was mainly green, but the undeflected portion was yellowish. The latter became more and more brownish after short use. On again exhausting the tube and filling it with fresh hydrogen, the fluorescence became more green again. But a few seconds of the discharge sufficed to bring out the brownish-yellow colour again. It was only after several weeks' treatment of a tube with pure hydrogen and discharges that I succeeded in imparting the green colour to the whole of the fluorescence produced by the canal rays. If, then, the hydrogen was pumped out and air admitted, the brownish-yellow colour appeared again. In the case of another tube, which, however, was not treated so long with hydrogen, there was always some yellow light remaining. The second tube, which was permanently filled with air, allowed of a direct comparison of the colours produced. If the third tube containing the drop of mercury vapour was freed from gases, exhausted and heated, it filled with mercury vapour, which then produced the gas discharge. It appeared that the canal rays then generated produced a fluorescence on the glass, in which no green light appeared at all, and nothing but a brownish-red fluorescence distinctly different from that produced by air. The electrostatic deflection was much less than in the case of air and hydrogen, and also non-uniform. In the case of mercury vapour it is, above all, necessary first to eliminate the gases by lengthy heating and discharging to such an extent that the discharge passes through pure mercury vapour. But it is difficult to obtain a regular discharge in which the cathode rays nearly proceed along the axes. I have been able to carry out these experiments with four different tubes, two with copper electrodes and two with aluminium electrodes, which all had the same result. In others I altogether failed to obtain a regular discharge in mercury vapour, but even in the useful tubes the regular discharges only lasted a short time, for mercury drops were precipitated upon the cathode, and evolved mercury vapour during the discharge, and this mercury vapour took over the conduction of the current in quite an irregular manner. On observing the tubes filled with hydrogen, air, and mercury vapour, side by side, the difference between the various tubes is very striking. To fill one tube with pure oxygen, I filled a small glass tube with powdered and dried crystals of potassium permanganate, and fused it to the system of tubes. The substance was freed from air by a lengthy heating and exhaustion, and was then made to produce oxygen by further heating. The canal rays developed in oxygen produced a brown fluorescence on the glass wall, in which no green light was to be seen, and which most closely resembled that produced in mercury vapour. Potassium glass free from sodium, which shows a blue fluorescence under cathode rays, also fluoresces with a feeble blue light under the canal rays generated in hydrogen, but not perceptibly under canal rays generated in oxygen. It would be premature to conclude from these observations that the canal rays produced in the various gases are very different. For in the first place the behaviour of canal rays in the various gases is very different, and in one, different canal rays may be absorbed from those absorbed in the other. In the second place, it is not impossible that chemical effects play some part in the fluorescence, and this would thus depend upon the chemical nature of the gas. These experiments require further extension and completion.

(*To be concluded.*)

APPLICATION OF SCIENCE TO THE ELECTRICAL INDUSTRY.

On Tuesday the report of a special sub-committee of the Technical Education Board on the application of science to industry was presented to the London County Council, and will be considered next week. The committee state that they were directed to inquire and report—

(*a*) As to the need and present provision for special training of an advanced kind in connection with the application of science (especially chemistry and electricity) to industry.

(*b*) As to what, if any, developments are needed to secure efficient training in these subjects for senior county scholars and other advanced students who desire to qualify themselves to take leading positions in scientific industries.

Amongst those whom the committee have consulted are Mr. J. W. Swan, F.R.S, Prof. J. A. Fleming, Sir H. Roscoe, Prof. J. Dewar, Dr. Merz (Newcastle-on-Tyne), Prof. W. E. Ayrton, and Mr. Alex. Siemens. As the result of their inquiries, the committee say they are unable to resist the conclusion that various branches of industry have, during the last 20 or 30 years, been lost to the country owing to the competition of foreign countries; that in many others our manufacturers had fallen seriously behind their foreign rivals; that London in particular has distinctly suffered, and that these losses are to be attributed in no small degree to the superior scientific education provided in foreign countries.

In support of these conclusions the committee cite the rapid development in the United States, Germany and Switzerland of various branches of manufacture of electrical machinery as compared with the relatively slow progress made in this country. In 1890 the imports of electrical appliances and scientific apparatus were too insignificant to be separately scheduled. In 1900 they amounted to £1,174,000 and £522,000 respectively. Dr. Merz, who has a very wide experience in connection with electric light and power companies in the North of England, informed the committee that although England was forging ahead in respect to the machinery required for continuous-current work, in alternating-current work, and for the three-phase and polyphase systems of working, Germany, Switzerland and America have now got hold of the trade. To-day dynamos are imported from America and motor-generators from Zurich. Prof. Ayrton told them that "if they want a piece of electrical machinery constructed according to a well-drawn-out specification English buyers give their orders to other countries. For dynamos manufacturers send to Germany, for magnet steel to France or Germany, for the materials for resistance coils to Germany, and for the paper used for insulating underground cables to America. Engineers regularly import manufactured articles from America, Germany and France, not merely because of the lower price, but because they are distinctly better than anything that can be obtained in this country irrespective of price. In fact, in many cases the article labelled 'Made in Germany' is really sought after by the buyer. The reason for going abroad for such materials as the above is that the English manufacturer has too little idea of the value and importance of minute attention to scientific details." Prof. Cormack says that "although British manufacturers may say that they were hampered and restricted by statutes, the fact remains that when the chances came in electric lighting and traction they were unprepared, and now they are not taking their proper share in the development of these industries. The prosperity of electrical engineering in America, Germany and Switzerland can be directly traced to scientifically trained leaders. It required scientifically trained men to develop polyphase-current machinery, and no one who examined the electrical machinery at the Paris Exhibition could fail to be struck with the rapidity of the progress which is being made all over the Continent."

Summing up all the evidence the committee are convinced that the main causes of the relative failure in the electrical and other industries are (*a*) the lack of scientific training of the manufacturers themselves and their consequent inability to recognise the importance of scientific assistance; (*b*) the defective condition of our secondary education and the consequent lack of sufficiently-prepared recruits for advanced technological training. The committee believe that the influence of the Technical Education Board on the character and efficiency of the science training in the London elementary schools has been in the right direction, but that further improvements in the character of the science teaching is needed, and that the Board should continue to press for increased efficiency in that department. They further urge that the highest grade of technical education should be carried on in the London University during the day, and suggest the improvement in equipment; but apart from the new undergraduate science teaching they are specially impressed by the need of more advanced training in the application of science to industrial processes, such training to be of the nature of post graduate work and specialist teaching. The greatest need of London at the present time is the co-ordination of the provision for the highest grade of education and the development of new departments. They feel, however, that the expenditure required to put London in a position to equip itself as well as Berlin, is altogether beyond the range of the sums with which the County Council has entrusted the Technical Education Board. They could do no more than report the need with all the emphasis that they could give to their words, in the hope that either out of private or public funds something may be done. Meanwhile they recommend that the Board should continue its present policy.

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CORRESPONDENCE.

ELECTRICAL TRAMWAYS AND OMNIBUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The value of your criticisms on my letter on the above subject, and the conclusions you arrive at, would probably have been considerably modified had you read my last year's address to Section G of the British Association, referred to in my letter, and which would have cleared up several of the points which you at present misunderstand. I therein said that: "Traffic carried on a roadway by vehicles, whether horse-drawn or by cycle or by motor car, differs from traffic carried on rails in that the former class of vehicles possess an important power—namely, that of overtaking—which is not possessed by the latter; that is to say, that a faster vehicle running on the plain road surface can overtake and pass a stopping or slower vehicle going in the same direction without disarranging or interfering with the other traffic; whereas on rails, vehicles going in one direction must always remain in the same relation to one another, so that their average speed must be regulated by that of the slowest vehicle going on the rails and in the same direction."

You call this want of overtaking power a bogey or imaginary defect, but I think that if you, or anyone else who wishes to study this matter, watches the working of the latest and most improved systems of electrical tramway, he will find that although the electrical cars are larger, can carry more passengers, and can run at more than double the speed of horse-drawn omnibuses, yet that on account of the delays caused by the want of overtaking power, the point-to-point speed of the vehicles on the tramways is in most cases no greater, and in many cases less, than that of horse-drawn omnibuses running on the plain road surface. It is this want of over-taking power which causes electric tramways to have such a much smaller carrying capacity than would seem to be theoretically possible.

I think, Sir, that you speak of the possibilities of the omnibus driven by electrical accumulators in a very discouraging way, but I believe this is because you have not watched the recent developments of this very important matter. If you will read the chairman's report of the E.P.S. Company, or would interview the managers of the Westminster or the St. James' Electric Lighting Companies, I think you would learn that a very great increase has taken place in the number of vehicles that are using accumulators as motive power, and that such commercial progress has been made during the last year that I am not over sanguine in believing that we shall soon see a great development in the use of electrically-propelled vehicles which do not require rails and which do possess this overtaking power. In my letter I stated that there were a considerable number of electrically-driven vehicles on the streets. I then referred to privately-owned cars and not specially to omnibuses; but if this development is a commercial success for private vehicles it surely will come into use for public ones. At any rate, large numbers of mechanically-propelled vehicles of all classes are now using our streets, and this number is certain to increase, and I contend that the travelling public as a whole will be better served by the development of such vehicles, which are able to run anywhere on our roadways, than by the indiscriminate laying of rails which has hitherto been considered the chief and only remedy for congestion of traffic. I think, if you would interview the surveyors of most of the West-End districts of London, you would find their views agree with mine on this important matter.—Yours, &c.,

R. E. CROMPTON.

London, W., July 15.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read your interesting and suggestive editorial notes concerning Col. Crompton's advocacy of motor omnibuses as against tramways, but in one particular it appears to me that you miss his point.

Surely, when referring to the greater "overtaking powers" of motor omnibuses, the Colonel was but showing that, as a counsel of perfection for dealing with street traffic congestion, the ideal system for public vehicles would rather be by a number of motors which could run in and out between other vehicles than by "trams" (running on rails) which are dependent on their course being clear.

Surely, too, where tramways are permitted in the middle of the public thoroughfare at the expense of the existing road space, the carrying capacity of our streets is not readily increased, and tramlines are certainly a source of inconvenience—indeed danger—to all other vehicles.

We shall all hail with delight the dismissal of the horse in connection with public vehicles—and the horse will not altogether regret it either, one may imagine—but whether in favour of improved motor busses or electric trams—preferably with their own separate road at one side of the public thoroughfare—is another question, which I hope you may be able to allow a free discussion of in your columns.—Yours, &c.,

London, S.W., July 17. CHARLES BRIGHT.

INDUCTION MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Kindly publish the following remarks in answer to Mr. A. Rothert's letter appearing in your issue of July 11th, in which he takes part in the discussion on the above subject:—

In view of the exclusively Continental experience put forward by Mr. Rothert, it is not surprising to find that he sides with Mr. Eborall on the main points, and it can only be regretted that he, in common with many of the Continental engineers, seems to be misinformed as to the development and use of polyphase machinery in the States when compared with the Continent. The writer, who has been connected for several years with both Continental and American manufacturing concerns as a designer of such apparatus, feels convinced that the principles outlined in his Paper represent the best practice, even in view of the unqualified preference which the Continent gives to the slip-ring motor. It must be admitted that the squirrel-cage motor, like the rotary converter, requires considerable discretion in its installation, otherwise it is liable to give trouble, which tends unjustly to prejudice the public opinion against it. This I found to be the case on the Continent, where, probably due to some faulty installations made in the early days of the art, both the squirrel-cage motor and the rotary converter are avoided in a great number of cases where they are most successfully used in the States.

In regard to the figures which Mr. Rothert advances for the proper slip in standard squirrel-cage motors—*i.e.*, 6 to 7 per cent. as against 4 to 5 per cent. used in my Paper—I consider this a matter of opinion. The continual loss of about 2 per cent. in efficiency stands against the saving of about 4 per cent. in starting current and the increase of from 15 to 20 per cent. in starting torque. In special cases this may be of advantage, but for a standard line I consider the lower figures preferable.

In regard to the efficiency of polar-wound motors when compared with squirrel-cage motors, I agree that theoretically the former, neglecting the slip-ring losses, should have as good or even a better efficiency than the latter, which has to start, say, under 30 per cent. of full load torque with not more than full load current. However, in actual practice, most of the standard slip-ring motors, even of the very best Continental make, show a poorer efficiency than the corresponding squirrel-cage motors, this result being due to the desire of every designer to obtain a motor which is cheap to manufacture. Such small rotor resistance as would be required to realise Mr. Rothert's claim for the efficiency, would mean a large copper section in the rotor, which either necessitates a larger diameter or a very small number of slots, both undesirable features. Furthermore, the large copper section brings a similar increase in the dead copper of the end connections, and, therefore, a motor will result which is very expensive to build.

The decrease of contact resistance and friction losses in the slip rings by means of a greater number of turns in the rotor further complicates the conditions due to the increased space required for insulation, but even with a great number of turns the losses in the slip rings remain appreciable, and it is for

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this reason that most of the Continental firms introduce short circuiting and brush-lifting devices.

In regard to the influence which a large squirrel-cage motor starting under full voltage exerts on the system, Mr. Rothert's figures, though somewhat ambiguous, only prove what the writer has given in his Paper—*i.e.*, that under such severe conditions a compensator must always be used, and that great care should be exercised in installing a suitable generator.

The last paragraph in Mr. Rothert's letter agrees with the writer's recommendation, and certainly leaves a good field for the squirrel-cage motor. If these ideas are widened on the strength of the good results obtained from many installations in the States with this type of motor, the points brought out in my Paper seem fully covered, and I hope that the development in English mining and mill work will offer an opportunity to prove that the Continental views in this direction are too conservative to be "the best engineering practice."—Yours, &c.,

H. S. MEYER.

Rugby, July 14.

DOUBLE-CURRENT GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the leading article on the above in your current issue you remark:—"Had these machines been thought of 10 or 15 years ago the uneconomical employment of the single-phase system of distribution would never have obtained the foothold which it has acquired." May I remind you that double-current generators constituted one of the features of Messrs. Schuckert's exhibit at the 1891 Frankfort Exhibition, and that in a series of articles contributed to the *Electrical Review* at the time I briefly described them as follows:—

Messrs. Schuckert show . . . . some motor dynamos for multiple currents of rather peculiar construction. These latter are the direct-current flat-ring machines of Schuckert, just as they have been described and illustrated, but with the addition of insulated contact rings mounted concentrically on the shaft, from which alternating currents may be also collected. On the particular six-pole machine examined there were two pairs of such rings, with collecting brushes to correspond. Wires from one pair were led to two opposite points of the armature winding, while from the second pair were led wires to two other points, also opposite, but at right angles to the first two. On driving such a machine we get from the ordinary commutator a direct current, and from the contact rings two alternating currents differing in phase by 90deg. Obviously the machine may be used in a variety of ways. We may drive it as a dynamo and take from it a direct or alternating current, or both; we may take from it a direct or two alternating currents, or both. We may drive it as a motor by direct current and use part of the energy mechanically by belting something to the pulley, while taking the balance out in one or two alternating currents. Or we can drive it as a double-phase motor by two alternating currents, taking from it mechanical power or direct currents. It is, in fact, rather a striking appliance, seeing that only one armature is used. . . . . In these machines the commutator segments are insulated by cardboard and the segments are cross connected, so that the number of pairs of brushes used is optional.

It will be seen from the above that not only was the double-current generator *thought of* 10 years ago, but it was actually made and working. Moreover, it was in the hands of one of the largest and most influential Continental firms, and without discussing at the moment whether the single phase system is or is not uneconomical, I suggest that its rapid development during a certain period within the last 15 years was due, not to any lack of knowledge as to the capabilities of double-current generators, but to the impossibility of getting, at the time, reliable incandescence lamps to work at a higher pressure than 100 or 110 volts.—Yours, &c.,

London, July 11. W. B. ESSON.

New Crucible Furnace.—An electric-resistance magnesia crucible furnace for laboratories was recently described by Mr. H. M. Howe in a Paper read before the American Institute of Mining Engineers. This furnace is employed by the author for the determination of the cooling curves of steel and the determination of melting points. The furnace itself consists of two semi-cylinders of magnesia with a cover and cone-shaped stopper of the same material, the stopper being perforated to admit the leads of a thermo-electric couple. The interior of the furnace is designed with a spiral groove fitted with a coil of platinum wire, through which a current of any desired strength is passed, and by means of which the crucible is heated.

PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

A number of the tube railway bills which have already passed the Committee and third reading stages of the House of Lords came up for second reading in the House of Commons on Wednesday.

Mr. HAY moved the rejection of the **Baker Street and Waterloo Railway Bill**, in which an extension of time by two years for the completion of the line was asked. He drew attention to the close alliance of Mr. Yerkes, who now controlled this railway, with the District Railway Co., and thought it extremely probable that it would be simply used to divert traffic from its natural course to the District Railway. To carry out the intentions of Parliament, the line should be joined to a great through route; at present it would serve not London, but the District Railway.

Mr. T. COURTENAY WARNER seconded the motion, but on a division the second reading was agreed to by a majority of 164.

Mr. HAY next moved the rejection of the **Brompton and Piccadilly Circus Railway (New Lines, &c.) Bill**, on the ground that it served to take away the cream of the traffic without in any way relieving the congestion. It was another bill to serve the interests of the District Railway Co.

Mr. MELLOR protested against these details being gone into, which was the work of a committee.

The bill was eventually read a second time without a division.

Sir J. DICKSON POYNDER desired to move an instruction to the Committee to insert as far as practicable in the bill provisions to carry out the recommendations as to workmen's trains and fares contained in the report of the Joint Committee of Session, 1901, on underground railways and to deal with railways promoted by different companies, but forming continuous through routes, as one railway for these purposes.

The SPEAKER ruled that the instruction would not be in order unless it were made to terminate with the words "underground railways."

The instruction was not pressed.

On the order for the second reading of the **Charing Cross, Euston and Hampstead Railway** (Nos. 1, 2 and 3) **Bills**,

Mr. HAY said he had a motion in respect of two of these bills similar to that which he had had in connection with the two previous bills, but, on a question from the Speaker, said he would not move it.

The three bills were accordingly read a second time.

Mr. HAY again had a motion down for the rejection of the **Great Northern and Strand Railway Bill**. This line, he said, was ostensibly designed to give facilities for the population served by the Great Northern Railway Co. There was no proper intercommunication between the two, and no guarantee that workmen's tickets would be issued at through fares.

Sir J. DICKSON POYNDER, speaking on the question of workmen's fares, said he hoped the House would agree to an instruction to the Committee which would consider this bill similar to the one he had proposed in respect of the Brompton and Piccadilly Bill. He also hoped that there would be joint consideration of all these bills, and that they would not be sent to different committees.

Mr. Warner, Mr. Bousfield and Mr. Burns concurred in this view.

Mr. R. W. PERKS said the promoters of this bill would not have the slightest objection to this instruction being passed.

The bill was then read a second time, and the following instruction to the Committee agreed to:—"That it be an instruction to the Committee to insert, so far as practicable, in the bill, provisions to carry out the recommendations as to workmen's trains and fares contained in the report of the Joint Committee of Session 1901 on Underground Railways."

Mr. BANBURY moved that the **London United Electric Railways Bill** be read a second time that day three months, because he believed it to be wrong in principle. This bill, together with the Piccadilly, City and North-East London Railway Bill made practically one undertaking, and only about 4 miles of the whole scheme—viz., Marble Arch to Clapham Junction—were not in competition with existing railways. Both from the point of view of annoyance to frontages by vibration and unfair competition with the District Company, he contended the bill should be rejected. This system of competition was wrong, as no necessity for the lines had been shown, and if they were constructed the only result would be a great loss of money to the people of this country without any benefit to the public.

Mr. BUTCHER thought it would be a disastrous thing for the travelling public if the principle laid down in the previous speech—*i.e.*, there should not be two competing modes of locomotion along the same route—was affirmed.

Mr. BULL supported this contention, and spoke of the laxity of the District Company in providing an efficient and cheap service from Hammersmith to the City.

Mr. JOHN BURNS thought Parliament ought to wait until the electrification of the District Company's system had been completed. If wise, it would impose upon the Metropolitan and District Companies, as well as the Central London Railway Co., that they should unify their schemes and give London a co-ordinated system, using existing railways as a nucleus, and not introducing an additional competitor. What would happen if Messrs. Yerkes, Morgan and the Central London Company made up their differences, and amalgamated and took all these lines into their hands? He regarded the scheme from every point of view as likely to lead to a wasteful and extravagant competition.

The Hon. W. PEEL thought the last speech seemed to be based upon a prejudice to American capitalists. Considering what British capitalists had done in other countries, he thought we ought to be the last to hold that idea.

Mr. ASHTON, one of the members of the Joint Committee in 1901, hoped the second reading would be passed.

Lord A. COMPTON took Mr. Burns' view of the question of competition.

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Sir L. McIVER drew attention to the danger the House was in of being led away from its legitimate functions and trespassing upon the ground of its own Committees.

Mr. D. MORGAN, the member for Walthamstow, having supported the bill, the House divided, and the figures were, for the second reading, 250; against, 69. Majority, 181.

The following motion by the Hon. W. PEEL was agreed to: "That it be an instruction to the Committee to take security from the undertakers for the completion of the whole scheme of railways comprised in the bill either by making the rights of the undertakers conditional upon the due performance of their whole undertaking or otherwise as the Committee might think fit." He said he wished to secure that the whole line should be built.

The Piccadilly, City and North-East London Railway Bill was also read a second time, and the above instruction was also to apply.

Finally, the **North-West London Railway Bill** was read a second time without comment.

LONDON TUBE RAILWAYS COMMITTEES.

Yesterday (Thursday) the Committee of the House of Commons on railway and canal bills appointed the 24th inst. for the first meeting of the two Select Committees of the House which are to consider the London tube railway bills. Sir Lewis McIver will preside over the Committee which will deal with the Great Northern and Strand Railway Bill, the Brompton and Piccadilly Circus Railway (New Lines, &c.) Bill, the London United Electric Railways Bill and the Piccadilly-City, and North-East London Railway Bill. The second Committee, of which the chairman has not yet been appointed, has referred to it the Great Northern and City Railway Bill, the Baker-street and Waterloo Railway Bill, the North-West London Railway Bill, the Charing Cross, Euston and Hampstead Railway (No. 1 and No. 3) Bill, and the Charing Cross, Euston and Hampstead (No. 2) Bill.

MEXBOROUGH AND SWINTON TRAMWAYS.

On Tuesday last Mr. Ashton's Committee of the House of Commons had under consideration the Mexborough and Swinton Tramways Bill.

Mr. WEDDERBURN, K.C., for the promoters, said this was a bill for construction of tramways in the urban districts of Mexborough, Swinton and Rawmarsh. The tramways were to be constructed by a company, who had found it necessary to make certain bargains between themselves and the three urban district councils mentioned. In the House of Lords Earl Fitzwilliam, who objected to the proposal to construct a refuse destructor on part of the land they sought to purchase from him, obtained a clause for his protection. Counsel supposed they would learn what his lordship now objected to when they reached the clauses.

Mr. G. B. WAUGH, one of the engineers to the scheme, gave formal proof of the preamble. There was no engineering difficulty in the scheme, and the tramways could be constructed for the amount of the estimates —namely, £50,000—which would not include the cost of bridge widenings.

By Mr. REES: It was proposed to erect a destructor to deal with the night soil, refuse, dust, &c., of the whole district; but its position was not yet decided upon. A clause had been put in for the protection of the Rawmarsh District Council in connection with this proposal, and he had no objection to similar protection being given to Swinton.

Mr. WEDDERBURN said he should not object to that.

The CHAIRMAN: Then we declare the preamble proved, subject to the clauses being satisfactory.

The clauses were then gone through.

Mr. WEDDERBURN said the company had previously agreed that they would not use the land belonging to Earl Fitzwilliam which they proposed to take, for the purpose of a refuse destructor, without his consent, and exception was now being taken to a clause which would simply enable them to erect a destructor in connection with their generating station on land with which Earl Fitzwilliam had no concern.

Mr. HANS HAMILTON said he wished to prevent anything that had passed hitherto being construed into assent on Earl's Fitzwilliam's part, and this was why he stipulated that consent in writing should be obtained "hereafter."

Ultimately the amendment suggested was adopted, and the other clauses having been adjusted, the bill was ordered to be reported to the House.

OTHER ELECTRICAL BILLS.

On Tuesday the Chairman of Committees of the House of Lords considered the Metropolitan Railway Bill as an unopposed measure, and it was ordered to be reported for third reading. It has already passed the House of Commons (see *The Electrician*, June 27, p. 396).

On the same day the Croydon and District Electric Tramways Bill was under consideration. The consent of all the road authorities having been obtained, there was no opposition, and formal evidence being given in proof of the preamble, the bill was ordered to be reported to the House for third reading. This bill, also, has passed the House of Commons (see *The Electrician*, May 16, p. 144).

All opposition to the Edgware and Hampstead Railway Bill has now been withdrawn, and it will, therefore, proceed through the remaining stages of the House of Commons as an unopposed measure. The proceedings before the House of Lords Committee were reported in *The Electrician* for May 9, p. 110.

In the House of Commons on Tuesday a bill, introduced by Mr. Tennant, to amend the law relating to the provisions for escape from fire in factories and workshops was read a first time.

In the House of Lords on Friday last week, the Southport and Lytham Tramroad and the Salford Corporation Bills were read a third time and passed.

The Norwich Corporation (Electricity, &c.) Bill was read a third time and passed in the House of Lords on Monday, as also was the North Metropolitan Electric Power Supply Bill on Tuesday.

TELEGRAPHIC COMMUNICATION WITH THE NORTH.

The CHANCELLOR OF THE EXCHEQUER, replying to Sir J. Leng in the House of Commons on Wednesday, said that a considerable sum was provided in this year's estimates for the extension of underground telegraph wires to the North, and he did not think it could be increased on account of the termination of the war in South Africa.

LEGAL INTELLIGENCE.

Attorney-General v. Bournemouth Corporation.

This case came before the Court of Appeal, composed of Lords Justices Vaughan Williams, Romer and Stirling, on Tuesday, on plaintiff's appeal from the judgment of Mr. Justice Swinfen Eady. The action (reported in our issue for June 20) was brought by the Attorney-General at the relation of the Poole and District Electric Traction Co., and by that company as co-plaintiffs for an injunction to restrain defendants from constructing a certain tramway on the ground that the statutory proviso of the defendant Corporation had determined. The circumstances under which the original action was brought were given in our report of the proceedings on that occasion.

Mr. WARMINGTON, K.C., for the appellants, contended that what the defendants had done did not comply with the requirements of their provisional order. They had obtained tenders for the construction of plant, and had entered into certain contracts for machinery and cars, but there had been no actual construction of works. He submitted that the learned judge in the Court below was wrong in holding that anything the defendants had done amounted to a substantial commencement of the works.

Mr. VERNON SMITH, K.C., for the respondents, said that this was not a ratepayers' action, but really an action between two rival tramway companies. The Corporation had power up to August of this year to complete their line, and at the end of that time the Poole and District Company would have power to step in.

Lord Justice VAUGHAN WILLIAMS asked if any application had been made by the Bournemouth Corporation to the Board of Trade for an extension of time.

Mr. VERNON SMITH said that while their action was pending an application was made, and the Board of Trade had agreed to extend the time for completion of all the tramways with the exception of the one which was now chiefly concerned. As litigation was pending with regard to this section nothing was said. The action, however, related really to all the Corporation tramways, so that if this action was successful all their tramways must go. The Corporation could not do the work themselves, but they had given instructions that it should be done.

Lord Justice ROMER said that a person who was ordered to do work did not comply with that order by simply telling his servants to do it.

Mr. VERNON SMITH said that if he was not in a position to do the work, and he ordered someone else to do it, it showed, at all events, an intention to comply with the order. He should submit that in the present case there had been a substantial commencement of work, and that Mr. Justice Swinfen Eady had arrived at a right conclusion in dismissing the action.

Mr. PARKER having replied for the appellants.

Lord Justice VAUGHAN WILLIAMS gave judgment, and said he was of opinion that the appeal ought to be allowed. The point they had to consider was one of importance, but it did not seem to him that it raised any very great difficulty. They were asked to say whether what had been done by the Corporation in connection with their tramway service up to the time fixed by the provisional order for the commencement of the works did or did not, in fact, amount to such commencement of the works. A good deal had been said on behalf of the respondents in support of the contention that substantial progress had been made, but he was unable to arrive at any such conclusion. He was of opinion that when the time fixed by the order had expired, nothing which would save the rights of the Corporation had been done, and that, therefore, their powers under the order ceased. There had been no prolongation of the time fixed for the commencement of the works. True, an application had been made to the Board of Trade for an extension of the time for completion, but that was quite another matter, and such an application was based upon the hypothesis that the time for commencement had been observed. If Mr. Justice Swinfen Eady's decision could not be supported, it seemed to them that the order of the Board of Trade extending the time for completion would go for nothing, because that order did not in any way affect the non-commencement within the time specified. Under the circumstances, he saw nothing for it but to reverse the decision of the Court below, upon the ground that it was plain upon the evidence that there had been no substantial commencement within the time mentioned. He would have been very glad if there was a way in which this could be put right by the Board of Trade, for the Bournemouth Corporation were in the position of knowing what were the wants of Bournemouth, and he was afraid, also, they had spent a considerable sum of money, and rendered themselves liable to pay a considerable sum of money, in respect of the contracts they had entered into. Under the circumstances, one would be glad to afford the Corpora-

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tion an opportunity to get the Board of Trade to do something to obviate this unfortunate result, though, at the same time, he did not see what could be done. The appeal must be allowed and the order for an injunction would have to go.

Lords Justices Romer and Stirling agreed, and the appeal was allowed with costs

British Pioneer Electric Light and Power Co of India (Ltd.) v. Bigham.

This case came before Mr. Justice Byrne on July 10. Plaintiffs (represented by Mr. Levitt, K.C.) sought a declaration that defendant was a trustee for them of a certain commission, the object of which was to convert to electric traction the tramways of Bombay. Plaintiffs also sought to restrain defendant from revoking an irrevocable power he gave to them in respect of this concession, plaintiffs' case being that the concession was obtained by defendant as their agent. There was a counter action arising on the construction of the agreement under which the defendant became the plaintiffs' servant. The first point was whether, as part of his remuneration for the service of obtaining the concession for the company, defendant was entitled to subscribe for 200 shares in the company. The concession having been obtained, had practically been re-sold at a large profit, and the shares of the company were worth seven or eight times their nominal value. The agreement between the parties was really made by telegram.

Mr. NORTON, K.C., for defendant, said he did not say his client was not trustee of the concession for the plaintiffs; he obtained the concession for them, but he contended he was not bound to give plaintiffs a power of attorney.

Mr. LEVITT then explained the circumstances under which plaintiffs secured the concession.

In the result his LORDSHIP held that defendant was entitled to £400 from plaintiffs, subject to an account showing what was due, and the 200 shares in the company, and the expenses properly incurred as agent for the plaintiffs (not being his personal and travelling expenses) for obtaining the concession. His lordship made a declaration that the defendant was the trustee for the plaintiffs, and the defendant not to have the right to apply for further shares. His lordship granted a limited injunction restraining defendant from interfering with the disposal or carrying out of the concession, except as trustee and agent for the plaintiffs. His lordship said that the defendant had no right to superintend or claim to superintend the carrying out of the Bombay contract. He directed that there should be no costs on either side.

Manchester Carriage and Tramways Co. v. Manchester Corporation.

Mr. Justice Bigham, in the King's Bench Division, yesterday, heard an action concerning the taking over of plaintiffs' tramways by defendants.

Mr. FLETCHER MOULTON, K.C., said he was moving to enforce an award.

Mr. BALFOUR BROWNE, K.C., said that was not so, and contended that he should open the case. This was a special case sent to the Court by the arbitrator, and if it stood his clients would have to pay about £500,000.

Mr. MOULTON pointed out that the arbitrator had adopted their contention, and the award was in an alternative form, and could not be enforced without the decision of the Court.

His LORDSHIP decided that plaintiffs had the right to commence. It seemed to him that the point was a short one. Plaintiffs, as lessees of certain tramways, were obliged to build certain depôts and make certain conveniences for the working of the tramways. Plaintiffs were also owners of other tramways worked in conjunction with the tramways which they leased from defendants. The lease had fallen in, so that defendants had entered into possession of their tramways, and they now, under statutory powers, called upon plaintiffs to sell on the terms of the statute the lines which plaintiffs had themselves constructed. The question was whether in the purchase price ought to be included the depôts and other places built by the plaintiffs, and which they had used not only for the purposes of the line, but also for the purposes of the leased lines which plaintiffs' themselves constructed. The question was whether the word "all" used in the act comprised all or only part. He asked, What is the difference in the two amounts?

Mr. MOULTON: In one case £250,000, and in the other £500,000; but a large amount of property went with the half a million which did not go with the quarter-million. The arbitrator found it was necessary for the practical working of the lines that they should be worked as a continuous system. The finding of the arbitrator (Sir F. Bramwell) was a finding of fact in favour of plaintiffs, and that it was essential for the well-doing of the lines as a business undertaking that they should be worked as one system and under common management. The sole reason why defendants did not want to take over the whole concern was that they wished to work the system with electric power.

His LORDSHIP said he thought the whole point was whether "suitable to and used by" plaintiffs for the purposes of their undertaking meant "suitable to and used by" them for the exclusive purposes of their tramways.

Mr. MOULTON contended that defendants had no right to take only certain portions of the system.

Mr. BALFOUR BROWNE, (for defendants) said this was not a mere assertion between one purchasing authority and the tramway company, but between 12 purchasing authorities, who had all separate rights. It was not a joint purchase, according to the Tramways Act, but the periods fell in at different times.

His LORDSHIP asked if Mr. Balfour Browne contended that the logical consequence of Mr. Moulton's argument was that if Openshaw, one of the 12 purchasing authorities, served notice upon the tramway company, saying they intended to take over the lines in their district, the tramway company could answer that they must take all the lines?

Mr. BALFOUR BROWNE: Absolutely.

His LORDSHIP: And that Mr. Moulton's argument is, further, that they would have to take all the horses and all the tramcars to run over these lines, and the depôts in which the horses and cars were stored at night? If that was the logical conclusion (added his lordship) then any little authority could paralyse the whole system. Here the tramway company have gone to great expense in building the depôts, &c., and now the Corporation said they must be left with them and get what they could for them. Using common sense it seemed that they should be paid for. Another thing he could not shut his eyes to was the fact that these districts, either by being absorbed by Manchester or joined with Manchester, were practically one.

Mr. BALFOUR BROWNE thought not. They all had to find the money for the purchase. Manchester would take over the lines for 21 years and work them, the others paying a rent. The rent was equivalent to a rate and the sinking fund would be extinguished in the 21 years.

His lordship reserved judgment.

Extension of Tramway Companies Powers.

In the Chancery Division on Saturday, before Mr. Justice Farwell, Mr. Bramwell Davies, K.C., appeared in support of a petition by the Leamington and Warwick Electrical Co. (Ltd.) for sanction to an expansion of the powers of their memorandum of association. The company was originally known as the Leamington and Warwick Tramways and Omnibus Co., but the name was changed by order of the board with the intention of introducing electrical work and applying other traction than horse power to their vehicles. In 1901 there was an electric lighting provisional order obtained by which they were authorised by the Board of Trade to transfer the benefit of that order to the company. They got authorisation, and secured a site for electricity works and plant to supply the town of Warwick with electric light and power, and it was on this account the company asked the Court to sanction the enlargement of their powers. The company was incorporated in 1880, and on Jan. 22 last special resolutions were passed, by which the articles were altered, the name of the company changed, and original capital of £25,000 in £10 shares increased to £100,000.

After counsel had explained the steps taken by the company to secure the sanction of their shareholders, debenture-holders and creditors to the scheme,

His LORDSHIP gave his sanction to the enlarged powers, as modified.

Tramway Speed Indicators.

The Dudley Bench on July 12 heard several summonses against the Dudley and Stourbridge Electric Traction Co. Three were for having no speed indicators on their cars; two, under the bye-laws, for failing to exhibit in the cars the Board of Trade regulations; and two for carrying passengers on the roof of the cars on the Pensnett light railway.

For the defence it was urged that the failure to post the regulations was due to negligence of the car cleaners; that there was no apparatus of the kind required in existence; and that while the Light Railways Order by one clause prohibited double-decked carriages, it specified in another what precautions should be taken for the protection of passengers on the top of such cars.

In each of the first three summonses a fine of 2s. 6d. and costs was imposed; for the breaches of the Light Railways Order a fine of 20s. and costs was inflicted in each case; and the summonses for failing to provide speed indicators were adjourned *sine die*.

Tramway Companies Rights and Responsibilities.

At Newcastle-under-Lyme County Court on July 8, before Judge Mulholland, K.C., an action was brought against the Potteries Electric Traction Co. by a market gardener named Whiston, who sought to recover £50 damages for personal injuries. Plaintiffs' case was that on April 5 one of the company's cars collided with his cart. He was badly injured, and his cart and harness were damaged. He alleged that the car was travelling at a great speed, and that it was not stopped until it had gone some 40yds. after the collision. The defence was that the plaintiff was apparently asleep whilst driving, and that the driver of the car sounded his gong and tried to pull up, and passengers affirmed that the car was not going at a rapid rate.

The JUDGE said the plaintiff when driving on the tramlines knew that a powerful car under great momentum, which could not turn to either side, might come along at any moment. The responsibility to get out of the way, and allow the car to pursue its course, lay on the plaintiff. Negligence on the part of the company's servants had not been proved, and he held that plaintiff had brought about the accident. Judgment for defendants.

Trolley Rope Accident.

At Durham Assizes, Mr. Justice Bruce heard an action brought by a cyclist named Maxwell against the Hartlepools Tramway Co. (Ltd.) for damages for personal injuries. Whilst plaintiff was cycling, the tramway trolley pole rope on an electric tram caught him by the neck, and he was badly injured and his machine smashed.

Defendants' counsel admitted liability, and judgment was entered for plaintiff for £250, without costs.

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INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

MISCELLANEOUS EXHIBITS.

(*Concluded from p.* 486.)

Batteries.—At stand 44 the Imperial Electric Supplies (Ltd.) made a good show of I.E.S. dry cells, a new cell of British manufacture specially recommended for telephone work and for ignition purposes on motor-driven vehicles. At stand 96 Le Carbone made an excellent display of Leclanché cells and also of "Carbo" and "Lacombe" types for bell, telegraph, telephone and signalling work. The "Carbo" cell, in its larger sizes, is designed for charging small accumulators. The "Paris" cell for electric ignition on motor cars was also shown, and the "Sans Pareil" dry cells in different sizes. Messrs. Sutherland and Marcusson at stand 139 made a good show of testing batteries.

Bearings.—In addition to a good show of roller bearings, previously described in our columns, Messrs. Fleming, Birkby and Goodall, at stand 97A, made a display of oil-less (carbonated) trolley bushes or bearings, overhead pulleys for electrical power transmission as applied to tramway propulsion (Entwistle's patents), and oil-less (carbonated) bearings for machinery, shafting, motors, turbines, engines, &c., applicable to every type of rotary or sliding motion.

Belting.—There was a notable absence of belting exhibits at Islington, one of the principal stalls at which a special feature was made of this class of engineering stores being that of Messrs. Fleming, Birkby and Goodall (No. 97A), who showed excellent examples of "Teon" belting for motor vehicles and power transmission of all kinds.

Fuel Economisers.—At Messrs. E. Green & Sons' stand (No. 83) the well-known Green economiser is shown. In the majority of the larger electrical installations in Great Britain, America and the Continent Green's economisers form a regular item in the equipment.

Life Guards.—Messrs. W. E. Rowlands & Co., at stand No. 162, showed an improved form of lifeguard for tramcars, consisting of two finders, one behind the other, the first or front finder projecting slightly beyond the collision buffer, the second being attached to the pilot board of the car, so that, should the first finder fail to pick up the second is brought into operation automatically. The National Rail and Tramway Appliances Co., at stand 163, showed Hudson's automatic lifeguard, which is constructed on the gate principle, and is claimed to be simple and effective in working. A full-sized side delivery lifeguard, with feeler, placed as it would be on a tramcar when in its normal position ready for action, was shown by the Dewar Patent Tramway Lifeguard Co. This guard, immediately an obstruction comes in contact with the feeler, drops and swings round to the side of the car, delivering the obstruction clear of the vehicle. A working model of the guard was also shown. Another patent automatic lifeguard was shown by Messrs. Gabriel & Co. at stand 168. This guard is constructed with a front hanging gate and a back tray. On coming into contact with an obstruction, the gate flies back and releases the back tray, which receives the obstruction. The driver has control of the back tray, and it is considered by the manufacturers an important feature of this guard that, when it has been dropped, it is impossible for it to be raised by contact with the obstruction. This guard is in use in a number of towns in the United Kingdom.

Repair Shop Tools.—In the large and varied exhibit made by the Britannia Co. (No. 88) there is a fine display of repair shop tools, of which this company make a special feature.

Track Tools.—At the stand of the Midland Mfg. Co. (No. 98), a good show of track tools was displayed. This exhibit was specially strong in contractors' and platelayers' tools of large variety. Messrs. V. Demerbe & Co., at stand No. 5, also made a good show of track tools. Also, at the stand of Messrs. Askham Bros. and Wilson (No. 50) was shown a varied assortment of these goods.

Troughing and Conduits.—In addition to the large exhibits of special types of conduits and troughing made by Messrs. Doulton & Co., Callender's Company, and other well-known firms, whose exhibits have been dealt with in another portion of our current issue, there is the exhibit made by the Albion Clay Co. (stand 84) of Sykes' patent solid system of troughing provided with spigot and socket ends. There is also a 3-chase troughing shown by this company, the advantage of which consists in its multiple form of manufacture, for which it is claimed that less excavation and consequently less reinstating of the roadway or footway is required.

Ventilating Fans.—A notable exhibit of the Blackman type was shown at stand 104 by the James Keith and Blackman Co. Several types of fans were exhibited in motion of a class largely used for ventilating electric power stations, engine rooms, transformer rooms, workshops, &c.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Tonbridge Urban District Council are advertising on another page for applications for the post of electrical engineer, to have control under the Electric Lighting committee of the electricity supply undertaking and its administrative departments. Commencing salary £150 per annum. Applications to the clerk (Mr. Arthur H. Neve), Tonbridge Castle, Tonbridge, by Aug. 2.

Belfast Library and Technical Instruction committee require a chief lecturer in physics and electrical engineering and also a chief lecturer in mathematics. An advertisement contains further particulars. Applications to the Principal (Mr. F. C. Forth), Municipal Technical Institute, Belfast, by July 21.

A teacher is required for teaching magnetism and electricity and electric light and power at the Harris Institute, Preston, for two evenings a week. Applications by July 28. Further particulars from the secretary, Mr. T. R. Jolly. See advertisement.

Halifax Technical Instruction committee invite applications for the appointment of lecturer in electrical engineering and physics. Applications to principal by July 30. See advertisement.

Portsmouth Electric Lighting committee require an assistant engineer to take charge of a shift. Applications to superintendent (Mr. E. Price) by 23rd inst. See advertisement.

There is a vacancy for a switchboard attendant at Blackburn electricity works. Applications to chief electrical engineer (Mr. Alfred S. Giles) by 24th inst. See advertisement.

A junior draughtsman is wanted in the distribution department of a large electric supply company in London. See advertisement.

An assistant electrician is required for a large private installation. See advertisement.

First-class fitters, with good knowledge of switchboard work, are required by Messrs. Ferranti (Ltd.), Hollinwood, Oldham. See advertisement.

An assistant salesman is required for the bell and telephone department of a large Manchester supply house. See advertisement.

A working man is wanted to take charge of and keep in order, with assistance, two Willans engines, boilers and complete electric generating plant. Apply to Messrs. Jardines, Deering-street, Nottingham. See also advertisement.

The Stepney (London) Guardians require an engineer for their Childrens' Homes at Stifford, Essex. Applications to clerk by July 23.

Mr. J. D. Coales, B.Sc., A.M.I.E.E, of the Hartley College, Southampton, has been appointed lecturer in electrical engineering at the University College, Nottingham.

Mr. A. E. Constable has been promoted to the position of mains superintendent and test-room engineer at Croydon at £180 per annum.

Mr. E. Donoghue, late of the Portsmouth electricity works, has been appointed shift engineer at Blackpool.

Mr. J. M. McGown, of Glasgow, has been appointed assistant electrical engineer at Oban.

Aberdeen.—In order to meet the anticipated heavy traffic during the Highland and Agricultural Show, the Tramways committee recently telegraphed Glasgow asking for the loan of six cars for the week, but the Glasgow Corporation declined to comply with the request, "as they required the whole of the cars at present available for their service."

Ashton-under-Lyne.—The charge for electric current to private consumers is to be reduced from 4½d. to 4d. per unit, with the alternative of 1s. per quarter per 8 c.p. lamp, and 1½d. per unit. The charge for motive power is to be reduced from 3d. to 1½d. per unit, with special terms for users on a large scale.

Barrow-in-Furness.—The accounts of the electricity department for the year ended March 31 have been issued, and show total receipts £5,281. 5s. 4d., including £4,799. 16s. 5d. from the sale of current to private consumers. The annual expenditure was £3,286. 16s., leaving £1,994. 9s. 4d. gross profit to meet interest (£1,256. 11s. 10d.) and sinking fund instalment (£1,079. 0s. 6d.). The total units sold were 284,709.

Belfast.—An inquiry will be held on Tuesday into the application of the Corporation to borrow £20,000 for electric lighting extensions

Bilston.—The Bilston-Willenhall electric tramway has been opened for traffic.

Brierfield (Lancs.).—Nelson Town Council have offered to supply electric current to Brierfield for public lighting at 2d. per unit.

Canary Islands.—In a recent report on the trade of the Canary Islands for 1901 it is stated that the electric tramway at Teneriffe has proved a very remunerative undertaking to the Belgian company which established the line, which has not yet been extended beyond Laguna, but will ultimately run through Tacoronte on to Oratava. Meantime arrangements are being made by a local British firm to

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run motor vehicles between Laguna and Orotava. There is a steam tramway service, 4 miles in length, between Las Palmas and Puerto de la Luz, which is of a primitive character, and compares most unfavourably with the excellent electric line at Teneriffe.

Carnarvonshire Electric Power Scheme.—A meeting was held at Carnarvon on Tuesday, when Sir Wm. Preece outlined the suggested electric power scheme for the county of Carnarvon. He estimated that the power used throughout Carnarvonshire was at least 20,000 H P. Wallsend was producing electrical power at ½d. per unit; Llandudno at a little over 1¾d. per unit. If Llandudno, Conway, Bangor, Carnarvon, Pwllheli and Criccieth amalgamated together to generate their own electric energy in one spot they would save a third of their capital and get the electricity at a third of the price they could obtain it under present conditions. In that county there was a great deal of water running to waste. There were not many catch areas in Carnarvonshire large enough to secure the water power they wanted. What they had to ascertain was the cost of the carriage of coal on the railways as against the cost of conveying electrical energy. He had found that it was not economical to go beyond 15 miles for a generating station. Sir William Preece next referred to the numerous objects for which electrical energy could be applied. Out of every 100 tons of slate rock disrupted by explosives only 2½ tons reached the market. He could not help thinking there was something barbarous in the mode of blowing down the face of the rocks. In the Pyrenees the French were cutting the slate by means of wire saws worked by electric motors. He had, he said, no scheme to lay before the meeting, but he was prepared to go in with them to work out any scheme, and to plank down his money to the best of his ability to enable them to do it. He would advise Carnarvonshire to have nothing to do with outside financiers. They had a market rich beyond measure, and they wanted powers to develop that market; and they wanted to do it themselves. They had only to put down a small sum each to get the Parliamentary power, and when that was obtained it would be for the County Council and other bodies to help them to consider ways and means. At the conclusion of the address a committee was appointed to promote and develop the project.

City of London.—At the meeting of the Court of Common Council, last week, a motion was passed authorising the several committees of the Corporation to afford facilities to the Post Office in introducing the telephone service in the departments under their respective control, and that the proposed charge of £1 per annum for each attachment be not insisted on.

Clacton.—The Board of Trade have intimated that consideration of the revocation of the Council's provisional order has been postponed until January.

Cleckheaton.—£6,000 additional is to be spent on the electricity undertaking, of which an engineer and manager is to be appointed at £200 per annum. The Electricity committee have had under consideration a draft agreement with the British Electric Traction Co. as to the supply of current for working their tramways in the district. The further consideration of the matter has been adjourned.

Darlington.—The salary of the borough electrical engineer (Mr. J. R. P. Lunn) has been increased by £50 per annum.

Denton.—The Council have applied to the Board of Trade for an extension of time to August, 1904, for the completion of their proposed tramways.

"Dialite."—A report, dated June 30, 1902, has been prepared by Mr. C. H. Wordingham on cables insulated with "Dialite." The cables tested range from 7/22 to 37/12 core, and each of the cables had two laps of tape with the exception of the 7/22, in which there were two tapes laid on longitudinally, each covering half the circumference of a single spiral round them. There was no protection outside the tape with the exception of the 37/12, which was braided. The three smaller cables were intended for use in the interior wiring of buildings, and the tests were directed chiefly to ascertaining their suitability for this purpose. The three larger sizes were intended for underground work. The insulation resistance in megohms per mile is set out as under :—

	Length in yards.	After 1 min.	After 2 min.	Capacity in microfarads. Per mile.
7/22	534	133	144	0·807
7/17	510	142	147	0·859
7/14	690	76	83	0·864
37/15	598	49	54	0·98
37/14	650	139	162	1·449
37/12	440	125	150	0·832

An alternating pressure was employed of a periodicity of about 80 periods per sec. for half an hour. The three smaller cables—*i.e.*, 7/22, 7/17 and 7/14—were tested with from 1,800 to 1,900 volts, the larger cables with from 2,500 to 2,700 volts, and all of them successfully withstood the pressure. The tests (concluded Mr. Wordingham in his report) showed that all the cables have a satisfactory insulation resistance, whether they be intended for underground work or for house wiring. The tests of the dielectric strength are, however, far more important than the insulation resistance, and the results attained are most remarkable. That a wire so small as 7/22 should withstand for half-an-hour, without breaking down, a pressure of between 1,800 and 1,900 volts, shows exceptionally high dielectric strength, and, seeing that there was no paper at all on this sample, it shows conclusively the valuable properties of "Dialite." The series of tests carried out in connection with the house wires are the most satisfactory evidence as to the mechanical properties of the material. The conditions were severe, and were just those to which cables would be likely to be subjected in practice. So far as can be judged by experiment, wires insulated with "Dialite" appear to be of good insulation resistance, of high dielectric strength, and even without the additional protection of braiding or taping, very strong mechanically. Not only, therefore, should they be well suited for underground mains, but also for the interior wiring of premises.

Eccles.—An inquiry is to be held into the Council's application for a loan of £22,815 for electric lighting extensions.

Electric Automobiles.—In the "Notes and Notices" of the Automobile Club, dated July 10, there is an account of a meeting held on July 11 of the Club's committee to advise on electrical vehicles. There were present Mr. Joel, Mr. Carl Oppermann, Mr. Ernest Hutton, Mr. Cozens-Hardy, Mr. J. M. Gorham and Mr. Cockerton. The secretary reported that, although the final date for entries for electrical vehicles for the forthcoming trials was July 12, no entry had yet been received. Mr. Cockerton said that Mr. Theodore Chambers was entering two cars. Mr. Oppermann notified that he was entering one car. It was ultimately resolved that, if there were not at least five entries in each of the two electric car classes, the trials of electric vehicles should be postponed until the last week in August, and the event itself be taken as part of the big automobile trials the first week in September, provided there were not less than three entries in each electrical section. In connection with the same event, Messrs. Shippey Brothers announce that they are unable to enter four cars which they had intended to run, in consequence of their carriage building premises being destroyed by fire, and the City and Suburban Carriage Co. cannot enter their cars "owing to pressure of business."

Electric Lighting Notices.—By July 1 electric lighting companies and others desirous of obtaining electric lighting powers have to give notice to local authorities of their intention to apply for provisional orders. In the last two or three issues we have given particulars of some of these notifications, and we give below those that have been issued during the week :—

Ashford (East), Cranbrook and Bridge.—South-Eastern Electric Lighting Co.
Bideford.—Electric Supply Corporation & Electric Supply & Traction Co.
Bognor.—Two companies have given notice.
Bridgwater.—Bridgwater and District Electric Supply and Traction Co.
Bromley Rural District (Farnborough, Hayes, Keston, Orpington and St. Mary Cray).—Edmundson's Electricity Corporation.
Burslem.—Potteries Electric Traction Co.
Castleford.—Provincial Electric Supply and Traction Co.
Calverley (Yorks.)—Provincial Electric Supply and Traction Co.
Chesterton.—Cambridge Electric Supply Co.
Gosport and Alverstoke.—Provincial Electric Supply and Traction Co.
Hollingbourne,—South-Eastern Electric Lighting Co.
Isle of Wight (Carisbrooke and Northwood).—Isle of Wight Electric Light and Power Co.
Newton-le-Willows.—Provincial Electric Supply and Traction Co.
Renfrew.—Electric Supply Corporation.
Ripley.—Provincial Electric Supply and Traction Co.
Rochester.—County of Kent Electric Power Co., Kent Electric Power Syndicate, and Provincial Electric Supply and Traction Co.
Spalding.—Provincial Electric Supply and Traction Co.
Walton.—Urban Electric Supply Co.

Exeter.—The deputation recently appointed to visit British and Continental electric tramways to obtain information for the Electric Traction committee, have presented their report, and recommend that tramways be constructed on the overhead trolley system, with the exception of High-street and Fore-street lines, for which it is probable the conduit system will be recommended.

Falmouth.—The Council have come to terms with Messrs. Crompton & Co. for the erection of electricity works, and a formal agreement is being prepared.

Frome.—The Council have applied for sanction to a loan for electricity supply works. Mr. F. H. Medhurst is consulting engineer.

Germany.—In a review of the trade of Germany for 1901, Mr. Consul John Schwabach notes that there was a large falling-off of dividends yielded by the larger industries in Germany. In the electrical industry the dividends averaged in 1900 9·55, and in 1901 only 5·79. In commenting generally upon the state of trade in Germany, Mr. Schwabach's remarks upon the electrical industry are as follows :—

The unfortunate business conjuncture was felt nowhere so severely as in the electrical branch. Tempted by the success of certain large well-organised firms, several others were started, not so much because they were required, as because they afforded an investment more or less speculativ for superfluous capital. These latter, of course, suffered the most, but

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even the better-founded undertakings were influenced more or less injuriously, for the speculating firms accepted recklessly any orders, and often carried them out at a loss, thus lowering the prices obtainable for legitimate work.

A company has been formed in Berlin by the A.E.G. with a capital of £25,000, the object of the company being "to give poor inventors an opportunity of bringing their inventions before the public."

Glossop.—Edmundson's Electricity Corporation propose to commence the erection of the electricity station building at once, and the construction of the permanent way of the electric tramway system will also be proceeded with shortly.

Halifax.—The Tramways committee have been urged by Brighouse Corporation and the Hipperholme and Greetland Councils to exercise their powers to construct electric tramways to those districts.

Hebburn.—The Council have decided to apply, on behalf of the Northern Counties Electricity Supply Co., for consent to the use of a high-pressure system of electricity supply in order that Felling may be supplied from Hebburn.

Huddersfield.—Major Druitt, R.E., held an inquiry on Saturday into the circumstances under which a tramcar on the Almondbury route got out of control on June 28, left the metals, and crashed into a shop killing three persons and injuring a number of others.

GEORGE W. HEWITT, driver of the runaway car, explained his mode of manipulating the brakes on the journey. He said the hand brake on the car was defective, and that the electric brake failed to act. He was absolutely certain he had never received any instructions as to reversing the motor to "brake" the car until after the accident. He was sure he did not turn the brake handles the wrong way. The hand brake had given him some trouble, but he had had no difficulty with the electric brake before the car ran away.

Mr. JOHN E. DYSON, electrical engineer, said he wished to withdraw a suggestion he had made as the cause of the accident—that by putting on the electric brake to one notch and at the same time applying the hand brake the driver failed to excite the motors. Such a thing could not happen with motors wound as the car motors were.

Mr. F. W. TAYLOR, electrical engineer, expressed the opinion that if the electric brake were put only at the first notch there would be an insufficiency of current generated to pull up the motor.

Mr. H. N. THOMAS, manager of the Corporation tramways, said that since the accident the car had been under lock and key, and no one had had access to it except the town clerk and Mr. Dyson, at the request of the coroner. It had not been interfered with, and nothing had been done to repair it in any way.

(The Inspector and several electrical witnesses examined the car at this stage.)

Mr. TAYLOR said he had examined the car, and found all the leads in perfect condition. The controller was perfect in every way, and all the connections were good. He did not see anything that could be called a defect.

The INSPECTOR: Coming down a gradient of 1 in 18, would the electric brake be sufficient?—It would pull the car up on a much steeper gradient.

Even though the car had got up a speed of 10 or 12 miles an hour?—I should consider it safe up to 18 miles an hour.

Mr. J. W. WAINWRIGHT, general manager of the British Electric Car Co., contractors for the Huddersfield cars and equipment, said he had examined the car that morning, and was satisfied that it was in good order. The electrical apparatus was perfect, and the braking most powerful. One of the blocks of the hand brake was in contact with the wheel flange, but that was accounted for by the skewing of the car when it left the metals. The slipper brake had been shattered by contact with the pavement. The car should have been under perfect control on a 1 in 18 gradient.

Mr. DYSON said he had examined the car a second time, and satisfied himself that all the connections and apparatus were in order. In his judgment the car was in such a condition that it could have been pulled up by the electric brake.

Do you agree that it would have been under control if it had been properly handled?—I do.

And you cannot suggest any reason why the car should have got out of control if it had been skilfully handled?—I cannot.

The inquiry then closed.

On the previous day the coroner's inquiry was concluded, when the jury returned a verdict of "Accidental death" owing to failure of the car brakes. They strongly recommended that the car drivers should receive more efficient instruction and more thorough examination as to their fitness before taking charge of cars, that every driver and conductor be made to sign for the book of rules, that recognised passing places be adopted, and that the men receive instructions to use them.

Japan.—There was a falling-off in the imports into Yokohama in 1901 of electric light apparatus from £36,660 in value in 1900 to £28,764; an increase in the value of imported wire and cable from £8,188 in 1900 to £11,235 in 1901; an increase in submarine cables from £39,991 to £49,648; and a decrease in telephones and accessories connected therewith from £30,373 to £14,080.

Kirkintilloch.—A committee has been appointed to consider and report as to whether the Council should take advantage of the clause in the Clyde Valley Electric Power Bill to apply for a provisional order to become the distributors of electricity within the burgh.

Kilmarnock.—The Council have postponed their electric lighting scheme, and the consulting engineer (Mr. W. A. Bryson) has been paid £330 in settlement of his claim for professional services.

Light Railways.—Objections to the confirmation of the Spen Valley Light Railway Order were heard on Tuesday. Mr. Trevor Edwards, for the West Riding of Yorks. County Council, detailed the objections to the order as to the maintenance of the roads, and Sir H Jekyll said that the Board of Trade would follow the Worcester precedent, the effect of which was that the promoters were required to restore any portion of the waste broken up for the purpose of the railway to as good a condition as before, but not to maintain and repair it as they would do a metalled portion of the road.

Worthing Council decided on Friday to apply for an order to construct light electric railways in the borough.

Liverpool.—The Tramways committee have authorised the general manager (Mr. C. Petrie), the chairman (Mr. S. W. Higginbottom, M.P.), the deputy-chairman (Ald. F. Smith) and Mr. E. L. Lloyd to visit the United States and Canada to inspect the principal tramway systems in operation in those countries.

The City Council are applying for sanction to a further loan of £300,000 for electricity supply extensions.

London County Council.—At Tuesday's meeting it was agreed to loan £25,000 to Fulham for electric light installations.

Tramway Rolling Stock.—The adjourned report of the Highways Committee asking authority to expend £59,000 in the purchase of electric cars of a special kind for use on the Streatham lines was submitted and was adopted without discussion.

South London Tramways.—It was reported by the Highways Committee that notice had been served on the South London Tramways Co. requiring the company to sell the portions of their undertaking authorised in 1879 and 1880 respectively. The directors of the company had offered to recommend their shareholders to accept £201,150 for the whole of the company's undertaking. This the committee thought fair and reasonable, and proposed that the transfer should take place on Nov. 1. In addition the Council will purchase the rolling stock, horses, &c., at an agreed price. The committee recommended the purchase, and this was carried.

Reconstruction of Bridges for Tramways.—The adjourned report of the Highways committee recommends:—

That application be made to Parliament for powers to enable the Council to enter into arrangements when any bridge carrying, or over, any thoroughfare in London which is already, or may probably be selected by the Council as, a route for tramways (although no Parliamentary sanction has yet been given to such tramway route) is about to be re-constructed or altered, for the work to be carried out in such manner as to permit of the placing of electric conduits in the carriageway of the bridge, or of the laying of a double line of tramways in the road beneath the bridge; and to enable the Council to contribute the whole or part of the extra cost to be incurred in respect of the work necessary to adapt the bridge for the purpose.

The recommendation was adopted.

Erection of Car Sheds.—It was agreed that an expenditure on capital account of £30,000 be authorised in respect of the first portion of the building and other works in connection with car shed accommodation for the electric cars at Clapham.

Fuel Economisers.—Dr. Kennedy having submitted specifications of fuel economisers required for the Greenwich electricity generating stations, it was decided that £3,500 be set aside, and that advertisements be issued.

Reconstruction for Electric Traction of further Tramways.—The Highways committee recommended—"That estimates of £9,000 and £105,000 be approved in respect of (1) alterations to, and reconstruction of, bridges, and (2) lines and rolling stock in connection with the reconstruction, for electric traction, of the Council's tramways between New Cross-gate and Trafalgar-road, Greenwich." Consideration was postponed for a week.

Longton.—In future electric current will be supplied to places of worship at 4½d. per unit. The gross profit on the electricity undertaking for the past half-year was £382. Interest came to £357. 4s. 4d., and sinking fund to £274. 5s. 6d., leaving a deficiency of £249. 2s. 5d.

Manchester.—The total connection to date for lighting and power are equivalent to 426,367 8 c.p. lamps.

Market Drayton.—The Council have consented to the application of the Market Drayton Electric Light and Power Co. for a provisional order.

Melbourne.—The Royal Commission on Victorian Government Railways recommend the Railway Department to acquire the Melbourne tramway system, as the Commission is of opinion that "electric tramways on the overhead system are superior to and offer greater facilities than steam railways for dealing with suburban traffic."

Municipal Telephony.—Swansea Telephone committee have received a communication from the Postmaster-General stating that the proposal that persons who became subscribers before March 31 last should have the free use of the telephone for three months

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after the establishment of the municipal exchange was inconsistent with the terms of the licence.

Scarborough Property committee have been instructed to apply for a municipal telephone licence.

The proposal to establish a municipal telephone exchange at Huddersfield was discussed by the Town Council on Wednesday. The General Purposes committee recommended the Council to enter into an agreement with the National Telephone Co. to lay underground wires for a period expiring in 1911. On the committee's minutes coming up for confirmation, Ald. Sugden moved that all previous resolutions of the Council and committees with reference to the municipalisation of telephones, and the proposed agreement with the National Company be rescinded or varied, so as to admit of an agreement being entered into with the company on the terms mentioned, and that a sub-committee be appointed to settle details. The proposal was approved.

Plymouth.—At the Council meeting on Monday the minutes of the Electricity and Street Lighting committee contained a report from the borough electrical engineer (Mr. E. G. Okell) on the cost of street lighting. The report stated that the cost of electric and gas lighting last year was £6,615, compared with £6,206 in 1899, while the total candle-power had increased from 32,746 to 185,680, and the cost per candle-power had decreased from 45·5d. to 8·4d.

The chairman of the Tramways committee (Mr. B. Monk) said the balance-sheet for the year was not as favourable as could be wished. There had been an increase in the cost of current from 2·3d. to 3d. per unit. For permanent way and overhead equipment there had been an increase of £1,100, and rent and other items had also increased. The receipts, however, for the week ended July 12 were more than £100 in excess of the corresponding week last year, and the receipts for the 13 weeks from March to July showed an increased of £131. 17s. 6d. Bad weather in May and June was responsible for a great deal of the loss. There was some criticism of the management of the tramways, but eventually the minutes were adopted.

Power Transmission in India.—The first portion of the Cauvery Falls power transmission plant was started on Tuesday. Power is transmitted from the Falls to the Kolar goldfield, a distance of 90 miles. The scheme was inaugurated by the Mysore Government, and provides for the supply of 4,000 H.P. to the mines under Messrs. John Taylor & Son's management, with the option of taking additional power to the same extent later. The agreement with the Government is for 10 years, and for the first year £29 per H.P. per annum is to be charged to the companies; for the second, third and fourth years £18 per annum; for the fifth year not exceeding £24 per annum, and for the remaining five years £10. The contract has been carried through by the General Electric Co. (U.S.A.), whose tender of £140,941 was for the completion of plant for the generation and transmission of 5,000 H.P. within 20 months from November, 1900, so that contract time has been well observed.

Presentation.—Mr. W. Wilde, of Bolton Corporation tramways department, recently received an appointment at Cardiff, and on his departure was presented with a gold chronograph and a travelling bag by the Bolton staff.

Rawmarsh.—The Board of Trade have deferred the revocation of the provisional electric lighting order for six months.

Romford.—Proposals received from Messrs. J. and J. S. Enright, the Allgemeine Electric Co., and the United Electric Light and Power Co. for the erection of electricity works are under the consideration of the Council's consulting engineer.

St Helens.—Application is to be made to the Board of Trade for approval of the leasing by the Corporation to the New St. Helens and District Tramways Co. for the residue of 21 years from Oct. 21, 1898, of all the Corporation's tramways constructed since Dec. 21, 1898.

Scunthorpe.—The Council will oppose the application of a company for a provisional order, and have themselves to decided make application.

Seaford.—Mr. F. J. Warden-Stevens recently applied to the Council for facilities for the erection of electricity works. The Council have asked for further details of the scheme.

Slough.—The Windsor Electrical Installation Co. has decided to form a new company to take a transfer of a provisional order authorising the supply of electricity in Slough and Datchet.

Southampton.—The accounts of the electric lighting department for the year ended March 31 show total receipts £20,900. 10s. 2d., of which £12,736. 18s. 6d. was received from private consumers, £6,028. 19s. 11d. from the tramways department, and £1,759. 19s. 5d. for public lighting. Annual expenditure amounted to £12,916. 12s. 8d., leaving £7,983. 17s. 6d. gross profit to meet interest (£3,722. 2s. 3d.), and sinking fund charges (£3,515. 15s. 8d.). The net profit was, therefore, £717. 13s. 2d. The total capital expenditure to date amounts to £125,940. 10s. 6d., an increase of £10,302. 18s. 8d. in the year. 1,856,216 units of current were generated; 589,040 units were supplied to private consumers, 117,701 to public lamps, 723,479 to Corporation tramways, and 56,421 units were used on works. There are 166 public lamps, and the total maximum supply demanded was 1,143kw.

Stonehaven (N.B.).—An electricity supply scheme is being prepared by Messrs. Barlow and Young, of London.

Swindon.—An extension of 12 months has been obtained by the Council for carrying out the terms of their tramway provisional order.

Telephone Developments.—A correspondent to *The Times* contributed to that journal on June 28 an interesting article on the subject of telephone developments in the State of Indiana (U.S.A.) This is the smallest of the States west of the Alleghany Mountains, the population last census being a little over 2,500,000. It is chiefly an agricultural state, where manufactures are developing, however, on a considerable scale. In 1895, when the telephone patents expired, there were about 6,000 instruments in the State and about 40 exchanges; but long-distance telephony was practically unknown. The rates for business houses in the capital, Indianapolis, was just under £15 a year, and for private houses about £13. The Indiana State Government passed a law fixing the annual charge at a maximum of £8, which was resented by the Bell Telephone Co., who owned the monopoly, and the company practically withdrew its service. When the patents were about to expire (the correspondent proceeds) some energetic men with capital entered upon the business, commencing with the manufacture of telephones, and finally erected and equipped exchanges varying from 100 telephones upwards. By 1897 the number of these small local companies supplying an urban telephone service had grown considerably, and in that year it was decided to establish in Indianapolis, a city with a population of nearly 200,000, a local service in opposition to the Bell Company. A charter was obtained, a service established, including long-distance lines, and now the independent telephone companies of the State of Indiana own 169 exchanges, serving the 92 counties of the State with about 55,000 telephones. The principal company has a capital invested in the business of £2,250,000, nearly all provided locally. The Bell Company also has about 22,000 telephones and 60 exchanges in the State, with about £1,850,000 capital invested in this section of its business. The result is that in the whole State of Indiana there are nearly 80,000 telephones, or about 13 compared with 1 in 1895. In the city of Indianapolis the rate is rather less than £9 per annum for unlimited service in business houses, and about £5 per annum for residential connections. About one-fifth of the entire number of telephones erected in the State are in farmhouses, and are largely used in connection with agriculture. The long-distance telephone rate has been materially reduced, but is still much higher than in Great Britain. The manager of the company referred to has predicted "that within four years every family in the State of Indiana which possesses a clock will by that time possess a telephone."

Telephoning Telegrams.—It is stated that the National Telephone Co. has made arrangements with the Postmaster-General by which telegrams are accepted from the company's subscribers, not only at the post office directly connected with the exchange to which the company's subscribers themselves are connected, but also, when that office is closed, at any post office open that may be most readily available to the subscriber.

Tiverton.—The Council has received an offer from a company to take a transfer of its provisional electric lighting order. Another company has notified its intention to apply for electric lighting powers, but the Council are anxious to retain their order. The borough surveyor (Mr. J. H. Smith) is obtaining information on the subject. The Council have come to terms with their late consulting engineer (Mr. W. Adams), who has agreed to accept £100 in discharge of his claim for services rendered.

Tunbridge Wells.—The annual report of the borough electrical engineer (Mr. Horace Boot) states that the excellent progress achieved by the electricity works since their inauguration in 1895 has been maintained, and last year the equivalent of 8,113 additional 8 c.p. were connected to the mains, a larger number than in any previous year. The gross and net profits for the year were £3 941 and £440, against £2,362 gross profit and £482 deficit in 1901. The income had increased by £1,672 over last year, and the gross profit by £1,579. Coal cost £4,117. 4s. 7d., against £4,230. 18s. 3d. in the previous year. The public lighting department had cost £344, increase £50. 97,542 more units were generated last year at £50 less than the previous year. The average price obtained from private consumers was 4¾d. per unit, and for public lighting 1¼d. per unit. Extensions had involved an expenditure of £25,000, and there is sufficient spare plant to supply an additional 10,000 8 c.p. lamps. Cables have been laid in all the principal streets, the aggregate length being about 64 miles. Mr. Boot thinks it would be profitable for the Corporation to obtain powers to give a supply of current in Southborough, Langton, Frant, Wadhurst, Crowborough, Eridge, Groombridge and Pembury. During the seven years the Corporation had been supplying electricity to private consumers and public lighting the undertaking had given to the general district rate on three occasions a penny rate (aggregating £2,750), which, added to surplus of £1,985, made a total of £4,735, which might be regarded as a reserve, equal to 7½ per cent. on the capital outlay of £65,934.

West Ham.—The accounts of the electric lighting department for the year ended March 31 show a total capital expenditure of

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£131,312, revenue £21,073, annual expenditure £13,688, leaving a gross profit of £7,385, against £2,407 in 1901. After paying interest and sinking fund, there was a surplus of £2,076. 17s. 11d., of which £1,000 has been carried to reserve and the balance remains unappropriated. The borough electrical engineer (Mr. J. K. Bock) has submitted estimates of the cost of erecting a new generating station at Canning Town, the total being put at £184,747, and application is to be made for sanction to borrow £185,000.

Weymouth.—The Town Council have decided to proceed with their electricity supply scheme. The charge for current for private lighting has been fixed at 6d. per unit, and that for public lighting at 3d.

Wolverhampton.—In presenting the accounts of the electricity department at the Corporation meeting on Monday, Mr. A. Crosbie said that last year a profit of £507. 13s. 11d. had been made, against £687. 15s. 9d. in the previous year. The accounts for the June quarter showed a considerable improvement. Ald. Lewis contended that there was some obsolete machinery at the generating station, and that the value should be debited in the accounts. Mr. Crosbie, in reply, maintained that the whole of the machinery was in use and doing good work. If any machinery had to be thrown away the loss would be borne out of revenue. The accounts were approved.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Leicester Tramways committee invite tenders for steel girder tramway rails and fishplates; bolts, nuts and tie-bars; points, crossings and special track work; stoneware pipes and conduits; feeder cables; telephone and test wires; roadway frames and covers; overhead electrical equipment and copper bonds; steam-raising plant, engines, generators, batteries, boosters, switchboard, overhead travelling crane, &c., and also for electric tramcars. An advertisement contains further particulars. Specifications, &c., of the borough engineer (Mr. E. George Mawbey, M.Inst.C.E.), Town Hall, Leicester, and can be seen at the office of the consulting engineer (Mr. E. Manville), 29, Great George-street, Westminster, S.W. Tenders to chairman of committee by noon Sept. 3.

Ilford Urban District Council invite tenders for a combined track-watering and sweeping car on maximum traction truck with complete electrical equipment. Specification, &c., from the clerk to the Council (Mr. John W. Benton), Town Hall, Ilford, and further information from the consulting engineer, Mr. W. C. C. Hawtayne, 9, Queen-street-place, London, E.C. Tenders (addressed to the chairman of the Council) by noon Aug. 19. An advertisement gives additional particulars.

Malvern Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work), engines, alternators exciters and switchboard, high and low-tension concentric cables and transformers. Specifications, &c., from the engineer and surveyor (Mr. H. P. Maybury), Council House, Malvern. Tenders (addressed chairman of the Gas, Water and Electricity committee) by Aug. 23. An advertisement contains further particulars.

Rochdale Corporation invite tenders for the supply and delivery at the car depôt, Rochdale, Lancs., of three tramcars complete with trucks, motors and equipment. Specification, &c., can be seen at the office of the engineers (Messrs. Lacey, Clirehugh and Sillar), 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, London, and can be obtained from the latter address only on and after 19th inst. Tenders to the town clerk (Mr. James Leach), Town Hall, Rochdale, by July 28. An advertisement gives additional particulars.

Farnworth Urban District Council invite tenders for a 400 H.P. enclosed high-speed engine direct-coupled to a 250kw. lighting and traction generator, extensions to switchboards, pipe work, foundations, condensing plant, &c. Specifications, &c., from the chief engineer (Mr. J. D. Pember), and tenders to the clerk (Mr. W. Tyldsley), Council Offices, Farnworth, R.S.O., by noon July 31. See advertisement.

Hendon Urban District Council desire tenders from companies and others for the purchase or lease of their provisional order (1899) for electricity supply. Tenders have to be sent to the chairman before 4 p.m. July 28. Some additional particulars will be found in an advertisement.

Truro Electric Lighting committee invite proposals for the electric lighting of the city, which must be sent to the town clerk (Mr. Robert Dobell) by 31st inst. See advertisement.

The Visiting committee of *Devon* County Asylum, Exminster invite tenders for wiring alterations and additions, 2,000 lamps, booster dynamo and motors, switchboard, replacing of battery of 120 700-ampere-hour cells, &c. Tenders to clerk to County Council, Exeter, by noon July 23.

Manchester Electricity committee invite tenders for condensing water pumps, pipework and tanks, storage feed-water tanks, and circulating pipes over the workshops. Tenders to chairman by noon July 22.

Accrington Electricity committee invite tenders for Lancashire boiler, steam and other piping. Tenders to chairman by noon July 21.

Pontypridd Council invite tenders for cables and dust destructors. Tenders to chairman Electric Lighting and Tramways committee by July 31.

Swindon Guardians invite tenders for electric lighting installation at their workhouse and infirmary. Tenders by 29th inst.

Pemberton District Council invite tenders for cables, &c. Tenders by July 23.

Bradford Corporation require tenders for electric lighting of new conditioning house. Tenders by June 24.

Bishop's Stortford District Council invite tenders for public lighting. Tenders by 4 p.m. 22nd inst.

Hapton (Lancs.) Parish Council require tenders for the electric lighting of the township. Tenders by 23rd inst.

Dundee Gas Commissioners require tenders for machine tools, &c., for the Dudhope Crescent-road electricity works. Tenders by noon Aug. 1.

Dublin Lighting committee invite tenders for construction of cast-iron subway under the Grand Canal Dock. Tenders by noon July 29.

Guernsey Board of Health invite tenders for electric lighting of the new isolation hospital, Castel. Tenders by 19th inst.

Tenders are required for boilers, wrought-iron smoke stack, high-speed engines, single-phase alternator, exciters, surface condenser, main switchboard, transformers, mains, &c., for the King Electric Lighting and Cold Storage Co. (Ltd.), King William's Town, South Africa. Specifications from London agents (Messrs. A. E. Booth & Co.), 16, New Union-st., Moorfields, E.C., to whom tenders by Aug. 7.

The City Council of *Amsterdam* has voted a credit of £525,000, and a further credit of £234,000, for building and equipping works to generate electric current for lighting, power and traction purposes, and it is intended to convert the street railways of the city to electric traction. It is announced that the engines, dynamos and plant generally will be provided by German and Dutch manufacturing firms, and particulars relating to the contracts for cables, which include three-phase and direct-current cables and test and telephone cables, can be obtained in German from the City Printing Office, Amsterdam. Tenders must be in by Sept. 8.

The municipal authorities of *Nisch* (Servia) are inviting tenders until Aug. 13 for the establishment of central electricity works.

Tenders are invited till Aug. 10 by the municipal authorities of *Trujillo* (Spain) for a concession for the electric lighting of the town for 20 years. Tenders to El Secretario del Ayuntamiento-de Trujillo.

TENDERS RECEIVED AND ACCEPTED.

The London County Council have received the following tenders for steam piping, &c., for Loughborough temporary generating station. The lowest tender was not in order, and that of Sir H. Maxim Company was accepted :—

Sir Hiram Maxim Elec. and Eng. Co.	£2,268	7	0	Mechan & Sons	£2,700	0	0
Light & Power Fittings Co.	3,421	15	6	Babcock and Wilcox	2,605	10	0
Refuse Destructors (Ltd.)	3,106	10	0	Ashton, Frost & Co.	2,600	0	0
D. Stewart & Co.	2,945	0	0	Aiton & Co.	2,500	17	0
Cowlishaw, Walker & Co	2,910	0	0	British Mannesmann Tube Co.	2,473	12	6
Wenham and Waters	2,885	12	6	Wm. Waterhouse, Ltd.	2,035	9	4

West Ham Borough Council have accepted a tender, amounting to £108,900, for the construction and equipment of electric tramways.

West Ham Corporation have also accepted the following tenders :—

W. H. Allen, Son & Co	(fans and engines)	£2,200
Babcock and Wilcox	(steel chimneys)	1,648
Ditto	(economisers)	2,480
Ditto	(brickwork in connection with flues)	3,425

The Rosario (S. America) Electric Lighting Co. have placed an order for three 360 H.P. Willans engines, combined with dynamos by the A.E.G.

We are informed that the St. Helens Cable Co. have secured contracts for Dialite bitumen cables from the municipalities of Maidstone and Nuneaton.

Greenwich Borough Council have accepted the tender of Messrs. Rawlings Bros. for wiring the lecture hall at £282.

The Burgh of Motherwell have given their contract for an 800 H.P. steam set to the Lancashire Dynamo and Motor Co. (Willans engine).

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We understand that the Premier lamp is to be installed at the New Baltic Sale Rooms, in Threadneedle-street, London. The number of lamps installed is to be about 3,000.

Walsall Town Council have accepted the tender of Mr. W. Harvey Gibbs for the erection of a tramway depôt at £7,450.

Ashton-under-Lyne Corporation have accepted the tender of Messrs. Siemens Bros. & Co. for electric lighting cables.

Messrs. Willans and Robinson have received an order (through the B.T.H. Co.) for three 180 H P. engines for supplying power to the Burton-on-Trent tramways.

BUSINESS NOTICES.

Messrs. A. H. C. Gibson and E. G. Miles and Ada Gibson (trading as Hugo Gibson & Co.), electric light and power contractors and engineers, 14, Temple-street, Warwick, have dissolved partnership. Debts by Mr. A. H. C. Gibson, who continues.

The Newton Electrical Works (Ltd.), Taunton, have acquired the gas and oil engine business lately carried on in that town by Messrs. Allen and Barker, and have special facilities for manufacturing these engines on a larger scale than heretofore.

The Electric and Ordnance Accessories Co., Stellite Works, Cheston-road, Aston, Birmingham, have recently completed their agency arrangements, and are now represented in London, Leeds, Liverpool, Nottingham, Middlesbrough and Glasgow.

Messrs. Willans and Robinson notify that, on the occasion of their annual holiday, the works will be closed from Aug. 2 to Aug. 11, a small staff remaining to deal with urgent matters.

BANKRUPTCIES AND LIQUIDATIONS.

A meeting of the creditors of David Roberts, electrical engineer, 30, Machlin-street, Derby, was held on Friday. Unsecured liabilities £139. 10s. 7d., deficiency £111. 18s. 1d. Causes of failure given as loss of law suit and of credit and trade in consequence, experimenting on motors and want of capital.

The Hiram Maxim Lamp Co. (Ltd.) is to be wound up voluntarily. Mr. W. F. Mills, 37, Walbrook, London, E.C., is liquidator, and claims are to be sent in by Aug. 27. This company is, of course, distinct from the Sir Hiram Maxim Electrical and Engineering Export Co. (Ltd.)

Mr. J. A. Binns, trustee in the bankruptcy of G. F. Cook, electrical engineer, Charles-street, Bradford, has been released.

A receiving order has been made against C. V. de Falbe, Penywern-road, Earl's Court (lately trading at 17, Shaftesbury-avenue, London, as the Electrical and General Contracting Co.). The first meeting of creditors will take place on 22nd inst., and the public examination on Aug. 6, at Bankruptcy-buildings, London.

In the bankruptcy of Alex. Pollock, electrical engineer, Middlesbrough, the first meeting of creditors will take place on 25th inst. at 8, Albert-road, Middlesbrough, and the public examination on the same date at the Court House, Middlesbrough.

In the bankruptcy of A. J. Greenberg (trading as the Midland Electrical Co., Birmingham), Mr. L. J. Sharp, 174, Corporation-street, Birmingham, has been appointed trustee.

Winding-up Petition.—A petition for the winding-up of the Electric Lamp Regenerating Co. (Ltd.) will be heard in the Chancery Division, London, on July 29.

Plant, &c., for Sale.—Norwich Electricity Co., in order to make room for larger sets, offer for sale some Willans engines direct-coupled to Laurence-Scott shunt-wound dynamos. Inquiries to the Company, Duke-street, Norwich, where the plant is running. See also advertisement.

Particulars of some electric lighting plant for sale, are given in an advertisement. The plant includes two Crossley 16 H P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

A Crompton-Howell battery, in fair condition, is for sale. Offers to general manager, Gloucester Railway Carriage and Waggon Co., Gloucester. See advertisement.

Two compound-wound Siemens dynamos, complete with rails, pulley, &c., are advertised for sale on another page.

Messrs. White Bros. & Co., High-street, Stratford, London, E, have for sale a pair of 90 I.H.P. Ruston-Proctor compound horizontal engines, and a Crompton dynamo giving 380 amperes at 110 volts. See advertisement.

Some excellent plant, suitable for mill lighting or for a complete installation of 500 lights, is advertised for sale on another page.

Sales by Auction.—The tramways system of the borough of Cardiff having been electrically equipped, horse cars are no longer required and will be sold by auction on July 28 at the Corporation depôt, Wood-street, Cardiff. Some further particulars are given in an advertisement.

Capital Required.—The owners of a small electric lighting station, operated under provisional order, advertise in another column that they are prepared to consider proposals to enlarge the company to meet an increasing demand for electric current.

Exhibitions.—The 68th exhibition of the Royal Cornwall Polytechnic Society will open at Falmouth on Aug. 26. The society have decided to make electricity a special feature of the exhibition, and the president is Sir William Preece, K.C.B., and in view of the fact that this is Coronation year and that His Majesty is patron of the society, no charge is to be made for space. Some particulars will be found in an advertisement, and all further information can be obtained of Mr. Edward Kitto, The Observatory, Falmouth.

Under distinguished patronage, there is to be an important exhibition opened at Cape Town from November, 1903, to February, 1904. The promoter and general manager is Mr. A. P. Baker, of Cape Town, whose English address is Seymour-grove, Manchester. It is fully anticipated that by the time everything is in trim for the exhibition matters in South Africa will have settled down, and the holding of the show will serve as a send-off for a general commercial awakening. It is said that all the necessary funds have been obtained and that promises of support have come in on a large scale.

There is to be an exhibition of automobiles at Hamburg from Oct. 3 to 12 next. The show is organised by the Association of German Cycle Merchants, and will be held at the Rotherbaum Vélodrome. Particulars can be obtained of M. Löffler, 32, Dammthorstrasse, Hamburg.

An exhibition of commerce, industry, fine arts, &c., is to be opened at Athens on Oct. 15. The enterprise has no official character, although favourably regarded by the Greek Government.

The Coronation.—Messrs. Johnson and Phillips notify that they have a stock of searchlights which may be hired for the occasion of the Coronation, or can be purchased outright.

Carbon Brush Holders.—The Electric and Ordnance Accessorie Co., of Aston, Birmingham, have recently placed on the market a new patent carbon brush holder, in which a simple arrangement is introduced for regulating tension. This consists of a series of notches on which the position of the looped end of the string can be changed from notch to notch. The brush holder has a parallel movement, current being carried by a flexible cable.

Automatic Wheeled Conduit Rods.—Messrs. J. S. Barron & Co., New York, have recently placed on the market the "Villard" automatic wheeled conduit rod, for which it is claimed that they are quickly coupled and uncoupled, are instantaneous in action, and will not buckle when being pushed through the conduit. In the construction of these rods special provision is made for their becoming rigid when pushed through the conduit and flexible when they are pulled, this provision allowing a considerable variance when crossing a manhole, and making it easy to take another duct out of line with the first, the rods becoming again rigid when pushed into the new conduit. It is said to be a physical impossibility for these rods to become uncoupled when in the conduits, as an angle of about 40deg. has to be obtained before the joint can be separated. For the wheels to which the rods are run it is claimed that they save friction and wear on the rods themselves, enabling one man to work long lengths of rods, that they serve as duct cleaners and as a guide to the rods.

Catalogues, &c.—Messrs. Nalder Bros. and Thompson, 34, Queen-street, London, E.C., have now ready section 2 of their new catalogue, which treats of permanent magnet ammeters and voltmeters. Section 3, dealing with recording instruments, and section 4, covering automatic switches and circuit-breakers, will shortly be issued. These goods are all manufactured by Messrs. Nalder Bros. and Thompson in their own works under careful supervision. The section under notice is well got up and fully illustrated.

There was an omission in our note last week relating to the physical instrument list sent us by Messrs. Isenthal & Co. It should have been mentioned that, in addition to being in German, the book is also in English and French, and is, of course, all the more serviceable on this account.

"**Electric Ozone and Light Treatment in Disease.**"—There is ready for circulation, to the medical profession only, a pamphlet on the electric ozone and light treatment by high-frequency currents, published by the Electric Ozone and Light Institute, 14, Hanover-square, London, W. The use of electricity in medical work has been of slow but sure growth, until to-day the number of uses to which electrical apparatus is put in the cure of disease are numerous and important. Any arrangement or system calculated to administer to the curative needs of mankind in an effective and a rapid manner is to be encouraged, and the pamphlet just issued, besides dealing with the methods adopted at the institute, gives a synopsis of over 1,500 cases treated by the electric ozone and light treatment combined with high frequency and electric massage.

"**Flying.**"—The third number of a quarterly magazine devoted to the subject of aerial navigation is just issued by Messrs. Iliffe & Sons, of St. Bride-street, London.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured

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electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 9 to 15, with the ports of destination :—

Africa—Alexandria, £105 (including £56 telegraph material) ; Durban, £214 ; East London, £1,032 ; Port Elizabeth, £124. *Australasia*—Auckland, £1,298 ; Christchurch, £61 ; Lyttleton, £37 ; Melbourne, £387 ; Sydney, £1,329 ; Wellington, £531. *Brazil*—Rio Janeiro, £135. *Burma*—Rangoon, £90. *Canada*—Vancouver, £813,000 (telegraph cable). *Ceylon*—Colombo, £484. *Channel Islands*, £40. *China*—Shanghai, £47. *France*—Boulogne, £15. *Germany*—Hamburg, £572 (including £521 telegraph material). *Holland*—Flushing, £11. *Hong Kong*, £10. *India*—Bombay, £27 ; Calcutta, £352. *Japan*—Tokio, £20 ; Yokohama, £254 ; Yokosaka, £659. *Siam*—Bangkok, £15. *Straits Settlements*—Singapore, £233 (including £209 telegraph material). *Sweden*—Gothenberg, £444 ; Stockholm, £455. *U.S.A.*—New York, £560. Total £822,541, against £12,675 in the corresponding week last year (July 10 to 16).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

May 14, 1902.

11,067. E. TYER, F. T. HOLLINS, and F. W. LEAKE. Electric signalling on railways.
11,068. SIEMENS BROS. & Co. Actuating electrical railway motor cars. (Siemens and Halske A.G., Germany.)
11,072. BRITISH THOMSON-HOUSTON Co. Switches for electric circuits. (J. J. Wood, U.S.)*
11,073. BRITISH THOMSON-HOUSTON Co. Controlling electric circuits. (J. J. Wood, U.S.)*
11,074. BRITISH THOMSON-HOUSTON Co. Winding forms. (J. W. Sundskog, U.S.)*
11,075. BRITISH THOMSON-HOUSTON Co. Switches. (E. M. Hewlett, U.S.)*
11,076. BRITISH THOMSON-HOUSTON Co. Arc lamps. (E. W. Rice, jun., U.S.)*
11,077. BRITISH THOMSON-HOUSTON Co. Supports for high tension conductors. (A. F. Batchelder, U.S.)*
11,078. BRITISH THOMSON-HOUSTON Co. Arc lamps. (W. C. Fish, U.S.)*
11,079. BRITISH THOMSON-HOUSTON Co. Cutouts. (Pendleton G. Watmough, jun., U.S.)*
11,080. BRITISH THOMSON-HOUSTON Co. Multipolar electric switches. (H. R. Sargent, U.S.)*
11,081. BRITISH THOMSON-HOUSTON Co. Starting rheostats. (F. Mackintosh, U.S.)*
11,082. BRITISH THOMSON-HOUSTON Co. Third-rail insulators. (S. B. Stewart, jun., U.S.)*
11,085. STOTHERT AND PITT and E. EVANS. Electric cranes.
11,086. D. R. BROADBENT. London. Switches.
11,101. O. ROMANZE. Electric clocks.
11,102. M. C. KRUEGER. Electric heaters and rheostats.*

May 15, 1902.

11,127. J. T. TRAINER. Huddersfield Trolley arms over electric cars with roofs or covers.
11,134. A. ECKSTEIN and A. G. ANGOLD. Manchester. Arc lamps.
11,139. A. R. BELLAMY. Manchester. Electric ignition.
11,159. W. EMERSON. Grimsby. Spring roller for electric light pendants.
11,160. A. KIRBY and A. J. KIRBY. Arc lamps.
11,165. G. L. ADDENBROOKE. Switch box apparatus for testing, standardising or calibrating electrostatic instruments, and for measuring electric currents.*
11,177. H. HIRST and C. F. TRIPPE. Apparatus for opening and closing circuits.
11,188. P. NÉTY. Continuous-current dynamos.
11,197. J. FENTON, A. du LAC and A. JONCKHEERE. Extracting electricity from the atmosphere and storing it.
11,206. F. ENGELHARDT. Arc lamps.
11,209. F. B. ASPINALL and J. D. DALLAS. Electrical conduit systems for tramways.

May 16, 1902.

11,240. J. C. MACALESTER. Glasgow. Switches.
11,245. W. BERRENBERG. Germany. Cocks or valves for vacuum pumps.
11,249. J. MILNE. Edinburgh. Sliding pendant.
11,269. J. MUNRO. Croydon. Wireless signalling.
11,281. H. W. C. COX. Localising apparatus X-ray coils.
11,286. G. B. PUCHMULLER and G. PEARSON. Galvanic cell.*
11,290. H. H. LAKE. Switches and regulating sockets. (W. P. Pinchard, U.S.)*
11,313. L. WALTER and P. WALTER. Transmission of electrical impulses.
11,323. L. J. ARON and J. W. FOWLER. Electricity meters.
11,324. L. J. ARON and J. W. FOWLER. Two-rate electricity meters.

May 17, 1902.

11,339. W. E. HEYS. Manchester. Portable telephonic apparatus for persons with impaired hearing. (Hutchinson Acoustic Co., U.S.)*
11,340. W. E. HEYS. Manchester. Dry or semi-dry cells. (Hutchinson Acoustic Co., U.S.)*
11,342. W. E. HEYS. Manchester. Charging switches for secondary batteries. (Hutchinson Acoustic Co., U.S.)*
11,357. K. ANDERSON. Leeds. Electricity meters.
11,369. J. J. O'CONNOR and W. O. S. HILDITCH. Manchester. Electric governing devices.
11,374. B. CRUVELLIER. Halifax. Electric traction.*
11,377. L. M. WATERHOUSE and SIMPLEX STEEL CONDUIT Co. Liverpool. Fittings for metallic conduit systems.*
11,393. T. B. STEWART, W. E. TURNER, and R. E. DIXON. Automatic apparatus for controlling points of electric railways and tramways.
11,395. W. R. LAIDLAW and G. H. SCHOLES. Manchester. Rheostat switches.
11,404. O. L. PEARD. Electric fuses.
11,416. E. DUSSEK. Overhead conductors.
11,423. E. CHAQUETTE. Electric clam dredges.*
11,427. J. BAXTER, O. CLARK and C. HILLMANN. Endless conveyor for conveying tin plates from the bath.*

May 20, 1902.

11,454. C. CAREW-GIBSON. Surbiton. Register dials for meters.
11,460. R. C. THOMSON. Glasgow. Electrical propulsion of cars. (D. Kempt, Argentine.)
11,437. G. HARRISON (D. Young & Co.). Electric cables. (Kabel fabrik A.G., Austria.)*
11,489. BRITISH THOMSON-HOUSTON Co. and H. S. MEYER. Starting devices for alternating-current induction motors.
11,499. G. C. MARKS. Electric low-water alarms for steam boilers. (G. Fuller, U.S.)*
11,500. G. C. MARKS. Multiple switches. (Cutler Hammer Mfg. Co., U.S.)*
11,508 and 11,509. W. P. THOMPSON. Production of electrodes for secondary batteries. (Akkumulatoren- und Elektricitäts-Werke A.G. vorm. W. A. Boese & Co., Germany.)*
11,510. W. A. CROOK and E. MINES. Liverpool. Incandescent lamps with rare earth filaments.
11,516. H. J. HADDAN. Electrically-operating tools. (J. S. Andrews and W. M. Simpson, U.S.)
11,523. M. DEBI. Transmitting electricity in works for traction purposes.*

May 21, 1902.

11,567. L. H. WALTER. Receiver for wireless telegraphy.

May 22, 1902.

11,640. A. MARR. Manchester. Cushions for electric light shades.
11,668. A. SCHMIDT-PREDARI. Electric accumulators.
11,683. W. S. SIMPSON. Generating and utilising electricity.
11,692. E. P. THOMPSON. Wireless telegraphy.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

3,935. JONES and DAVIS. Laying underground conductors.
9,284. TYER, HOLLINS and LEAKE. Electrical signalling on railways.
9,770. BROWN. Electrical ignition for internal combustion engines and similar purposes.
10,166. BOULT (Joy Printing Telegraph Co.). Printing telegraph receivers.
10,766. MACQUISTEN. Electromagnetic selectors for loom jacquards.
11,931. ALLCROFT. Regulating and controlling electric motors.
13,010. BING and BELL. Telephone and bell set.
13,078. GIBBS. Accumulators.
13,402. LATOUR. Self-exciting alternating-current dynamos. (Rights under sec. 103 not granted.)
13,666. DRAKE and NERNST ELECTRIC LIGHT (LIMITED). Lamp-holders for electrolytic lamps.
14,165. POHL. Manufacture of carbon electrodes.
14,486. QUIRAY (Soc. Electro-Metallurgique Française). Manufacture of wrought iron, steel and cast iron by electric heating.
14,643. QUIRAY (Soc. Electro-Metallurgique Française). Electric furnace arranged to be oscillated or tipped.
14,822. RHODIN. Electrolytic apparatus.
16,460. WILKINSON. Alternating-current transformers and accessories.
18,597. W. J. CLARK (J. B. Foote). Electric regulating apparatus.
20,497. WILKINSON. Cable terminal boxes.
24,054. DAVIES. Arc lamp resistances.
24,239. DRAKE, SHEPHERD, RAM and NERNST ELECTRIC LIGHT. Holders for Nernst lamps.
26,484 and 26,485. LAKE (Central Electric Construction Co.). Third rail conductors for electric railways.
26,604. SIEMENS BROS. & Co. (Siemens and Halske A.G.). Instruments for recording varying magnetic fields or the currents producing them.

1902.

1,736. PHILLIPS. Controlling supply of electricity to medical heating apparatus.
1,737. PHILLIPS. Electric sweating appliance for medical use.
1,888. HOPKINSON. Electrical distribution.
1,984. STUTCHBURY and GORICK. Transformer.
2,701. LAMBERT. Telephone line jacks.
2,820. GARUTI AND POMPILI. Apparatus for the electrolysis of water.
3,224. CEREBOTANI and BAUMER. Intercommunication telephone systems.
4,520. APPLE. Electric batteries.
4,522. APPLE. Electric ignition for explosion engines.
4,906. SIMPSON. Controllers for electric vehicles.

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COMPANIES' MEETINGS AND REPORTS.

Chili Telephone Co. (Ltd.)

The thirteenth ordinary general meeting was held yesterday, Mr. GEORGE KEITH presiding.

The SECRETARY (Mr. Edmund Petley) having read the notice convening the meeting,

The CHAIRMAN said: The business of the company has been working very favourably during the past year and the progress is satisfactory. The gross revenue in Chili shows a large increase, with a relatively small increase in the expenditure. The result is a net increase of income in Chili of $57,605, or about 17 per cent. more than it was in the preceding year. A large portion of this gain has been required to adjust the business to the lower sterling value of the currency ruling during the year. The net income when converted into sterling comes out at £24,340, showing an increase for the year of £1,050. Looking at the revenue account you will find the usual London expenses and charges. The debit for income tax shows an increase of £193; and as an offset to this, the credit for interest and discount is £322 more. After paying the debenture interest and adding the amount brought forward from last account, we have an available balance of £21,720. With this amount we have put £7,986 to the reserve, and now propose the payment of a dividend, same as last year, of 5 per cent. for the year, free of income tax, carrying forward £2,733. Now, turning to the balance-sheet, the loss on the valuations due to the fall of the exchange, amounts to £986, and is taken from the reserve. Last year £800 was added owing to the exchange having risen. This item may be neglected, as it adjusts itself from year to year. The sum of £7,986 is added to the reserve from the revenue of the year, as compared with £5,200 last year, and £2,733 is carried to next account, as compared with £2,680 brought forward from last account. On the other side, capital expenditure shows an increase for the year of £948, and investments an increase of £9,549. Altogether, I think, the balance-sheet shows a good improvement in the finances of the Company. As regards the property, a large amount of improvements and extensions has been carried out during the year. Some 163 miles of new wire have been put up and equipped. The new multiple switchboard, which I mentioned last year we had on order, has now been erected and installed at Santiago. This enables an improved service to be given there, and will, no doubt, lead to an increase of business. I may also mention that we are arranging to put our wires underground in the central part of the city of Santiago. During the past year several serious accidents were caused in the streets by overhead wires coming in contact with the electric tramway trolley wires. In order to obviate this public danger the Government has introduced a bill for regulating electric services which requires telegraph and telephone wires to be put underground. The bill has already been favourably reported upon by a Commission of the House of Deputies, and now awaits the approval of Congress. As soon as it is passed, the work of putting our wires underground will be commenced. The cost will be heavy, but as the work will extend over a considerable period, I think we will be able, if all goes well, to meet it without overtaxing our finances. The past year was not very favourable for successful business in Chili. The difficulties with the Argentine concerning the boundary question, and the postponement till 1905 of the metallic conversion of the currency, had a depressing effect on the Chilian money market and business generally. Lately, the international difficulties have disappeared. In May Chili and the Argentine came to an amicable arrangement regarding general arbitration and limitation of armaments. The exchange has risen, and now stands at 15⅞d. Our business continues to work favourably, and the prospects for the present year are good. I now move the adoption of the report and accounts.

The motion was seconded by Mr. FRANK W. JONES and carried unanimously.

Resolutions approving the dividend, and re-electing the retiring Director, the Hon. H. Allsopp, and the retiring Auditor, Mr. T. A. Welton, were then carried and a vote of thanks to the Chairman, Directors and officials of the Company terminated the proceedings.

Telegraph Construction and Maintenance Co. (Ltd.).

A half-yearly meeting was held on Tuesday, Sir R. G. W. HERBERT presiding.

The SECRETARY (Mr. E. Dickens) having read the notice convening the meeting,

The CHAIRMAN said: This is our interim half-yearly meeting, and we present no report and accounts, but avail ourselves of the opportunity of declaring an interim dividend at the rate of 5 per cent. We are pleased to have the opportunity of assuring you that the affairs of the company, its factories and ships, and its business, are progressing in the usual satisfactory manner. This has been a very busy half-year, and a great amount of cable has been constructed and shipped. On Saturday our new ship, the "Colonia," sailed for Vancouver with 3,500 knots—a long stretch of cable—to connect Vancouver and Fanning island, and we have every hope that the excellent trial trip she made and the admirable construction she evinces will prove that she will do her work quite as well as the "Anglia" has done her work. The "Colonia," as you know, is the largest cable ship we own or which exists in the world. She carries 11,000 tons of dead weight, is 500ft. long, and can carry 4,000 knots of cable, and did steam on her trial trip as much as 14½ knots, so that she is a very efficient vessel, and we look forward with sanguine hopes to the result of her present work, which is rather difficult because of the great length of the section. The "Anglia" has returned to England, having laid the shorter portions of the line connecting Vancouver with Australia and New Zealand. She went through the very severe experience of a cyclone, but behaved in a very satisfactory manner, and proved herself a thoroughly good sea-going ship. We are hard at work, and are still constructing some portion of the Pacific cable. The whole contract will be completed before the time in which we undertook to finish the work. The whole of the cable connecting Canada with Australia and New Zealand had to be completed before the end of the year, and we shall be more than ready with the work when that time arrives. We have smaller jobs to execute than that of laying the Pacific cable, such as providing lengths of cable for repairs and occasional breakdowns for various companies. We expect to be pretty well employed until we meet you again at the regular annual meeting. I have only now to inform you that the interim dividend will be paid.

Mr. CROFT moved a vote of thanks to the chairman, directors, and staff, which was carried unanimously, and the chairman having replied, the proceedings terminated.

Eastern Telegraph Co. (Ltd.).

The report of the directors for the half-year to March 31, 1902, states that the revenue amounted to £617,525. 15s. 9d., from which are deducted £149,650. 5s. 9d. for ordinary expenses and £39,795. 8s. 11d. for expenditure relating to repairs and renewals of cables, &c. After providing £6,784. 8s. 4d. for depreciation of spare cable, £217. 12s. 9d. for differences in exchange, and £11,024. 19s. 8d. for income tax, there remains £410,053. 0s. 4d., to which is added £24,533 brought forward, making £434,586. 0s. 4d. From this there has already been paid in interest and dividends £114,546. 3s. 1d., leaving £320,039. 17s. 3d. The directors have placed £10,000 to maintenance ships reserve, and £175,000 to general reserve, and now recommend a final dividend on the ordinary stock for the year ended March 31 of 1½ per cent. and a bonus of 2 per cent., absorbing £130,000, both payable 24th inst., tax free, and making a total distribution of 7 per cent. for the year, carrying forward £5,039. 17s. 3d. The revenue includes £27,193. 5s. dividends on the company's investments in other telegraph companies.

This company, in conjunction with the Indo-European Telegraph Co., have entered into an arrangement with the Indian Government for the reduction of the tariff between Europe and British India on the basis of a partial guarantee of revenue, and of a "standard revenue" somewhat similar to that already adopted in connection with South Africa and Australia. Tariffs between Europe and the Straits Settlements and Dutch Indies have also been reduced.

Under a tentative arrangement made with the Government of the Commonwealth of Australia, the tariffs between Great Britain and the colonies of Victoria, Queensland and New Zealand were reduced from June 1 last, and the three above-named States, during the continuance of the tentative arrangement, are now in the same position as the other States of the Commonwealth.

The section of cable between Perth and Adelaide was successfully established by the Eastern Extension Company in March last, thus completing direct telegraph communication between Great Britain and Australasia via South Africa.

The report of the Inter-Departmental Committee on Cable Communication, dated March 26 last, has been issued in the form of a Blue Book. After an exhaustive inquiry into the whole question of telegraphic communication, the examination of existing rates and the consideration of the political and commercial aspect of international telegraphy, the Committee have issued a report which is a gratifying vindication of the policy hitherto pursued by the Associated Companies.

NEW COMPANIES, STATUTORY RETURNS, &c.

BATH ELECTRIC TRAMWAYS (LTD.)—Reg. July 9, capital £230,000 in £1 shares (75,000 preference, 125,000 preferred ordinary and 30,000 deferred), to acquire and work tramways in or near Bath by electricity or other power, to manufacture and deal in motor vehicles, accumulators and dynamos, to adopt an agreement with the E.C. Syndicate, to manufacture, lay down and maintain cables, wires and lines, and to carry on the business of a tramway, telephone, telegraph and electric light company, &c. The subscribers are Sir V. Caillard, Hon. Sir J. Sivewright, K.C.M.G., H. F. Clutterbuck, H. A. Butters, director of Geneva Electric Tramways and Mexico Electric Tramways Co., and A. A. C. Swinton (each with 250 shares), J. E. Huxtable and A. R. Warren (one share each). The minimum cash subscription is fixed at £135,000. The first directors are the first five names set out above. The company have invited public subscription this week.

BRITISH EASTERN ELECTRIC POWER CO. (LTD.)—Reg. July 9, capital £1,000 in £1 shares, to carry on the business of electricians, suppliers of electric light, proprietors of tramways, light railways, &c., engine and machinery builders, makers of rolling stock, &c. The subscribers are W. D. Hoare, G. Miller, R Miller, R. S. Guinness, J. Kincaid, C.E., E. Manville, C.E., and J. E. Waller, C.E.

BRITISH UNITED TRAMWAYS (LTD.)—Reg. July 9, capital £100 in £1 shares, to construct, maintain and work tramways, light railways, electric and other railways, motors, accessories and appurtenances, to supply electricity, &c.

BURGE, WARREN AND RIDGLEY (LTD.)—Reg. July 7, capital £25,000 in £1 shares (10,000 first class and 5,000 second class cumulative preference, and 10,000 ordinary), to take over the business of manufacturers of and dealers in vulcanite, ebonite and indiarubber, &c., carried on in London as Burge, Warren and Ridgley. Messrs. W. B., C. E. and A. V. Warren and H. Ridgley are permanent directors and managers. Reg. office: 91–92, Great Saffron-hill, London E.C.

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CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24⅝d. per oz. (July 17). Consols (2¾ per cent.) 95⅞—95½ for money, 95⅞—96 for account; 2½ per cent. 96—96½ (July 17). Consols Pay Day, Aug. 7; Stocks and Shares Continuation Days, July 28 and Aug. 12; Ticket Days, July 29 and Aug. 13; Pay Days, July 30 and Aug. 14; Mining Share Carry-over Days, July 25 and Aug. 11.

BARCELONA TRAMWAYS CO. (LTD.)—The company is offering £51,900 4½ per cent. redeemable debenture stock at 93 to its share and debenture stock holders.

BATH ELECTRIC TRAMWAYS (LTD.)—During the week this company (with a share capital of £230,000 in 75,000 £1 5 per cent. cumulative preference, 125,000 £1 preferred ordinary, and 30,000 £1 deferred ordinary shares) has invited applications for the whole of the preference and 100,000 preferred ordinary shares at par.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD CO.—In their report for 1901 the directors state that Parliamentary powers have been acquired to reconstruct this line on a viaduct from the borough boundary to Rottingdean, and it is hoped the necessary capital may be raised and the line constructed ready for next summer.

BRITISH ELECTRIC TRACTION CO. (LTD.)—Mr. W. L. Madgen has been appointed a director of this Company.

CITY AND SOUTH LONDON RAILWAY CO.—The accounts for the half-year ended June 30 show a balance, after providing for debenture stock interest, payment of dividend on preference stocks and transfer to renewal fund of £2,000, sufficient for a dividend on the consolidated ordinary stock for the half-year at the rate of 3 per cent. per annum, carrying forward £1,750. The dividend for the corresponding period last year was 1¾ per cent., carrying forward £733.

CITY AND SURREY ELECTRIC RAILWAY CO. (LTD.)—This is described in a private prospectus as a "new parent syndicate," and is floated by the National Electric Traction Co. (Ltd.), who offer for sale "the shares which have been issued to them under the terms of a contract." The capital of the City and Surrey Railway is £150,000 in £10 shares, 5 per cent. dividend and a 17½ per cent. bonus being guaranteed by the National Electric Traction Co. (Ltd.) (called the contracting company) during the construction of the line. The financial proposals set out in the prospectus are unique and somewhat involved—a fact which will, doubtless, be duly taken into consideration by investors. Some Press opinions, set out boldly on the front page of the prospectus, are as brief as they are anonymous. The prospectus will be issued to the public in a few days, and in the meantime applications, to ensure allotment (according to a circular which is being issued), should be sent in promptly, as "such allotments will be made in the order in which such applications are received."

CROMPTON & CO. (LTD.)—The directors have decided, subject to audit to recommend the payment of a dividend at the rate of 6 per cent. per annum for the half-year ended March 31.

DIRECT UNITED STATES CABLE CO. (LTD.)—A final dividend of 3s. per share and a bonus of 1s. per share (both tax free), payable 31st inst., is declared, making, with three interim dividends, a total distribution of 3½ per cent. for year ended June 30, and, after placing £5,000 to reserve, the carry forward is about £2,196. The transfer books are closed from July 16 to 29 inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The interest on the 4 per cent. mortgage debenture stock for the half-year to July 31 will be paid by warrant on Aug. 1. The register will be closed from 28th to 31st. inst. inclusive.

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended June 30, 1902. The following statement, dated June 11, shows the condition of the company at the close of the quarter ended March 31, 1902:—

Surplus Jan. 1, 1902, as per last quarterly report.....		$10,209,866 28
Net revenues, quarter ended March 31, 1902		1,592,218 37
		$11,802,084 65
From which deducting for—		
Dividend of 1¼ per cent. paid Apl. 15	$1,217,008 75	
Interest on bonded debt	254,770 00	
		1,471,778 75
Left a surplus April 1, 1902, of		$10,330,305 90
The net revenues of the quarter ending June 30, based upon nearly completed returns for April, partial returns for May, and estimating the business for June will be about		1,850,000 00
From which appropriating for—		$12,180,305 90
Interest on bonds.....		254,770 35
		$11,925,535 55
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,217,010 00
Deducting which leaves a surplus, after paying dividend, of.....		$10,708,525 55

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared payable on and after the 15th inst.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—An interim dividend on the 7 per cent. preference shares and on the ordinary shares at the rate of 10 per cent. for the half-year to June 30 has been declared. The share transfer books will be closed from the 18th inst. to Aug. 1, inclusive.

The amount of electricity sold by the company for the quarter ended midsummer, 1902, is returned at 1,420,683 units, estimated to produce £24,270, against 1,115,593 units, which produced £19,383, for the corresponding period last year.

STOCK EXCHANGE NOTICE.—Application has been made to the Stock Exchange committee to appoint a special settling-day in, and to grant a quotation to, the 4 per cent. first mortgage debenture stock and a further issue of 4 per cent. first mortgage debenture stock (in lieu of the 4½ per cent. first mortgage debenture stock now quoted) of *Willans and Robinson (Ltd)*.

WELSBACH INCANDESCENT GAS LIGHT CO. (LTD.)—In the directors' report it is stated that the Austrian company sold during the past financial year a moiety of the French, Spanish and Portuguese patent rights of the osmium electric lamp to the Société Française, Paris, for £40,000. Owing to technical difficulties the production of the osmium lamp has not yet reached the desired development. The results obtained hitherto in the preparatory stages of manufacture are, however, so favourable that nothing stands in the way of starting manufacture on a large scale.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	...	...	...	...	...	...
Ayr Corporation	July 12	302	...	8	2,504	...
*Birmingham Tramways.	„ 12	5,241	+ 334	1	5,241	+ 334
*Blackburn Corporation..	„ 11	860	+ 118	15	12,931	+ 2,138
Blackpool Corporation...	„ 10	996	− 295	15	11,062	− 719
Blackpool and Fleetwood	„ 12	714	− 328	2	1,171	− 656
Bolton Corporation	„ 13	1,611	− 79	15	24,515	+ 1,632
Bradford Corporation ...	„ 13	3,616	+2,510	15	49,471	+34,987
Brighton Corporation ...	„ 13	1,003	...	33	21,653	...
Brisbane Tramways.....	May 23	2,289	− 459	22	51,154	+ 3,859
*Bristol Trams & Carriage	July 11	5,151	+ 86	1	5,151	+ 86
*Buenos Ayres & Belgrano	June 15	2,758	+ 418	...	...	...
Burnley Corporation ...	July 12	784	+ 263	‡15	10,664	+ 3,762
Calcutta Tramways Co...	„ 12	₹24 218	+₹4,161	2	₹ 48,777	+₹ 8,886
Cardiff Corporation	„ 12	1,584	...	15	18,279	...
Carlisle Tramways Co....	„ 12	470	+ 255	†28	4,621	+ 349
Central London Railway	„ 12	6,847	+ 702	2	14,043	+ 1,819
City & South London Ry.	„ 13	2,786	+ 914	2	5,607	+ 1,763
Cork Elec. Tramways Co.	„ 10	764	+ 152	§27	12,995	+ 790
Devonport & Dist. Trams	„ 4	465	+ 132	26½	10,810	+ 184
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	„ 12	269	− 5	15	3,318	− 66
Dublin & Lucan Railway	„ 13	120	− 33	2	240	− 61
Dublin Southern Dist....	† „ 11	1,152	− 53	†2	1,695	− 210
Dublin United	† „ 11	4,051	− 121	†2	6,320	
Dudley—Stourbridge ...	„ 4	786	+ 56	26½	18,604	+ 2,693
*Dundee Corporation ...	„ 9	777	+ 88	...	...	...
East Ham Council	„ 12	597	+ 34	3	1,683	+ 271
Gateshead & Dist. Trams	„ 4	806	+ 260	26½	18,326	+ 2,476
Glasgow Corporation ...	...	...	...	...	...	...
Greenock & Port Glasgow	„ 4	658	+ 394	26½	12,144	+ 7,134
Hartlepool Tramways ..	„ 4	315	+ 41	26½	6,112	+ 685
Hull Corporation	„ 12	1,806	+ 30	15	25,927	+ 929
Isle of Thanet Co.	„ 5	893	− 112	...	...	...
Kidderminster & Dist....	„ 4	166	− 20	26½	2,985	+ 57
Leeds Corporation	„ 12	5,378	+ 576	15	80,231	+13,175
*Liverpool Corporation...	„ 5	10,484	+ 548	27	254,087	+22,513
Liverpool Overhead Rly.	„ 13	1,584	− 181	‡2	3,179	− 313
Manchester Corporation	„ 12	5,475	+2,954	§57	140,946	...
Merthyr.....	„ 4	223	− 18	26½	5,324	− 666
Middleton	„ 4	334	...	14½	4,543	...
Newcastle-on-Tyne Corp	„ 12	2,688	...	...	...	...
Oldham, Ashton & Hyde.	„ 4	587	+ 56	26½	13,402	+ 432
Perth (W.A.) Elec. Trams	„ 11	1,007	+ 143	¶27	29,599	+ 5,785
Poole & Dist.....	„ 4	298	+ 20	26½	6,043	− 66
Portsmouth Corporation	„ 12	1,945	+ 936	...	...	...
Potteries	„ 4	1,689	− 71	26½	33,039	+ 1,497
Salford Corporation ...	„ 14	2,736	+ 789	15	38,475	...
*Sheffield Corporation ..	„ 13	4,277	+ 370	2	8,793	+ 1,290
Southampton Corporat'n	„ 10	1,091	+ 88	...	...	...
Southend Corporation...	„ 9	348	...	14	3,532	...
Southport Tramways ...	„ 4	382	+ 204	26½	5,831	+ 1,984
*S. Staffordshire Trams...	„ 4	810	− 22	26½	20,315	+ 728
Sunderland Corporation.	„ 13	1,190	− 97	15	17,399	+ 1,707
Swansea Trams.....	„ 4	583	+ 111	26½	11,975	+ 1,403
Taunton Trams.....	„ 4	71	...	26½	1,580	...
Tynemouth & Dist.	„ 4	393	+ 60	26½	6,392	+ 539
Wigan Corporation	„ 10	260	+ 41	...	...	...
Wolverhampton District	„ 4	157	+ 100	26½	3,846	+ 2,479

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, July 9.		Price Wednesday, July 16.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 16	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Bl'okh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½	¾	½	¾		...	...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100	104	100	104	4 6 9	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	5 12 0	...	12	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101	104	101	104	4 6 7	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9	9½	9	9½	4 4 3	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9¼	9	9½	3 13 8	March and September	...	...
21,000	5	3/6	Calcutta Elec. Supply Ordinary (Nos. 1-20,000)	8½	9½	8½	9½	3 3 2	...	...	...
10,000	5	3/4.5/16	Do (Nos. 20,001-30,000)	8½	9¼	8½	9¼		...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	107	105	107	3 15 2	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	10	9	10	5 0 0	February and August	9 1/16	9 5/16
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	5¾	5½	5¾	3 18 3	,, ,,	5 11/16	5 5/8
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	105¾	...
44,426	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½	5¾	5½	5¾	2 12 2	March	5⅝	...
* £150,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8	9	8½	9½	5 5 3	February and August	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref. xd	11½	12½	11½	12½	4 16 0	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	121	126	122	127	3 18 9	June and December	125	124
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	101	104	101	104	4 6 7	...	103½	102
40,000	10	4/0	County of London and Brush Prov. Ordinary	8	9	8	9	4 9 0	...	8⅝	8⅜
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12½	11½	12½	4 16 0	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	108	111	108	111	4 1 1	...	108¾	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5¾	6¼	5¾	6¼	3 12 0	...	...	...
£250,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10	11	10	11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½	6¾	6½	6¾	4 8 11	January and July	...	...
£200,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104	107	105	108	3 14 11	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1½	1¾	1½	1¾	...	...	...	...
49,340	5	3/0	Do. 6 per Cent. Preference	4	4½	4	4½	6 13 4	...	4½	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	94	99	94	99	4 0 10	Mar., June, Sept., Dec.	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16	17	16	17	3 16 6	April and October	16½	16½
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	109	113	109	113	3 19 8	June and December	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	98	101	99	101	3 10 0	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary xd	14	15	13½	14½	4 2 9	March	14⅛	...
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock xd	99	102	97	100	4 0 0	...	...	...
300,000	1	...	Rand Electric	⅜	⅞	⅜	⅞	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 7 0	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97	100	97	100	3 10 0	...	100	99⅝
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2⅝	3⅛	2⅞	3	...	...	5⅝	...
110,000	5	5 6	Westminster Electric Supply Ordinary	11	12	0⅛	1⅛	5 0 0	March and September	11⅛	10⅝
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5⅛	5¾	5⅝	6⅛	4 0 0	...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4⅛	4⅜	3⅞	4⅛	4 17 0	April and October	4 1/16	3⅞
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	8½	9⅜	9	9⅛	3 3 2	...	9⅛	...
10,000	10	5/0	Do. 5% Cumulative Preference	8¾	9¼	8¾	9⅛	5 5 3	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 4	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½	14½	13½	14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3¾	4¼	3¾	4¼	...	...	...	...
75,000	5	2/6	Do. 5% Cum. Pref.	4¾	5	4¾	5	5 0 0	...	4 13/16	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	102	105	102	105	4 5 9	...	104¼	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21	22	21	22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd.)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures xd	105	107	105	107	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7½	7	7½	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9¼	10	9½	10	5 0 0	May and November	9⅞	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102⅝	104⅞	102⅞	104⅞	4 6 9	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12	13	12	13	6 18 6	...	12⅞	12⅝
100,000	10	6/0	Do. 6% Cum. Pref.	12	12½	12	12⅝	4 16 0	February and August	12⅝	12⅜
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	126	124⅞
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝	1⅞	1⅝	1⅞	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅞	5⅛	4⅞	5⅛	5 14 3	...	5⅛	...
27,500	5	10/0	Do. "B"	5	5⅜	5	5⅜	5 9 1	...	5⅛	5 1/16
£220,000	Stock	5%	Do. 5 per Cent. Debentures	102	105	102	105	4 15 3	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	95	98	95	98	5 2 0	...	...	...
35,000	10	6/0	Calcutta Tramways (Nos. 1 to 34,440)	...		...		2 0 0	...	...	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	106	108	106	108	4 3 7	...	...	...
480,000	1	1/2⅞	Cape Electric Tramways Shares xd	2⅝	2⅞	2⅝	2⅞	3 16 2	...	2 3/16	2 1/16
£1,810,014	Stock	4%	Central London Ordinary Stock	106	109	106	109	3 13 5	June and December	108⅜	107⅝
£494,093	Stock	4%	Do. 4% Preferred Stock	107	110	107	110	3 12 3	...	108¼	107⅝
£494,993	Stock	4%	Do. Deferred Stock	104	107	103	106	3 15 6	...	106	103⅛
£698,201	100	4%	Do. 4% Deb. xd	117	120	115	118	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	4¾	5¼	4¾	5¼	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	2½%	City and South London Railway Con. Ordinary	74	76	73	75	2 13 4	February and August	75¼	73
37,500	10	1/0⅝	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	,, ,,	...	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	..		...		...	...	...	..
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	133	128	133	3 15 5	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	128	131	129	132	3 17 0	...	...	...
£150,000	Stock	...	Do. (1901)	122	126	122	126	...	...	125	124⅝
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	115⅛	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11½	12½	11½	12⅝	3 16 11	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½	15⅝	14½	15⅝	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4¼	4⅝	4¼	4⅝	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	102	99	102	4 18 0	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8	9	8	9	3 6 8	...	...	...
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	13¾	13½	13¾	4 7 3½	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture xd	108	110	108	110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½	5	4½	5	...	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4 13/16	4 15/16	4 13/16	4 15/16	3 0 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅜	11	10⅜	11	4 11 1	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture xd	99	101	97	99	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	10½	11	11⅛	11	4 10 11	...	10⅞	10¾
30,999	10	2/3	Do. (£7, 10s. paid)	8	8½	8	8½	...	...	...	...
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	107	109	107	109	3 13 3	...	108⅜	108
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	81	83	81	83	...	...	...	...
$5,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	xd115	119	112	117	4 5 7	...	...	...
£80,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	104	106	104	106	4 14 9	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	104	106	104	106	4 6 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½	4⅛	3⅝	4⅛	6 13 4	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93	98	93	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100	103	100	103	4 17 5	...	103	101½
18,334	10	8/0	Potteries Electric Traction Ordinary	8½	9⅜	8½	9⅜	4 4 3	...	8⅝	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10⅜	9½	10⅜	4 15 2	February and August	10 1/16	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	107	110	107	110	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...		...		...	...	...	...
51,182	1	...	Do. 6% Preference (12/0 paid)	...		...		...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...		...		...	,, ,,	...	...
500,000	Stock	...	Do. 4½% Debenture Stock (60% paid)	...		...		...	January and July	...	...
1,000,000	Stock	2½%	Waterloo and City Ordinary	93	98	92	95	3 3 0	June and December	92	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 9.		Price Wednesday, July 16.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending July 16. Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.).....	98	102	98	102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph.....	3⅜	4⅜	3⅜	4⅜	...	June and December ..	4 1/16	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£758,840	Stock	12/6	Anglo-American	43	49	46	49	5 17 3	Feb., May, Aug., Nov.	...	...
£3,105,580	Stock	25/0	Do. Preferred.....	90	92	90	92	6 7 1	,, ,,	92	90½
£3,105,580	Stock	2/0	Do. Deferred	7	7⅛	6⅞	7⅛	1 6 8	,, ,,	7⅛	7 1/16
$13,333,300	$100	$12	Commercial Cable Capital Stock.....	165	175	165	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock.....	95	97	95	97	4 2 6	,, ,,	96½	95⅝
16,000	10	4/0	Cuba Submarine Ordinary	4⅜	5⅛	4⅛	5⅛	7 5 6	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½	13½	12½	13½	7 8 2	,, ,,	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅜	3⅛	2⅜	3⅛	5 14 4	April and October.....	2⅜	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7⅜	8⅛	7⅜	8⅛	5 17 8	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞	103⅞	97⅞	103⅞	4 7 8	January and July	...	...
60,710	20	3/0	Direct United States Cable	10	11	10	11	5 18 2	Jan., Apr., July, Oct.	10½	10
196,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December ...	...	...
£4,000,000	Stock	25/0	Eastern Ordinary ....[to 1,200) (red.)	120	130	120	130	5 7 8	Jan., Apr., July, Oct.	124	121½
£1,955,565	Stock	17/6	Do. 3½ per Cent. Preference Stock ..... xd	88	91	88	91	3 17 8	,, ,,	83½	88
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	107	111	108	112	3 12 2	,, ,,	109	...
300,000	10	2/6	Eastern Extension ..... xd	12	13	12	13	5 7 8	May and November ...	12⅝	12⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	108	113	110	114	3 11 4	Jan., Apr., July, Oct.	112	111½
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100	103	100	103	3 19 0	February and August	101½	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red. ...	100⅞	103⅞	100⅞	103⅞	3 18 3	May and November ...	100	...
150,000	10	5/0	Great Northern of Copenhagen	25	27	25	27	5 11 1	January and July	26⅜	26⅜
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos.	99	102	99	102	4 8 1	June and December ...	...	...
17,000	25	37/6	Indo-European.....[1 to 1,200) (red.	37	41	37	41	6 1 11	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 .	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.) ...	99	102	99	102	3 18 5	June and December...	...	...
15,609	10	...	*West African Telegraph Shares	3⅜	4⅛	3½	4⅛	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	100	103	100	103	4 18 5	March and September	...	...
30,008	2½		West Coast of America.....	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97	100	97	100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	⅜	⅝	⅜	⅝	...	May and November ...	⅛	...
34,563	10	0/0	Do. 6 per Cent. 1st Pref.	5⅛	5⅝	5⅛	5⅝	10 8 8	,, ,,	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅛	4⅛	3⅛	4⅛	...	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	January and July	...	...
207,980	10	3/0	Western Telegraph (late Er xill'n Submarine)	11⅛	12½	11⅛	12⅛	5 16 4	Mar., June, Oct., Dec.	12½	11⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	101	104	101	104	4 16 2	June and December...	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)...	97	100	98	101	3 9 6	...	...	...
			TELEPHONES.								
44,000	£5	5 0	Ohill Telephone (fully paid)	⅜	½	⅜	½	5 18 0	August	4 1/16	4
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October.....	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¼	⅜	¼	½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	½	1	½	1	5 0 0	,,		
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	97½	95
200,000	5	0/1½	Do. Preferred Shares (£3. 12s. paid)	4⅜	4⅞	4⅜	4⅞	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	54	58	55	59	7 15 2	...	56	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference..	12	14	12	14	4 5 9	February and August	13½	13⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	12	14	12	14	4 5 9	,, ,,	...	...
250,000	5	2,6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	4⅞	5⅛	4⅞	5⅛	4 17 6	,, ,,	...	...
£2,000,000	Stock	3e%	* Do. Debenture Stock 3½ per Cent. (red.)....	93	96	94	97	3 12 0	June and December ..	95	94
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6	...	...	...
171,504	1	0/8²	Oriental	1/16	1 1/16	1/16	1 1/16	5 12 11	April and October.....	...	...
58,000	5	2/6	United River Plate ..... xd	5	5½	4½	5½	6 13 4	July	...	...
40,000	5	2 6	Do. 5% Cumulative Pref.	4½	5	4½	5	4 15 3	June and December ...	4⅝	...
£179,947	Stock	5	* Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 16 2	June and December ...	...	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref..... ...	⅜	½	⅜	½	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛	¼	⅛	¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜	½	⅜	½	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary —	7⅛	8⅛	7⅛	8⅛	5 17 8	July and February ...	...	...
70,000	5	3/0	Do. 6 per Cent. Preference ..... xd	5⅛	6	5⅛	6	5 0 0	January and July	...	...
£250,000	Stock	4 %	Do. 4½% 1st Mort. Deb. Red.	100	103	101	104	4 6 1	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference..... ...	5⅞	6⅛	5⅞	6⅛	4 18 0	...	6 1/16	5⅞
105,731	2	...	Brush Electrical Engineering	1⅛	1⅜	1⅛	1⅜	...	March	...	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅛	2⅛	1⅛	2⅛	...	March and September	1⅜	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock.....	101	104	101	104	4 6 7	March and September	103⅜	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	94	99	94	99	4 10 10	January and July	...	...
30,000	5	5/0	Callender's Cable Construction Ord. ... xd & bonus	16	17	15½	16½	4 10 11	,, ,,	...	...
40,000	5	3/6	Do. 5 per Cent. Cumulative Preference..	5⅛	6	5⅛	6	5 0 0	,, ,,	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb.(red.).....	103	113	103	113	3 19 8	November and May ...	...	...
450,000	1	0,9⅜	Castner-Kellner Alkali Co. (fully paid).....	1	1⅛	1	1⅛	4 16 0	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	95	100	95	100	4 11 9	...	...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	8 0 0	March	...	...
85,000	3	1/9⅜	Crompton and Co. (Nos. 1 to 54,000)	3	3½	2½	3½	6 19 0	January and July	3	2⅝
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb.(red.) ...	101⅝	106⅝	101⅞	106⅞	4 14 4	...	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid) ..	⅛	⅜	⅛	⅜	...	February and August	...	...
17,139	5	...	Do. (£5 paid).....	1⅛	2⅛	1⅛	2⅛	...	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.) ..	76	78	76	78	5 3 0	June and December...	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	76	81	76	81	6 3 5	...	79	...
£5,500	5	4 0	Edmundson's Electricity Corporation Ord..... xd	6½	6⅞	6	6⅛	5 7 8	Half-yearly	6⅝	...
33,000	5	3/0	Do. 6% Cumulative Preference	5⅞	6⅛	6	6⅛	4 12 4	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.) xd	107	110	105	108	4 3 4	...	107	...
112,100	2	1/2½	Electric Construction Co. ..... xd	1½	1⅝	1½	1⅝	6 17 2	January and July	...	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference ... xd	2⅞	3	2⅞	3	4 13 4	July	...	...
£132,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) xd	99	102	97	100	4 0 0	January and July	...	...
122,985	1	...	Electro'ytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	1	1½	1	1½	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	9¾	10½	9⅝	10½	4 17 7	...	10	9⅝
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98	101	98	101	3 19 3	...	...	...
35,000	5	5/0	Henley's Telegraph Works Ordinary	16	17	14	17	4 8 3	February and August	...	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	6	5⅛	6	3 15 0	,, ,,	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) ..	111	115	111	115	3 18 3	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 10 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	103	100	103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary ..... xd	15½	16½	14½	15½	6 9 0	July	...	...
37,350	12	12 0	Telegraph Construction and Maintnce, ... xd	35	38	35	38	6 6 5	March and July	37⅛	36⅛
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	101	104	102	105	3 16 2	January and July	104½	...
25,000	5	8 0	Do. Manufacturing Ordinary		...		...	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference		...		...	4 3 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary		...		...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.....		...		...	...	,, ,,	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3 0	Electric and General Investment 6% Cum. Pref. ...	5½	5⅝	5½	5⅝	5 9 1	...	...	...
180,227	10	2/6	Globe Telegraph and Trust	8	9	8⅛	9⅛	5 10 6	Jan., Apr., July, Oct.	9⅛	8⅛
180,042	10	3/0	Do. 6 per Cent. Preference.....	12½	13½	12½	13⅛	4 8 11	,, ,,	13⅛	13
11,939	8	4/0	Reuter's.....	6½	7½	6⅝	7½	5 6 8	April and October.....	...	...
8,303	£100 Cert	6%	Submarine Cables Trust.....	110	120	110	120	5 0 0	,,	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

ELECTRIC railway matters at present are in a decidedly interesting phase. It is instructive, for instance, to contrast the 4 per cent. dividend on the preference and ordinary stock of the Central London Railway with the 2¼ per cent. paid by the Metropolitan Company. Although in some circles there is an affectation of disappointment at the "Twopenny Tube" dividend, the proprietors of this busy line are to be congratulated upon the maintenance of profits at so high a figure in so new a railway.

ANOTHER notable electric railway event is the advertisement in our pages this week, by the North-Eastern Railway Co., inviting tenders for the complete electrical equipment of about 37 miles of standard-gauge railway, mostly of double track, in the neighbourhood of Newcastle-upon-Tyne. There is also a very credible rumour that the Lancashire and Yorkshire Railway Co., through the severity of the competition of trolley lines in and around Manchester and Liverpool, are considering the question of electrically equipping their lines in those districts.

IT is a remarkable coincidence that on two of the chief goldfields of the world attention is now and simultaneously being directed to the use of electricity in the mines, for lighting and for power. These are (1) the goldfields of the Rand, where 20 miles or more of rich reef will soon again be an active mining centre, and (2) the rich but more restricted goldfields of Mysore. On the Rand the fortunes of the local electricity supply works have been severely set back by the recent war; but there is a prospect, not only that these works will regain lost custom, but also that the much greater attention now being paid to the use of electricity will inaugurate a period of unprecedented success. In the Indian goldfields, where conditions differ considerably from what obtain on the Rand, electric power is nevertheless quite as likely to prove a success, though, of course, not on the same large scale as in South Africa. The Mysore mining district, some 5 miles in extent, is now about to be supplied with electric power from the Cauvery Falls, situate some 90 miles distant. Indeed, quite recently a portion of the 4,000 H.P. plant for the Champion Reef mines was successfully put into operation.

THE attention of British manufacturers of electrical tools and special plant might well be directed to the production of suitable electric plants for gold mines, where the conditions both on the surface and below ground are very different from those in coal mining at home. Besides lighting, pumping, hauling and mineral tramway working, which can be handled mostly on ordinary mining lines, there are the driving of stamps and the various departments of the mill work, which, in order to get the best results, should be handled on special lines. Much of the existing work even in the best and most enduring mines is done in a very rough and crude manner, as regards the economy of power. With cheap electric energy available, and with suitable tools for each piece of work, we see no reason why even the excavating and stoping work might not be done electrically, with considerable saving in cost. We strongly advise that the merits of electricity be carefully considered by mining authorities, especially now that the labour question is looming so large in the South African mines.

MR. HENNIKER HEATON has followed Prof. SILVANUS THOMPSON'S advice to "try again," but with no more success than at the first onslaught. In *The Times* of Saturday he sprinkles his letter with a fine mixture of ideas:—

I do not deny that JUBAL first "struck the chorded shell," but I hold that BEETHOVEN was an incomparably greater musician. ROGER BACON invented gunpowder, but Sir HIRAM MAXIM with his machine gun civilised the Soudan. Again, while we are separated from our fellows by thousands of miles, distance has a good deal to do with the matter. LODGE'S installation might serve a college or a monastery; MARCONI'S supplies the needs of an empire.

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The force of the argument is altogether lost in this cloud of ancient historic dust. If the issue between the disputants is as to who was the first to transmit wireless signals over any distance whatever, Sir OLIVER LODGE must undoubtedly take precedence over Mr. MARCONI. But even Sir OLIVER LODGE was only repeating in a modified manner the researches of the immortal HEINRICH HERTZ himself, to whom the palm is primarily and chiefly due. It is a great pity when the annals of scientific progress are besmirched by personal disputes and selfish jealousies. Honour is the due of HERTZ above all others; but Mr. MARCONI has done great things to apply HERTZ'S researches in commercial wireless telegraphy. Honour, therefore, is also the due to Mr. MARCONI.

OUR readers may peruse with advantage, and doubtless will do so with some amusement, the results we publish this week of some tests on the relative speeds of horse omnibuses and electric tramcars. We recommend our representative's figures to the careful consideration of Lieut.-Col. CROMPTON, and we trust they will convince him of the error of his statement that horse 'buses can beat the trolley car in the matter of "point-to-point speed." Errors of this serious nature ought not to be allowed to be floated, especially when engineers so responsible as Lieut.-Col. CROMPTON are their authors. They are as damaging as if they were true, for there are plenty of people whose interest it is to put them into extensive circulation; and the gullible public will generally believe what it hears once, and always what it hears more than once. The task of pursuing error by truth with a greater "overtaking power" is therefore not an easy one; but we have taken it up because of the great importance of the issues involved.

WE wish our readers, however, to disabuse their minds of any idea that we condemn the use of accumulators for traction. The reverse is the case, with limitations. We do, indeed, oppose the introduction at present of public accumulator omnibuses on any scale that could compete commercially with tramways. The time is not ripe for such a use of the battery. It is in the interests neither of the public nor of electrical engineers, nor even of the responsible firms of battery makers, that this class of promotion should be encouraged by the electrical press. The leading battery firms would be the first to admit this; for they and the public would be the worst sufferers from the effects of the inevitable fiasco. Let the accumulator makers join hands with Lieut.-Col. CROMPTON in producing, first, a suitable battery, and then a set of complete omnibuses—'buses that will carry the public cheaply and satisfactorily, and that will work profitably on a regular daily service. When this is accomplished and has been at work for a reasonable period, we will admit that the case for the accumulator omnibus will have been greatly strengthened.

APROPOS of this discussion, we may remark that much injustice is often done to tramway interests by the erroneous statements which are circulated, to the effect that the tramway companies rob the public of the roadways, which they have the user of for nothing. As a matter of fact, a tramway company is compelled to contribute largely to the maintenance of the roads through which it lays its tracks. Besides this, it often is obliged at the outset to pay for costly widening of the streets, or for the construction of new streets—to say nothing of the form of blackmail by which it is sometimes compelled to pay for municipal works that have not the remotest connection with tramways. The fact is, that tramways do pay for road maintenance, whereas omnibuses do not. Electric tramcars, moreover, never wear the roadway—they only wear out the tramway company's rails. Heavy electric omnibuses, on the other hand, are a terrible enemy of ratepayers, for they do much damage by reason of their great weight being imposed on the road itself. Yet people who affect to know of something better for the public than trolley tramways, calmly tell us that tramway companies are thieves and robbers who monopolise the roads for nothing.

Electrical Power in China.—The Tien-Tsin International Tramway and Lighting Co. has been founded at Brussels with a capital of 6,250,000f.—£250,000—for electrically lighting Tien-Tsin, providing it with a system of tramways and everything connected with the generation and utilisation of electric energy.

Dublin Section of the Institution.—In consequence of the resignation of Mr. F. Gill, who is leaving Dublin to take up his new position in London, Mr. W. Tatlow, M.A., B.E., has been appointed honorary secretary to the Dublin Local Section of the Institution of Electrical Engineers, and all communications should be sent to Mr. Tatlow, at 20, Fleet-street, Dublin.

National Telephone Co.'s Recent Fire.—Up to 9 a.m. yesterday 1,600 subscribers on the London Wall exchange were again able to use their telephones, and the company anticipate that the whole of the interrupted services, including 560 necessary junction lines to other exchanges, will be in working order by Friday next.

University College, London.—The courses of instruction in mechanical, civil, municipal and electrical engineering and architecture commence at the college on October 2nd. Some particulars are given in an advertisement, and all further information can be obtained of the secretary, Dr. T. Gregory Foster, at University College, Gower-street, London.

University College of North Wales, Bangor.—In October a systematic course of instruction in electrical measurement and practical electricity for students proposing to enter the profession of electrical engineering will be commenced at this college. Some further particulars are given in an advertisement, and all additional particulars can be obtained from the secretary and registrar, Mr. J. E. Lloyd, M.A.

Chemical Science Congress.—A congress to discuss applied chemical science questions is to be held in Berlin in 1903. The four preceding congresses were held in Brussels (1894), Paris (1896), Vienna (1898) and Paris (1900). A committee of prominent German scientists and industrials has been formed with offices at Charlottenburg, and the congress is to hold its meetings in the buildings of the Imperial Diet.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Bolama	April 19, 1902
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Santa Cruz—Teneriffe	July 7, 1902
Puerto Plata—Martinique	July 10, 1902
Cap St. Jacques—Haiphong	July 12, 1902

A Current Changer.—In the physical laboratory of the Società Edison of Milan at the arrival station of the Paderno

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high-tension transmission line, some very interesting tests were made during the past week in the presence of several distinguished Italian electricians on the new machine invented by Signor Secondo Sacerdote, and called a current changer. This new apparatus has the property of changing the voltage, the frequency and the number of phases of an alternating-current; and it is possible, also, with the same machine, to transform direct-current into alternating and alternating into direct, just as well as in an ordinary rotary converter. Amongst other tests the current from Paderno, which is three-phase, and which, after leaving the transformer station has a voltage of 2,200 volts, was transformed into direct current at 360 volts with a very high efficiency. This machine will now be utilised by the Società Edison to feed the trolley extensions.

Electric Lighting Provisional Orders.—The report of the Board of Trade respecting the applications to and proceedings of the Board, under the Electric Lighting Acts 1882–90, during the past year shows that 67 applications were made, of which 45 were made by local authorities and 22 by companies. Of these only five related to the County of London. The full list appeared in our issue of January 3rd last, page 430. Only three applications were rejected—viz., those of the Bournemouth Corporation, Chiswick District Council and Southwark (London) Borough Council. In the case of Bournemouth, the Corporation applied for powers for Pokesdown, Southbourne, Winton and part of the parish of Bournemouth. An application was also received from the Bournemouth and Poole Electricity Supply Co. for Pokesdown, to which preference was granted. In regard to Chiswick the District Council applied for an order to supply electric current for public lighting. The application was opposed by the Aberystwyth and Chiswick Electricity Supply Corporation (Ltd.), who already possess powers for giving a supply for public and private lighting. In regard to Southwark the Board based their refusal to grant an order on the fact that there are two companies already authorised to supply electricity in the area embraced by the Council's application. In five other cases—Barton Regis, Chepstow, Leatherhead, Bermondsey (London), and Stanley and Tanfield—the application was partially successful. In regard to the Bermondsey application an order was granted in respect of the parish of Rotherhithe, but the district of St. Olave was excluded, as there were two companies already authorised to give supply there. The application of the Camberwell Borough Council fell through, as the promoters objected to the conditions upon which the Board were willing to grant an order. Two orders were granted to the Northern Counties Electricity Supply Co. (Ltd.), one in respect of the urban district of Bedlingtonshire and the other in respect of Morpeth, Ashington, Newbiggin-by-the-Sea and Morpeth (rural). Only one application for a licence has been made—viz., from the Market Drayton Electric Light and Power Co. in respect of a portion of the parish of Drayton-in-Hales, and the application is under consideration. Prior to the present year the Board of Trade had dealt with 969 applications, of which 743 were granted, 735 were confirmed and 127 since revoked or repealed. During the year the following 28 transfers of orders took place—viz., Alnwick (1901), Annfield Plain (1901), Barnard Castle (1900), Benfieldside (1901), Consett (1901), Cowpen (1900), Handsworth (1901), Malton (1900), Norton (1901), Pickering (1901), Shildon (1901), South Blyth (1900), Spennymoor (1900), Thirsk (1900) and Whitley and Monk seaton (1901) to Northern Counties Electricity Supply Co.; Airdrie (1898) to Scottish House-to-House Electricity Co.; Ambleside (1897) to Windermere and District Electricity Supply Co.; Banbury (1900) to Banbury and District Electric Supply Co.; Birkdale (1898) to Birkdale District Electric Supply Co.; Denton (1897) to Manchester Corporation; Ilfracombe (1898) to Ilfracombe Electric Light and Power Co.; Newhaven (1900) and Seaford (1900) to Newhaven and Seaford Electric Lighting Co.; Ross (1901) to Ross Electric Light and Power Co.; Sevenoaks (1900) and Sheerness (1900) to County of Kent Electrical Power Distribution Co.; Staines, Egham and Chertsey (1900) to Thames Valley Electric Supply Co.; and Wellingborough (1900) to County of Northampton Electric Power and Traction Co.

Obituary.—On Sunday evening, July 20th, a conspicuous figure in Atlantic cable enterprise passed away in the person of Mr. John W. Mackay, whose connection with the Commercial Cable Co. dates back to the year 1883, and whose association with the Postal Telegraph Co. of New York and the Commercial Pacific Cable Co. of New York, although more recent, was no less intimate. Mr. Mackay was born in Dublin on November 28, 1831, of very humble parents, and was of Scottish descent. He left Ireland with his parents for the West in 1840, when only nine years of age, and received his education in America. At the age of 18 he joined the trekers for the Californian goldfields, via the Isthmus of Panama, and later, in 1860, went to Nevada State, and was for many years the leading light of the mining fraternity in the Silver City. Here, after many disappointments, and after more than once losing what little capital he possessed, he, with a small band of persistent workers, discovered, at what was then considered the great depth of 150ft., the great silver pockets of the Bonanza mine. From this and other mines in Nevada Mr. Mackay and his fellow workers won vast quantities of the bright metal, and Mr. Mackay speedily became a very wealthy man. In the early 80's he turned his attention, along with Mr. James Gordon Bennett, to telegraphy, and entered the field of Atlantic cable enterprise with Mr. Bennett. This association continued up to the day of Mr. Mackay's death, and it was to the work involved in this branch of industry that Mr. Mackay's subsequent energies were principally directed. The story of the Atlantic cable competition of the past is well known to our readers, and it will be remembered that after a couple of years' fighting and rate-cutting an amicable arrangement was come to with the Atlantic companies on this side, and all have since been working in the fullest accord consistent with the most active competition. Mr. Mackay was, at the time of his first attack of illness, in England with Mr. George Gray Ward, vice president of the Commercial Cable Co. (of which Mr. Mackay was president), and it was while engaged in London on the affairs of the Commercial Cable Co. and the Commercial Pacific Cable Co. that Mr. Mackay's serious condition first became apparent. While taking a frugal lunch, as was his wont, the first symptoms occurred, and Mr. Mackay went straight from the offices of the Commercial Company in Bishopsgate-street, E.C., to his house in Carlton House-terrace, and within a few days, in spite of the most assiduous care and attention, passed away at the age of 71 years. Mr. Mackay was also interested in the Sprague Electric Co., and was instrumental in introducing into this country the Sprague electric elevators on the Central London Railway, and into large blocks of buildings in New York, paving the way for the extension of this branch of the Sprague Company's business. In spite of a keen business instinct, Mr. Mackay had his softer side, and the staffs of all the concerns with which he was associated have good reason to feel the sad loss of a liberal employer and a just and generous man. He was their personal friend, and took a lively interest in their general welfare. To those with whom he was more intimately connected in business and social life his loss is irreparable. He leaves one son (Mr. Clarence H. Mackay), who is now on his way from America to this country, his eldest son having been killed in 1895 near Paris from the fall of a horse which he was riding. The complaint to which Mr. Mackay succumbed was congestion of the brain, followed by congestion of the right lung and heart failure. Mr. Mackay's body will be taken to New York to be interred in the family vault at Greenwood Cemetery, Brooklyn.

We deeply regret also to announce the death of Mr. C. T. Child, of New York, at the early age of 35. Mr. Child was for some time technical editor of the *Electrical World*, and subsequently of the *Electrical Review* of that city. His signed contributions to electrical literature will also be remembered by our readers. He was connected at various times in his life with numerous electrical schemes, notably with successful water-power utilisation at Richmond, Va., his native city.

The death is also announced of Mr. Charles Snowdon, of the Post Office Engineering Department, Sunderland. Mr. Snowdon was knocked down by a cab on Tuesday, and succumbed to his injuries the following evening.

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THE NEW SMALL BRANCH EXCHANGES OF THE POST OFFICE TELEPHONE SERVICE.

Two of the new telephone exchanges which the Post Office has been erecting in the Thames Valley are now completed and in actual service. These two exchanges, at Putney and Kingston, are only of comparatively small size, but as they are built on lines which the Post Office proposes to follow in other small branch exchanges in the neighbourhood of London, a detailed description of one of them will, doubtless, be welcomed by our readers. The system employed at both these exchanges has been worked out for exchanges in which the number of subscribers is not likely to exceed 1,000, and it may briefly be described as a non-multiple system, in which a common battery is employed for signalling but not for speaking purposes. Both as regards the subscribers' and junction

FIG. 1.—GENERAL VIEW OF 200-LINE SWITCHBOARD.

lines, the calling and clearing is automatic, as in the ordinary central battery system. Some features of the old Post Office "Permanent Current" exchanges have been adopted, notably the employment of 8-point jacks. This article, although a description of the Putney exchange, may be taken to apply almost in every detail to the other exchanges in the Thames Valley.

Figs. 1 and 2 give a general idea of the arrangement of the switchboard, which has an ultimate capacity of 200 lines and will be the standard for these small exchanges. It has three panels, and is arranged to be worked by two operators at the busiest periods of the day. The panels to the right and left are mainly devoted to the subscribers' calling lamps and local jacks, and the central panel to the corresponding apparatus for junction lines. Along the bottom of all three panels and just above the keyboard shelf are seen the rows of clearing indicators—two lamps to each pair of cords. Above the clearing indicators on the subscribers' panel are alternate rows of lamps and local jacks (five rows of 20 each on each panel), each jack being placed immediately above the calling lamp to which it corresponds. Finally, forming the top row of each of the side panels are 10 call-wire plug-keys which will be connected to call wires on the junction boards of other metropolitan exchanges.

Above the clearing lamps on the middle panel are two strips of jacks for out-going junctions, and a short distance above these two strips of jacks in which the in-coming junction lines terminate, two clearing lamps being provided for each jack. The indicator flap seen high up on the central panel is a self-restoring indicator for night calls on the in-coming junction lines, and the bright spot seen just above the plug shelf at the bottom of this panel is the pilot lamp which lights up whenever a call is received.

There are 38 pairs of cords and their corresponding combined speaking and ringing keys on the keyboard shelf. It will be noticed in Fig. 2 that 10 of these, distributed among the others, have white rings round the thimbles of the plugs. These are for use in connection with the in-coming junctions, the remaining 28 plugs and cords being for the ordinary connections which originate at the board. The thimbles of the answering plugs are coloured black, and the calling plugs red. To the left of each operator is a row of five keys, four of which are for ringing on party lines, as will be explained presently, and the fifth (the topmost) for ringing on any out-going call-wire at night time or during the less busy hours of the day. Finally, on the extreme right of the keyboard, is a key for replacing the self-restoring indicator, and a hand generator is fixed on the right-hand of the switchboard for use during night-time or in the event of a breakdown of the machine ringer. As two operators will be required only during the busy hours of the day, the connections of the instrument jacks, to which the operator's telephone sets are connected, are so arranged that on the withdrawal of either instrument plug from its jack the two operator's speaking circuits are connected in parallel. Meter keys or meters are not provided as in the case of the larger exchanges; the operators merely record the call in pencil on a form provided for the purpose.

The cylindrical boxes seen above the board in two wooden cases contain the relays in the cord circuits, and the remaining relays, &c. (with the exception of those on the junction lines to the central exchange, which are carried on two shelves in the test room), are contained within the switchboard and in the cupboard to which the hand generator is attached, one side of this cupboard and the back of the switchboard being easily removable.

Coming now to the actual connections of the line circuits and the keyboard, reference must be made to the diagrams Figs. 3 and 4 respectively. To the left of Fig. 3 the subscriber's instrument is represented; and it is seen that it is so connected that when the receiver is on its hook the A-line is connected through the bell to earth, and when the receiver is removed the A and B lines are connected together through the receiver circuit, the earth connection being removed. Two Leclanché cells are employed for the subscriber's transmitter circuit, and his bell is a 100-ohm magneto-bell. The usual magneto generator at the subscriber's office is dispensed with, the calling being effected on the common battery system, as already mentioned.

The two line wires of the subscriber's circuit terminate in the exchange at the outer main springs of an eight-point jack, through which the A-line is normally earthed, and the B-line is connected through the line relay to the negative terminal of the common battery. As the positive pole of the battery is permanently earthed, the battery is normally connected across the A and B lines, through the line relay; and, therefore, when the removal of the subscriber's receiver connects the far end of the lines together through the subscriber's receiver circuit, the line relay is actuated. This closes a circuit from the positive of the battery, through the main coil of the pilot relay, the tongue of the line relay, and the outer spring of the eight-point jack, to the calling lamp and back to the battery. The pilot relay closes the cir-

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cuit of the 250-ohm relay above it, as well as the circuit of the pilot lamp or bell according to the position of the switch S; and this 250 ohm relay puts the low resistance (0·88-ohm) coil of the pilot relay in parallel with its 30-ohm coil, with the result that the calling lamp, having now less resistance in circuit, glows with its proper brilliancy.

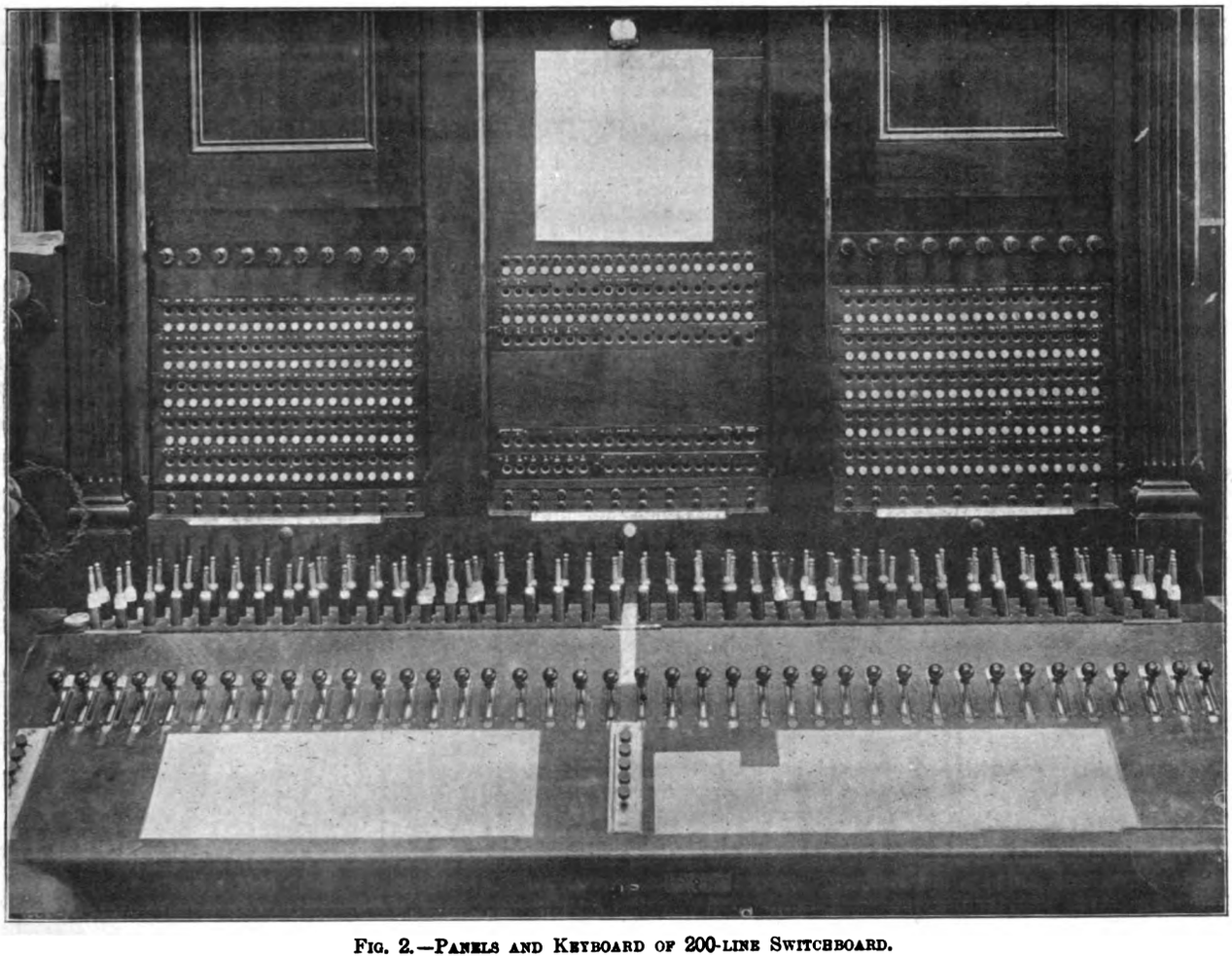

FIG. 2.—PANELS AND KEYBOARD OF 200-LINE SWITCHBOARD.

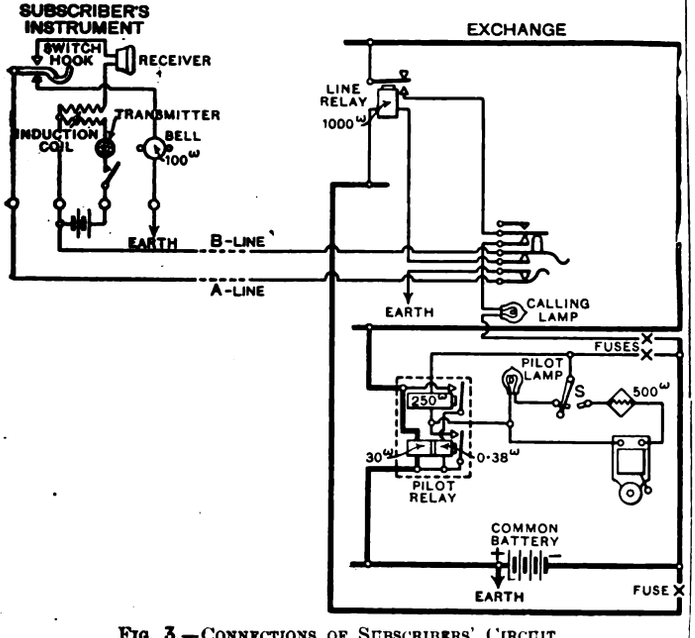

FIG. 3.—CONNECTIONS OF SUBSCRIBERS' CIRCUIT.
(The thick lines are common to all the jacks.)

As seen in Fig. 4, both the answering and calling plugs are connected through the combined speaking and ringing key and 2-microfarad condensers, while a differentially-wound 2,000-ohm relay is bridged across each cord. The middle points of the windings of these relays are connected together and to the negative pole of the earthed common battery, and the local circuit of each of the relays includes merely a clearing lamp and the common battery. As soon as a call is received, as explained in the last paragraph, an answering plug is inserted in the jack of the calling subscriber, and the key is put over to the speaking position. This connects together the long and the outer springs of this side of the key, connecting the operator's set to the answering plug. Referring back to Fig. 8, it is seen that the tip and sleeve of this plug are then connected through the eight-point jack to the A and B-line respectively, while the circuits of the line relay and calling lamp are broken, as is also the earth con-

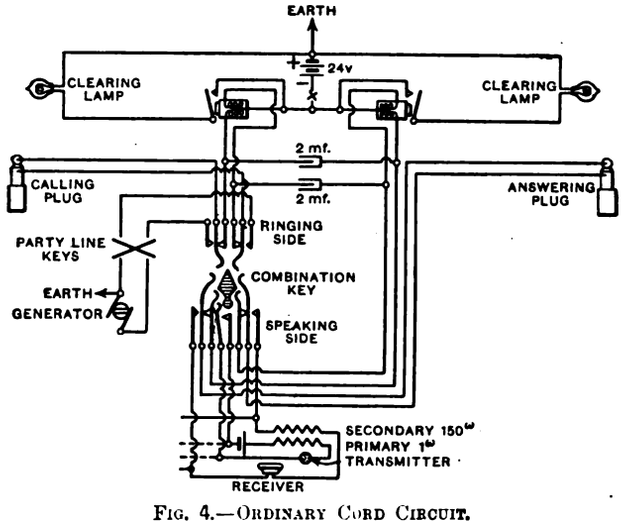

FIG. 4.—ORDINARY CORD CIRCUIT.

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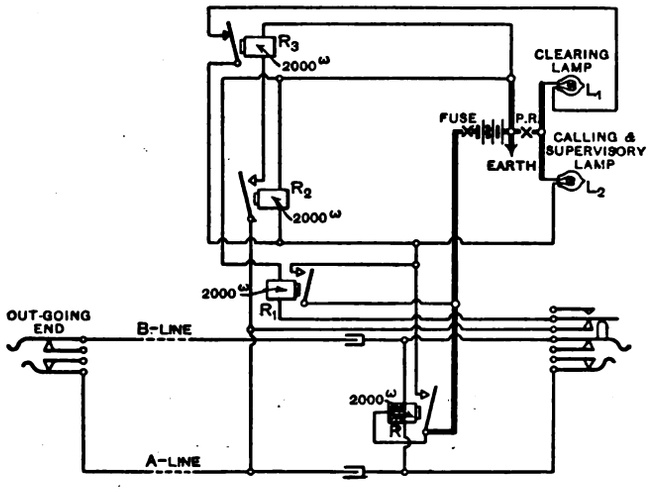
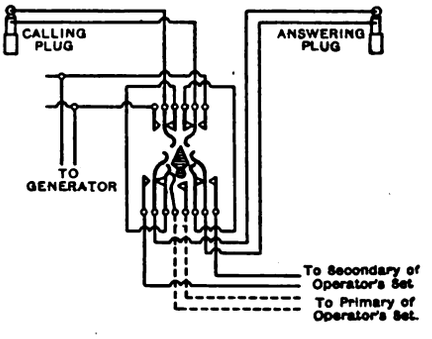
nection previously made through the inner spring of the jack. If the demand is for a local subscriber the calling plug is inserted into this subscriber's jack, and he is rung up by pushing the key over to the ringing position. It is unnecessary for the operator to cut in again to ascertain if the wanted subscriber has answered, for, on releasing her key into the through position, the clearing lamp corresponding to the calling plug will be glowing if the wanted subscriber has not yet removed his instrument. The path of the current actuating the relay in this case will be from the common battery, through the one coil of the relay, the ringing side of the key, to the tip of the calling plug, and thence through the subscriber's A-line and his bell to earth and back to the battery. As soon as the wanted subscriber answers, his earth connection is removed and the lamp ceases to glow; and on either of the subscribers hanging up his receiver the corresponding clearing lamp glows, the connections on the side corresponding to the answering plug being similar to those of the calling plug, but through the speaking side of the combination key. Busy-back jacks will be fitted in connection with the special commutator of the machine ringing generator, as at the central exchange, and the subscribers will be educated up to this intimation of "line engaged."

At the time of our visit to the Putney exchange, all the out-going junction calls except those to the Kingston Post Office exchange were transmitted to the central Post Office exchange, but eventually all the out-going and in-coming calls to and from exchanges of fairly large size, whether on the system of the Post Office or National Telephone Co., will be dealt with directly. The out-going junctions terminate simply on five-point jacks (only two points of which are made use of), as seen in Fig. 5, which shows the junction line connections between two small "Common Battery Signalling (C.B.S.)" exchanges of the Putney and Kingston pattern. The in-coming junction terminates on the line springs eight-point jack, but is not directly connected to them as a condenser is included in series with each line. A relay, R, is bridged permanently across the line to the jack side of the condensers. In the case of these smaller exchanges, no call-wire is employed, and the insertion of a plug into the jack at an out-going exchange automatically calls the in-coming end. At the out-going exchange the ordinary plugs and cords (Fig. 4) are employed, but at the in-coming end the special junction plugs and cords already referred to are made use of. When the originating operator inserts her calling plug in the five-point jack at the out-going end, a current flows from the negative pole of the central battery at that end (see cord connections in Fig. 4) through one coil of the clearing relay, and the ringing side of the combination key to the tip of the plug, and thence to the A-line. At the in-coming end the current reaches the outer springs of the eight-point jack and thence passes through the relay R_1 to earth and back to the battery. Although the clearing lamp at the out-going end glows, this must not be taken as a clearing signal at this stage of the proceedings. At the in-coming end R_1 closes the circuits of R_2 and the calling and clearing lamps, all of which are in multiple. But R_2 closes the circuit of R_3 which opens the circuit of the clearing lamp, so that the visible result is merely the lighting of the calling lamp at the in-coming end.

This is responded to by the insertion of an answering junction plug, which opens the outer springs of the eight-point jack and by interrupting the circuit of R_1 restores all the relays to their normal position and extinguishes the lamps, including the supervisory signal at the out-going end. The operator at the in-coming end, having inserted the answering plug, pulls over her key to the speaking position, ascertains the number wanted, inserts the calling plug into the corresponding jack and rings. It should be noticed that the junction plugs and cords (shown to the right of Fig. 5) have no condensers, so that the two plugs are in actual metallic connection. Hence, when the key has returned from the ringing to the through position, a current flows from the battery through R to the eight-point jack, and thence through the plugs and cords to the A-line of the wanted subscriber, and through his magneto to earth. R closes the circuits of R_2 and R_3, the calling lamp glows again, but, as before, the circuit of the clearing lamp, made this time by R, is interrupted at R_3. But in addition to this, R_3 being connected between the A-line of the junction line and earth, makes a circuit for a current to flow from the negative pole of the battery at the originating or out-going end (Fig. 4) through one coil of the clearing relay on the calling cord to the tip of the calling plug, the A-line, earth and back to the battery. The clearing lamp on this cord glows a second time, and this time again it does not mean "clear" but merely that the wanted subscriber has not yet answered. On the wanted subscriber removing his telephone to answer the call the earth connection at his end is broken, and the current from the battery at the in-coming exchange is cut off, and things return to their normal condition until the conversation is over. Then, by hanging up their receivers again both subscribers transmit actual clearing signals to the originating exchange, and the operator there, observing that both clearing lamps are alight simultaneously, removes the plugs. The wanted subscriber's telephone being on his hook, the relays R_1, R_2 and R_3 are actuated as they were before he removed it, but as soon as the originating operator clears, the current from the originating exchange battery through R_3 is interrupted, and the circuit of the clearing lamp on the junction cord at the in-coming exchange is made by the tongue of this relay falling back, the local circuit being completed through R. Thus the clearing signal is received at this exchange too, and the junction line is cleared. It is to be noticed that the junction line cords and plugs have no clearing signals, but the in-coming junction



JUNCTION CIRCUITS BETWEEN TWO P.O. COMMON BATTERY SIGNALLING EXCHANGES.



CORD CIRCUITS FOR IN-COMING JUNCTIONS.

FIG. 5.

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lines have clearing as well as calling signals placed below their jacks, the clearing lamp being red to distinguish it from the calling lamp.

In the case of junctions in-coming from large common battery exchanges, call-wires are employed, the call-wire and the out-going end of the junctions being multipled on the subscribers' sections at the common battery exchange. At the in-coming end the call-wires are connected permanently to the operator's speaking set, and for night use there is a self-restoring indicator, the dropping of whose flap closes a bell circuit in the usual manner. On receiving the demand the operator at the in-coming (C.B.S.) exchange notifies to the operator at the out-going (C.B.) end what junction

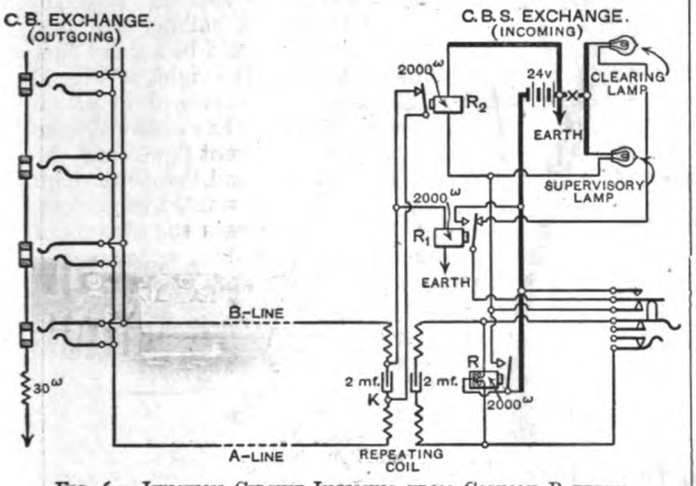

FIG. 6.—JUNCTION CIRCUIT INCOMING FROM COMMON BATTERY EXCHANGE.

(NOTE.—The thick lines are common to all the jacks. The positive lead to the lamps goes through the Pilot Relay, as shown in Fig. 3.)

wire to use, inserts her answering plug into the jack of that junction wire and the calling plug into the wanted subscriber's jack, and rings; and the originating operator meanwhile inserts her calling plug into the out-going jack of the junction line. The clearing lamp on this cord at the C.B.S. exchange will glow, during the intervals between the rings, as the wanted subscriber's telephone is still on its hook, and the clearing signal is sent just as when the conversation is concluded—viz., by a current flowing through the relay R (Fig. 6) and the subscriber's A-line and back to the battery by the earth connection at the subscriber's end. R closes the circuit of R_2, and R_2 in its turn removes the short-circuit from the condenser K and interrupts the current flowing out from the central battery exchange, preventing it from flowing through the supervisory relay there, this latter relay (it will be remembered from our description of the common battery exchange, *The Electrician*, Vol. XLVIII., p. 809, and Fig. 13) performing the function of shunting the clearing lamp when it is energised. As soon as the wanted subscriber answers, R and R_2 return to their normal positions, and all the clearing lamps are darkened. If the operator at the originating (C.B.) exchange is slow in inserting her plug into the junction jack, the clearing lamp at the C.B.S. exchange will glow, but the operator makes allowance for this, and does not take it as the actual clearing signal. On the other hand, if the out-going operator plugs into the junction line first, the supervisory lamp at the in-coming end glows, this lamp being a check on the number of the junction wire being taken correctly, and also preventing another operator at the in-coming exchange from making use of this junction in the period during which the operator who first selected it is plugging into it. It is seen that while R_1 is in its normal position the insertion of a plug into the jack closes the clearing lamp circuit, while if the plug is not inserted and R_1 is actuated the supervisory lamp circuit is closed. When a plug is inserted at the out-going end, an earthed battery is connected to the B-line there (see diagram of cord connections, *The Electrician*, Vol. XLVIII., p. 809), and a current flows from the B-line to R_1 and back via the earth connection. During the conversation, therefore, R_1 is actuated, and the jack at the in-coming end being occupied, the circuit of the supervisory lamp is not made. As soon as the originating operator receives the clearing signals from both ends (the circuits from the wanted subscriber's end have already been traced for this case), she clears, and the junction line plug being removed at the out-going end, the tongue of the relay R_1 falls back, as already explained, and the operator at the in-coming end receives the clearing signal and clears. As a matter of fact, the latter operator receives a double clearing signal as well as the originating operator, as the replacement of the called subscriber's telephone puts his A-line to earth and closes the circuit of one coil of R_1, which relay connects up the supervisory lamp.

(*To be continued.*)

THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

(*Continued from page 512.*)

The United Asbestos Co. (Ltd.), of Dock House, Billiter-street, E.C., had, at stand No. 181, a most interesting exhibit of all kinds of asbestos goods, also indiarubber goods, lubricating oils and greases, engineers' tools, boiler fittings and all engineers' requisites. After much experimenting with various combinations of asbestos and metal, this firm has introduced and placed upon the market its well-known "Eclipse" (patent), "Gladiator" and "Victor" metallic packings and jointing materials. We understand that the "Victor" metallic jointing materials have been in continuous use in H.M. Navy for 15 or 16 years past.

Several of the stands included among their exhibits various types of car wheels. Among these were Messrs. Askham Bros. and Wilson, whose spacious stand we illustrated on July 11th, also Hadfield's Steel Foundry Co. But the stand which was exclusively devoted to this class of manufacture, and in which car wheels were arranged in the most attractive manner, was undoubtedly that of Messrs. Miller & Co., of Edinburgh. A view of this stand is given in one of our illustrations. Besides actual car wheels the exhibits included a wheel grinding machine, wheel presses, &c. It is unnecessary to call the attention of tramway men to the importance of having good car wheels, but we may point out that for electric and other forms of mechanical traction good wheels are far more essential than they are for horse cars. For in the horse car the wheel does none of the work of propulsion, while in an electric car the entire work of gripping the track falls ultimately on the wheels. An inspection of Messrs. Miller & Co.'s exhibits must have well repaid the time spent in looking over the variety of wheels and wheel machines on show there.

The Sturtevant Engineering Co., of 147, Queen Victoria-street, E.C., showed, at stand No. 88, an interesting variety of motor-starting and speed-regulating rheostats, in addition to a large number of electrically-driven fans and Crosby steam gauges and valves. One of the steam exhibits was a collection of five indicators coupled together electrically, showing how diagrams can be taken on five indicators simultaneously by operating one indicator only. The new reducing gear lately brought out by the Crosby Company was also on view. This reducing gear is something quite new, and differs in almost every way from previous reducing gears which have been brought before engineers. The apparatus is attached directly on to the indicator cock below the indicator, and provision is made for adapting the apparatus to strokes from 10in. up to 72in. by means of a nest of aluminium pulleys, which are attached in a convenient form to the main spindle of the reducing gear. The spring which provides for the return stroke of the drum is of spiral type instead of the coil spring attached on other

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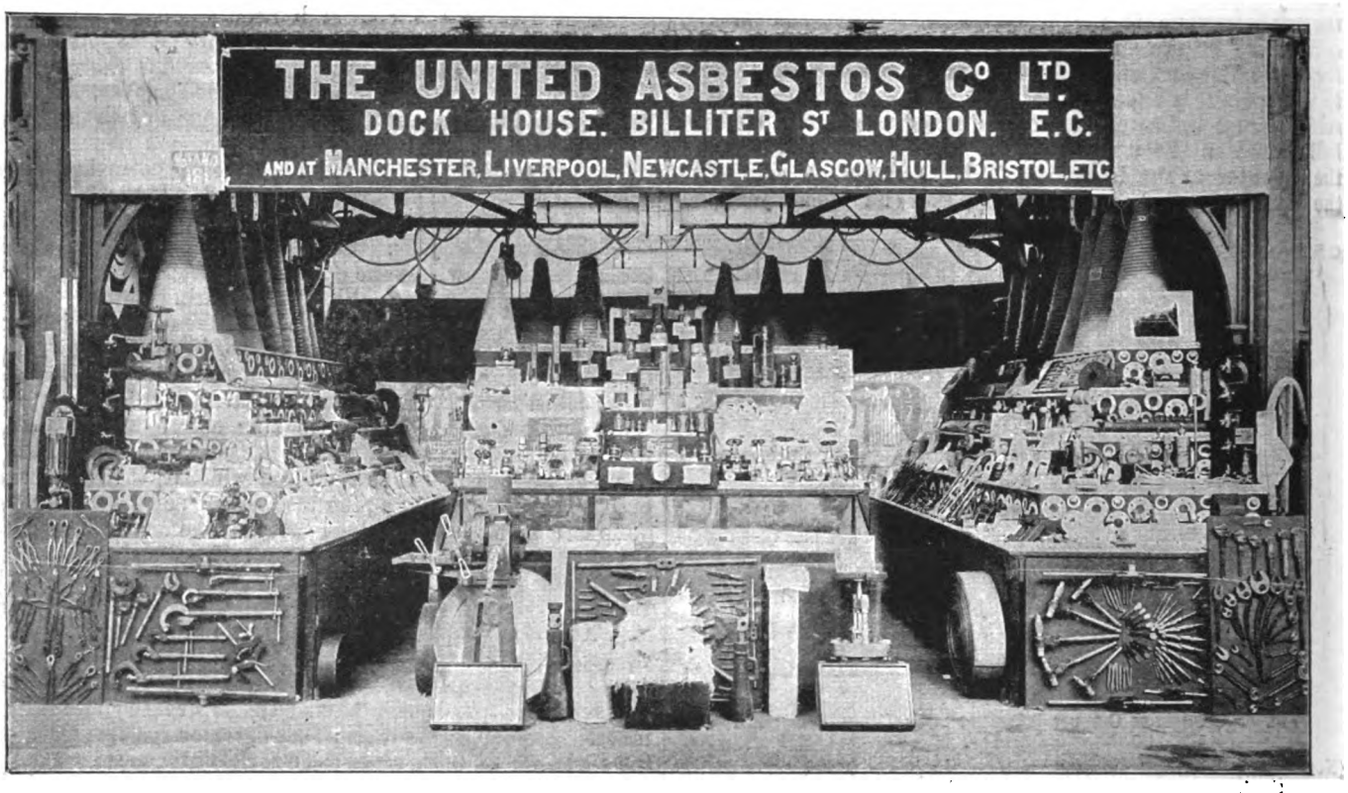
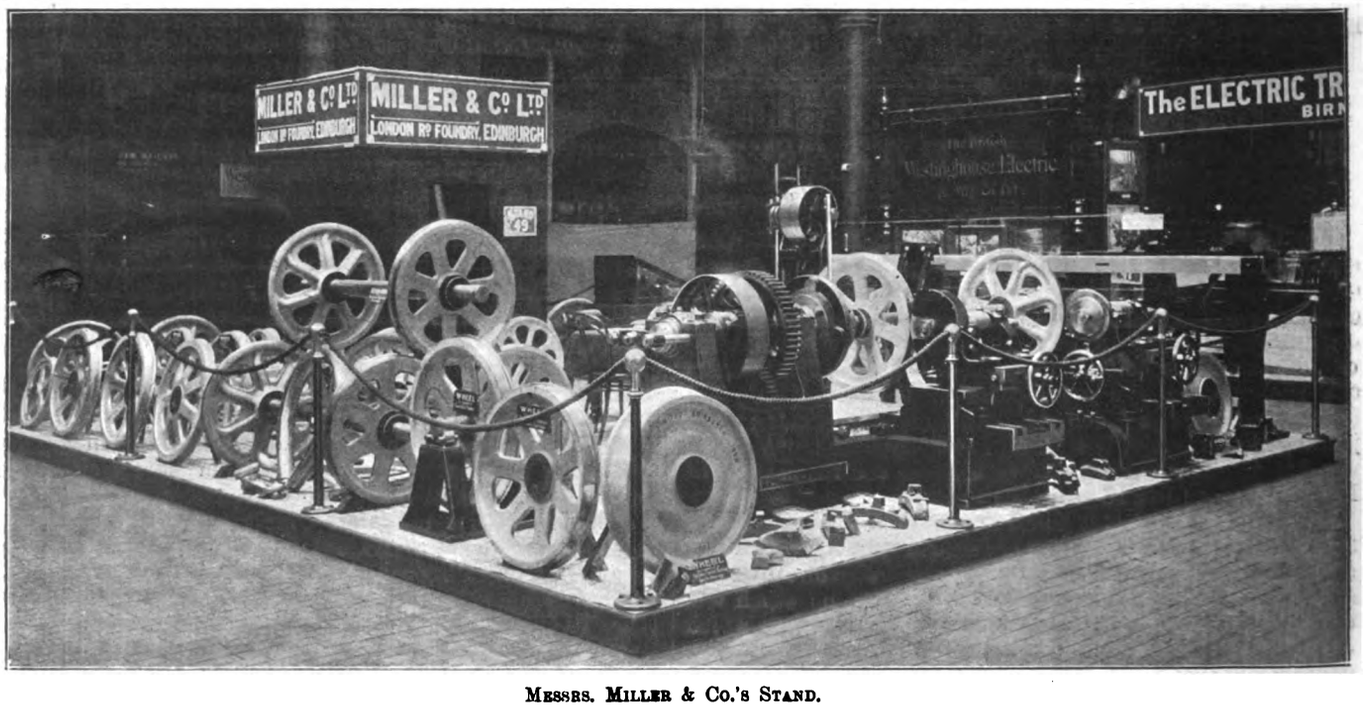
gears. In practice this apparatus has been found to be absolutely reliable and easy to fix and adjust. Something quite new in pressure gauges was also to be seen. The Crosby improved pressure gauge, of which we give an illustration, is fitted with two Bourdon tubes, an arrangement which allows of stouter tubes and fittings being used. The Bourdon tubes are attached to the gauge by means of screwed joints, no solder or brazing material being used. The base casting to which the tubes are screwed is carried up to the centre of the gauge, and supports the quadrant and levers. This gauge has been found to be suitable for high-pressure steam, and especially in positions where the gauge is subjected to a great deal of vibration, as even under the most trying conditions vibration of the needle is practically non-existent.

The renewable seat valve, of which we also give an illustration, having V-shaped seats, known as the Crosby "spring seat" valve, was well represented, samples being shown from ¼in. up to 8in. This valve has been remarkably successful when used with superheated steam. The seats are so arranged that full provision is made for expansion, and the material of which the seats are made resists the action of high pressure and high temperature steam. The whole of the parts of this valve are interchangeable. Many samples were shown, including sectional


THE UNITED ASBESTOS Co LTD
DOCK HOUSE. BILLITER St LONDON. E.C.
AND AT MANCHESTER, LIVERPOOL, NEWCASTLE, GLASGOW, HULL, BRISTOL, ETC

THE UNITED ASBESTOS CO.'S STAND.



MESSRS. MILLER & CO.'S STAND.

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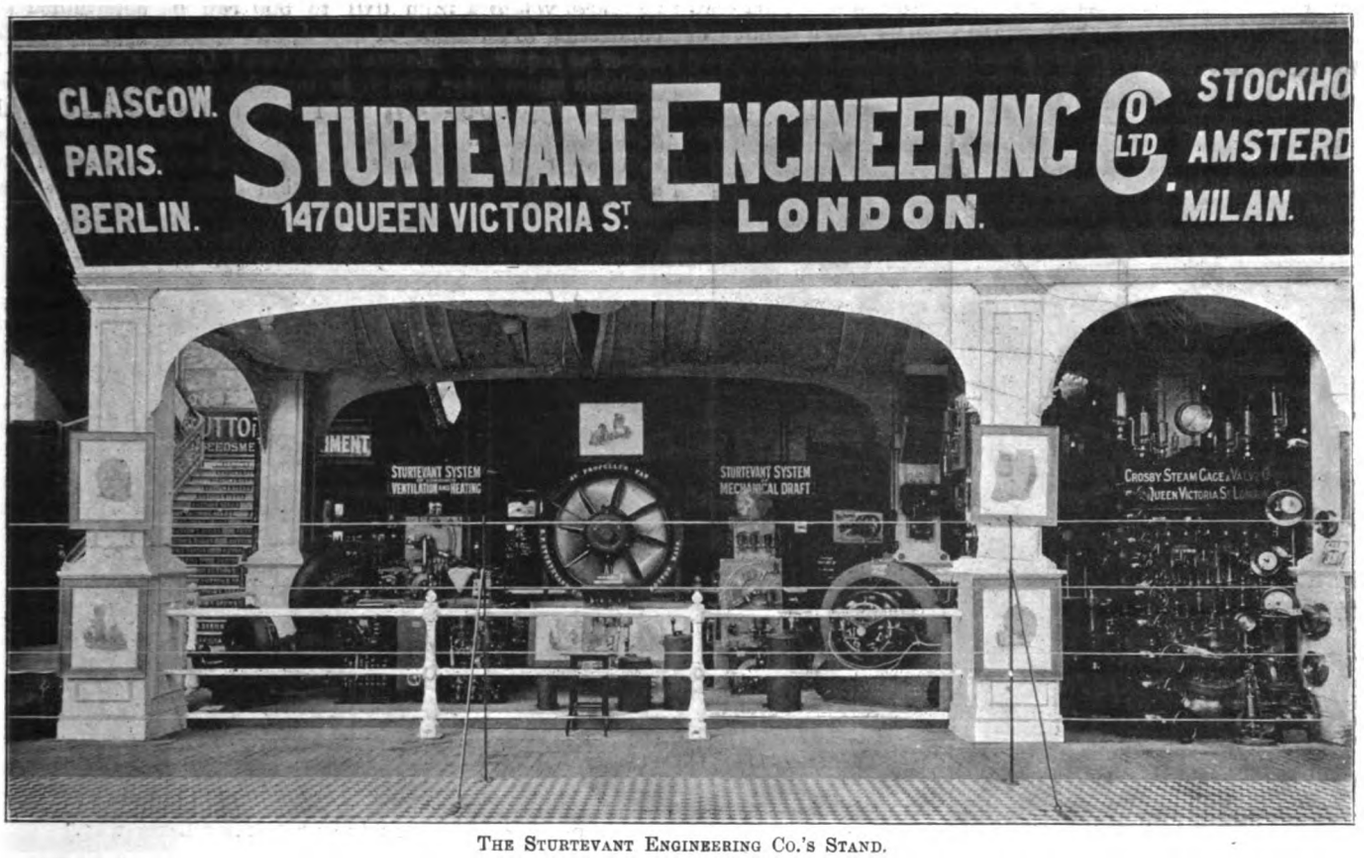
samples of Crosby "pop" safety valves, sight-feed lubricators, chime whistles, water relief valves, and other steam fittings, also pressure recording instruments of various kinds. A very convenient form of pressure recorder was that in which a

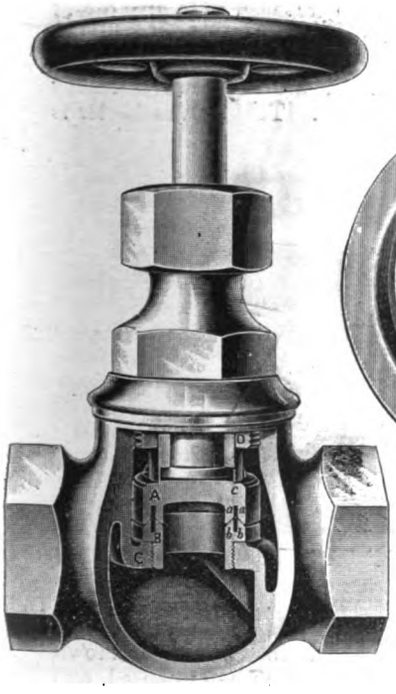
troller to be operated mechanically by a rope passing through the car in the usual manner. A motor-starting rheostat, with a quick-break D.P. switch operated from outside the steel cover presented a very serviceable appearance. The two



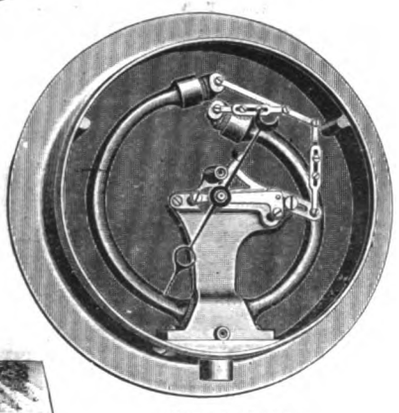
THE STURTEVANT ENGINEERING CO.'S STAND.

circle of graduations surrounds the recorder chart, the gauge pointer records the actual pressure at any moment, while the pen arm makes a continuous record upon the chart. The

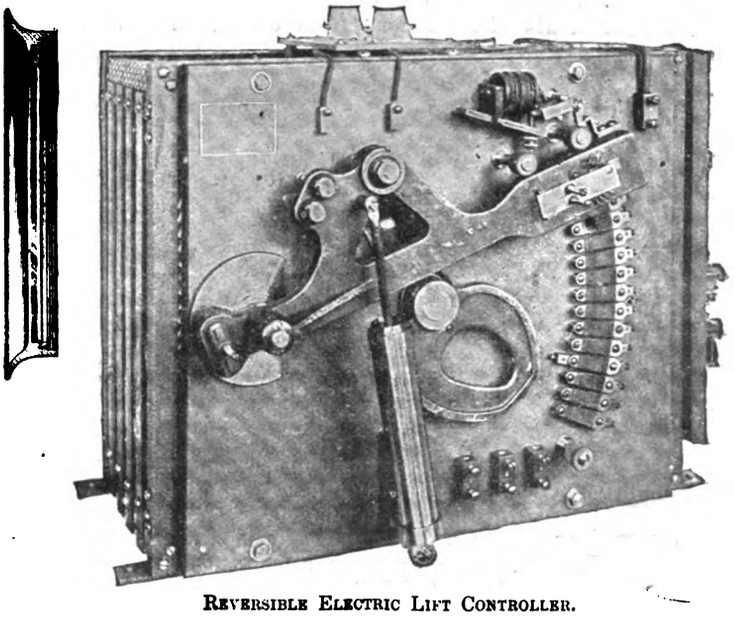
poles of the switch are mounted on separate slate slabs, and the rheostat and switch panel are mounted on a combined steel angle frame. Special arrangements have been made for completely enclosing these in a cover with cast-iron end plates, the main switch lever coming through at the right-hand side to operate the D.P. main switch, and a hand-wheel with index plate in front for operating the starting switch lever.



CROSBY RENEWABLE SEAT VALVE.



CROSBY GAUGE WITH TWO BOURDON TUBES.



REVERSIBLE ELECTRIC LIFT CONTROLLER.

Chapman fullway gate valves, for whom the Crosby Company are the sole agents in this country, were exhibited, samples being shown of valves for pressures from 60lb. to 250lb. The Sturtevant Co. also showed a reversible electric lift con-

At stand No. 43 Messrs. Geipel and Lange, of Parliament Mansions, Westminster, exhibited various steam traps, separators, rheostats, meters and measuring instruments. Perhaps the most interesting to electrical engineers was an instru-

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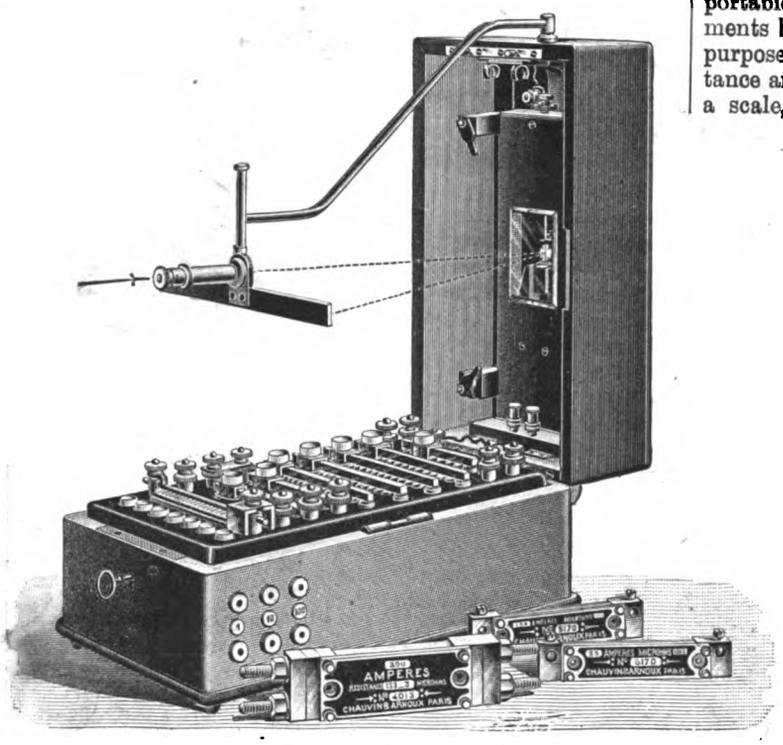
ment known as a "Portable Laboratory," which owes its name to the fact that such a large number of operations can be performed with the one set of apparatus. It consists, essentially, of two portions: (1) A delicate suspended reflecting galvanometer with viewing eyepiece and magnified scale. (2) A case of standardised resistances with the necessary connections, cursors and switches, the various combinations of which permit of the different readings being made. The



"Portable Laboratory."

illustration shows the general appearance of the set when erected ready for use. It will be noted that a magnifying eyepiece is mounted on a bracket which is pivoted in the top of the case. This bracket can be moved over a considerable angle to bring any portion of the scale within the field, and, with the eyepiece and scale, is packed away when not in use in the lid of the case, as are also the shunts which are shown. The connections of a Thompson bridge are adopted for measurements of resistances from 0·0000001 to 1 ohm, the connections of the unknown resistance being made to terminals L and M with an accumulator in series. For resistances between 1 and 999,999 ohms an ordinary Wheatstone bridge method is the arrangement used, a few dry cells being connected to S and F and the unknown to L and K. Measurements of resistances from 100,000 ohms to 300 megohms are made by comparing the deflection of the galvanometer in series with the resistance of 100,000 ohms with that obtained in series with the unknown resistance. Current from 0·0000001 to 0·3 ampere can be measured by shunting the galvanometer and thus allowing a known strength of current to pass through it. The deflection gives direct the significant figures of the result. The leads in this case must be connected to terminals K and H. Current measurements up to 300 amperes can also be made, voltages from 0·01 to 300 can be determined by connecting to terminals H and J, and shunting the galvanometer as required. Messrs. Geipel and Lange also showed a portable micrometer, which is intended for making measurements between 0·0000001 and 1 ohm, and is applicable for all purposes where rapid measurements of extremely low resistance are required. The results obtained are read direct from a scale, and no further calculation is necessary than that

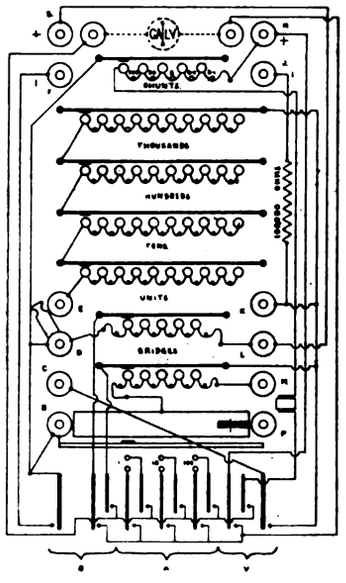
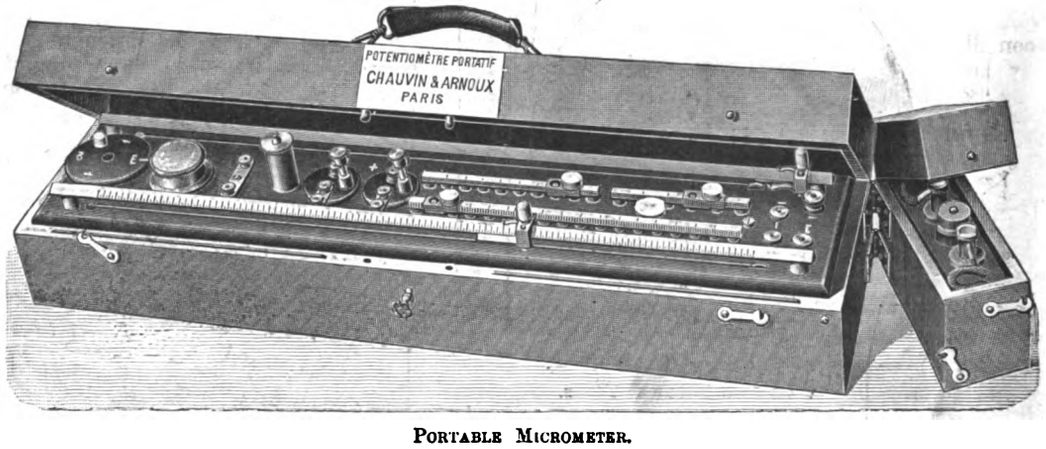


Diagram of Connections of "Portable Laboratory."

required to determine the position of the decimal point, which is easily done by following a simple rule. The set itself consists of a polished oak case, size 19in. by 5in. by 4in., and weighing 7lb. to 8lb. The connections are those of the ordinary Thompson double bridge, the parts being so arranged as to give direct indications as above stated. The galvanometer is of a highly sensitive and dead-beat pattern, the end of the needle only appearing under a magnified lens, which shows distinctly the slightest movement of the needle. This galvanometer is



Portable Micrometer.

spring suspended, and cannot, therefore, be damaged by rough handling in transit. To operate this instrument a known current is passed through the resistance to be measured, and also through the ohmmeter. The difference of potential produced in the unknown resistance is then balanced against the known length of the standard resistance in the set. When no deflection of the needle is noted a reading is at once taken without any further operation. An universal station equipment was also shown, by which it is possible to measure

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voltages between 0·01 and 600, and currents between 0·01 and 1,000 amperes. The instruments and their shunts are contained in one case 18in. by 9in. by 5in., and can easily be carried by one person. Several specimens of Vulcan watt-hour meter were shown, a 1,500-ampere specimen being particularly interesting, its field coil, consisting of 0·75 of a turn of copper, having a section of about 3 sq. in. A large number of the well-known Ward-Leonard rheostats were also exhibited.

Messrs. Greenwood and Batley, of Albion Works, Leeds, had only two exhibits at their stand, No. 70. One was a De Laval steam turbine coupled to a bipolar machine rated at 45 amperes with a voltage of 220. The turbine itself works at the enormously high rate of 24,000 revs. per min., and by means of gearing the speed of the generator is reduced to 2,400. Steam enters the turbine by means of nozzles placed at an angle to the vanes of the wheel. It is stated that by boring the nozzles in the form of a cone, with its base forming the outlet, a far greater efficiency is obtained than by keeping the section uniform. The machine also becomes more economical if the steam pressure is raised. Among the advantages claimed for this turbine over an ordinary reciprocating engine is the fact that the vibration is reduced to an almost negligible quantity. The working is not affected by a loose bearing and the erection is a very simple and cheap matter. The speed is regulated by means of a governor and is said to be practically constant for all loads. By shutting off one or more of the nozzles the output may be diminished at will. All parts are interchangeable. If doing nothing else, high-speed turbines are making possible the use of bipolar machines, which are becoming so obsolete that one almost expects to find them under a glass case. The other exhibit was a centrifugal pump, called the "Zeta" pump, coupled direct to a 12 H.P. motor. This pump was engaged in the somewhat hopeless task of drawing water from a tank with its suction and immediately returning it with the delivery pipe. The discharge was remarkably steady and even, and the pump is capable of throwing a jet of water 65ft. high at the rate of 290 gallons per minute.

(To be continued.)

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Radio-activity Produced by Light.—G. Le Bon, whose discovery of what he termed "dark light" made a stir some five years ago, has since studied the effects of light of different wave-lengths upon all kinds of material bodies. He finds that practically every kind of matter may be made to emit Becquerel rays by the sole action of light. It has long been known that ultra-violet light enables free electrons to escape from a negatively-charged body. The author makes out that the body need not be negatively charged at all. It suffices to expose it to sunlight, or, better still, to ultra-violet light. It then gives off a form of radiation which is capable of discharging an electroscope charged positively. Amalgamated tin, copper, or zinc show the strongest effect. Gold, cobalt, pure mercury, tin, cardboard, wood and phosphorescent sulphides only show one-thousandth of the intensity of action. Living matter shows least of all, but black paper and lamp-black are almost as good as the metals. As regards the quantitative value of the different regions of the spectrum, the author allocates 6 per cent. to the visible spectrum, 9 per cent. to the region between 400 and 360 $\mu\mu$, and 85 per cent. to the region between 360 and 295 $\mu\mu$. Mercury may be highly "sensitised" by adding a trace of tin.

[G. LE BON, *Comptes Rendus*, July 7, 1902.]

Coherers.—J. Fényi has observed that an exceptionally strong current can be used with a coherer if the latter consists of a number of steel needles in series. If six needle coherers are placed in series, it is possible to connect them up with a Leclanché cell of E.M.F., 1·5 volts. If several cells are to be used, it suffices to add three or four coherers for every volt of additional E.M.F. In this manner, currents considerably above the standard "milliampere" may be obtained in the coherer circuit. In fact, 100 milliamperes may be used. The author describes a striking experiment to demonstrate this. Six needle coherers, a trembling electric bell, and a Leclanché cell are connected in a circuit. A small spark excites the coherer and the bell rings. The ringing ceases abruptly, as its trembling decoheres the coherer. If the coherer is put to earth on one side and connected on the other side with a very long insulated conductor, an apparatus is obtained which announces distant thunderstorms. If a magnetic recording device is inserted in parallel with the bell, distant thunderstorms may be recorded. A conductor 26 metres long is suitable for most ordinary purposes, but a length of 360 metres gives ten times the effect.

[J. FÉNYI, *Comptes Rendus*, July 7, 1902.]

Electromagnetic Relations.—A. Righi discusses the experiments of Crémieu and their bearing upon the four electromagnetic effects predicted from Maxwell's theory. The four effects are: (*a*) The production of a magnetic field by a moving electric charge; (*b*) the production of an electric impulsive force by a varying magnetic field; (*c*) the production of an electric field by a moving magnet pole; and (*d*) the production of a magnetic impulsive force by a varying electric field. Of these, Crémieu denies the existence of the first and second, and the third and fourth have not yet been studied. The fourth offers the same difficulty as the first, inasmuch as the magnetometer must be protected from direct electrostatic action by a conducting shield. The author deals specially with the second effect (see *The Electrician*, this volume, p. 419), and gives reasons for regarding Crémieu's result as inconclusive. He describes his own experiments on the same subject, which are of extreme delicacy, but also hitherto inconclusive, owing to the many sources of error involved. In conclusion, he shows that Crémieu's negative results are not able to shake our confidence in the soundness of modern electromagnetic theory; but it would be very desirable that experiments be made along all the four lines indicated, so as to clear up the matter thoroughly.

[A. RIGHI, *Physikal. Zeitschr.*, July 1, 1902.]

Relative Motion of Earth and Ether.—Besides the principle ordinarily known as Doppler's principle, Christian Doppler in 1845 put forward another rule which deals with rotating bodies. It is that a ray penetrating such a body undergoes a deflection in the direction of the rotation. E. R. von Oppolzer discusses this principle in the light of modern ether theories, and proposes an experiment to discriminate between Michelson's three alternatives of (*a*) the free penetration of the ether through the earth, (*b*) a change of length of all bodies when moving through the ether, and (*c*) a drag of the earth upon the ether up to several thousand miles from its centre. A flat cylinder of flint glass 1 metre in diameter is given a velocity of rotation of 30 turns per second. A beam of light is made to impinge upon the circumference of the disc, and to penetrate it along a diameter. Then if the ether is dragged along by the disc with the same speed, the beam should be deflected by 0·226 seconds of arc, an amount which is quite observable with modern instruments. If Lorenz's view of the increase of length holds good, there should be no deflection, or, as Doppler would call it, rotational refraction. Fresnel's idea that the ether is dragged along with a velocity smaller than the speed of rotation would be verified if the deflection were smaller than the amount mentioned.

[E. R. VON OPPOLZER, *Ann. der Physik.*, No. 8, 1902.]

Tesla Currents from Induction Coils.—A. Möhlmann maintains that the difference between Tesla currents and those furnished by an induction coil is only one of frequency and of tension. With an induction coil giving sparks of 50cm., fed by an alternate-current dynamo giving 350 reversals per second, he obtained all the characteristic phenomena described by Himstedt—viz., that a disc placed opposite a point connected with the source was positively charged at short distances, and negatively at greater distances. Between the two cases there

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was a point at which the disc was not charged at all. The position of the point of reversal was found to be only dependent upon the potential of the source, and not upon the frequency. The higher the potential, the further do the positive ions penetrate, and the greater, therefore, the distance of the neutral position. It appears that smooth, rounded surfaces give off negative ions by preference, and rough or pointed surfaces positive ions. This explains why positive ions are best obtained by fusing a platinum wire into a glass tube, and filing the projecting point down to the level of the glass. The sides of the wire, which are smooth, are thus prevented from sending out negative ions, end the point alone remains in action.

[A. Möhlmann, *Ann. der Physik.*, No. 8, 1902.

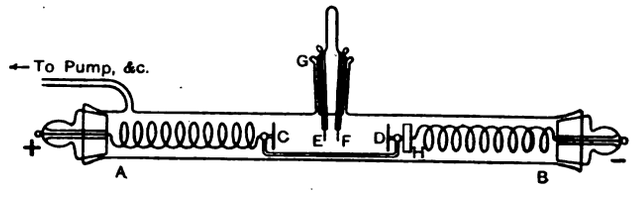
Optical Effect of a Current in a Metal.—P. V. Bevan puts the question whether the optical constants of a metal are altered on conducting a current through it, and whether such alteration persists as long as the current lasts. It is conceivable that the reflective power of a metallic mirror might be considerably increased by the passage of a current through it, in which case it would be more brilliant while the current passed, and duller when it ceased. The author calculates the effects theoretically on the basis of Drude's theory. He finds that the effect of the current in the metal is to cause an alteration in the constants of the metal, but this alteration is too small for the effect to be measurable, taking one-hundredth of a wave-length as the minimum change of phase which can be detected. The alteration, also, of the plane of polarisation, or rather the major axis of the ellipse of polarisation, of reflected light is similarly too small to be detected. In silver and sodium the chances would be more favourable, but in all cases the thickness of metal through which light can be passed being only a few wave-lengths, there is no possibility of a small difference of velocity producing a change of phase large enough to admit of measurement.

[P. V. Bevan, *Proc. Cambridge Philos. Soc.*, May 5, 1902.]

Conductivity and Atomic Heat.—Clausius believed that the resistance of metals was proportional to their absolute temperatures, and that, therefore, the coefficient of thermal increase of the resistance was the same as that of the expansion of gases—viz., 0·00866, or $\frac{1}{273}$. More recent measurements made with carefully-purified metals have shown that the rule does not hold good, as palladium, according to Dewar and Fleming, has a smaller coefficient, and all other substances a larger coefficient than 366×10^{-6}. F. Streintz shows, however, that if the metals are arranged in groups of lower and higher atomic weights a general rule may be formulated, according to which the coefficient increases in each group with the atomic weight. Thus, the coefficient would rise from platinum (384) to bismuth (454) in the heaviest group, and from palladium (854) to tin (440) in the next group. A more important relation is that between resistance and atomic heat. As the thermal coefficient of the atomic heat falls, so the thermal coefficient of the resistance rises. In all metals whose atomic weight is above 100, the thermal coefficient of the resistance is the greater the greater the atomic volume, and the smaller the displacement of an oscillating atom in comparison with the distance from the neighbouring atoms.

[F. Streintz, *Ann. der Physik*, No. 8, 1902.]

Hall Effect in Gases.—H. A. Wilson has demonstrated with great success the existence of a Hall effect in the positive column of a vacuum discharge. The condition theoretically necessary for the existence of a Hall effect is a difference between the velocities of the two kinds of ions, and this is known to exist between the fast negative and the slow positive ions of the vacuum discharge. He found that the Hall effect was independent of the current, but proportional to the intensity of the magnetic field. To give an example of the effect observed, a Hall effect of 7·20 volts per centimetre was obtained in the uniform positive column of hydrogen at a pressure of 0·183mm. with a field of 44·2 units. The variation of the Hall effect along the discharge in air was studied by means of the apparatus shown in the diagram. It consisted of a glass tube, AB, 58cm. long and 4·5cm. in diameter, provided with a glass stopper at each end. At the centre of the tube a side tube, G, was sealed on, and also provided with a glass stopper which carried two electrodes, E and F, for measuring the Hall effect. The discharge was passed between two aluminium discs, C and D, each 3cm. in diameter, which were supported by a framework of thin glass rods which kept them at a constant distance apart. Flexible spirals of copper wire connected these electrodes with platinum wires sealed through the ends of the stoppers at A and B. A coil of thin sheet iron, H, was fixed to the frame carrying the electrodes, and enabled it to be moved along the tube by means of a small electromagnet. In this way the electrodes E and F could be brought into any portion of the discharge between C and D. The electrodes E and F were 1·40cm. apart, and were connected through a commutator to an insulated quadrant electrometer. A pair of circular coils, each of about 15cm. radius were arranged symmetrically one above and one below the tube, and separated by a distance equal to the radius of either. A current, measured by means of a Weston ammeter, could be passed through these coils, and this produced a very uniform magnetic field near E and F in a direction parallel to the axis of the stopper G. When making a measurement of the Hall effect, the stopper G was first rotated until the electrometer indicated that E and F were at the same potential. The magnetic field was then applied and reversed, and the change in the P.D. between E and



F on reversing the field was measured by the electrometer. The results show that the Hall effect varies along the tube very nearly as the electric intensity, but in the striated positive column the Hall effect falls to an almost zero value between the striæ, whereas the electric intensity only falls to a comparatively small extent. It appears, therefore, that the difference between k_2, the velocity of the negative, and k_1, the velocity of the positive ion, in the dark spaces between the striæ is very small. It is probable that when a molecule is ionised a free electron or negative corpuscle is split off so that the negative ion is of very small mass compared with the positive ion; $k_2 - k_1$ is, therefore, at first very large. After a short time, however, the negative corpuscle probably becomes attached to a neutral molecule, so that the two ions are then of almost equal mass and $k_2 - k_1$ is very small. It seems, therefore, probable that ions are formed largely in the striæ, and that by the time they get into the dark spaces, the negative ions which were electrons at first have become attached to molecules. This view is in agreement with the idea that each stria and its adjacent dark space constitute a, to some extent, independent portion of the discharge analogous to that formed by the negative glow and Faraday dark space, but is opposed to Stark's view, according to which the dark spaces are the regions in which the negative electrons travel without collision.

[H. A. Wilson, *Proc. Cambridge Phil. Soc.*, May 5, 1902.]

THROUGH TRAFFIC ON TRAMWAYS FOR PASSENGERS AND GOODS.

A Paper dealing with this subject was read before the Liverpool Chamber of Commerce by Mr. J. E. Waller, M.Inst.C.E., on Monday. The subject is dealt with in three parts, the first referring to passengers, the second to goods, and the third to parcels. Although it is possible to cover quite a considerable distance by means of tramways, yet to accomplish this it is necessary to change, not only from one

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car to another, but from system to system. This occasions delay and inconvenience to passengers, and therefore the author proposes to link up several systems and persuade the local authorities to grant "through" running facilities. He says that this necessity has long been recognised by the railways, and proceeds to describe the dislocation of passenger and goods traffic throughout the country if it were not adopted. Although the actual speed of the tramcar is less than that on a railway, a large number of people would gladly avail themselves of the opportunity of travelling by the former in preference to the latter. Railways with their vast main line passenger and goods traffic do not usually trouble much about local lines, and no one needs to be reminded of the frequent stops at stations, delays at junctions and the utter disregard of punctuality displayed by certain companies towards their local, to say nothing of suburban, traffic. Mr. Waller cites an instance of a passenger wishing to travel from Chowbent to Liverpool, a distance of 26 miles. The average time occupied is about 2 hours, there are no trains between 9:30 a.m. and 1:5 p.m., and only seven in one direction and ten in the other throughout the day; in addition, the unfortunate passenger would have to change trains at Tyldesly, Kenyon, and sometimes at St. Helens Junctions. The distance by road is only 24 miles, and there is no reason why it should not be traversed by a tramcar in 3 hours. Although this is a longer time than that taken by rail, yet the difference would be compensated for by the frequency of the cars, and the fact of the cars passing one's own door, as it were, obviating the necessity of a lengthy walk to the station. The fares would also be less, an example being taken from the third-class single from St. Helens to Liverpool at 11½d., the return being ordinarily double, and special return fares two days in the week at 1s. 3d. The whole distance, from any part of one town to any part of the other, could be done by tramway for 9½d. single or 1s. 3d. return, and even these figures will probably bear reduction. Although the proposal to carry goods on tramways seems a novel one, yet almost every act or order contains a schedule of rates to be charged for goods. In South Lancashire there is a large goods traffic, consisting of coal, building material, machinery, &c., and it is found that the cost of double handling of this necessitated by rail conveyance is prohibitive for small distances.

The question of the transport of coal is gone into very fully, and it is stated that goods conveyed from the docks at Liverpool are, at the present time, transhipped no less than six times. All this labour could and would be eliminated by the use of tramways; time and money would be saved, and consequently a much larger traffic could be dealt with, thus increasing business and profits all round.

The parcel traffic would probably be considerable, and would be carried in the daytime, either by trailer cars attached to the passenger cars or special independent self-propelled vans. The cost of conveyance of both goods and parcels will undoubtedly compare most favourably with that entailed by the present method of railway carrying, and the profits gained thereby will go a long way towards making electric tramways still greater financial successes than they are at the present day.

TROLLEY CAR VERSUS HORSE OMNIBUS.

In order to test Lieut.-Col. Crompton's singular statement that a public horse omnibus has a greater "overtaking power" than a trolley car, and can cover a given distance from point to point in less time, a representative of *The Electrician* this week went down to Hammersmith and timed a number of horse omnibuses over the route between Hammersmith and Turnham Green, this last being the terminus of the 'bus route. We have frequently made this test ourselves in an informal way, *i.e.*, without scheduling the results; so the result of our representative's tests was, in our opinion, a foregone conclusion. However, as Lieut.-Col. Crompton seemed so sure about the matter, we thought it best to get actual figures. We hope Lieut.-Col. Crompton has followed our suggestion and done the same; we shall be glad to publish his figures too. Our own figures are tabulated below:—

Trip No. 1.

12:23 ..... Omnibus started from Hammersmith Broadway.
12:28 ..... 1st stop.
12:31 ..... 2nd stop.
12:32 ..... Overtaken by trolley car No. 44.
12:37 ..... Arrived at end of journey (Turnham Green).

Trip No. 2.

12:47 ..... Started from Turnham Green level with trolley car No. 23 which immediately went ahead.
12:49 ..... 1st stop.
12:50 ..... 2nd stop and overtaken by trolley car No. 57.
12:55 ..... 3rd stop.
12:57 ..... 4th stop.
12:58 ..... 5th stop.
12:59 ..... Overtaken by trolley car No. 16.
1:2 ..... Arrived at Hammersmith Broadway.

Trip No. 3.

2:47 ..... Started from Hammersmith Broadway.
2:48 ..... Overtaken by trolley car No. 12.
2:55 ..... Do. Do. No. (?)
2:58 ..... Do. Do. No. 80.
3:2 ..... Arrived at Turnham Green.

Trip No. 4.

3:9 ..... Started from Turnham Green.
3:10 ..... Overtaken by trolley car No. 26.
3:12 ..... 1st stop.
3:18 ..... Overtaken by trolley car No. 15.
3:19 ..... End of journey (Hammersmith Broadway).

It will easily be seen by the above list that electric tramcars do possess considerable overtaking power, even in the most crowded thoroughfare.

The trolley cars ran at intervals of 2½min. and the 'buses at 10min. intervals. This fact alone surely proves that tramways do increase the carrying capacity of the road, especially when the above tables are taken into account, and when it is known that a trolley car carries about 60 passengers, as compared with 26 for a full omnibus. The particular 'buses on which the experiments were carried out rarely carried more than two or three passengers, and consequently were seldom required to stop, while on the other hand, the trolley cars were fairly fully loaded and frequent stops were made by them. There are about 18 optional and 8 compulsory stopping places between Hammersmith Broadway and Turnham Green, and this is only half way to Kew.

Neither the 'bus nor any other vehicle was ever prevented from going forward by a trolley car; but the cars were frequently held back by 'buses, &c., particularly in King-street, Hammersmith. Moreover, when two or three heavily laden vans get into this street the rest of the traffic—cabs, 'buses, carts, carriages and trolley cars—has to proceed at a walking pace in a long procession behind them; nothing is able to pass, not even Lieut.-Col. Crompton's non-existent accumulator omnibus.

DELAY AND OUTPUT.*

BY C. H. GARLAND.

Recents events have demonstrated how closely related are delay and output in the telegraph service. Since the days of that fateful committee which was appointed by Mr. Arnold Morley in 1893 there has been a constant endeavour to increase the individual output of telegraphists. This endeavour has been largely successful, but the success has been purchased by the sacrifice of many of the cardinal principles of the service. During the period since 1894 there has been a progressively increasing delay in the speed of telegrams. It has required no deep insight to see the intimate connection between the two factors. It is not my purpose to praise or blame the result. It is for the people of England to say whether they think they are adequately compensated for the slower service by the economies effected. From the point of view of the employés the near future will show whether the higher pressure will bring in its train the same disastrous results as in America, where telegraphists seldom pass the age of 35 untouched by cramp or a general nervous breakdown. The purpose of this article is to introduce to English readers some interesting results which have been published during the last month in the organ of the Italian tele-

* From the *Teleyraph Chronicle.*

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graphists, the *Giornale dei Telegrafisti*, and which have a most instructive bearing upon the question of the relation between delay and individual output.

Signor Ettore Rossi, of the Roman Telegraph Service, has, during the last two years, made a tour of the principal telegraph offices of the world, and has published some interesting notes upon his journey. The most instructive portion of his articles, however, is the summary of results which is appended to the final chapter. I feel sure that the interest of this summary will form a sufficient excuse for translating it from the Italian.

Signor Rossi has constructed the two tables which follow, and which are intended to form a synthetic recapitulation of his data, and compare them with the figures of the Roman office. Table I. shows the mean delay in minutes of telegrams at three stages in their course in the offices named. The first column shows the delay in collection, the second column shows the delay in delivering, and column 3 shows the time occupied in transmission :—

Table I.—*Mean Delay in Minutes of Telegrams at the Various Stages Named.*

Office.	Collection.	Delivery.	Transmission.
Alexandria (Eastern Telegraph Co.)	6	4	6
Brussels	12	5	7
Athens	15	7	12
Bucharest	18	10	15
Berlin	27	5	18
London	25	12	20
Munich	30	10	21
Buda Pesth	30	10	25
Vienna	35	10	22
Paris	45	17	25
Pera	40	23	32
Rome	105	50	90

Table II. shows in the first column the approximate number of telegrams dealt with daily at the offices named ; in column 2 is shown the approximate number of employés, and column 3 shows the average number of telegrams per day per employé.

Table II.

Office.	Average daily work.	Number of employés.	Number of telegrams per employé.
Buda-Pesth	31,000	320	96·8
London	475,000	5,000	95
Paris	120,000	1,300	92·3 (1)
Alexandria	7,000	80	87·5 (2)
Brussels	18,000	244	73·7 (3)
Munich	11,000	150	73·3 (4)
Vienna	45,000	700	64·3 (4)
Berlin	89,000	1,500	59·3 (4)
Rome	14,500	315	46·7 (5)
Pera	3,500	80	43·7 (6)
Athens	2,200	62	35·5 (7)
Bucharest	6,000	180	33·3 (6)

Notes to Table II.—1. The words of the French language are longer than those of English. The actual relation is as 5·5 letters to 5. The average of 92·3 is, therefore, roughly equal to the English average. As a set-off to this, it must be remembered that the minimum charge for telegrams in England allows 12 words, whilst the minimum charge in France allows only 10 words. The Baudot, used in France to a very large extent, is a much faster instrument than any in common use in England, and counts for something in the high French average.

2. The telegrams have an average length of only 12 words, but this is compensated for by the fact that no fast apparatus is used.

3. At Brussels the managing, supervising and distributing staff is very numerous, and the low delay is obtained at the expense of a low individual output.

4. The Hungarian language has a large proportion of very long words, and in the German Confederation very little use is made of the Baudot, the Wheatstone or any fast system.

5. In Italy the proportion of long messages is greater than elsewhere, the minimum charge of 1 lira allowing 15 words in an inland telegram. The mean is, nevertheless, low.

6. A low average, which must be attributed to the large number of lines and the small amount of traffic.

7. As note (6) and the absence of fast apparatus.

I have added one or two things to Signor Rossi's illuminating notes, and should like to note also in passing that as the average charge for an English inland telegram is 7½d., the average number of words is, therefore, 15.

From the above tables and notes there is one thing that can be deduced with certainty, although much interesting and useful information can also be obtained. That deduction is hinted at in note (3) referring to the Brussels office. After making allowance for all the circumstances that render comparison difficult and qualify the results obtained, there remains the undoubted fact that high individual output is bought at the price of increased delay. London stands high in the individual averages, but in the matter of delay the Belgian capital is well ahead, and even our great commercial rival, Germany, despite the large area of her inland service, takes a place in front of us. These facts need no accentuation, and all thoughtful students of telegraph service will feel grateful to Signor Rossi for bringing before them in so striking a manner the relation between delay and individual output.

ELECTRICITY WORKS ACCOUNTS.

Lancaster Municipal Electric Supply Works.

While the last accounts of this undertaking indicate an unhappy general increase in the expenses, the costs results should be regarded, we think, as still quite satisfactory in the circumstances. A glance at our table will show that as between the last two years the load-factor has fallen materially, while the output shows the insignificant increase of only 5·2 per cent. In themselves these facts are certainly unsatisfactory, but at the same time they form some excuse for the upward movement in the working expenses. As a matter of fact, a comparison of the cost figures shown for last year with the corresponding average costs of municipal undertakings of similar size and load-factor in 1900 would result in a favourable verdict for Lancaster. The works and total costs at this place are certainly not above those averages, while the total revenue per unit sold is below them by about 0·3d. The strong point of this concern, however, lies in its low capital expenditure relatively to the business done, and this explains why it is that with such a moderate total revenue the financial results are so satisfactory. During the last six years the average total revenue has been 4·36d. per unit, the average allocations out of revenue on capital account have been 5·32 per cent. of the mean capital, while the net profits paid in aid of the rates amount to £2,725 in total.

Morley Municipal Electric Supply Works.

Poor progress is being made by this undertaking. Not only is the output small for an undertaking which has completed its fourth year, but the costs are still much too high, even for that small output. The only reasonable item among the generating costs is that of repairs. The high management and property charges contribute to make the total costs quite 0·7d. above what they should stand at. To add to the difficult position of the concern, the capital expenditure is heavy in relation to the output. It is, however, a hopeful sign that a general and substantial improvement in the costs sheet has been effected in the past year with the relatively satisfactory result that the deficit was less than that of 1900–1, although the average price for supply was diminished.

Accrington Municipal Electric Supply Works.

Our third analysis presents the more interesting data afforded by the Accrington undertaking accounts. It is necessary to point out at first that this station is worked in conjunction with a dust destructor. In the official accounts no provision is made for the steam supplied by the destructor to the electricity department. This explains the lowness of the figure shown for "fuel." The costs displayed, with the exception of repairs at the station and, of course, the fuel item, are considerably too high. The output and load-factor are both very low, however, and it is to be remembered that the results were those of the first year of working.

REMARKS.

LANCASTER.—*a* £20 per annum for each 10 ampere arc and incandescents, £18 per annum for each 5 ampere arc and incandescents. *b* Of which £848 was paid out of revenue through sinking fund. *c* "Reserve" fund. *d* No lands. *e* Accumulators £1,020, public lamps £748. *f* Accumulators £1,020, public lamps £814. *g* Over-expended. *h* Insurance £17, auditing £4. *i* To "Reserve" fund. *j* Insurance £14, auditing £6. *k* After deducting public lighting, attendance and renewals costs.

MORLEY.—*a* Over-expended. *b* After deducting £190 cost of steam supplied for heating baths. *c* Of buildings £5 and of machinery and plant £43. *d* Salaries of engineer and assistants £265, of electrical staff £25. *e* Insurance. *f* After deducting £157 cost of steam supplied for heating baths. *g* Buildings £39, plant £28. *h* Of engineer and assistants £256, of electrical staff £28. *i* Insurance £7. *j* Met by general district rate.

ACCRINGTON.—*a* Land £1,000. *b* Accumulators £1,909. *c* Over-expended. *d* 90,507 units for lighting £1,526 and 7,362 units for power £56. *e* 250 units at 3d., £3. *f* This is a dust destructor station and nothing was charged for heat from destructor, the coal used (corresponding to the fuel charge of £66) was 1237 tons. *g* Buildings £18, plant £30. *h* Engineer £249, deputy-engineer £99, clerk £16. *i* Insurance—accident £3, boiler £3. *j* Charged to general district rate.

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	LANCASTER.		MORLEY.		ACCRINGTON.
Undertaking Worked by	Lancaster Corporation.		Morley Corporation.		Accrington Corpn.
Date of Commencement of Supply	April, 1894.		February, 1898. [network.		November, 1900.
System of Supply	3-wire continuous-current.		Alt.-current trans. sub-stations supply'g 2-wire		3-w. con.-current.
Chief Engineer	Wm. A. Tester.		H. Drewett.		H. Gray.
YEAR ENDED	MAR. 25, **1901.**	MAR. 25, **1902.**	MAR. 25, **1901.**	MAR. 25, **1902.**	MAR. 31, **1902.**
QUANTITIES—					
Units generated	370,607	384,000	109,861	133,677	136,225
„ **SOLD (TOTAL)**	**334,737**	**352,075**	**77,776**	**99,205**	**97,869**
„ sold to consumers	272,010	288,862	47,026	—	97,619
„ sold for public lighting, &c.	52,674	52,674	30,750	—	250
„ sold for traction	nil	nil	nil	nil	—
„ used on works	10,053	10,539	8,472	10,551	27,584
UNITS SOLD per MEAN 8 c.p. CAPACITY	**25·6**	**21·7**	**9·21**	**12 5**	**—**
Actual maximum supply demanded	366 kilowatts	410 kilowatts	80 kilowatts	100 kilowatts	142 kilowatts
Load factor	10·4%	9 80%	11·1%	11·3%	7·87%
Number of public lamps	31 arc, 62 (32 c.p.) glow	31 arc, 62 (32 c.p.) glow	15 arc, 33 (32 c.p.) glow	15 arc, 3 glow	4 (180 c.p.) glow
Number of consumers	560	644	75	89	111
Connections to mains in 8 c.p. at end year	24,416	29,247	6,861	8,397	10,446
CAPACITY of PLANT in KW. at END YEAR	**420**	**620**	**270**	**240**	**533**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kw. capacity.**
AUTHORISED (TOTAL)	— / —	— / —	£22,500 / £83·3	— / —	£45,140 / £84·7
Share	— / —	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	— / —	— / —	22,500 / 83·3	— / —	45,140 / 84·7
RECEIVED (TOTAL)	£35,807 / £85·3	£36,098 / £58·2	22,500 / 83·3	£25,500 / £106	36,250 / 68·0
Share	— / —	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	35,807 / 85·3	35,098 / 58·2	22,500 / 83·3	25,500 / 106	36,250 / 68·0
AUTHORISED, NOT RECEIVED (TOTAL)	— / —	— / —	— / —	— / —	8,890 / 16·7
Share (unissued)	— / —	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —	8,890 / 16·7
REPAID (TOTAL)	557 / 1·33	2,148[b] / 3·47	— / —	— / —	1,037 / 1·95
RESERVE OR SINKING FUND	1,793 / 4·27	2,124 / 2·43	1,907 / 7·06	2,686 / 11·2	18 / 0·034
DEPRECIATION FUND	1,200[c] / 2·86	2,131 / 3·44	— / —	— / —	— / —
EXPENDED (TOTAL)	35,380 / 84·2	39,346 / 63·5	24,181 / 89·6	24,308 / 101	36,979 / 69·4
Lands and buildings	3,852[d] / 9·17	4,246[d] / 6·85	— / —	— / —	11,628[a] / 21·8
Plant	15,589[e] / 37·1	17,144[f] / 27 6	— / —	— / —	13,213[b] / 24·8
Mains	15,486 / 36·9	17,469 / 28·2	— / —	— / —	12,025 / 22·6
Miscellaneous	453 / 1·08	485 / 0·78	— / —	— / —	114 / 0·214
BALANCE OF CAPITAL ACCOUNT	427 / 1·02	−3,248[g] / −5 24	−1,681[a] / −6·23	1,192 / 4 97	−729[c] / −1·37
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of tota' units sol'.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sol'.**
TOTAL	**£5,665** / **4·061d.**	**£6,115** / **4·167d.**	**£1,326[b]** / **4·094d.**	**£1,569[f]** / **3·798d.**	**£1,617** / **3 968d.**
Revenue from supply	4,951 / 3·548d.	5,419 / 3·693d.	933 / 2·880 i.	1,175 / 2·843 i.	1,582[g] / 3·882d.
„ meters, &c.	1 / 0 001d.	34 / 0·023d.	40 / 0·124d.	48 / 0·116d.	— / —
„ public lighting	658 / 0·472d.	649 / 0·442d.	346 / 1·068d.	346 / 0·837d.	3[e] / 0 007d.
„ supply for traction	nil / —	nil / —	nil / —	nil / —	— / —
„ miscellaneous sources	55 / 0·039d.	13 / 0 009d.	7 / 0·022d.	— / —	32 / 0·079d.
EXPENDITURE—					
TOTAL COSTS	**£2,961** / **2·123d.**	**£3,579** / **2 440d.**	**£1,473[b]** / **4·547d.**	**£1,446[f]** / **3 500d.**	**£1,124[f]** / **2·757d.**
TOTAL WORKS COSTS	**2,478** / **1·777d.**	2,708 / **1·847d.**	1,067[b] / **3·293d.**	1,011[f] / **2·444d.**	623[f] / **1·528d.**
Generation of Electricity	*2,070* / *1·484d.*	*2,105* / *1·435d.*	*946[b]* / *2 920d.*	*910[f]* / *2·201d.*	*543[f]* / *1·332d.*
Fuel (including cartage, &c.)	1,249 / 0 895d.	1,170 / 0·798 i.	488[b] / 1·506d.	428[f] / 1·036d.	66[f] / 0·162d.
Oil, waste, water, stores	131 / 0·094d.	171 / 0 117d.	126 / 0·389d.	110 / 0 266d.	98 / 0·241d.
Wages at station	589 / 0·422d.	628 / 0·428 i.	285 / 0 880d.	305 / 0·738d.	330 / 0·810d.
Repairs & maintenance at Station	101 / 0·072d.	136 / 0 093d.	47[c] / 0·145d.	67[g] / 0·162d.	48[g] / 0·118d.
Distribution of Electricity	*304* / *0·218d.*	*474* / *0 323d.*	*38* / *0·117d.*	*36* / *0·087d.*	*80* / *0·196d.*
Wages, &c.	304 / 0·218d.	474 / 0·323d.	16 / 0·049d.	13 / 0·031d.	60 / 0·147d.
Repairs, renewals of mains, &c.			23 / 0·071d.	23 / 0·056d.	20 / 0·049d.
Public Lighting	*104* / *0·075d.*	*129* / *0·088d.*	*83* / *0·256d.*	*65* / *0·157d.*	— / —
Attendance	104 / 0·075d.	129 / 0·088 i.	39 / 0·120d.	36 / 0·087d.	— / —
Renewals			43 / 0·133d.	28 / 0·068d.	— / —
MANAGEMENT CHARGES, &c.	483 / **0·346d.**	871 / **0 592d.**	406 / **1·253 i.**	436 / **1·055d.**	502 / **1·231d.**
Net Rents	*15* / *0·011d.*	*15* / *0·010d.*	nil / —	— / —	*56* / *0·137d.*
Rates and taxes	*135* / *0·097d.*	*306* / *0·209d.*	*63* / *0·194d.*	*82* / *0 198d.*	*2* / *0·005d.*
Management	*333* / *0·239d.*	*550* / *0·375d.*	*343* / *1·059d.*	*354* / *0·856d.*	*444* / *1·089d.*
Salaries	211 / 0·151d.	277 / 0·189d.	290[d] / 0·895d.	284[h] / 0·687d.	371[h] / 0·910d.
Stationery, &c.	36 / 0·026d.	114 / 0·078d.	11 / 0·034d.	13 / 0·031d.	30 / 0·074d.
Establishment charges	65 / 0·047d.	133 / 0·094d.	31 / 0·096d.	44 / 0·106d.	37 / 0·091d.
Law charges, &c.	21[h] / 0·015d.	21[i] / 0·014d.	11[e] / 0·031d.	13[i] / 0 031d.	6[i] / 0·015d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'd.**
WORKING PROFIT FOR YEAR	**£2,706** / **7·94%**	**£2,537** / **6·79%**	**−£147[f]** / **0·615%**	**£124** / **0·512%**	**£493** / **1 50%**
Carried to Depreciation Fund	750[i] / 2·20%	931[i] / 2 49%	— / —	— / —	— / —
Carried to Reserve Fund	560 / 1·64%	568 / 1·52%	617 / 2·58%	731 / 3 01%	974 / 2·97%
Net int. on loans (incl. Deb. charges)	968 / 2·84%	1,037 / 2·78%	1,238 / 5·18%	1,181 / 4·87%	1,077 / 3·28%
Net profit for the year	427 / 1·25%	nil / —	— / —	— / —	— / —
BALANCE FROM LAST ACCOUNT	— / —	— / —	— / —	— / —	— / —
Do. AVAILABLE for DISTRIBUTION, &c.	427 / 1·25%	nil / —	— / —	— / —	— / —
Deficit	— / —	— / —	*2,002[j]* / *8·37%*	*1,789* / *7·38%*	*1,558[j]* / *4·75%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —	— / —
PER CENT. of TOTAL COSTS to REVENUE	53·2%	58·5%	111%	92·2%	69·5%
Expenditure per mean kilowatt capacity	£7. 1s. 0d.	£6. 17s. 7d.	£5. 9s. 1d.	£5. 13s. 5d.	—
REVENUE PER MEAN KW. CAPACITY	**£13. 9s. 10d.**	**£11. 15s. 0d.**	**£4. 18s. 2d.**	**£6. 3s. 0d.**	—
REV. PER 8-C.P. CONNECTED, MEAN	**4s. 11d.**	**4s. 7d.**	**4s. 3d.**	**4s. 1d.**	—
Price charged for lighting, per unit	5d.	5d.	5½d.	5½d.	5d. to 3d.
„ for power, per unit	3d.	3d.	3d.	3d. to 2d.	4d. to 1½d.
„ for public lighting	—[a]	—[a]	£22 per arc lamp	£22 per arc per ann.	3d. per unit
Receipts per unit for private supply	4·37d.	4·50d.	4·76d.	—	3·88d.
„ „ for public lighting	2·52d.[k]	2·37d.[k]	2·4d.	—	2·88d.
„ „ for traction	—	—	—	—	—

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ELECTRIC TRAMS AND TRAINS.

While certain electrical engineers are concerning themselves in a war of words about the alleged superiority of the time-honoured horse omnibus over the electric tramcar, many of our steam railway companies are evincing a far more heart-searching concern about the steady and substantial decrease in their traffic receipts caused by the running of electric tramways parallel with their steam lines. Neither the horse omnibus nor the horse tramcar has ever caused these railway companies one moment's anxiety; but with the advent of the trolley car things began to go wrong, and the present state of affairs is such that a remedy is urgently needed. History is repeating itself; the same thing happened in many parts of America several years ago. And the remedy which was advocated in the United States, and in not a few cases adopted, was the so-called electrification of the steam lines. For instance, the Nantasket Beach branch of the New York, New Haven and Hudson River Railroad was equipped on the third-rail method and worked on a system of heavy trains corresponding to the steam trains. Subsequently other standard railway tracks in America were similarly equipped, among these being the elevated railways of New York and other leading cities.

In casting about for a valid reason for the cause of this depreciation of their traffic receipts, the railway companies—both in America and more recently in this country—have riveted their attention upon the electrical character of their rival, the trolley car, and have scarcely heeded its other characteristics. They have consequently jumped to the main conclusion that, since it was the electrification of the tramways which depleted their traffic receipts, it is only necessary to equip their own lines electrically in order to win back again all that they have been deprived of. It is ignored altogether that the electric tramcar provides the public with travelling facilities of an entirely novel character—facilities which the slow-going and antiquated horse-car never could provide it with, nor the standard railway, even equipped on the best of electrical systems, succeed in imitating or improving. We refer here, of course, to standard railways run on the same plan as steam lines, with only the motive power changed. Imagine the ordinary business man, with tramcars passing his home and his office, and with a railway station five to ten minutes walk from either destination. He has the choice between a quick succession of swift tramcars, and a 10 or 15 minutes train service. To reach his car he has only to cross half the width of the road; to reach his train he has to book a ticket, pass a barrier, ascend or descend a stairway, and wait about on a wind-swept platform. In nine cases out of ten he chooses the tramcar—not because it is electrical, but because it best suits his convenience. Now, we contend that the ordinary business man, travelling daily over short distances of only a few miles, will be, on the average, quite uninfluenced in his selection by the mere fact of

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the steam railway being electrified. His trains, except where tunnels abound, will not be much cleaner nor more comfortable than in the old steam days; and the speed, on the whole, will not be materially greater. He will be just as liable to be delayed by adverse signals or by fog; and the frequency of the stations, to say nothing of the curves, &c., on the track, will prohibit any great increase in the maximum speed. On the whole, therefore, the mere electrification of his steam suburban line will not appeal to him. Accordingly, we may conclude that the steam railway company which goes no further with its scheme of reformation than to replace steam locomotives by electric locomotives does not stand much chance of recapturing the traffic beguiled from its lines by parallel electric tramways. In America the steam railway companies have given up hoping that they would. We incline to the view that British steam railway companies must eventually come to the same conclusion.

But fortunately it is possible on many, perhaps most, suburban railways to carry the reformation much further, by supplying a service of trains or of separate coaches more closely resembling in its conditions what we meet with on a well-organised electric tramway. By this we mean, not that suburban railways should be turned into what Mr. SWINBURNE calls "glorified tramways," but that by increase in the frequency of the trains the passengers may be ensured against having to waste time in waiting about on platforms. A 5 minutes service of two or three coach trains might replace a 15 minutes service of nine or 10 coach trains. Even in these conditions, however, the inconvenience of having to enter and leave stations, and perhaps to book tickets, would lead all the short-journey passengers to choose the handy tramcar.

It must not be overlooked, in considering this question, that many suburban lines carry a mixed traffic of slow and fast trains, with, perhaps, goods and mineral traffic interspersed. It would be utterly impracticable, of course, to run mixed traffic of this description on the system we have just described. Lines on which the frequent-service system is to be run must be lines on which this system is exclusively used, and they must not even cross lines used for other purposes. The steam railway company, therefore, which aspires to compete against parallel electric tramways must be prepared to separate entirely and at all points the local from the main-line traffic. Even were it practicable to run main-line trains on the frequent-service system, which we maintain it is not, it would still be necessary to provide separate and quite distinct tracks for the fast and the local services. As regards the express and other main service, we do not agree with those engineers who recommend the same frequent supply of trains of small size as seems best to meet the requirements of suburban traffic. A 5 minutes or even a 30 minutes service of express trains would be an impossibility on most main lines. For main lines, therefore, substantially the same traffic arrangements as are now in vogue will probably be found most suitable.

Erroneous ideas are frequently spread, through the agency of the daily press, as to the speeds which electrification makes possible on steam railways. Wonderful speeds are talked of; it would seem that it is only necessary to equip a standard railway electrically for its trains to be able to run at 150 to 200 miles an hour. Undoubtedly, electricity is quite capable of running trains at these speeds on a suitably-prepared track. But we doubt if there is a single railway in the United Kingdom on which it would be safe to run trains, even at 90 miles an hour, over any considerable distance. Mean speeds of over 100 miles an hour are only to be attained on specially-designed and carefully-laid tracks, and, as the Berlin–Zossen trials are clearly proving, the difficulties in the construction of an electric railway for such speeds are far from light. In our opinion not one of the existing main lines of the United Kingdom will ever be equipped electrically for substantially higher speeds than at present in practice without very radical alterations of the permanent way and, in many places, of the route. Nevertheless, although by means of electric equipment our standard main steam lines are not going to be improved in their top speed, there is little doubt that electric locomotives would enable much improvement to be introduced in the average speed. Less time need be wasted in accelerating up to maximum speed, and gradients could be climbed with less reduction in speed. The problem of electrically equipping our standard steam railways, whether suburban or main line, therefore, has many points to recommend it to the consideration of railway managers and engineers, and we do not doubt that ere long it will be one of the most important problems before the electrical profession.

REVIEWS.

Copies of the undermentioned work can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

Coal Cutting by Machinery in the United Kingdom. By SYDNEY F. WALKER. (London: The "Colliery Guardian" Co.)

This book, which constitutes No. 15 of the *Colliery Guardian* Series of Handbooks, is a reprint of matter which originally appeared in the *Colliery Guardian*, and it partakes of the nature of a general discussion of the conditions, difficulties and advantages of coal cutting by machinery. As such it is ably written, and should prove useful to colliery owners, managers, and to would-be designers of coal-getting machinery. Unfortunately, we must say that the work suffers from two important shortcomings—a comparative lack of data and figures which should be available from actual experience in coal cutting in this country and America, and the almost exclusive use of blocks showing general views of machines. With one or two unimportant exceptions, the detailed drawings are of machines only historically interesting.

Considering the increasing importance of electrically-driven coal cutting machinery, this class is, we think, inadequately dealt with. It is true that in this country the compressed air machine has been and is the more popular, but it is at least doubtful if this is the case in America, and if it will remain so in this country with the advent of electric three-phase induction motors.

The author holds up to us the example of American methods and the bogey of American competition on almost every page —*ad nauseam*—and he apparently fails to reflect that there may be a profoundly potent underlying cause for the more universal use of machinery in America—the greater cost of comparatively unskilled labour there than in this country. Perhaps of all the fields of application of machinery the coal-cutting problem is the one most vitally dependent in its solution on the price of labour. We should like to endorse a suggestion of the author's which expresses a conclusion which we have often arrived at in studying the problem of coal-cutting, especially in seams much dislocated by faults—viz., the great advantage which might possibly accrue from the use of hand coal cutting machines or, rather, tools that would increase the individual miner's capacity for coal-getting. Such a tool would bear the same relation to him that the pneumatic rivetting tool, for instance, bears to the boiler maker, and, similarly, it would carry with it all the flexibility (in altered conditions of the coal face) of the human machine armed only with the primitive pick or mandrel.

William Gilbert of Colchester: A Sketch of his Magnetic Philosophy. By CHARLES E. BENHAM. (Colchester: Benham & Co.) Post free 2s. 2d.

This interesting booklet, emanating from Gilbert's native place, is at once a tribute to his memory and to the labours of the Gilbert club, who recently published its splendid translation of Gilbert's famous work, *De Magnete* (*The Electrician*,

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Vol XLVIII., p. 697). For readers unable to possess themselves of the original Mr. Benham's appreciative sketch of its contents will be a very welcome assistance. In some respects it is much more than the mere outline it professes to be; for while doing full justice to Gilbert's insight, originality and industry, and to the boldness with which he confronted the current prejudices and superstitions of his age, the author brings to bear upon Gilbert's work a discriminative and critical faculty by no means common in this class of book. Historically and scientifically he was far ahead of his times; but as Mr. Benham is careful to point out, he was by no means free from the very weaknesses he himself so vigorously denounced. Making, however, all due allowance for these shortcomings, Gilbert deserves all the honours which have latterly, though tardily been showered upon him; and Mr. Benham's little book will help to establish them on a more just and permanent footing.

The Generators of Electricity at the Paris Exhibition of 1900.
By C. F. GUILBERT. (Paris: C. Naud.) 1902. 30fr.

This book is a critical description of the dynamos exhibited at the 1900 Paris Exhibition. It is a large book of nearly 800 pages, and contains many drawings and tables, and will, doubtless, be of considerable interest and value to the dynamo designer; but coming, as it does, after the closing of the exhibition, a number of descriptions of dynamos following one after another, even though they are classified in a certain order, will not appeal to the ordinary student or to the dynamo user as would a general survey with typical examples. Moreover, it must be remembered that, as the book is published two years after the opening of the exhibition, all the dynamos described in it must have been designed at least three years ago, so that the collection is not absolutely representative of the most recent practice. M. Guilbert would have performed a more useful office if he had made use of his notes on the exhibition to form the basis of a short work of a highly technical character on dynamo design, as he could then have omitted all repetitions and redundant matter and, moreover, have brought the book quite up to date. It should be added, as a caution to English readers, that the essential parts of the book is in French, the English language being only found on the title-page, the headings, the foot-lines to the illustrations, the tables and the "Contents."

THE CORRECT TYPE OF ENGINE FOR LARGE GENERATING STATIONS.*

BY A. A. DAY.
(Borough Electrical Engineer, Bolton.)

In bringing the subject of the correct type of engines to be used in future electric power stations before this association, I would point out that many stations have now arrived at that state of congestion which will necessitate before long a larger electric supply station being put down. Under these circumstances it seems to the author very desirable that the type of engine which should be employed in such a station should be discussed by this association. Further than this, it is quite apparent, if the various types of plant employed in central stations throughout the country are considered, that it is not an easy question to settle which is the correct one.

I think it may be taken generally that the engines used in the United Kingdom are mostly high-speed, with a sprinkling of the low-speed type, both horizontal and vertical. In America the low-speed type, both horizontal and vertical, is almost exclusively employed. On the Continent low speed is also almost universal. It must, therefore, be taken as a matter of fact that all three types can be and are used successfully in electric lighting and power works. It may, perhaps, also be further noted here that, in the case of the power schemes which have recently sprung up in England, the engines proposed for these are of the low-speed type, and that the larger generating sets in the large generating stations of this country have also been put in at low speed. On the whole, therefore, I think it may be taken at the present time, having regard to the fact that larger generating sets are being used, that there is a tendency towards the low-speed type. One great factor in the matter is that the space occupied by large generating sets does not appear so unfavourable to the low-speed type when the set is large, say 2,000 H P. or upwards.

* Paper read before the Incorporated Municipal Electrical Association, July 3rd.

The whole question of high versus low speed I do not propose to enter into in this Paper, as I am quite sure the members of this association are quite familiar with the advantages and disadvantages of both types, it having been discussed repeatedly before various societies and in the public Press. If, however, one goes outside electrical engineering and compares the results from the engine point of view only, one finds the low-speed engine still holds the record for low steam consumption. The conditions under which engines in existing electric power stations run are such that very little can be gained from their records which will help towards the solution of this question, as not only is the load-factor bad in most cases, but the plant-factor also, and the very large amount of steam piping which is necessarily kept alive (but not to the full extent of its usefulness) all combine to produce the very poor results which most central stations at the present time show in pounds of coal per unit generated. The effect of the above-mentioned factors together is so marked that it is almost impossible to gain any figures from central station statistics bearing upon the relative figures of merit of different types of plant, for it might even be argued from such statistics that condensing was the reverse of an economy.

The author's opinion on this question of high versus low speed is that, if one adopts the principle of high speed, it should be high speed and not, as is very frequently the case, and especially with engines developing large power, only a moderately high speed, and the larger the set generally the less the speed, so that when one comes to a set of about 2,000 H P. the space which is necessary for a high-speed set or a low-speed set is approximately the same. If one adopts the high-speed principle one must of necessity abandon the idea of personal human supervision of the working parts; if this is admissible, the higher the speed the better the results, both as regards economy of steam, space and material.

The question of space occupied is not, however, of vital importance where a station is being built on large lines for the supply of a considerable amount of power—say, on the three-phase alternating system—giving a high-pressure supply and, therefore, rendering the position of the power house a question of much less moment than it was in the case of the first electric light stations put up, when the public were timid as to the utility of an electric supply, and had very small notions of what that electric supply would develop into in the course of a few years. The author also thinks it may be generally taken that the question of the space occupied per horse-power has been very considerably overdone in the past.

Many stations now are very cramped, and when repairs are necessary a good deal of inconvenience is caused by the cramped way in which the engines are arranged, and when, as appears to be the tendency, the generating sets are of much larger dimensions than they have been hitherto, the necessity for space round the engine is much greater and a larger amount can be allowed without making the horse-power per square yard of the engine room, as a whole, too small. It should also be borne in mind that in a station employing large units, if the engines are placed close together, it is impossible to put the boiler power into so compact a space. The consequence is that, if one generating set requires half-a-dozen of any type of boilers to supply it with steam, there is no necessity why that set, from a space point of view, should occupy less than the length of the engine room covered by the boilers. If this rule be carried out (and it will be found a point of considerable importance in the designing of large stations), it will be found that it is unnecessary to cramp an engine for the sake of saving its floor space, especially in putting down a station such as is here being considered, where the power units are large, while at the same time paying due regard to the importance of having as small an amount of steam piping as possible. It therefore seems to justify the employment of low-speed engines in a station such as we are discussing.

It may be objected that the large unit is not a necessity in the case of an ordinary town supply. If, however, a little consideration is given to the probable demand for electric energy during the next 20 years, the author feels sure that the putting in of small sets, such as one repeatedly sees even now, will cease. There is no reason why large towns, such as Manchester, Glasgow, Liverpool, and so on, should not be employing at the end of the period above stated 100,000 H.P. for all purposes. On the Continent, Berlin has already reached half that amount, and the output is seven times that of Liverpool. In England we have just as good an opportunity, and probably the demand for electric energy will be quite as great once the principle is grasped that electric motive power is, undoubtedly, the coming means of power distribution.

This cannot, however, come about in England until the price of current is reduced below the figure at which it now generally stands for motive power, because in England we have a very good supply of cheap coal in the manufacturing districts where a motor demand is likely to be of the most importance. Nevertheless, the author thinks the figure above stated for such towns is a reasonable one, and if one takes 50,000 H P. in the same period for towns next in point of size, and 20,000 H P. for comparatively small towns in the manufacturing districts, it will be at once evident that if these figures are reasonable, large generating sets must be the order of the day; if not, the

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power stations connected with such towns will become unwieldy in size, and the advantages of large engines will be lost, and the loss in steam pipes will become enormous.

After very carefully considering this subject from all points of view, the author considers the low-speed type of engine should be the one adopted in the future for large power stations. That it will be condensing goes without saying. The type which the author suggests as most suitable in the long run (and it should be borne in mind that the power stations must be put down to last as a business concern and without anything about them of an experimental nature) is a horizontal low-speed compound or triple-expansion engine, with direct-coupled generator between cranks. This type does not appear to have been very largely tried in England. It has, however, succeeded well on the Continent, and, in the author's opinion, may generally claim to have the following advantages, if the question of the space occupied is left out.

1. *Economy.*—The most economical engines have been built of this type, and certainly it can hold its own, if properly built, with any results obtained in electric light stations. These results, as far as they have gone, do not require any very economical engine to obtain them, although one is fully aware that the reason why the pounds of coal used per unit in electric light stations generally is very largely due to the poor load-factor which these stations have. The author has recently had occasion to inquire very closely into the question of the cost of producing power in large cotton factories such as there are in Bolton, and the figures obtained were equally a good advertisement for the horizontal type of engine, which is almost universally employed, and also very useful as a guide to the price at which it is necessary for power to be supplied in order to make its use become general. Such engines are found to give an indicated horse-power-hour for less than 0·1d. with coal about 7s. per ton, and this on a load having a variation of 10 per cent.

2. The horizontal engine does away with the necessity for steam pipes in the engine-room, or rather above the engine-room floor, and enables the steam pipes to be reduced to a minimum. This is a question of vital importance in a large station, and one of the points which requires very careful consideration. By adopting the horizontal type of engine the difficulty of steam pipes can be satisfactorily overcome as far as the engine-room is concerned, and at the same time keep the engine-room neat, doing away with all obstructions to the free use of a traveller from one end of the engine-room to the other.

3. The engine can be kept clean at a minimum of expense and trouble.

4. The repairs to such an engine will be found to be reduced to a minimum if the valve gear be of the Corliss tripped type, which appears to frighten some engineers by its complication. The complication seems to the author to be far more apparent than real. It is no more necessary that the gear should be more complicated than in the case of an enclosed high-speed engine, but it is seen in the one case and not in the other, and a good deal of the complication can be done away with if the motion work were not made so that it could be adjusted while the engine was running, which the author considers to be too great an advantage to be thrown away for the sake of appearances.

5. The engine can be easily got at for repairs, and the same applies to the dynamo. It seems to the author that the weak point of a similar type of engine to that under discussion, but vertical instead of horizontal, is that to remove the top half of the field-magnet ring, or to get at anything of importance on the dynamo, necessitates the dismantling of the engine to such an extent that it practically means rebuilding, and if this dismantling has to be done in a cramped space it is a very costly and lengthy business.

6. The dynamo being placed between the two cranks, the shaft is not in any way cut up. We all know the difficulty that has been found to exist in making a crankshaft with built cranks strong and able to withstand the throwing off and on of the full load repeatedly, as must necessarily be the case with electrical generators for power purposes and traction. The author does not mean by this that there is anything extraordinary in the strains set up in a generator on traction supply, as it has been attempted to prove, it is obvious that such strains cannot exist; nevertheless, practice bears one out that a three-crank shaft is not so easily made strong enough to stand the shocks which do occur as two cranks at the end of a plain simple shaft.

7. The bearings of such an horizontal engine can be adjusted both vertically and horizontally, so enabling the armature to be adjusted inside the field, which it is very advisable should be possible. A point about which there has been considerable discussion, and which seems to have been at one time considered insurmountable in conection with low-speed engines, is the difficulty of getting a very even turning moment without an abnormal flywheel. It is, of course, of the utmost importance that the turning moment should be very even in the case of three-phase or polyphase transmission, but a good deal more has been made of this point than is necessary, as there are three-phasers running on the Continent, and running satisfactorily, with engines that have only a single crank, the percentage variation being 0·3 per cent. of the angular velocity, and it is not at all difficult to make a two-crank engine such as has been described with a far more even turning moment than is possible with such an engine, however well designed. The weight of the magnet wheel in the above-mentioned instance is 43 tons. This proves conclusively that an even turning moment can be obtained from low-speed engines, enabling such a type to be used in connection with alternating-current machinery, and therefore the arguments which have been adduced as to the advantages which high speed gives in this matter are, to a certain extent, done away with, because there can be no need for the flywheel of a low-speed generating set being made abnormally heavy to obtain a sufficiently even turning moment, especially if the engine is not a single-crank one.

One knows that the usual way of looking at this question of high versus low speed is that a high-speed engine with a short stroke gives a higher mean effective pressure in cylinders, and that, in combination with the quick stroke, reduces the condensation in the cylinders to a minimum, and in so far as this takes place the high-speed engine has the advantage over the low-speed one, and as it is not practical to make a high-speed horizontal engine of large size, it has that advantage over that type; but the horizontal type of engine, if fitted with Corliss valves, is much better drained than the vertical, either high or low speed, and if the condensed steam can be easily got rid of, the advantage of the high-speed vertical type due to lessened condensation is minimised. It is also true that the wear and tear of pistons on a horizontal type is greater than in the vertical, but this can be minimised by having tail rods without side bearings, &c., and the amount of wear which actually takes place is, to a certain extent, due to the material of which the cylinder and piston respectively are composed, and in a well-designed engine of good proportions the wear is not excessive. When we see engines that have run for 20 years without new cylinders or re-boring and still show good economy, it may be argued that this wear is a matter of small importance.

A very great point is gained when, in trying to arrive at the correct solution of this question, one can get the various points down to their relative importance. For instance, in taking the question of condensation in cylinders. This is a point on which great stress is laid by some engineers. At the same time the condensation which takes place in the steam pipes and which is more easily avoided than that which takes place in the cylinders of the engines, amounts to many times that which takes place in the latter case. The same thing with regard to the friction of the piston and cylinder liner. The difference in this item between a horizontal and a vertical engine does not amount to that which may be caused by a slightly inferior grade of cylinder oil, and although one does not say for one moment that all these points are not of great academic interest and that we should all strive to obtain as perfect a result in all parts of central stations as is possible, still it is not worth while nor likely to increase the efficiency of the station as a whole, if such small points of economy are to be considered without the question of convenience and the relative importance of such points being taken into consideration, since indirectly they may very materially add to the running costs of the station. In the matter of convenience, for instance, the time occupied in making the bottom cylinder cover joints on a vertical and horizontal engine respectively would probably be somewhere in the ratio of three to one, or if through any cause the work had to be done quickly the probable time the joint would stand would show a still greater difference in favour of the horizontal type.

This matter of convenience in getting at parts for repair work is very much greater in the case of horizontal engines than in vertical engines, and this point very largely outweighs the economy due to the reduction of condensation losses, especially seeing the relation the comparatively insignificant proportion of these losses bear to the total, and if the engine of the slow-speed type can produce an indicated horse-power-hour for 0·05d. or 0·06d. for coal, and the question of the space occupied is not of vital importance, as it should not be in the case of a power station put down on the high-tension alternating-current system, on the whole there can be no question that the horizontal low-speed type is the one which should be employed in the future.

The author has previously stated that, with regard to the question of high and low speed, if it is to be high speed it should be a very high speed, and as it is not likely that engines of the reciprocating type would be obtained giving a higher speed than that now usually employed for that type of engine, where space is important the steam turbine type would be the correct one to adopt. The author has not had any reecnt experience with the steam turbine from which he is able to draw conclusions, and after the Paper we have had from Mr. Fedden, he does not propose to enter upon that question, but some years ago, in the early days of the steam turbine, he ran one which was very satisfactory except in one point, and that was the question of governing. He has since seen engines of this type running, and in their case the governing seemed to be excellent. There is a great future for this type of engine, and where space is of importance it seems likely to come to the front.

However, he would give preference to the low-speed type for power station work of the size which is being considered in this

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Paper, because, as in the case of both alternators and dynamos, it is an advantage to build them of such a size that it is not necessary to employ a high speed of rotation in order to get the necessary E.M.F., and at the speed at which a turbine runs, the rotating part of the dynamo or alternator will become too cramped to make a thoroughly sound engineering job of it, which is very necessary at such a high speed of rotation.

There is one point in connection with low-speed engines of large power which some members may be inclined to bring forward, and that is, on large sets, especially on the Continent, it seems necessary to employ a large number of men. In the engines recently erected in the power station at Pinkston a very large number of men were employed, but this is not necessary, and was mainly due to the contractors wishing to have no mishaps on a brand new engine. At any rate, the number of men required is not excessive in the case of horizontal low-speed engines, and there is no reason whatever why two men, one to drive and one to grease, should not run a 5,000 H.P. set of the horizontal type, and not have a very hard life at that.

It has always appeared to the author that an electric supply station is somewhat analagous to that of a pumping station, and the contrast between the quiet, cool and clean engine-room of a pumping station which runs night and day, and the easy and very free-from-anxiety sort of life that the drivers of such engines seem to have, when compared with the unrest which takes place in the electric power house, is very great. This, notwithstanding that the high-speed engineer would probably say that the valve gear of such pumping engines was the most complicated box of tricks that he ever saw in his life.

There is no reason why the future power house should not be as clean and tidy and free from noise and heat as the ordinary pumping station, and this will be most easily obtained without the sacrifice of any economy by the employment of low-speed engines of the horizontal type, coupled to steam pipes carried underneath the floor direct to the boiler house. We should then, in our future power houses, probably be able to show results such as some members of the Institution saw during their trip to the Continent, where the cleanliness of the engine room and machinery was remarked by everybody, and where, notwithstanding complications and the alleged disadvantages attached to low speed, the results obtained were sufficient to advance the business at a much more rapid rate than any English station can show, and sufficiently low to bring electricity into far more general use than it has yet attained in England.

The author does not wish to be misunderstood in this matter; the claims of the high-speed engine to economy of space and steam, at any rate in small sizes, he admits, also the advantages of all engines of the vertical type as regards floor space; but the horizontal type has advantages as above stated, and these outweigh those of the other types except in the matter of space. If an electric light station were not so largely affected by its load-factor, the relative values of the different types would be apparent, and we, as station engineers, should be able to lay ourselves out to get the very utmost economy of coal, as in the long and steady runs of marine engines; but as in the very nature of the case we cannot hope to establish records for coal consumption per I.H.P. in electric supply stations, the refinements which lead to the utmost economy in steam may be dearly purchased, and it is for this reason that the convenience, economy of oil and labour, easy access for repairs, with the other points already mentioned, the horizontal engine of low-speed type appears to the author to be the most suitable for large sizes where space is not of supreme importance.

The author has not gone into the question of the arrangement of cylinders or the question as to whether compound or triple expansion engines should be used. Personally he would divide the plant up, some triple expansion and others compound. This is a matter which has to be settled generally for each individual station, but generally triple expansion is not warranted except in the case of very large sets when they can be kept fully loaded. In any case the horizontal engine can be made triple-expansion or compound, and the cylinders can be so arranged that the turning moment for either will, without doubt, enable alternators to run perfectly in parallel.

The question of price the author has not gone into in this Paper (although this is not against the type proposed) because in the question of electrical machinery price is of secondary importance, the more so as the importance of the electric supply increases. It is also rather difficult to discuss the question of engines without taking into consideration the kindred question of boilers, or indeed the question of the whole of the station plant, any part of which is so much dependent upon the other. If, however, sufficient has been said to bring about a discussion on this important point, it may be of use to us in the future.

Aluminium Cables.—The use of aluminium for cables appears to be finding favour to a very large extent, particularly in America. Aluminium lines have been erected in all parts of the United States, and especially on the Pacific slope, where also there has been a remarkable utilisation of mountain water power.

INVESTIGATIONS OF THE ELECTRIC DISCHARGE IN RAREFIED GASES.*

BY W. WIEN.

(*Concluded from p. 525.*)

3. *Electrostatic Deflection of Canal Rays.*—In my last work on the electric discharge in rarefied gases I communicated the observation of the magnetic deflection of canal rays, which showed that even with a constant tension between anode and cathode in the discharge tube the magnetic deflection of the canal rays showed extraordinary differences. The fluorescence of the glass excited by the canal rays was drawn apart, while a maximum luminosity of the fluorescence remained distinctly perceptible, and corresponded to a deflection of a certain amount. It was further seen that a fluorescence of the glass was produced more by the magnetically deflected rays and that of the gas chiefly by those which were only slightly deflected. A central bundle of rays always remained and showed no perceptible magnetic deflection. Taken together with measurements of the difference of potential between the electrodes and of the ratio of the heat produced by the canal rays to the quantity of electricity transported by them, the observations give widely different values of the ratio of the mass to the charge, values which show no connection with those obtained for this ratio by other methods.

It resulted from these observations that the positive electrons were probably given such various charges by the splitting off of very different quantities of negative ions. The possibility always remained that the positive electrons on their way through the gas could take up negative ions again and increase the ratio mentioned. An elucidation of this question was to be expected from a determination of the electrode potential in connection with the electrostatic deflection. If an electrical particle of mass m and charge e was exposed to an electrical force F at right angles to its direction of motion, then,

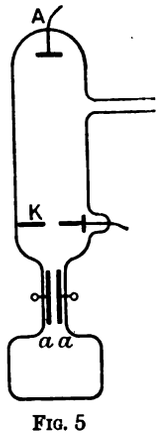

FIG. 5

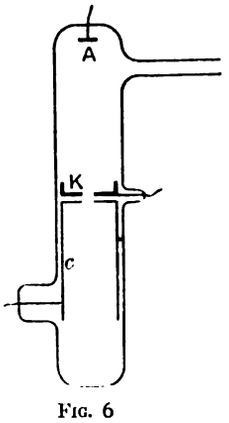

FIG. 6

after the particle has traversed the length with the velocity v_0, there will be a deflection normal to the path amounting to $y = \mathrm{F}cx^2/2v^2_0m$. If the particle is driven by a difference of potential V, then $\frac{m}{2}v^2_0 = e\mathrm{V}$. Hence, $\mathrm{F}/\mathrm{V} = 4y/x^2$.

If the particle moves the distance x in the electrostatic field, and a further distance b after leaving it, then for x^2 we must put x^2+2bx, hence, $\mathrm{F}/\mathrm{V} = 4y/x^2+2bx$.

The tube used for the determination is shown in the accompanying diagram (Fig. 5); the anode A consists of an aluminium disc, and the cathode K of a copper disc whose edge lies close to the inner wall of the tube, which is 3cm. wide. In the centre it has an opening 2mm. in diameter. Immediately behind the cathode the tube diminishes to a width of 1cm., and in this portion two strips of aluminium, a, 5cm. long and 5mm. apart, are fused in parallel to each other. Beyond these strips the tube widens again to its former diameter. The distance, b, between the ends of the aluminium strips and the bottom of the tube is 5cm. If we call V the difference of potential of the two strips a, then $\mathrm{V}_1 = \mathrm{F}l$, and we have $\mathrm{V}_1/\mathrm{V} = 4yl/x^2+2bx = 0{\cdot}0267 \times y$ cm.

The tension between anode and cathode was measured by a Siemens voltmeter of Thomson's construction reading up to 15,000 volts. The difference of potential between the aluminium strips a for the electrostatic deflection was derived from a high tension accumulator, or, for greater differences from a Schukert high-tension dynamo yielding 4,000 volts. The observations showed at first the same result as in the case of the magnetic deflection, being an electrostatic deflection with a great lack of uniformity. I noticed that the rays whose deflection could not be observed with certainty produced on the

* Translated from *Annalen der Physik*, 8, 2, pp. 244-266, 1902.

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glass a brownish fluorescence, while the deflected ones produced more greenish fluorescence.

Among the deflected rays the maximum fluorescence was deflected by 1cm. for $V_1=200$ volts and $V=8,000$ volts, also for $V_1=400$ volts, and $V=12,000$ volts, whence $V_1/V=0{\cdot}025$ and $0{\cdot}033$. This corresponds better with the figure $0{\cdot}0267$, derived from $y=1$, than might be expected from the uncertainty of the observations.

The brownish fluorescence was not perceptibly deflected at $V=15,000$ and $V_1=3,500$ volts. If $y=0{\cdot}2$cm., we have $V_1/V=0{\cdot}23$, while $4yl/x^2+2bx=0{\cdot}0053$.

The only interpretation of this result is that the slightly deflected rays at first possessed a smaller ratio of mass to charge, and then took up negative electrons on their way. Then, of course, the electrostatic deflection would appear too small. If we were to assume that not all the canal rays are driven by the whole potential gradient between anode and cathode, they would have to show a stronger electrostatic deflection than the greatest deflection noticed.

4. *Acceleration of the Canal Rays.*—Des Coudres was the first to show that cathode rays penetrating a Lenard window may be accelerated or retarded by electric forces. Later, Kaufman used an apparatus to accelerate or retard the cathode rays in the tube itself. I used a similar contrivance to alter the speed of the canal rays. A copper electrode, K (Fig. 6), had a perforation 2mm. in diameter. Opposite to it was a copper cylinder, *c*, closed at the bottom except for a perforation of the same diameter. The distance between the electrode and the copper cylinder was 1mm. The copper cylinder was open on the other side. It could be brought to a high tension by means of a wire leading outwards. The copper electrode was put to earth. Now, if the discharge was put through while it was cathode,

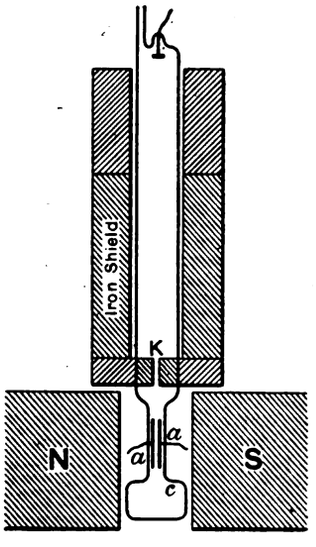

FIG. 7.

the canal rays entered by the two openings and produced an fluorescence on the glass. And if the copper cylinder was charged to a potential of $-3,800$ volts, the fluorescence became perceptibly brighter, while it became darker on charging to $+3,800$ volts—a result which was to be expected from the other properties of the canal rays.

5. *Simultaneous Magnetic and Electrostatic Deflection of the Cathode Rays.*—The non-uniform electrostatic deflection at constant potential had led me to the conclusion that the ratio of mass to charge is not always the same in the canal rays, but is subject to change on the way, in the sense that in one portion of the rays this ratio is increased. The difference between the amounts of fluorescence provoked by canal rays passing through different gases made it also appear possible that the ratio of mass to charge should be different in different gases. The only means of measuring in a mixture of rays of different velocities and different values of the ratio of mass to charge is the absorption of the magnetic and the electrostatic deflection. For this purpose the arrangement of Kaufmann is very convenient, since the electrostatic deflection occurs at right angles to the magnetic deflection.

The electrostatic deflection, as we have seen, is

$$y_e=\frac{V_1}{l}\frac{(x_e^2+2bx_e)}{2v_0^2}\frac{e}{m}.$$

If the magnetic deflection takes place in a homogeneous field of strength H, then on a length x_m

$$y_m=\frac{1}{2}\frac{x_m^2 H}{V_0}\frac{e}{m}.$$

Hence,

$$\frac{y_m}{y_e}=\frac{x_m^2 Hl}{(x_e^2+2bx_e)V_1}v_0,$$

also

$$\frac{e}{m}=\frac{2y_m^2 V_1(x_e^2+2bx_e)}{y_e l H^2 x_m^4},$$

$$v_0=\frac{y_m}{y_e}\frac{(x_e^2+2bx_e)V_1}{x_m^2 Hl}.$$

If the ratio m/e and the velocity v_0 change continuously in the rays, the fluorescent patch of the rays must be drawn out into a continuous curve if they are subjected to simultaneous magnetic and electrostatic deflection. If both y_m and y_e are different from zero, this curve must for constant values of v_0 become a straight line, and for constant values of m/e a parabola.

For these observations I used a tube (Fig. 7). K is an iron cylinder 3cm. long with a perforation of 2mm. At *a* are two aluminium strips 6cm. long and 5mm. broad and 5·5mm. apart. The bottom of the glass tube was as flat as possible, and was at distance of 5cm. from the ends of the strips *a*. The tube was placed inside an iron guard cylinder, and the pole-pieces of the electromagnet were so chosen that the field was as uniform as possible, as tested by a bismuth coil. The magnetic lines of force, as well as the electric one, were horizontal. Hence the electrostatic deflection was horizontal, and the magnetic deflection vertical. Against the plain end surface of the tube, whose diameter was 5cm., a glass plate was laid, on which a net of co-ordinates was traced with black silk threads at a distance of 2mm. apart. Every fifth thread was double, so that even in the dark, and with feeble fluorescence, the position of the band produced by the canal rays on the net of co-ordinates was invisible. Special care was taken to produce pure gases for filling. In the first case (that of hydrogen) the fluorescent patch was drawn out into a fairly straight band, inclined to the horizon. In this case the voltage was 30,000, the magnetic field 600 units, and the electric difference of potential 400 volts. For the two visible ends, I had $y_m=2{\cdot}2$cm., $y_e=1{\cdot}2$cm. It follows, from the rectilinear deflection, that the value of v_0 is nearly constant for all deflected rays. On the other hand, m/e must be variable, and must be the greater the smaller y_m is.

The central fluorescent patch, which, as a rule, has a slightly yellowish colour, and is due to the rays which produce the strongest fluorescence in the gas itself, is not deflected either by a magnetic or an electrostatic field. Whatever small deflection there is cannot be measured, and it can only be seen when the magnetic field is about 2,000 units and the electrostatic difference of potential 800 volts. With such a strong magnetic field the most highly deflected canal rays are placed at right angles to their original direction of propagation. The fluorescent patch then stretches over the whole glass wall of the widened tube up to the constriction C.

From the above figures it follows for the most deflected rays that $e/m=7,545$ with a voltage of 30,000. The velocity resulting for these rays $=V_0=1{\cdot}5\times10^8$ cm./sec.

In my last Paper I found for the most deflected rays in hydrogen $e/m=36,000$ with a voltage of 9,000. The value of e/m for hydrogen, from electrolysis, is 10,000 in round numbers. A hydrogen ion receives from a field of voltage 30,000 the velocity

$$v=\sqrt{2V\frac{e}{m}}=\sqrt{6\times10^{10}}=2{\cdot}4\times10^8.$$

The values for e/m found from the electrostatic and magnetic deflection are much smaller than those formerly obtained with lower voltages. The present values closely approach the value of the hydrogen ion. The values for the velocity also correspond as regards order of magnitude. We must recollect the numbers by which the discharge potential and the electrostatic deflection were compared, and that those which are most deflected possessed a deflection which would correspond to a particle projected without change. This might lead to the supposition that the canal rays are the hydrogen ions themselves which get partly neutralised on their path, and only remain unchanged when most highly deflected.

Although the differences in the fluorescence point towards an influence of the chemical nature of the gas, still the assumption that the canal rays are the gas ions themselves is not proved. In the first place, the observation of the most highly-deflected rays is so far uncertain, as the limit is always diffuse, and it is always possible that there are some rays which are still further deflected, and which cannot be seen. But above all, the molecular weight of the gases for different fillings should come out approximately, at all events, for the limiting rays, but that is by no means the case.

With a filling of air the greatest electrostatic deflection was 1·2mm., as in hydrogen. The greatest magnetic deflection was 1·5mm., with 600 magnetic units and 45,000 volts; this would give for e/m the value of 3,570.

In air, the fluorescent band was not quite straight, but was drawn out into a curve with the hollow in the direction of the electrostatic deflection.

In this case, however, v_0 is not constant, but gets smaller with the increasing deflection. With the filling of pure oxygen from potassium permanganate. I obtained again a straight band with the following maxima of deflection:—

$H=600$ C.G.S.,	$y_m=2{\cdot}5$,
$V_1=400$ volts.	$y_e=1{\cdot}2$,
$H=300$ C.G.S.,	$y_m=1{\cdot}1$,
	$y_e=1{\cdot}2$.

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Hence, $e/m = 9,800$ and $= 7,500$, values which again correspond with hydrogen.

It is true that the fluorescence of the more strongly developed rays was much feebler in air than in hydrogen. In oxygen it was still feebler and only visible in a totally darkened room.

The possibility that remnants of hydrogen may have been contained in the tubes and may have produced these more strongly deflected canal rays cannot be with certainty denied. I have, indeed, paid every attention to the drying, and to the stopping-off of the phosphoric acid vessels during the discharge by means of barometer valves so as to avoid a decomposition of water combined with phosphoric acid. But it is difficult to say whether there may not have been small quantities of hydrogen present after all. These experiments must be carried further with very pure gases, in order to elucidate this question as well as the colours of fluorescence. On the other hand, it can be concluded with certainty that the slight deflection of a portion of the canal rays must be attributed to a change in the ratio m/e which they undergo on the way. This, however, does not imply that a portion of the canal rays, if not all of them, originate within the gas. This is also in accordance with the fact that the canal rays are absent in an extreme vacuum.

Now, in a tube containing 200cc. at a pressure of 0·01mm., $3{\cdot}4 \times 10^{-8}$ grammes of air are contained. Taking even the highest value of $e/m = 10,000$, the mass transported by the canal rays with a current of 10^{-4} amperes would be $m = 10^{-10}$ grammes per second, if they make up 10 per cent. of the current. In reality it will be much greater, since e/m is much smaller for the most part. But in 10 hours, according to this calculation, the mass transported by the canal rays would be $3{\cdot}6 \times 10^{-6}$, *i.e.*, more than the total gas.

Now, since discharge tubes are always worked longer, the canal rays must always re-convert themselves to neutral gas, and there will be a constant circulation during the discharge.

CORRESPONDENCE.

MARCONI'S MAGNETIC RECEIVER.

TO THE EDITOR OF THE ELECTRICIAN.

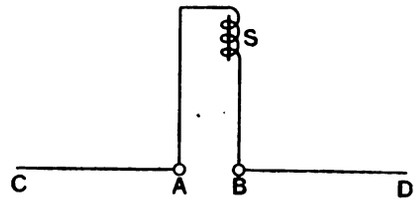
SIR: My attention has been directed to an article in your issue of June 20th, in which an account is given of Mr. Marconi's lecture at the Royal Institution on "Space Telegraphy." In this there is a short description of a magnetic receiver of electrical waves which he has successfully employed to receive messages between Poldhu and Poole. It may be of interest to your readers to draw attention to my original experiments on this subject, in which I showed that the demagnetisation of magnetised steel wire by electrical oscillations could be made the basis of a sensitive method of detecting electrical waves. This "magnetic detector" is well known to physicists, and has been utilised in a large number of investigations on electrical waves and oscillations by experimenters in various parts of the world.

An account of the original experiments appeared in the *Transactions* of the Royal Society in 1897, under the title of "A Magnetic Detector of Electrical Waves, and Some of its Applications." After a preliminary description of the surface nature of the effects observed when an oscillatory current is sent through a solenoid containing a magnetised steel needle, the Paper proceeds:—

It has been shown that the amount of demagnetisation of a magnetised needle depends on the fineness of the wire and the number of turns per centimetre on the magnetising solenoid. If a short piece of thin magnetised steel wire be taken, and a large number of turns be wound over it, it forms a very sensitive means of detecting electrical oscillations in a conductor when the amplitude of the oscillations is extremely small. It was on this principle that a dectector for electrical waves was devised, which proved to be a sensitive means of detecting Hertzian waves at considerable distances from the vibrator. About 20 pieces of fine steel wire, 0·007cm. in diameter, each about 1cm. long, and insulated from each other by shellac varnish, formed the detector needle. A fine wire solenoid was wound directly over it, of two layers corresponding to about 80 turns per centimetre. As the solenoid was of very small diameter, about 15cm. of wire served to wind the coil. This small detector was fixed at the end of a glass tube, which was itself fixed on to a wooden base, the terminals of the detector coil being brought out to mercury cups. S (see Figure) represents the detector needle and the solenoid wound over it. A and B are the mercury cups. CA and BD were two straight rods which served as receivers, one end of each being placed in the mercury cups.

The detector needle was strongly magnetised and placed before a small magnetometer, the deflection due to the needle being compensated by an auxiliary magnet. If the receiving wires were parallel to the electric force of the wave from the vibrator, oscillations were set up in the receiver circuit, the surface layers of the needles were demagnetised, and there resulted a corresponding deflection of the magnetometer needle. The amount of the deflection, of course, depended on the amplitude of the oscillations set up in the receiver, and, therefore, on the distance from the vibrator.

Long Distance Experiments.—When a Hertzian vibrator was used with plates 40cm. square, and a short-discharge circuit, quite a large deflection was obtained at a distance of 40yd., the waves passing through several thick walls between the vibrator and the receiver. Further experiments were made to see how far from the vibrator electromagnetic radiation could be detected. For the long-distance experiments, the vibrator consisted of two zinc plates 6ft. by 3ft., and separated by a short-discharge circuit of about 30cm. When large plates were used, a Wimshurst machine was equally as efficient as a Ruhmkorff coil for exciting the vibrations. The first experiments were made over Jesus Common, Cambridge, the receiver being placed in one of the buildings on Park Parade. Quite a large effect was obtained at a distance of a quarter of a mile from the vibrator, and from the deflection obtained it was probable that an effect would have been got for several times that distance. When the vibrator was set up in the top floor of the Cavendish Laboratory, a small but quite marked effect was obtained at Park Parade, a distance of over half a mile in the direct line. In this case the waves before they reached the receiver, must have passed through several brick and stone walls, and many large blocks of buildings intervened between the vibrator and receiver. The



length of wave given out by the vibrator was probably 6 or 7 metres, and a wave of that length seemed to suffer very little loss of intensity in passing through ordinary brick walls. From an experiment tried in the Cavendish Laboratory, it was found that the effect of six solid walls and other obstacles between the vibrator and receiver, did not diminish the effect appreciably. When the vibrator was working in the upper part of the laboratory, a large effect could be obtained all over the building, notwithstanding the floors and walls intervening.

These results were obtained before Marconi began his well-known experiments in England. From experimental data on the subject, I had come to the conclusion that the "magnetic detector" was inferior in delicacy to the coherer, and in the press of other scientific work, I have not devoted much further attention to the subject. I have, however, used in the laboratory, for more than a year, a device very similar to that employed by Marconi in his latest form of receiver—viz., an endless moving band of steel wire passing through the solenoid in which the electric oscillations are set up. Instead of using a telephone to detect the magnetic changes in the iron, I used a magnetometer needle close to which the steel wire passed. Marconi has, apparently, applied to the method the principle used by Poulsen for recording telephonic messages with very successful results. It is to be hoped that further success will attend his efforts to utilise this magnetic receiver, which has many advantages over the erratic coherer.—Yours, &c.,

E. RUTHERFORD.

McGill University, Montreal, July 5.

Electrical Dock Machinery.—The North-Eastern Railway have found their electric cranes at Middlesbrough Docks, supplied by Messrs. Cowans and Sheldon, of Carlisle, so successful that they have decided to equip their docks and quays at the Hartlepools in a similar fashion, and a number of cranes and capstans have already been installed. By the use of this electrical machinery a record was established at West Hartlepool, when the vessel "Westmanland," with 659 standards of pulpwood props, commenced discharging at midnight on Sunday. The whole of the cargo was discharged by 9 p.m. on Monday, making an average of 40 standards per hour. Five or six days would have been required to perform the same work by the old method. The cranes have a radius of 44ft. 9in., and the motors are placed in the base of the pedestals.

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PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

The Court of Referees of the House of Commons on Friday last, Mr. Parker Smith presiding, had before it applications for *locus standi* to appear against several of the London tube railway bills, which last week were referred to two committees.

In respect of the **Brompton and Piccadilly Circus Railway Bill** the Metropolitan Railway was granted a *locus* as landowners, and the proprietors of a competing system.

Mr. BALFOUR BROWNE, K C., claimed a *locus* on behalf of the London United Railways Co. on the ground of competition. He maintained that to all intents and purposes the Brompton and Piccadilly line, although sanctioned some years ago, was a new line, inasmuch as nothing had yet been done towards construction.

Sir RALPH LITTLER, K.C., in reply, said his company was actually at work.

The Chairman, before giving a decision, wished to hear the case of the Piccadilly, City and North-East London Railway.

Mr. VESEY KNOX, for the promoters of the latter railway, claimed a *locus standi* to appear against the Brompton and Piccadilly Railway, inasmuch as for about a quarter of a mile the routes were the same.

Sir RALPH LITTLER said he would not object to a *locus* where the two companies scheduled the same land, or where the two lines crossed.

The Chairman eventually allowed a general *locus* in both cases.

Against the **London United Electric Railways**, Mr. PEMBER, K.C., applied on behalf of the London County Council, chiefly by reason of the fact that the body were the owners of certain scheduled land. This *locus* was allowed.

Mr. H. LLOYD appeared in support of the petition of the Central London Railway with respect to the Marble Arch–Clapham Junction line, which came within their limits of deviation, but a *locus standi* was disallowed.

The opposition of the London County Council to the **Great Northern and City Railway** has been withdrawn, as the clause asked for has been given by the company.

In the House of Commons on Friday last, on the motion of Mr. Bull, the following instruction to the Committee on the Charing Cross, Euston and Hampstead Railway Bill was agreed to:—"That it be an instruction to the Committee on the Charing Cross, Euston, and Hampstead Heath Railway (No. 1 and No. 3) Bill to inquire and report whether the railway proposed to be authorised by the bill, if constructed on the lines mentioned, will not seriously injure Hampstead Heath, under which it is to pass, by tapping the wells, draining the soil, destroying the verdure, and interfering with this public place of resort; and that the Committee have power to call witnesses and receive evidence on the subject."

The following motion respecting this railway was also agreed to in the House of Commons on Tuesday:—"That it be an instruction to the Committee on the Charing Cross, Euston and Hampstead Railway (No. 1 and No. 3) Bill, and Charing Cross, Euston and Hampstead Railway (No. 2) Bill, that they have power, if they think fit, to consolidate the said two bills into one bill."

Sir Lewis McIver's Committee.

As announced in our last issue, all the London Tube Railway Bills remaining over after consideration by the House of Lords had been divided into two groups to be dealt with by the House of Commons. The Brompton and Piccadilly Circus Railway (New Lines, &c.), the London United Electric Railway, and the Piccadilly, City and North-East London Railway Bills had been referred to a Committee under the chairmanship of Sir Lewis McIver—the other members being Mr. George Whiteley, Mr. G. Montague, Mr. Emmott—and the proceedings before this Committee commenced yesterday (Thursday).

The **Brompton and Piccadilly Railway** (New Lines, &c.) **Bill** was the first considered.

Mr. BALFOUR BROWNE, K.C., on behalf of the London United Electric Railways and the Piccadilly, City and North-East London Railway, said that, in spite of those concerns having obtained a *locus standi* to appear against this bill, it was not proposed to make use of it. He merely proposed to watch the proceedings to see that, where the two schemes came down the same thoroughfare anything proposed by the Brompton and Piccadilly Railway Co. should not block his lines.

Sir RALPH LITTLER, K.C., who is appearing for the Brompton and Piccadilly Railway with Mr. Roskill and Mr. Courthope-Munroe, objected to this procedure. Either the companies in question withdrew their petition altogether, or they were opposing.

Mr. BALFOUR BROWNE contended that he could not be compelled to cross-examine.

The CHAIRMAN said that Mr. Balfour Browne adopted whatever course he pleased at his own risk.

Sir RALPH LITTLER said the whole object of Mr. Balfour Browne's method was to get in the last word, and in view of the fact that great expense had been incurred consequent on the granting of a *locus* to the London United and the Piccadilly, City and North-East London Railways, he should at a later stage make an application for very heavy costs against the promoters of these two schemes. He then addressed the Committee on behalf of the Brompton and Piccadilly Circus Railway bill. The first part of his speech went into detail concerning the original underground railways in London, prior to the inception of the idea of constructing the Circle and contiguous railways, and the refusal of Parliament to permit any railway under the Strand although efforts were made to secure this. He emphasised the bad financial results of these railways, and, at a later period, the great difficulty which had been experienced in raising capital for the earlier electric tube railways ending in the great over capitalisation of the Central London Railway. Traversing the now familiar history of electric tube railway enterprise in London from that time down to the advent of Mr. Yerkes, Counsel covered much the same ground as was given in the evidence before Lord Windsor's Committee on this bill (see *The Electrician* for May 2, p. 54). Dealing with the numerous statements which had been made, both inside and outside the House of Commons that the Brompton and Piccadilly line was not being and never would be built, he said that two shafts at the Bromption station had been sunk down to "formation level," and the tunnels were being driven east and west. The station at that point also was being constructed under the road. In addition, the whole of the contracts had been let to responsible contractors. The ironwork was not only being manufactured in Scotland, but was actually being delivered against cash, and only last Monday he had so satisfied the Lord Mayor of London that the capital was ready, that he had been given a certificate authorising the putting into force of his powers under the Lands Clauses Act for the compulsory acquisition of land. With regard to the Lots-road power house, all the plant for this had been ordered, and the buildings themselves were being erected, and it had been decided to supply power to all the companies under Mr. Yerkes control by contract as required. On the question of fares he said that in the original bill the ordinary fare of so much per mile was scheduled, as was the case in the Central London Bill, but, eventually, it would probably be found more satisfactory to have one fare throughout. But the fares of the Morgan combination which had been so much talked about on account of their extraordinary cheapness, had been completely revised and increased.

Mr. VESEY KNOX, for the London United Railway and the Piccadilly City and North-East London Railway, protested that this was irrelevant at this stage. The time to discuss it was when the Brompton and Piccadilly Company were opposing his schemes.

The CHAIRMAN agreed with this view.

Sir RALPH LITTLER, continuing, said the action of Mr. Balfour Browne as to his opposition, and the withdrawal of several other petitioners against the bill, left him with practically only one opponent—viz., the London County Council, which body was now asking for several clauses refused them in the House of Lords.

The CHAIRMAN asked for a detailed statement showing the capital and estimates of all the lines absorbed by the Underground Electric Railways Co. of London.

Sir RALPH LITTLER promised that this should be prepared.

The Committee adjourned until to-day (Friday).

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

This bill came before a Select Committee of the House of Lords, presided over by the Earl of Yarborough, on Monday last. (For the proceedings before the House of Commons Committee see *The Electrician* for May 9, p. 115, and May 16, p. 153.) It will be remembered that the Embankment tramway has been struck out. (*The Electrician*, June 27, p. 394.)

Mr. ERSKINE POLLOCK, K.C., in opening the case, said that the measure was an omnibus one contemplating numerous works and tramways, two of the latter being opposed. One of these, a tramway on the conduit system, would commence at Hammersmith, near the Broadway, come down the Fulham Palace-road, cross Putney Bridge and terminate in a bay at Lower Richmond-road, its length being 2 miles 5 chains. In connection with the line certain widenings would be made in the Fulham Palace-road and Church-street, and, by arrangement, the Fulham local authority would pay £30,000 towards the expenses. For about 200yds. the tramway would certainly come within 9ft. 6in. of the pavement, but this was not without precedent. The second opposed line would commence with a junction with the existing line running down Camberwell and Walworth-roads, Denmark-hill, Grove-lane, Dog Kennel-hill, and terminating at Lordship-lane, near the existing derelict tramway. The objection to both the lines came from frontagers and owners of property, who said that the noise would depreciate the value of their property, as well as increase the difficulty of access to their houses.

Mr. J. W. BENN was called and stated that the first of the opposed tramways was an important link between Queen-street, Hammersmith and Putney Bridge connecting north and south London, and it had increased importance from the intention to continue it to Wormwood Scrubbs. As to the Camberwell Green line it was necessary, he said, in order to meet the wants of the large and increasing population of East Dulwich. The tramway from Lordship-lane to the Crystal Palace had ceased running for 18 months, and it was not worth the while of the London County Council to acquire it, although they had power to do so.

Under cross-examination, WITNESS said the consent of the Fulham authority was not obtained in any way by the promise of further street improvements. Asked what happened to the Camberwell scheme to make it more acceptable than when a Committee of Parliament rejected it last year, he said there was a growing need in the locality for increased tramway facilities, and deputations had waited upon the County Council with regard to these lines.

Mr. COWARD: I suggest that the best solution of this problem, especially in a part of London like Dog Kennel-hill, with a gradient of 1 in 11 or 1 in 9 is by means of a tube railway, and not by a tramway?—I do not agree. The south of London is not suitable for development by tubes. We think this locality is adapted for a surface tramway on the conduit system.

Mr. MAURICE FITZMAURICE, engineer to the London County Council, said the estimate for the line, starting at Hammersmith Broadway, including improvements, amounted to £129,786, £72,200 of which was for the construction and equipment of the tramway. The estimate for the Camberwell Green–Lordship-lane tramway was £78,500. The worst

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gradient on Dog Kennel-hill was 1 in 11, which made the thoroughfare practically impossible for horse traffic. He thought the rural character of the neighbourhood of Denmark-hill and Champion-hill was gradually disappearing, and that the tramway would not do it much damage. Cross-examined: He did not know that several frontagers to this part of the line so strongly objected to the tramways that they would leave their houses if the tramways proposed were constructed there. Very few lines were worked on the conduit system in this country. In Blackpool he agreed that this system had been abandoned, but that was not a fair example.

On Tuesday, Mr. A. BAKER, tramway manager of the London County Council, stated that in the case of the opposed tramways the Board of Trade would define the speed at which the cars should run at different points. Dog Kennel-hill was one of the steepest points in the County of London, with a gradient of 1 in 11, but although omnibuses could not surmount it, it presented no difficulty to electric traction. There was very little vehicular traffic, but the pedestrians were numerous. Between eight and nine o'clock that morning he had counted 850 persons walking up the hill. The line which would cross Putney Bridge, was only an instalment of a larger scheme, and ultimately no doubt it would join the London United system.

Mr. C. W. TAGG, clerk to the Camberwell Borough Council, said that his Council supported the Camberwell Green tramway as being a great convenience in connection with a housing scheme which was contemplated in that district.

Cross-examined by Mr. LEWIS COWARD: It was only the gentlemen living in houses of considerable rateable value who objected to the tramways proposed. He had not heard of frontagers objecting.

Mr. ALFRED T. MOORE, a member of the Camberwell Borough Council, said the spot where the line would terminate in Lordship-lane was more than a mile from any railway station. The ratepayers had been agitating for tramways for the last 10 or 12 years, and one of the largest meetings of ratepayers ever held in Dulwich had recently heartily approved of the scheme.

Mr. J. GRANVILLE, builder and land agent, said he owned property in the neighbourhood of the proposed tramway. He had no doubt that the line would appreciate the value of the property and would benefit trade. At present people came to the houses on Dog Kennel-hill and after three months went away, declaring that they were tired of the walk up the hill. If the tramway came the people would stop.

Numerous other local witnesses having been called in support of this tramway, the line from Hammersmith Broadway to the south side of Putney Bridge was dealt with.

Mr. E. Rawlings, Chairman of the Law and Parliamentary Committee of the Fulham Borough Council, Mr. W. J. Bull, M.P. for Hammersmith, Mr. T. Davies, Mayor of Fulham, and Mr. W. Humphrey testified to the local need for this tramway.

Mr. F. STANLEY, a solicitor residing at Denmark-hill, gave evidence at this stage, by permission, against the tramway in that locality. He urged that it would drive away the occupiers of the larger houses. There was no indication of any large increase of population whose travelling requirements the tramway from Camberwell Green would supply. Already there were omnibuses running, and two railway stations within easy walking distance. If a tramway were required, it should pass along Lyndhurst-road, and not over Denmark-hill.

The promoters' evidence was then continued.

Mr. ANDREW YOUNG, valuer to the London County Council, gave the same figures as his estimates for acquiring the property and lands in connection with this bill that were published in *The Electrician* for May 9, p. 114. In the case of the widenings in Fulham and Camberwell, the Borough Councils would find one-third of the cost. The property which would be acquired was mostly of a poor rateable value.

Cross-examined: If drivers of cars were properly trained there should be no objection to the working of the tramways on the Denmark-hill route. In the case of one or two houses on that route the tramways might cause hardship, but not in many cases.

This closed the case for the bill. Evidence for the opposition was at once called.

Dr. STONE, residing on Denmark Hill, spoke of the facility with which he could reach a good tram, train and omnibus service to the City and West End. This district was the only one within the four-mile radius where large gardens could be obtained. Feeling in the locality was intensely strong against the tramway, the appearance of which would spoil the neighbourhood.

Mr. D. W. Money, a solicitor, living at St. Cloud, Denmark-hill, and Mr. T. H. Powell, a chemist, of 116, Denmark-hill, gave similar evidence.

Mr. GEORGE RAVENSHIRE, auctioneer and surveyor of the Broadway, Ealing, said the noise and vibration from tramways in the hot summer time, when one had the windows open, made life almost unbearable to anyone unused to it, and who was at all nervous. Many inhabitants were leaving Ealing in consequence of the advent of the trams, the noise of which could be heard from three-quarters of a mile to a mile away.

On Wednesday, the Rev. Dr. PORTE, Vicar of St. Matthew's, Denmark-hill, gave evidence against that part of the bill relating to the line projected between Camberwell and Dulwich. He was quite alive to the value of tramways to enable the artisan class to remove from congested districts to districts in which there was more room, but he submitted that Denmark-hill was not a route which should have been suggested.

Mr. L. REINCKE, C.E., of Champion Park, supported the previous evidence as to the sufficiency of existing travelling facilities.

Mr. J. ETHERINGTON, C.E., alderman of the Camberwell Council, declared that the tramway at Champion Park would be dangerous, owing to the disturbance of the subsoil which would be caused.

Mr. ERSKINE POLLOCK: That is a matter for the railway company who do not appear in opposition.

WITNESS said he assumed that the reason of that was that the ratepayers would be under obligation to make the road secure if the bill passed.

Mr. H. DAWSON, solicitor, of Grove-lane, also gave evidence against this part of the bill.

Mr. J. TOMLIN, stationer, of Fulham Palace-road, gave evidence against the Hammersmith and Putney part of the bill, as also did Mr. J. HARVEY, another resident in the Fulham Palace-road.

Mr. LEWIS COWARD then addressed the Committee for the petitioners. He said this bill altogether was a mere remnant of the measure originally deposited in the private bill office. It had contemplated tramways all over London—over 40 miles in length—but all that were now left were four short lines—the Camberwell line, the Hammersmith line and lines at Woolwich and Eltham, which latter were not opposed. He urged their lordships to refuse their assent to piecemeal legislation and to throw out the preamble so far as the opposed lines were concerned, for the reason that those tramways were not required.

Mr. ERSKINE POLLOCK, summing up the case for the promoters, declared that the bill was stamped with the authority, not only of the London County Council, but of the local road authorities. He submitted that the Camberwell tramway was required, owing to the increased population and the defective communication at present available in the district.

The Committee having consulted in private,

The CHAIRMAN announced that they had come unanimously to the conclusion that the preamble of the bill was proved.

LONDON COUNTY COUNCIL (SUBWAYS AND TRAMWAYS) BILL.

A Select Committee of the House of Lords, of which the Earl of Yarborough is chairman, the other members being the Earl of Denbigh, Lord Wandsworth, Lord Muskerry and Lord Ludlow, commenced the consideration of this bill (which has already passed through the other House) on Monday last. The proceedings before the House of Commons Committee were reported in our issues for April 25, p. 27, and May 2, p. 57.

Mr. ERSKINE POLLOCK, K.C., for the promoters, detailed the objects of the bill, as given in our issue for April 25 last. The only opponent now was the Great Northern and Strand Railway Co., whose tube railway would run from Finsbury Park under the new street from Theobald's-road to the Strand. This company were not interfered with under the bill, but they attempted to get better conditions than they had accepted in 1899. The petitioners said that the promoters' line would materially add to the difficulty and expense of making the Great Northern and Strand Railway, but that he denied. The company also objected to rate-aided competition, but he submitted that the competition would be very slight. He pointed out that originally it had been intended to take the tramway as well as the subway to the Thames Embankment, but the House of Lords had instructed the Committee not to allow the tramway to proceed further than the Strand. (*The Electrician*, June 27, p. 394.)

Mr. J. W. BENN, chairman of the Highways Committee of the London County Council, was then called, and gave evidence bearing on the counsel's statement. He said there were various streets where it was almost impossible to extend the surface tramways, but where tramways would be very valuable. Under an act of 1899 the Council obtained powers to construct a subway, in which it was intended to put gas, water pipes, &c., underneath the proposed new street from Holborn to the Strand. Under the original act it was not proposed to put a tramway in the subway, but no limit was placed on the size of the subway. Under an arrangement with the Great Northern and Strand Company, the latter could not construct their line until the new street was formed. It was not now proposed to alter that in any way. The Council were advised that no greater trouble or expense would fall upon the Great Northern and Strand Company in consequence of placing the tramway in the subway, and, therefore, he saw no reason for altering the conditions established by the Act of 1899.

Mr. J. A. BAKER, Vice-Chairman of the Highways Committee of the London County Council, gave identical evidence to that reported in *The Electrician* for April 25 before the House of Commons Committee.

Mr. MAURICE FITZMAURICE, engineer to the London County Council, having similarly duplicated his evidence given before the House of Commons Committee,

Mr. BALFOUR BROWNE, K.C., for the Great Northern and Strand Railway Co., said he was not really opposing the construction of the tramway or subway, but he objected to the County Council having the power to prevent his clients commencing the construction of their railway until the new street from Theobald's-road to the Strand was made. He asked the Committee to pass the bill conditionally upon the London County Council giving up the power of veto which they got in 1899, when the conditions were altogether different.

The Committee declared the preamble proved, and said they were against the principle of the clause proposed by Mr. Balfour Browne.

LONDON UNITED TRAMWAYS BILL.

On Wednesday the Select Committee of the House of Lords, presided over by Lord Yarborough, commenced consideration of this bill. The House of Commons Committee proceedings were reported in *The Electrician* for May 30, June 6, 13, 20 and 27.

Mr. BALFOUR BROWNE, K.C., in opening for the bill, said that originally introduced in the other House it included the construction of over 15 miles of tramways. The Commons Committee had struck out one small section on Wimbledon Hill, owing to the bona fide opposition of frontagers, and another line passing over Hammersmith Bridge, owing to the structure not being fitted to carry a tramway. Mr. Benn, however, had pledged the London County Council to come to Parliament next session for powers to reconstruct the bridge so that it would bear a tramway. With these small exceptions the bill had passed the Commons. The general rule was for tramway undertakings to

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pass to the local authorities after 21 years, but the company had agreed to make payments for an extension of that period to 25 and 30 years. The London United Company had developed their traffic to such an extent that in what was to have been the Coronation week they had carried on their 16 miles 1,025,000 passengers, and during the last year 40,000,000. Experience had shown that tramways served a more extended and different class of the community to railways. The London and South-Western Railway Co. opposed solely on the ground that the new lines of tramway would compete with them, but he knew of no instance in which, on the ground purely of competition with a railway, a tramway or light railway had been rejected, and he challenged the London and South-Western Railway Co. to produce a single case of the kind.

Mr. J. CLIFTON ROBINSON described in detail the system of the company and its proposed extension (see map *The Electrician*, May 30, p. 238). The extensions now proposed were about 13 miles in extent. These lines would serve the districts of six local authorities, and, he thought, all were supporting the present proposals.

Mr. J. D. FITZGERALD, K.C., for the tramway company: With the extensions proposed in this bill, and with your authorised lines, what do you compute that you will carry when they are complete?—At a very moderate estimate 200,000,000 passengers per year.

Since your tramways have been authorised and opened partly, do you find the building and generally the prosperity of the district increases?—That is the general experience not only here but in other places.

Cross-examined by Mr. PEMBER, for the London and South-Western Railway Co.: The capital involved in the 16 miles already open was about £2,500,000, and the capital involved in the 16 miles under construction was about £1,000,000. The capital for the whole 62 miles authorised would be about £5,000,000.

Cross-examined by Lord ROBERT CECIL, K.C., for frontagers: He agreed that, except as to the passing over Kew bridge, there was an alternative route to the route proposed between Richmond and Hammersmith, but that was not as desirable as the one now proposed by way of Mortlake and Barnes, partly because along the Chiswick-road, a portion of the alternative route, there was already a minute service of cars. The promoters' existing lines had not been a danger to the public, nor had the death of a single passenger been attributed to them. They had adopted the overhead system of traction instead of the conduit system because it was the most practicable, the most useful, and the most successful. Cost had nothing to do with determining the mode of traction.

Yesterday Mr. E. J. HALSEY, chairman of the Surrey County Council, said his counsel considered that this bill met their requirements.

Mr. HOWELL, surveyor to the Surrey County Council, also supported the promoters.

At this point it was announced that the opposition of the Malden and Coombe District Council had been withdrawn on the promoters agreeing to carry out a widening at the Norbiton Park Hotel, New Malden, which would removed to a large extent the sharp curve at present existing in the road there.

Mr. BARTON, chairman of the Highways committee of the Barnes Urban District Council, said the embankment which the company would build at Barnes-terrace would be a very great boon to the district, bearing in mind that periodically many houses fronting the river were flooded, and that in future this would be prevented.

Mr. Dixon, barrister, residing in Barnes, Mr. Skewes-Cox, M.P. for Kingston, a member of the Surrey County Council and of the Richmond Town Council, and Mr. Garrett, proprietor of the Bull's Head, Barnes, also gave evidence.

Mr. C. J. MORE, engineer to the Thames Conservancy Board, said that a licence would be granted to the London United Tramways Co. to make the embankment at Barnes, and the plan of the work had been agreed upon. The embankment would make no difference in the flow of the river, owing to the width of the river at this point.

Mr. Humphreys, a member of the Tramways committee and chairman of the Streets Improvement committee of the Richmond Town Council, Mr. Thompson, a member of the Town Council of Richmond, and a number of others spoke of the exceedingly bad train service between Richmond and Hammersmith, as well as the very high fares.

Evidence was then called in regard to the Wimbledon lines.

Mr. Bond, a member of the Wimbledon Urban District Council, Mr. W. A. Laycock, a member of a firm of land surveyors, estate agents and valuers of Wimbledon, and several other witnesses having been called, who all spoke in favour of the scheme, especially as affording facilities to the working classes, the case for the promoters closed.

The Committee adjourned.

LEEDS CORPORATION TRAMWAYS.

On Tuesday, before a House of Commons Committee, presided over by Mr. Ashton,

Mr. BALFOUR BROWNE, K.C., asked that a provisional order made by the Board of Trade with regard to certain tramways in Leeds should be confirmed. In Leeds there was authorised and constructed a system of tramways extending over something like 70 miles, and all they were now proposing to do was to construct some very small tramways 5¾ miles in length. The London and North-Western Railway Co. opposed on one or two points. In constructing their tramways the promoters had to pass over a bridge which carried a road over the railway line. Of course, the road was there long before the railway, but when the railway came, for the convenience of the public, the railway company had to put the road over the railway by means of a bridge, and they were compelled to maintain that bridge for all time, as well as the roadway over it. Now they said that the promoters were going to run trams over the bridge and they, therefore, ought to be in some way relieved from some of their responsibilities, inasmuch as this might necessitate the strengthening or widening of the bridge, and that the promoters of the tramway should be responsible for that widening or strengthening. He said that that bridge ought to be just as capable of carrying that traffic over the bridge as the road itself. The whole idea of their making that bridge was to substitute something in place of the bit of solid road. That was the general law.

Mr. SHAW (for the railway company) said he should argue that point.

Mr. BALFOUR BROWNE said the railway company also proposed to be in a position to stop the tramway traffic and give them no compensation. There were in Leeds six bridges which carried tramways over railways, and in none of those cases was such a thing even asked for. They were seeking to get a clause beyond the general law.

Mr. THOMAS WILSON, Leeds city engineer, having given evidence,

Mr. SHAW said he thought the Committee would find that what the railway company was asking for was absolutely fair and reasonable. One point was that they asked that the promoters, if the company had to strengthen the bridge because of the tramways, should pay the expense; and the other point was that, if the company had at any time to repair or alter the bridge, and in so doing stop or put aside the tramway, they should not have to pay the promoters compensation, because they were doing a work in the public interest.

The CHAIRMAN said the Committee thought that the railway company was quite sufficiently protected under the order as it stood at present.

PONTYPRIDD URBAN DISTRICT TRAMWAYS BILL.

Before the same Committee, Mr. RAM, K.C., for the promoters of these tramways, applied for the confirmation of a provisional order made by the Board of Trade, and said that it was opposed by some of the frontagers and also by the Taff Vale Railway Co. He asked the Committee to sanction the further extension of a scheme which found favour with two Committees last year, and which now came before them with the approbation of the Board of Trade, who had held what he might term an exceptional inquiry into the case, and also the sanction of the House of Lords. This year the promoters were asking for a supplemental power to bring their line into Pontypridd from the north, and they hoped in future to be able to form a junction with a horse tramway to the west.

Mr. FREDERICK GEORGE EDWARDS, chairman of the Urban District Council, said that all classes of the inhabitants were in favour of having the tramways, and he did not think the frontagers would suffer.

Mr. VESEY KNOX, for the Glamorgan County Council, said his Council had withdrawn its petition, because they intended to make connecting lines from the district outside, and the Urban District Council had consented not to oppose a subsequent application by the County Council for running powers on reciprocal terms, so as to make a through system.

The Committee adjourned.

(A report of the proceedings before the House of Lords Committee was published in our issue for June 27, p. 396.)

NORTH AND SOUTH SHIELDS ELECTRIC RAILWAY BILL.

On the consideration of the amendments to this bill in the House of Commons, on Tuesday,

Mr. PLUMMER, member for Newcastle-on-Tyne, moved that the company be required to provide accommodation for six bicycles on every train, on the ground that the railway, being a subterranean connection between the two sides of the Tyne, was not on the same footing as ordinary electric tube railways.

Mr. ATHERLEY-JONES and Capt. NORTON opposed this contention.

Mr. ROBSON thought the time had come when this question should be considered.

Mr. PARKER SMITH, who was chairman of the Court of Referees which disallowed the *locus* of the Cyclists' Touring Club on this question, said he had done so because the scheme was purely one for passengers. At the same time, he thought the standing orders ought to be extended, so as to allow such bodies as the one mentioned to have similar opportunities of being heard in Committee as were afforded chambers of commerce or agriculture.

On a division there was a majority of 171 in favour of the motion, and a clause to that effect will be inserted in the bill.

Mr. KEIR HARDIE next moved that the rate for dogs should be 1d. instead of 6d.

This was negatived by a majority of 35 and the bill read a third time.

OTHER ELECTRICAL BILLS.

The Electric Lighting Acts Amendment (Scotland) Bill was read a first time in the House of Lords on Tuesday.

Before Lord Morley, chairman of Committees of the House of Lords, on Thursday last week, the London, Tilbury and Southend Railway, and the Whitechapel and Bow Railway Bills were dealt with as unopposed measures.

In the House of Lords on Thursday last week, the Metropolitan District Railway and York Corporation Bills were read a third time and passed. On the same day, in the House of Commons, the Bristol Corporation and the Medway and Thames Canal Bills were read a third time.

On Monday the following bills were read a third time and passed in the House of Lords:—West Ham Corporation, Newport Corporation, North Metropolitan Tramways, Croydon and District Electric Tramways and the Metropolitan Railway. In the House of Commons, on the same day, the Central London Railway Bill was read a third time, and the Lords amendments to the North Metropolitan Electric Power Bill were agreed to.

PACIFIC CABLE BILL.

This bill, to substitute the Government of the Commonwealth of Australia for the Government of the States of New South Wales, Queensland and Victoria, in the Pacific Cable Act, 1901, was presented for first reading in the House of Commons on Monday last.

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LEGAL INTELLIGENCE.

Electric Tramways and Board of Trade Regulations.

At Margate on Wednesday James Welsh, a motorman employed by the Isle of Thanet Electric Tramways and Lighting Co., was summoned for driving a tram car at a greater speed than 4 miles an hour, which is the limit allowed by the Board of Trade regulations under certain conditions.

A CONSTABLE said he timed the car over a distance of 153yds., which it covered in 46secs., a rate of about 7 miles an hour, whereas it should have taken 78secs.

For the defence Mr. HILLS suggested, with respect, that perhaps the constable's evidence could not be absolutely relied upon, as the distance at which he stood from the car when it started was about 130yds.—he could not possibly tell when the car commenced to move. The company tried to keep within the regulations. He thought, also with respect, that the police, instead of trying to get up a case against the company, might have communicated with the manager instead of issuing a summons. The Board of Trade, he submitted, never intended that any authority should vexatiously carry out the regulations, as was the case at Margate.

The DRIVER said he believed the car did not exceed the regulation speed.

Mr. G. CARNON, the company's traffic superintendent, who was on the car, said he did not consider the car was going beyond 4 or 4½miles an hour. It was absolutely impossible, as the lever was on the fourth notch, for the car to travel up a gradient 1 in 20 at 7 miles an hour.

One of the magistrates pointed out that the Board of Trade regulations provided that each car should be fitted with a speed indicator, and he asked if there was one on the car in question.

Mr. CARNON said there was no such thing as a speed indicator in existence; thus the regulations provided for things that had never existed.

Mr. HUMPHRIES, general manager pro. tem. of the company, also questioned as to the provision of speed indicators, said the Board of Trade would not recommend one, and added that he did not think there was a line of tramways in the United Kingdom where such difficulties as to steep gradients and curves had to be contended with as in the Isle of Thanet.

The Bench convicted, and imposed a fine of 20s. and 11s. costs.

Formal notice of appeal was given.

Taylor, Tunnicliff & Co. (Ltd.) v. Mercier's Patents (Ltd.)

His Honour Judge Mulholland, K.C., heard this case at Hanly County Court on Friday last. Plaintiffs claimed £11. 4s. for breach of contract. It appeared that in 1897 defendants applied to plaintiffs for terms for boxes which defendants considered rather high, but they sent an order for a certain number to be made, leaving the others in hands of plaintiffs till the following year. Defendants had not sent for the remainder, and now refused to take delivery. The articles were manufactured for a special purpose to a special pattern. Plaintiffs submitted that defendants had not taken the goods in a reasonable time.

For the defence the objection was raised that plaintiffs were suing as Taylor, Tunnicliff & Co. (Ltd.), a company which had been voluntarily wound up, and was, therefore, non-existent.

His Honour overruled the objection, and amended the claim to Taylor, Tunnicliff & Co. (1901) (Ltd.). Judgment was then given for plaintiffs for £10. 6s., leave to appeal being refused.

National Co. for the Distribution of Electricity by Secondary Generators (Ltd.) v. Gibbs and Another.

This case came before the Court of Appeal (Lords Justices Vaughan Williams, Romer and Stirling) on Monday on the appeal of defendant, Madame Ruelle, from an order of Mr. Justice Cozens-Hardy of July 11, 1901.

Mr. EARLE, for the appellants, explained to the Court the proceedings which had been previously taken in this matter, and recited the judgment of Mr. Justice Cozens-Hardy, as given briefly in our issue of July 12, 1901.

Having heard Mr. Earle's statement,

Their Lordships, without calling upon counsel for the respondents, dismissed the appeal with costs.

Magnetisation of Steel at the Temperature of Liquid Air.—A Paper by Mr. C. C. Trowbridge, recently published by the American Physical Society, on certain brands of carbon steel and tungsten steel, magnetised at the temperature of liquid air (−185°C.), contains results of some practical interest. It seems, says the *Electrical World and Engineer* of New York, that the intensity of magnetisation induced in these magnets was practically the same as at normal temperatures; also that the warming of the magnets from −185°C. to +20°C. after initial magnetisation in liquid air, caused them to lose an appreciable fraction—11 to 38 per cent.—of their magnetic intensity. It seems, therefore, that no advantage is to be gained by magnetising hard steel bars at very low temperatures.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A teacher is required for teaching magnetism and electricity and electric light and power at the Harris Institute, Preston, for two evenings a week. Applications by July 28. Further particulars from the secretary, Mr. T. R. Jolly. See advertisement.

Halifax Technical Instruction committee invite applications for the appointment of lecturer in electrical engineering and physics. Applications to principal by July 30. See advertisement.

A qualified practical teacher of electric wiring for Thursday evenings is required early in September at the Walthamstow Technical Institute. See advertisement.

Meter hands are wanted for erecting and finishing small electric meters, &c. See advertisement.

There is a vacancy for an improver at Barnsley electricity works. Applications to borough electrical engineer (Mr. S. E. Bastow). See advertisement.

A leading cable company require an experienced engineer to take entire charge of lighting and power contract department. See advertisement.

Tonbridge Urban District Council require an electrical engineer. Applications to Mr. Arthur H. Neve, Tonbridge Castle, Tonbridge, by Aug. 2.

A lecturer and demonstrator in physics is required at the University College, Bristol. Applications by Aug. 30.

Limerick Technical committee require a principal for their schools. Applications to Cecil-street, Limerick.

Mr. J. H. Targett, of Salisbury, has been appointed shift engineer at Southwark (London) electricity works.

Mr. R. S. S. Baker has been appointed demand note clerk and collector at the Stepney (London) electricity department.

Mr. Mech has been appointed inspector of lamps and fittings by the Poplar Borough Council.

Mr. Thomas Stirk has been promoted to the position of chief traffic inspector of the Bradford electric tramways.

Mr. W. F. Bolton has resigned his position as chief assistant at Watford to take up a position at Lewes.

Aberdeen.—The accounts of the tramways department for the year ended May 31 show a surplus of £11,354. The total receipts were £37,931. 17s. 9d. Working expenses were £26,577. 1s. 7d. Interest absorbed £6,111. 11s., depreciation of stock and buildings £1,599. 18s. 1d., £734. 3s. 4d. was written off for preliminary and parliamentary expenses, £1,201. 2s. 3d. carried to sinking fund, and £1,708. 1s. 6d. to renewal account. Capital expenditure during year was £57,529. 12s. 10d. The total outlay on electrical equipment was £20,808. 8s. 9d., on ground and buildings £2,477. 10s. 5d., on rolling stock £7,361. 3s. 6d. (new electric cars costing £7,018. 18s. 6d.). The total liabilities are £246,726. 4s. 4d.

African Trans-Continental Telegraph.—It is reported that the work of constructing the telegraph line in German East Africa from Dar es Salaam through the interior to Ujiji, on Lake Tanganyika, where the junction is to be effected with the Cape to Cairo telegraph, is proceeding but slowly. Last year 390km., from Dar es Salaam to Mpahua were constructed, and this year another 480km., as far as Tabora, should have been completed, but as the German Reichstag voted only half the sum proposed by the German Government, it will not be possible to proceed this year beyond Kilimatinde, which is only half way to the point of junction with the Cape to Cairo line.

Alleged Embezzlement.—Wm. R. Jolly, a cable superintendent in the employ of the British Insulated Wire Co., was charged at Bilston on Tuesday with embezzling £34. 13s., the moneys of his employers. He was remanded on bail until to-day (Friday).

Aston.—The British Electric Traction Co. have approached the Council as to acquiring the local tramways, of which the Council recently obtained possession by the expiry of the leases. The company are also negotiating with Birmingham Corporation for running powers over the lines in the Birmingham district granted to the Birmingham and Aston Tramways Co. Electric traction will be adopted in the event of the negotiations succeeding.

Barcelona.—Some years ago an English company took in hand the opening up for building purposes of the rising land lying to the north-west of Barcelona, which was acquired at small cost. This land has been cleared and has been for some time past offered for sale for building purposes, and to enable residents to reach the heights a funicular railway was constructed and was opened to the public in November last. This enables the summit (the rise continues for about 4 miles and attains an elevation of about 1,200ft.) to

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be reached in 10 minutes, and the company has, consequently, taking the railway and the land together, reaped a rich harvest from its enterprise. The electric tramway has been extended to the station of the funicular railway, and in July last year a new line of electric tramways was opened to Horta, nearly 4 miles distant from Barcelona. The power station is erected about ¾ mile from Horta, and has a plant capacity of 800 H P., engine power being provided by two 150 H P. and one 300 H.P. Croseley gas engines. Twelve cars run over this line on a 10-minute service, the contractors for the work being Messrs. F. H. Bragge & Co., electrical engineers and contractors, Barcelona. Nearly all the old mule and steam lines in this district are being converted to electric traction, and many new lines are being constructed.

Beckenham.—The District Council has decided to promote a bill authorising them to construct electric tramways to confer further power with regard to their electricity undertaking, &c. The surveyor has been instructed to prepare a scheme, with estimates, of the relative cost of the overhead trolley and surface contact systems.

Notices of intention to apply for provisional orders have been received from the Blackheath and Greenwich Electric Light and the Lewisham and District Electric Supply Companies. The first-named desire to lay a cable through only a small portion of the district for the supply of current to Penge. At the meeting of the Council last week a letter was read from the electrical engineer with reference to a contract proposed to be made between the British Insulated Wire Co. and manufacturers of lamps, whereby tested and reliable lamps can be supplied to consumers in Beckenham at a reasonable charge. The Council have decided not to object to the proposed contract provided they incur no responsibility.

Beverley.—Sanction to a loan of £14,784 for electric lighting has been received.

Bexhill.—A report prepared by the consulting engineer (Mr. Robert Hammond) recommending the Council to borrow £16,000 further for extensions of the electricity works was considered and adopted at the meeting on Tuesday, when it was decided to apply for sanction to a loan.

Birmingham.—The General Powers Bill, to be promoted next session, has been approved by the Council. The powers sought include the construction and working of electric tramways.

Bolton.—A further loan of £20,000 for electric lighting extensions is being sought.

Boston.—An extension of time for complying with the terms of their provisional order, obtained in 1900, is being applied by the Council.

Bournemouth.—The official inspection of the Bournemouth-Pokesdown municipal electric tramway route took place on Wednesday.

Bray (Ireland).—An inquiry was held last week into the application of the Council to borrow another £7,000 for electric lighting. The chairman of the Electric Lighting committee (Mr. J. E. M'Cormack) said the Council acquired the works in 1895 for £3,060, and in 1896 a loan of £5,450 was sanctioned for remodelling and extending the works and machinery. Owing to increased demand for electric current for lighting within the past two years it became necessary to carry out extensions so as to put the undertaking on a sound commercial basis. The Council expected to increase their revenue by 50 per cent. It was now a matter of disposing of the works or getting a loan, as they did not want to work at a serious loss.

The Town Clerk (Mr. P. MacDonnell) stated that the Council had for a long time been unable to meet the demand for current. The loans already raised for electric lighting amounted to £8,509 12s. The consulting engineer (Mr. Robert Hammond) said that the works at present were suffering under an immense disadvantage in not having sufficient plant. Two years ago he drew attention to the matter, and the works were now a source of constant anxiety to those in charge. If the works were in charge of a company the public would have to pay more for current than was charged at present. The works were being run in a prudent manner. A portion of the works was worth money as a curiosity. The resident engineer (Mr. Arthur Wilkins) also gave evidence. The application was opposed by several ratepayers.

Brentwood.—A public meeting will be held early in August to discuss a proposal to apply for a provisional electric lighting order.

Brompton and Piccadilly Circus Railway.—At the Mansion House (London), on Saturday, an application was made to the Lord Mayor on behalf of the Brompton and Piccadilly Circus Railway Co. for a certificate under the Lands Clauses Consolidation Act to enable it to put its compulsory powers of purchase into operation. It was stated that the company, not being able to obtain the financial support from the public, had entered into an agreement with the Metropolitan District Electric Traction Co. to construct the line on consideration of the capital and debenture stock being issued to that company, which took over the company's obligations to construct the line and to provide capital. The benefit of this agreement had been assigned to the Underground Electric Railways Co., which had taken over the Metropolitan District Electric Traction Co., and had a capital of £5,000,000 sterling. £1,200,000 was paid up, and there was another £400,000 to come in next month. The latter company was a responsible one, had wealthy sponsors behind it, and had large interests in several tube railways. The Brompton and Piccadilly Circus line was actually in course of construction by Messrs. Walker and Reeves, and it was now desired to acquire station sites. The certificate was granted.

Cardiff.—The borough electrical engineer (Mr. A. Ellis) has received an intimation from the Ely Paper Works Co. that they have found electric lighting on their premises most satisfactory, better and cheaper than gas lighting. The company's bill for current comes to about £600 per annum, and they are likely to take current for power in the near future. The proprietors of the *South Wales Daily News* will take current for working their printing machines on condition that the Corporation puts in a short independent main to avoid risk of breakdown. Mr. Ellis advised the Lighting committee that the request is a reasonable one.

Chislehurst.—The Council is negotiating with the British Insulated Wire Co. for the supply of electric current in the district.

City of London.—At the meeting of the Court of Common Council, last Thursday, the report of the electrical engineer (Mr. A. A. Voysey) as to the further assistance required for meter testing (referred to in our last issue) was discussed. The Streets committee was authorised to appoint, under the agreement between the Corporation and the undertakers under the City of London Electric Lighting Orders 1890, 1891 and 1899, one assistant at £200 a year, and seven men whose wages are not to exceed £600 per annum. These outgoings are refunded to the Corporation under the agreement in question.

Coventry.—The accounts of the electricity department for the past year show a gross profit of £2,351, against £1,538 in 1901; but, after allowing for interest and sinking fund, there is a deficit of £1,807, against £2,250 in 1901.

Darlington.—The Council having obtained their provisional order for the construction of electric tramways, a special meeting has been called to authorise the immediate construction of the lines and to obtain tenders. A loan of £100,000 is to be obtained.

Dingwall.—A special meeting of the Council will discuss proposals submitted by Mr. Gair, engineer of the Strathpeffer electricity works, for the supply of electric current for lighting and power. In the meantime a committee (consisting of Bailies Frew and Henderson and Treasurer Ross) is making a canvass of the town.

Dundee.—The Electricity committee has decided to make extensions of the electric light cables.

Electric Lamp Making.—The *Manchester Evening Chronicle* has recently published an interesting non-technical description of incandescent lamp manufacture from notes made by a member of its staff on a recent visit to the Premier Electric Lamp Co.'s works at Huyton Quarry, Liverpool. The description of the process of manufacture is well done from the popular standpoint. On the subject of the filament used in the Premier lamp the following brief extract from the article may be made:—

A very fine paper is required for this purpose. It is obtained from Sweden in the form of scrap, and is, apparently, valueless owing to the smallness and irregular shape of the pieces. But size and shape are of no account to the electric lamp manufacturer. The first process consists of reducing the paper to pulp by immersion in a chemical solution. When this process is completed, the pulp is placed in a glass vessel with an exhaust pump attached and the air and gases are extracted, after which the pump is reversed and the pulp is forced through a very fine hole in the bottom of the vessel, and emerges as a thread of clear gelatine hundreds of yards in length. This thread is passed round a drum on which it dries, reducing it to about half its original thickness. It is then ready for conversion into filaments, and has a strength out of all proportion to what might be expected. These threads are then carbonised and made up into bundles of 25 of uniform lengths. Each bundle is then fixed on a carbon frame in such a way that no thread overlaps another. The frames are of all sizes and shapes varying according to the size and shape of the filament required. The threads are then wound round, and the ends secured by an adhesive solution. They are then packed in plumbago crucibles and carbonised at a temperature of about 100°C. When taken out of the crucibles they are easily detached from the frames, the adhesive solution and some string adjustments having completely disappeared. They have now a brilliant polish, which is afterwards reduced by a process designed to secure evenness of resistance. The filament is now ready for fixing into the foot of the lamp, which is now treated in a vessel containing hydrocarbon gas which automatically secures that the lamp shall glow just long enough to take up the required quantity of carbon from the gas to offer the proper resistance to the electric current.

Electric Launches.—An interesting trial run of an electric launch, built by the Thames Valley Launch Co., took place on 13th inst. The launch is a pinnace, 32ft. long, and is intended for use in the Bay of Naples. She is fitted with a Beevor-Edwards motor and a battery of 44 Leitner cells, and with W. Rowland Edwards' single-lever launch gear. The boat was designed to run 40 miles on one charge at 7 miles per hour, and this, the company informs us, she did. The same company have nearly completed a 32ft. pinnace for the Natal Government.

Electric Traction on Railways.—It is rumoured that the directors of the Lancashire and Yorkshire Railway Co. are contemplating the conversion of certain portions of their system to electric traction. As will be seen by an advertisement elsewhere, the North-

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Eastern Railway Co. require tenders for converting a portion of their system to electric traction.

Exeter.—The City Council are taking steps to acquire the undertaking of the local tramways company, whose lease has just expired.

Finchley.—The Board of Trade have deferred the revocation of the Council's provisional order for a year, as tenders for the erection of electricity works have been let.

Germany.—In a comprehensive review of the trade of Frankfort and district for 1901, recently prepared by Mr. Consul-General F. Oppenheimer, a list of some of the more serious fluctuations in the market price of shares in the leading industries are given, and four typical instances are shown in relation to the shares of electrical concerns. These are as under :—

	Price 1898-1900.	Price Dec. 31, 1901.	Dividend 1900.	Dividend since.
Helios Co., Cologne	198	34	11	nil
Cologne Electric Works	134	31	6	nil
Kummer & Co.	211	1	11	nil
Schuckert & Co., Nüremberg...	228	100	15	nil

Mr. Oppenheimer regards the electrical industry as having proved "the bankers' spoiled child" during the great industrial boom which occurred during 1898-1900. One electrical joint-stock issue followed another, and an immense amount of capital found employment in this industry. This activity was first of all checked by the tightness of the money market, and afterwards by the universal distrust of new enterprises which succeeded the boom. This was accompanied by many technical improvements in gas lighting without any corresponding reduction in the charge made for electricity supply. Much of the capital so provided by the public in the flotation of these electrical joint-stock concerns was (the report proceeds) invested and lost in foreign contracts and undertakings, resulting in the undermining of public confidence in electrical enterprises as a means of investment. It will thus be seen that there was, and is, nothing fundamentally amiss with the industry so far as it applies to the German home electrical industry, which (according to Mr. Oppenheimer) shows every evidence of soundess and progress.

Grimsby.—The first annual report of the borough electrical engineer (Mr. W. A. Vignoles) on the Council's electricity undertaking states that the gross profit was £1,567, but after allowing for interest and sinking fund there was a deficit of £2,014. 5s. 9d. It is anticipated that by March the equivalent of 20,000 8 c.p. lamps will be connected, the result of the year's working being a gross profit of £3,230 ; interest and sinking fund will absorb £4,350, leaving a deficit of £1,120. If the price of current be reduced to 4½d. Mr. Vignoles anticipates that there will be an increased demand for current, and that the number of lamps connected by March 31 next will be 25,000, and on this basis the gross profit would be £3,500, and the deficit £850. He recommends the Electric Lighting committee to reduce the price of current from Oct. 1 to 4½d. per unit, with rebates as under :—Exceeding 500 units and not exceeding 3,000 units per annum, 2½ per cent. ; not exceeding 5,000, 5 per cent. ; not exceeding 8,000, 7½ per cent. ; and not exceeding 11,000, 10 per cent.

Heckmondwike.—The inquiry held on Tuesday into the Council's application for a loan of £6,500 for extensions of the electricity works was unopposed.

Heston and Isleworth.—Mr. J. Enright has been engaged by the Council to prepare plan and specifications for electricity works.

Huddersfield.—Linthwaite Urban District Council has decided not to consent to the Huddersfield Corporation's application to extend their electric supply to Milnsbridge.

Hull.—Sanction to a further loan of £15,000 for electric lighting has been obtained by the Corporation.

Johannesburg.—The Municipal Council have received proposals from the local tramway company for the construction of electric tramways, but the Council have resolved to construct and work a municipal system, and a committee has been appointed to organise details.

Kingswinford.—The Council have requested the Midland Electric Corporation for Power Distribution to carry out the terms of its agreement with the Council for the supply of electric current.

Lancaster.—The Corporation are constructing a system of electric tramways. For some time negotiations have been proceeding with the local tramways company for the acquisition by the Corporation of their undertaking and thus get control of the line between Lancaster and Morecambe. Friction has arisen between the parties and matters are at a standstill.

Light Railways.—An inquiry was opened on Friday into the application of Southend Town Council for an order to extend their light railway service. Evidence was given by the Town Clerk and others. Opposition was offered by the London, Tilbury and Southend Railway Co. and others, and the inquiry was adjourned.

The Halesowen Light Railways (Extension) Order, 1902, has been approved by the Board of Trade.

Liverpool.—An inquiry was held here on Wednesday into the application of the Corporation to borrow £300,000 for extensions of the municipal electricity undertaking. The deputy town clerk (Mr. E. W. Pierce) said that when the Corporation took over the undertaking in 1896 the output was 1,352,000 units, while this year the estimate was 22,500,000 units. Further capital was necessary to enable them to keep pace with the demand for current. £500,000 was borrowed in 1896, of which £400,000 went in the purchase of the undertaking, and the remainder was spent in extensions. Since then £1,200,000 had been borrowed, and practically the whole had been expended in extensions. The charges for electric current had been considerably reduced, for lighting from 7½d. to 3¾d. per unit up to 3,000 units per quarter, and 3d. beyond ; and power from 5d. per unit to 2d. up to 3,000 units, and 1½d. beyond. Consumers had increased from 1,300 to 4,058, and the number of 16 c.p. lamps supplied from 52,490 to 190,041. Technical details were supplied by the city electrical engineer (Mr. A. Bromley Holmes), and evidence in support of the application was also given by the city controller and auditor (Mr. Barrow) and by Councillor R. Dart.

The Mersey Docks and Harbour Board have decided to adopt electric lighting for the south side of the Huskisson branch dock No. 1 at an estimated cost of £1,936. 13s., current being taken from the Corporation mains.

London County Council.—At Tuesday's meeting it was agreed to loan £6,000 to Battersea for electric lighting.

Telephonic Fire Alarms.—It was agreed, on the recommendation of the General Purposes committee, that Captain Wells, chief of the Fire Brigade, should assign to Mr. A. C. Brown his interest in their joint patent for improvement in telephonic fire alarms on condition that the free use of the machine be allowed to the Council, and that the name of Captain Wells or the Council is not used in connection with the patent. Captain Wells receives £200, which he hands over to the widows and orphans fund of the Fire Brigade.

Telephonic Communication.—On the recommendation of the Fire Brigade committee it was resolved to connect the Avenue, Bank, Battersea, London Wall, Deptford, Eastern, Kensington, King's Cross, Paddington and Westminster exchanges of the National Telephone Co. with the Fire Brigade stations.

Tramways.—It was decided to expend £9,000 and £105,000 for the alteration of bridges and the provision of permanent way and rolling stock in connection with the reconstruction of electric traction of the tramways between New Cross and Greenwich—about 5 miles of single track.

It was agreed that £73,800 be expended on capital account in connection with the reconstruction to electric traction of the tramways between (*a*) Camberwell Green and Vauxhall, (*b*) St. George's Circus and Kennington-road, and (*c*) Kennington Park-road and Brixton-road, and that Messrs. J. G. White & Co. be authorised to carry out the work at prices based upon those in their existing contract for the reconstruction of the Westminster to Tooting, &c, lines.

A report was submitted by the Highways committee with respect to the revised estimates for the reconstruction for electric traction of the Westminster to Tooting lines ; the establishment of an electricity generating station at Greenwich, and sub-stations at Brixton, Clapham and Elephant and Castle, and sheds at Clapham and Balham, and temporary electricity generating station near Loughborough Junction. The original estimates were £623,500, but it was now found that the total sum required was £981,497. All the additional cost, however, was for work not provided for in the original estimates, the chief item being the provision of a much larger generating station at Greenwich in lieu of the proposed station at Camberwell. The consideration of the report was adjourned, as was a report dealing with the proposed erection of car sheds, workshops and sub-stations at New Cross Gate, and a sub-station at Camberwell. Sufficient car-shed accommodation will be afforded at the New Cross depôt for the whole of the cars to be used other than those on the Tooting, Streatham and Camberwell lines. The estimated cost is £644,350 (including land).

The Highways committee further recommended that application be made to Parliament next session to run omnibuses along the routes of any tramways while under reconstruction for electric traction for a period not exceeding 12 months after the commencement of work.—Consideration adjourned.

A special report was presented by the same committee, containing proposals for new tramways, for which they recommended the Council to seek powers next session. In all, 26½ miles of tramway are proposed, at a total estimated cost of about £1,180,750. It was proposed that the whole of the new lines be constructed on the underground conduit system, with the exception of (*a*) those through the Blackwall Tunnel, (*b*) over Hammersmith Bridge, and (*c*) in continuation of the Bexley Council's lines in Widshaw-road, these being constructed on the overhead system. The suggested lines are as follows:—1. Hampstead-road terminus to Oxford-street end of Tottenham-court-road (5fur. 9ch.). 2. Edgware-road to Harrow-road, via Sutherland-avenue (5fur. 6ch.). 3. Hammersmith-broadway to and across Hammersmith Bridge, via Bridge-road (3fur. 8ch.). 4

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Greenwich to East India Dock-road, via Blackwall Tunnel (2 miles 2fur.). 5. Westminster Bridge-road to Victoria Embankment (2fur. 7ch.). 6. Harlesden to Hammersmith-broadway (2 miles 7fur. 7ch.). 7. Shepherd's Bush to Marble Arch (2 miles 6fur. 5ch.). 8. Marble Arch to Cricklewood (3 miles 5fur. 6ch.). 9. Deptford to Herbert Hospital, Woolwich (3 miles 3fur. 5ch.). 10. New Cross to Lee High-road (1 mile 3fur. 5ch.). 11. Battersea Park-road to Victoria (2 miles 4fur. 9ch.). 12. Tooting-broadway to Tooting Junction station (5fur. 3ch.). 13. Garrett-lane, Wandsworth, to the county boundary, via Wimbledon-road (1fur. 7ch.). 14. Rushey Green to Bromley Hill (2 miles 3fur. 5ch.). 15. Terminus of the Woolwich and South-East London tramways to the county boundary near Widshaw-lane (1 mile 1fur. 2ch.).—Consideration postponed.

London Electrical Contractors' Association.—The annual general meeting will be held on Wednesday evening next (July 29) at Anderton's Hotel, Fleet-street, London, at 6 p.m. The election of officers takes place on this occasion. An extraordinary general meeting will also be held a quarter of an hour earlier than the ordinary meeting, when some alterations in and additions to the rules will be proposed.

Maidstone.—Application has been made for a further loan of £6,567 for electric lighting.

Manchester.—The members of the Electricity committee made an inspection last week of the sub-stations and other work of the department at present in progress. At the end of March, 1902, the total expenditure on mains amounted to £522,123 for Manchester, £42,220 for Withington, £22,680 for Moss Side, £6,302 for Levenshulme, and £2,730 for Denton. On the 14th inst. the total length of mains laid was 261 miles. The quantity of electricity accounted for during the past year amounted to 11,518,940 units, and the number of consumers now connected is 4,084. In connection with the Stuart-street work 20 sub-stations will distribute energy for the whole of the tramway services within the city area (except a portion within the half-mile radius of Bloom-street), and also in Failsworth, Droylsden, Audenshaw, Gorton, Denton, Levenshulme, Heaton Norris, Moss Side and Withington. These sub-stations will also distribute energy for lighting and power in these districts, excepting Failsworth and Gorton, the local authorities of which places have not transferred their orders to the Corporation. When these sub-stations are at work there will be approximately 280 miles of mains laid. The total cost of buildings and machinery at distributing stations and of subways for carrying mains from the Stuart-street station will be about £250,000.

Mexico.—Arrangements are being made for the conversion to electric traction of a portion of the Mexican Railway between Esperanza and Vera Cruz, a distance of 179km. (about 111 miles). The waters of the Metlac River will be utilised in the generation of electric current for working the railway, which contains deep gradients.

Municipal Telephony.—The accounts of Glasgow Municipal Telephone department for year ended May 31 have been issued and show a total capital expenditure of £192,036. 4s. 10d. Of this outlay £113,212. 4s. 7d. has been on underground construction and £20,663. 15s. 9d. on overhead lines. The central exchange cost £11,615. The total revenue amounted to £28,171. 13s. 5d., and after paying expenses, including £1,960 for sinking fund instalment, there was a net profit of £434. No provision has, however, yet been made for depreciation.

A report on the proposal to establish a municipal telephone system for Rochester, Chatham and Gillingham has been prepared by Mr. A. R. Bennett, who recommends that, if at all practicable, the three authorities should apply for a joint licence for the whole area, and, if not, for a concession similar to the Manchester one—that is, concurrent licences for the three areas, the exchanges, when established, to be managed and worked as a joint concern.

It is announced that there has been a profit of £130 on the first year's working of the Tunbridge Wells municipal telephone system. There are over 700 subscribers.

New Cable Steamer.—It is announced that a new cable steamer is being built for the Norddeutsche Seekabelwerke, which will be a sister ship to the "Von Podbielski." The vessel is being built by the Vulcan Shipbuilding Co., of Stettin, Germany. She will be 380ft. in length, and will have, it is stated, tank capacity for 5,000 tons of cable.

Northfleet.—The Council recently decided to invite tenders for the transfer of its electric lighting order, but in the absence of a transfer clause the Board of Trade decline to consent, and the Council now propose to invite tenders for the erection and equipment of electricity works.

Penzance.—The Electric Lighting committee is to discuss with representatives of the Cornwall Electric Power Syndicate the terms of a draft agreement relating to the erection of works and the supply of current in the district.

Poplar (London).—The agreement with the Millwall Dock Co. for the supply of electrical energy to the Millwall Docks has been sealed. The Borough Council have decided to act upon the report of the borough electrical engineer (Mr. Alfred Blackman) and to supply customers with incandescent lamps for renewals free of charge. It was stated that complaints as to bad lighting and abnormal consumption frequently arose from the use of inefficient lamps or the continued use of exhausted lamps. The estimated cost of lamps for the first year is £450, and in subsequent years £350, on the basis of the present numbers of consumers.

Rawmarsh.—A committee is considering the question of the Council carrying out its electric lighting and electric tramway power obtained in 1898.

Redruth.—The Urban Electric Supply Co., who are erecting electricity works and have obtained a contract for public lighting, ask for an extension of time beyond Aug. 1 to carry out the contract.

Royal Assent.—Royal assent was given by commission on Tuesday to (amongst others) the Kent Electric Power, and the City of London (Public Health) Acts.

Salford.—The Council have applied to the Board of Trade for the appointment of an electrical inspector under the Salford Electric Lighting Order, 1890.

South Africa.—The *Daily Mail* of July 23 contains particulars of an interview reported to have taken place between their correspondent at Pretoria and the British Trade Commissioners, Messrs. Nichol, Jenkins, and B. Morgan. The Commissioners are stated to have been much impressed with the future for British trade in the Witswatersrand district, and more especially with the openings for electrical machinery of all descriptions. There is also scope for the introduction of tramway plant and material. The labour question appears by this report to be a serious disturbing factor in any calculations made regarding the immediate future of South African trade.

South Lancashire Tramways.—An address on "Through Traffic on Tramways for Passengers and Goods" was delivered by Mr. J. E. Waller, on Monday, before the Liverpool Chamber of Commerce. The speaker said the South Lancashire tramways, when constructed, together with the Liverpool and Prescot light railways, would directly connect up 13 tramway systems, extending from Liverpool to Stalybridge, and representing an aggregate length of about 400 miles.

Swindon.—The guardians, having received a communication from the Local Government Board suggesting the advantage of taking electric current from the Corporation for the lighting of their workhouse, have replied that the arrangements for an independent installation have proceeded too far for the change to be made.

The Late Mr. C. E. Grove.—Subscribers to the fund raised to provide a headstone over the grave of the late Mr. C. E. Grove, late hon. secretary of the Electro-Harmonic Society, will be pleased to learn that the result of the subscription for this purpose was the receipt of £33. 16s. 6d., and a handsome tombstone, with suitable inscription, has been erected by Mrs. Grove in West Ham cemetery.

The World's Railways.—According to a return recently prepared by the French Ministry of Public Works, the total length of railways in Europe on Dec. 31, 1900, was 283,534km., comparing with 223,193km. in 1890. In America (including North, South and Central and the Antilles) the total was 402,703km. and 323,740km. respectively; in Africa the total was 18,467km. and 9,331km.; in Asia 60,725km. and 32,929km.; and in Oceania (including Hawaii) 25,151km. and 18,732km. The grand total is 790,570km. for 1900 and 607,925km. for 1890. In Europe, Germany takes the lead with 51,391km. (including railways of first, second and third importance), followed by Russia with 48,107km., France 42,826km., Austria-Hungary 36,883km., and the United Kingdom 35,296km. In America, the United States, of course, comes an easy first with 311,287km. in 1900, compared with 263,228km. in 1890, Canada, with 28,410km. and 21,160km. respectively, coming second, and Argentina, Mexico and Brazil follow with a relatively good show. In Africa, British possessions (including Egypt) stand for 12,253km. in 1900, compared with 5,658km. in 1890, followed by France with 4,628km. and 3,595km. respectively. In Asia, British possessions represent 40,529km. in 1900 and 27,553km. in 1890, Russia coming next with 8,084km. and 1,433km. respectively, followed at a long distance by Japan, Asiatic Turkey and the Dutch Indies. For Oceania the total is wholly British except for 161km. for Hawaii. Out of the world's total of 790,570km., the British empire stands for 143,022km., while the United States (including Cuba, Porto Rico and Hawaii) stand for 313,629km., leaving for the rest of the world 333,920km. of railway.

Theatre Lighting.—The Alexandra Theatre, Stoke Newington, is to be lighted by electricity, current being taken from the Borough Council's mains.

Tottenham.—A petition from West Green-road tradesmen to establish electricity supply has been referred to committee by the Council.

Water Power in Ireland.—The Londonderry County Council have appointed a special committee to inquire into the practicability of utilising the water power of the river Bann in the generation of electric current. It was stated that 8,000 H.P. would be available for three months in summer, and about 24,000 H.P. during the remaining nine months of the year.

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Watford.—The Council have received notification from the Board of Trade that the Board has no power to authorise the supply of electric energy outside the area prescribed by the Council's provisional order of 1897. The Council will, therefore, apply for an order to enable this policy to be carried out. The increase of population and the erection of factories and other large buildings outside the present area render the Council's present powers inadequate to meet the increasing demand for current.

Wells.—The Council regard favourably the proposals submitted by Messrs. Crompton & Co. for the erection of electricity works.

West London Electricity Supply.—Owing to the increasing demand for electric current, the Charing Cross and Strand Electricity Supply Corporation are laying additional cables in the principal streets in their area of supply, including Pall Mall, St. Martin's-lane, Garrick-street, Strand, Long Acre, &c., at an estimated expenditure of about £50,000.

Wolverhampton.—A special meeting of the Council was held on Monday to consider the question of tramway inter-communication between Wolverhampton and neighbouring towns. Many letters have passed between the Council and the British Electric Traction Co. on the subject, and the Tramways committee reported they had made three offers to the company, none of which had been accepted, but in their last letter the company stated that with slight modification one or other of the offers might supply a solution.

Ald. S. CRADDOCK then moved:—"That, subject to the consent of the Board of Trade, a single line of track be forthwith constructed upon the Lorain surface contact system along Bilston-road, provided that the Lorain Steel Co. agree to the same conditions as at present apply to the other lines laid down by them in the borough." He said he objected to the overhead system for Dudley-road because he contended that the Lorain system was proving to be a most satisfactory one. It would be no use having dual control over that piece of line, and if an alien company were allowed to run into the borough the Corporation would find that they would run their cars at a loss. It had been said that the isolation of the borough from the adjoining towns was ruining Wolverhampton; but he denied that such was the case. It would be a mistake to allow a great company to run into Wolverhampton. The company was going to Birmingham, and a great battle would be fought there, and there would be a fight in Wolverhampton if they were allowed to lay down their lines.

The MAYOR (Mr. Plant) seconded, and contended that the borough ought to retain the trams in their own hands.

Mr. G. R. THORNE moved that the report be referred back to the committee, with instructions to appoint a sub-committee to continue negotiations within limits, and with power to make a final settlement. The reason the negotiations had fallen through was because there had been too much personal feeling, passion and invective imparted into the matter.

After an animated discussion the original resolution was carried.

Worsley.—The Lancashire Electric Power Co. offer to supply electricity in bulk, and a committee has been appointed by the Council to meet the company to discuss terms.

Yeovil.—The Council have received an offer from a company to take a lease of a provisional order and make an annual payment of £50.

X-Ray Outfits for the Navy.—It is announced by the *British Medical Journal* that complete Röntgen ray outfits are to be installed on all the flagships of His Majesty's navy at a cost of £67. 18s. 6d. per ship.

Annual Outings.—The employés of the Hart Accumulator Co. held their annual outing on 19th inst. at Epping.

The annual outing of the employés of the Lowestoft electricity department took place last week, when a visit was paid to Buckenham Ferry. The borough electrical engineer (Mr. G. A. Bruce) accompanied the party.

Cricket.—In a match played at Clifton Junction between the Chloride Electrical Storage Co.'s club and the Tudor Accumulator cricket club, the Chloride team were successful with a total of 42, against Tudor's 34. The customary réunion of the teams followed the match at the tea party.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

The directors of the *North-Eastern Railway Co.* announce in an advertisement that they are prepared to receive tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz., electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment, but tenders for either section separately will not be considered. Specifications, &c., may be obtained after 29th inst. from the company's chief mechanical engineer (Mr. Wilson Worsdell), Gateshead-on-Tyne, or from Mr. Charles H. Merz, consulting engineer, 28, Victoria-street, Westminster, S.W., from whom further information may be obtained. Tenders, addressed to the secretary (Mr. C. N. Wilkinson), must be delivered at his office in York by noon, Oct. 7.

Leicester Tramways committee invite tenders for steel girder tramway rails and fishplates; bolts, nuts and tie-bars; points, crossings and special track work; stoneware pipes and conduits; feeder cables; telephone and test wires; roadway frames and covers; overhead electrical equipment and copper bonds; steam-raising plant, engines, generators, batteries, boosters, switchboard, overhead travelling crane, &c., and also for electric tramcars. An advertisement contains further particulars. Specifications, &c., of the borough engineer (Mr. E. George Mawbey, M.Inst.C.E.), Town Hall, Leicester, and can be seen at the office of the consulting engineer (Mr. E. Manville), 29, Great George-street, Westminster, S.W. Tenders to chairman of committee by noon Sept. 3.

Malvern Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work), engines, alternators exciters and switchboard, high and low-tension concentric cables and transformers. Specifications, &c., from the engineer and surveyor (Mr. H. P. Maybury), Council House, Malvern. Tenders (addressed chairman of the Gas, Water and Electricity committee) by Aug. 23. An advertisement contains further particulars.

Coventry Corporation require tenders for supply of single or two-phase electric motors for hiring, the single or two-phase to run at 50 periods and single-phase at 87 periods, voltage 200, sizes from ½ to 50 B.H.P. Some further particulars are given in an advertisement. Tenders to Mr. Lewis Beard, town clerk, 10, Hay-lane, Coventry, by 10 a.m. Aug. 5.

Manchester Corporation Tramways committee invite tenders for the supply of quick-break switches. Specifications, &c., from Mr. J. M. McElroy, general manager, tramways department, 55, Piccadilly, Manchester, where tenders (addressed chairman of committee) must be sent by 1 p.m. Aug. 2. An advertisement gives further particulars.

Warrington Corporation invite tenders for cables. Specifications, &c., from the consulting engineers (Messrs. Preece and Cardew), 8, Queen Anne's-gate, Westminster, S.W. Tenders, addressed to town clerk (Mr. J. Lyon Whittle), Town Hall, Warrington, by noon Aug. 6. See advertisement.

Warrington Tramways committee require a set of car-lifting jacks, an armature removing bogie and two 12-ton travelling jacks. Tenders by Aug. 4.

Hendon Urban District Council desire tenders from companies and others for the purchase or lease of their provisional order (1899) for electricity supply. Tenders to the chairman before 4 p.m. July 28. Some additional particulars will be found in an advertisement.

Wolverhampton Guardians invite tenders for electric lighting plant, and for wiring their new workhouse. Specifications, &c., from the architect, Mr. A. Marshall, King-street, Nottingham, and tenders to the clerk (Mr. Frank Harrison) by Aug. 13. See advertisement.

Truro Electric Lighting committee invite proposals for the electric lighting of the city, which must be sent to the town clerk (Mr. Robert Dobell) by 31st inst. See advertisement.

Farnworth Urban District Council require a 400 H.P. enclosed high-speed engine direct-coupled to a 250kw. lighting and traction generator, extensions to switchboards, pipe work, foundations, condensing plant, &c. Tenders to clerk, Council Offices, Farnworth, R.S.O., by noon July 31.

Ilford Urban District Council invite tenders for a combined track-watering and sweeping car on maximum traction truck with complete electrical equipment. Tenders to chairman of Council by noon Aug. 19.

London County Council invite tenders for seven tubular fuel economisers and seven motors, and also for dampers and frames for flues and chimney openings. Tenders to clerk by Aug. 15.

Pontypridd Council invite tenders for cables and dust destructors. Tenders to chairman Electric Lighting and Tramways committee by July 31.

Bexley Council require tramway and lighting cables, switchboards, accumulators, motor booster, rotary converter and motors. Tenders by Aug. 9.

Swindon Guardians invite tenders for electric lighting installation at their workhouse and infirmary. Tenders by 29th inst.

Dundee Gas Commissioners require tenders for machine tools, &c., for Dudhope Crescent-road electricity works. Tenders by noon Aug. 1.

Dublin Lighting committee invite tenders for construction of cast-iron subway under the Grand Canal Dock. Tenders by noon July 29.

Tenders are required for boilers, wrought-iron smoke stack, high-speed engines, single-phase alternator, exciters, surface condenser, main switchboard, transformers, mains, &c., for the King Electric Lighting and Cold Storage Co. (Ltd.), King William's Town, South Africa. Specifications from London agents (Messrs. A. E. Booth & Co.), 16, New Union-st., Moorfields, E.C., to whom tenders by Aug. 7.

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Tenders are invited until Aug. 11 by the Provincial Goverment authorities, *Liege*, for the construction and working of an electric tramway between Seraing and Val St. Lambert. Tenders to Le Gouvernement Provincial, Liege, Belgium.

TENDERS RECEIVED AND ACCEPTED.

Walsall Corporation have accepted the tender of Messrs. Crompton & Co. for the supply of a reversible booster and switches at £322.

The tender of the Hart Accumulator Co. has been accepted for the supply of a storage battery for the Fulham Union electric lighting installation.

London County Council have received six tenders for laying stoneware duct for electric cables between the temporary electricity station to be erected at Loughborough Junction and the Tooting, &c., tramways, and that of Mr. J. A. Ewart, £6,173. 5s. (the lowest tender), was accepted.

Bexley District Council have accepted the tender of Hadfield's Steel Foundry Co. for points and crossings, and that of John Fraser and Son for boilers.

West Ham Corporation have accepted the tender of Messrs. Witting Bros. for 50 car bodies, trucks, controllers and motors at £518 per car.

Dartford District Council has let a contract to Callender's Co. for the laying of electric lighting mains.

For alteration to car sheds, &c., at the Balham depôt the tender of Messrs. C. R. Roberts & Co., at £1,900, has been accepted by the London County Council.

BUSINESS NOTICES.

Mr. Herbert Umney has opened offices at 46, King William-street, London, E.C., and represents the firms of W. R. Renshaw & Co. (Ltd.), Stoke-on-Trent; Isaac Storey & Sons (Ltd.), Manchester; Pollock, Whyte and Waddell, Johnstone, N.B.; T. D. Robinson & Co. (Ltd.), Derby; and Mason Bros., Cradley Heath.

Messrs. F. S. Thomas and R. H. Stimpson (trading as the Saxonia Electrical Wire Co.), engineers and electricians, Roan-street, Greenwich, have dissolved partnership. Debts by Messrs. F. S. Thomas and S. Turnor Smith, who continue under the old title.

Messrs. Crompton & Co.'s Chelmsford works will be closed for the annual holiday from Aug. 2 to Aug. 11. A small staff will remain to deal with urgent matters.

Messrs. Evershed and Vignoles' works at Harrow-road, London, W, will be closed from Saturday, Aug. 2, until Monday, Aug. 11. Only urgent matter will be attended to.

LIQUIDATIONS.

Official intimation appears on another page that notices referring to the liquidation of the Hiram Maxim Lamp Co. (Ltd.) have no reference whatever to the Sir Hiram Maxim Electrical and Engineering Co. (Ltd.).

Claims against the Trafford Power and Light Supply (Ltd.) must be sent to Mr. E. E. Johnson, 78, King-street, Manchester, by Sept. 6. This company's undertaking was acquired, and is being carried on, by the Trafford Power and Light Supply (1902), Ltd., and consequently the Trafford Power and Light Supply is being voluntarily wound up.

A meeting of the Bute Electrical Mfg. Co. (Ltd.) will be held on Sept. 8, at 12, Mount Stuart-square, Cardiff, to receive an account of the winding up.

Plant, &c., for Sale.—Norwich Electricity Co., in order to make room for larger sets, offer for sale some Willans engines direct-coupled to Laurence-Scott shunt-wound dynamos. Inquiries to the Company, Duke-street, Norwich, where the plant is running. See also advertisement.

A dynamo by P. R. Jackson & Co., giving 160 amperes at 200 volts, is advertised for sale.

Some excellent plant, suitable for mill lighting or for a complete installation of 500 lights, is for disposal. See advertisement.

Sale by Auction.—The tramways system of the borough of Cardiff having been electrically equipped, horse cars are no longer required and will be sold by auction on July 28 at the Corporation depôt, Wood-street, Cardiff. Some further particulars are given in an advertisement.

Patent for Sale.—A patent relating to generation and regulation of electricity supply is advertised for sale on another page.

"Steel, Tools and Fuel."—Mr. Francis Marsden, consulting engineer, of St. Petersburg (Russia), has prepared for circulation, in many languages, an interesting little work entitled "Economising on Steel, Tools and Fuel," which he describes as "Corrected knowledge of the nature and property of all the various qualities, tempers and sorts of steel as usually worked, with a description of a new hardening process."

Catalogue—We have received a copy of the new catalogue of the Cothias' Alloy Co., of Ivry-Port, France, from Messrs. Norman and Young, 36, Camomile-street, E.C., who are agents for the United Kingdom. M. Cothias, has discovered several alloys which can be cast in metal moulds, and the surface of the moulds being highly finished and polished, besides being made to the exact required dimensions, the castings are in a finished condition on leaving the mould, and are all exactly alike, thus making the system peculiarly suitable for repetition work in connection with electricity meters, arc lamps, &c. We have a specimen before us which is a clean casting, requiring no tooling or machinery to make it fit for use.

"Anglo-Japanese Gazette."—This is the title of a new monthly devoted to the commercial and social interests of the British empire in Japan. The price is 6d.

Typewriting Telegraph.—A new illustrated pamphlet, containing particulars of the typewriting telegraph (Steljes' patent) is issued by the Typewriting Telegraph Corporation, Dashwood-house, London, E.C. This machine can now be rented from the postal authorities, and can be worked on any existing telephone circuit.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 16 to 22, with the ports of destination :—

Africa—Alexandria, £500 (telegraph material); Durban, £5,734 (including £1,362 telegraph material); Larache, £16; Port Elizabeth, £1,180. *Argentina*—Buenos Ayres, £1,703. *Australasia*—Melbourne, £611; Otago, £70; Perth, £1,169; Sydney, £1,047. *Belgium*—Ghent, £10; Ostend, £262. *Burma*—Rangoon, £12. *Ceylon*—Colombo, £3,932. *China*—Shanghai, £103; Tientsin, £39. *Denmark*—Copenhagen, £1,258 (including £177 telegraph material). *Gibraltar*, £23. *Holland*—Amsterdam, £123; Rotterdam, £35 (telegraph wire). *India*—Bombay, £306 (telegraph material); Calcutta, £1,923 (including £1,053 telegraph instruments); Madras, £7. *Japan*—Moji, £71; Nagasaki, £500; Yokohama, £106. *Norway*—Christiania, £45 (telegraph wire). *Russia*—Riga, £68; St. Petersburg, £220. Total £21,473, against £7,835 in the corresponding week last year (July 17 to 23).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

May 23, 1902.

11,722. J. J. Carter. Dublin. Trolley head, arm and safety appliance.
11,725. L. M. Waterhouse and Simplex Steel Conduit Co. Liverpool. Metallic conduits and fittings.
11,728. O. Pearson. Newcastle-on-Tyne. Switch.
11,765. C. W. S. Crawley and A. P. Trotter. Measuring temperature at a distance by electrical means.

May 24, 1902.

11,800. A. Denny and J. A. Robertson. Glasgow. Electrical indicator.
11,814. H. H. Lake. Preventing sparking. (General Electric Co., U.S.)
11,815 and 11,817. H. H. Lake. Electric railways. (General Electric Co., U.S.)
11,816. H. H. Lake. Variable speed electromotors. (General Electric Co., U.S.)
11,818. H. H. Lake. Switches. (General Electric Co., U.S.)
11,819. H. H. Lake. Insulating conductors or windings of electrical apparatus. (General Electric Co., U.S.)
11,820. H. H. Lake. Electrical connection for current-measuring instruments. (General Electric Co., U.S.)
11,821. H. H. Lake. Brush holders. (General Electric Co., U.S.)
11,822. H. H. Lake. Control of electric circuits. (General Electric Co., U.S.)
11,823. H. H. Lake. Regenerative apparatus. (General Electric Co., U.S.)
11,824. H. H. Lake. Dynamo-electric machines. (General Electric Co. U.S.)
11,825. H. H. Lake. Transformers. (General Electric Co., U.S.)
11,826. H. H. Lake. Rheostats. (General Electric Co., U.S.)
11,827. H. H. Lake. Magnetic clutches. (General Electric Co., U.S.)
11,828. H. H. Lake. Regulation of dynamo machines. (General Electric Co., U.S.)
11,829. H. H. Lake. Starting devices. (General Electric Co., U.S.)
11,830. H. H. Lake. Brush holders. (General Electric Co., U.S.)
11,831. H. H. Lake. Field magnets. (General Electric Co., U.S.)
11,832. H. H. Lake. Oil guards for commutators. (General Electric Co., U.S.)
11,833. H. H. Lake. Switches. (General Electric Co., U.S.)
11,834. H. H. Lake. Condensers. (General Electric Co., U.S.)
11,835. H. H. Lake. Speed regulators. (General Electric Co., U.S.)
11,836. H. H. Lake. Commutator brushes. (General Electric Co., U.S.)

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11,837. H. H. Lake. Electric railways. (General Electric Co., U.S.)
11,838. H. H. Lake. Controllers. (General Electric Co., U.S.)
11,839. H. H. Lake. Controlling devices for arcs. (General Electric Co., U.S.)
11,840. H. H. Lake. Cleats or holder for electric conductors. (General Electric Co., U.S.)
11,841. H. H. Lake. Apparatus for measuring potentials. (General Electric Co., U.S.)
11,842. H. H. Lake. Meters. (General Electric Co., U.S.)
11,843. H. H. Lake. Fuses. (General Electric Co., U.S.)
11,844. H. H. Lake. Controlling electro-meters. (General Electric Co., U.S.)
11,845. H. H. Lake. Plug fuses. (General Electric Co., U.S.)
11,846. H. H. Lake Railway signal apparatus. (General Electric Co., U.S.)
11,847 and 11,848. H. H. Lake. Variable speed driving mechanism. (General Electric Co., U.S.)
11,849. H. H. Lake. Controlling motors from a distance. (General Electric Co.)
11,850. H. H. Lake. Volt-ampere meters or direct-current wattmeters. (General Electric Co., U.S.)
11,851. H. H. Lake. Windings of transformers and other high potential windings. (General Electric Co., U.S.)
11,881. L. J. Abrahams. Electric fire alarms.
11,889. W. Norbes. Liverpool. Electric igniting of mines.*
11,914. G. C. Fricker. Maximum demand indicator.

May 26, 1902.

11,919. F. C. N. Bergh and F. Farrer. Brighton. Maximum demand indicator, cutout or switch.
11,940. Palatine Engineering Co. and R. Blakiston. Liverpool. "Frog" for overhead conductors.*
11,950. C. Mitchell. Yorkshire. Brush holder.*
11,971. J. O. Rhodes. Liverpool. Incandescent lamps.
11,972. A. Fischer. Accumulator plates.
11,973. A. Fischer. Negative plates for accumulators.
11,994. O. Graetzer. Circuit-closing devices for the line selectors of telephones.*

May 27, 1902.

12,003. C. Beckingsale. Cheltenham. Feeder pillar for electric tramways and power distribution.
12,075. W. A. Phillips. Method of waterproofing electrical insulating or other materials.
12,078. H. H. Lake. Transformers. (General Electric Co., U.S.)
12,079. H. H. Lake. Laminated cores of dynamo-electric machines. (General Electric Co., U.S.)
12,080. H. H. Lake. Field-magnets of dynamo-electric machines. (General Electric Co., U.S.)
12,081. H. H. Lake. Lubricating devices for trolley wheels. (General Electric Co., U.S.)
12,083. H H. Lake. Arc lamps. (General Electric Co., U.S.)
12,106. J. I. Soudet and J. Turri. Liverpool. Pull-down devices for trolley poles.
12,110. J. Young. Telephonic intercommunication.*
12,120. W. T. Pember. Electromagnetic brakes.
12,121. A. Domaskinos. Telegraphic apparatus.*

May 28, 1902.

12,129. F. M. Lewis and H. S. Hatfield. Brighton. Arc lamps.
12,156. C. D. Abel. Incandescent lamps. (Siemens and Halske A.G., Germany.)
12,157, 12,158, 12,159, 12,160 and 12,162. C. D. Abel. Manufacture of filaments for incandescent lamps. (Siemens and Halske A.G., Germany.)
12,161. C. D. Abel. Incandescent lamps. (Siemens and Halske A.G., Germany.)
12,182. O. Imray. Glow lamps with osmium filaments. (Oesterreichische Gasglühlicht und Electricitäts Gesellschaft, Austria.)
12,201. H. H. Lake. Controlling devices for electric motors. (Compagnie de l'Industrie Electrique, Switzerland.)
12,205. J. H. Golding. Securing fittings to flexible conductors.
12,207. F. de Mare. Electrothermic ventilator.*

May 29, 1902.

12,218. J. J. H. Sturmey. Coventry. Electric ignition mechanism. (C.E. Duryea, U.S.)
12,231. J. Aspden and G. Aspden. Halifax. Brushes for dynamos and motors.
12,237. R. T. Quass. Boscombe. Circuit-breaker.
12,241. H. Bremer. Arc lamps.
12,262. H. Pace. Permanent ways of electric railways.
12,284. A. Engelsmann. Light accumulators for continuous and alternating currents.*
12,290. C. Turnbull, jun. Pressure regulating apparatus.
12,291. H. H. Lake. Electric switches. (General Electric Co., U.S.)
12,292. H. H. Lake. Electrical cutouts or fuses. (General Electric Co., U.S.)
12,294. H. H. Lake. Dynamo-electric machinery. (General Electric Co., U.S.)
12,293. H. H. Lake. Electric fuse-boxes. (General Electric Co., U.S.)
12,301. A. Pollak. Electric motor road vehicles.
12,309. F. de Mare. Electric heating device.*
12,316. J. Wetter. Electric railways and tramways. (A. Sengel, Germany.)

May 31, 1902.

12,329. L. Rottenburg and Paterson, Cooper & Co. Glasgow. Instruments for measuring electric currents and minute mechanical strains or movements.
12,330. L. Rottenburg and Paterson, Cooper & Co. Glasgow. Electric motor-starting switch.
12,340. G. H. Robinson. Southampton. Electrical water-gauge indicator.
12,343. A. C. Brown. Electric signals.
12,351. A. B. Tubini. Wireless telegraphy.
12,386. J. C. Stewart. Glasgow. Electric generators and motors.
12,390. D. L. Chapman. Manchester. The zinc dust secondary cell.
12,415. British Thomson-Houston Co. Regulators for alternating-current circuits. (C. P. Steinmetz, U.S.)
12,416. British Thomson-Houston Co. Tubulating machines for electric lamps. (W. R. Burrows, U.S.)
12,438. Siemens Bros. & Co. Induction coils. (Siemens and Halske A.G., Germany.)*
12,439. C P. Johansen. Electric safety devices for railways.
12,449. L. J. Aron. Metering electrical energy to be charged for under varying conditions of supply.
12,458. W. Judd, A. Fraser and G. Draper. Telegraphic perforators.
12,463, 12,469 and 12,476. E. Weston and A. O. Benecke. Electrical indicating and recording instruments.*
12,474. H. Shoemaker. Wireless telegraphy.*
12,481. G. C. Fricker and G. H. Nisbett. Maximum demand indicators.

June 2, 1902.

12,483. J. P. Tierney and J. Malone. Dublin. Electric signalling on electric railways and tramways.
12,494. R. S. Burns. Stockton-on-Tees. Safety guard for electric tramcars.
12,517. G. L. Hogan. Multiplex telegraphy.
12,536. J. Black and T. Hogg. Electric tramcars.*
12,547. F. von Liebermann. Electrolytic baths.*
12,554. Siemens Bros. & Co. Telephonic communication. (Siemens and Halske A.G., Germany.)*
12,556. H. Kiefer. Thermo-electric batteries.
12,570. I. B. Birnbaum. Telephonic instruments.*
12,573. F. Dessauer. Liverpool. Electrolytic circuit-breakers.
12,578. P. M. Justice. Current-reversing mechanism for oscillating electricity meters. (Theiler & Co., Switzerland, and P. Eilig, Germany.)*
12,581. A. Zehden. Electric traction apparatus.*
12,582. W. L. Wise. System of electric lighting. (Moor Electrical Co., U.S.)*
12,588. F. Dessauer. Röntgen tube.

June 3, 1902.

12,604 P. L. Robertson. Automatic telegraphic field transmitter.
12,607. W. G. Inglefield and H. G. Hackett. Manchester. Electric tramcars.
12,624. W. R. V. Marshall. Glasgow. Dynamo electric machines.
12,671. C. G. Burke. Telephone systems.*
12,684. W. Griffiths and B. H. Bedell, Preventing leakage of current to studs in surface contact systems.
12,687. W. P. Thompson. Polyphase current transformers. (Berliner Maschinenbau A.G. vorm L. Schwartzkopff, Germany.)*
12,689. A. Vandam. Combinations of electric switches and wall-plugs.
12,691. H. Cuénod and C. Fournier. Liverpool. Electric decomposition of alkaline chlorides.
12,694. L. Lohner and F. Porsche. Coils for dynamo electric machines.
12,697. A. Muirhead. Perforators for automatic telegraph transmitters.
12,700. S. A. Rosenthal. Active material for accumulators.
12,702. G. Gin. Electrical production of iron alloys with simultaneous production of alkaline oxides and earths.
12,706. Cornelius D. Ehret. Wireless telegraph systems.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can be obtained at the uniform price of 8d. each.

1902.

5,103. Callender's Cable and Construction Co. and Ward. Connecting cables to junction boxes, earth plates and other parts.
5,663. Waterhouse and Simplex Steel Conduit Co. Fuse-boxes.
5,718. La Cour and Rink. Electrolysis of alkaline chloride solutions.
5,851. Cooney. Repayment electric supply controlling apparatus.
6,000. Eisemann. Electric ignition for explosion motors.
6,184. Hirst and Wood. Section insulators.
6,209. Johnson. Arc lamps.
6,229. Kochendörfer. Electric typewriters.
6,310. Thompson (Ulke). Electrolytic separation of metals.
6,331. Bayno. Electrical cooking apparatus.
6,346. Joseph and Gardner. Circuit breakers or cutouts.
6,379. Rignon and Eisenmann. Continuous-burning arc lamp with inclined carbons.
6,478. Porter. Storage batteries.
6,854. Newton (Bliss Electric Car Lighting Co.) Systems of electrical distribution.
6,855. Newton (Bliss Electric Car Lighting Co.) Brush mechanism for dynamos.
7,169. Allison (Banks). Battery.
7,361. Siemens Bros. & Co. (Siemens and Halske A.G.). Connecting continuous-current motors to network on starting.
7,388. Högner. Arc lamps.
7,447. Otis Elevator Co. (Ltd.) (Otis Elevator Co.). Electric transmission of power.
7,851. Lake (Giroux and Seddon). Electrical sterilising and preserving apparatus.
7,858. Krouchkoll. Vacuum discharge tubes.
7,995. Jensen (Dr. G. Langbein & Co.). Production of metallic deposits by electrolysis.
8,487. Justice (Rowland Telegraphic Co.). Transmitting devices.
8,667. Siemens Bros. & Co. (Siemens and Halske A.G.). Regulating pressure of alternating-current dynamo-electric generators.

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COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.).

The sixtieth half-yearly ordinary general meeting of this Company was held on Wednesday, at River Plate House, Finsbury Circus, under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. George Draper) read the notice calling the meeting, and other formal business having been disposed of,

The CHAIRMAN said: It is now my duty to bring the queations relating to the Company before the meeting, and to conclude with a motion for the adoption of the report. The shareholders will see from the report before them that the gross revenue for the half-year to March 31, 1902, was, in round figures, £617,000, as against, in the corresponding period of 1901, £624,000, or a decrease of £7,000. The shareholders must remember that we are making a comparison with a year which was the second largest in receipts that has ever been noted in the history of the Company, and I think you will not forget that in January last I ventured to say that we could hardly expect the continuation of the very large revenues we had been receiving in the earlier stages of the war. It is, therefore, on the whole, I think, satisfactory to find that the diminution which we report in our revenue of £7,000 is no larger. It is also a very pleasant thing to realise that our commercial traffic with South Africa is showing a marked amount of vitality and is increasing—not very largely, but still in an encouraging way, since the termination of the war. Thus I hope that we may all look forward to a large amount of commercial business with those great colonies now that they are happily settled under the British crown.

Turning to the expenditure, you find that the ordinary expenses for the half-year amounted to £149,000, as against £135,000 in the corresponding period of 1901, or an increase of about £14,000. A few words are necessary to explain the reason of the increase. With respect to about £5,000, it is accounted for by our having to pay our proportion of the establishment charges of the stations belonging to the other associated companies, particularly on the new direct route to Australia, via the Cape. That is a matter we have undertaken, and, of course, we cannot carry on the extra stations without some increase in expenses. The other principal items of increase are salaries and wages at home and abroad, and maintenance of our instruments and the introduction of improvements. The salaries and wages at home and abroad increase in a natural proportion. I think it is the experience of everyone that these expenses tend to grow, and we have, I am happy to say, associated with the Eastern Company a very efficient and highly-trained staff, who claim the agreed increment of their pay as time goes on. There is another matter causing us to deal with increased salaries and wages, and that is the large increase in the extent of our ramifications and the necessity we are now under, owing to the reduction of the tariffs, of carrying a very largely increased number of words in proportion to the receipts.

As the tariff is lowered, if we keep up our standard revenue, as I hope we shall do, with the small exception I have mentioned, we cannot do it without doing more work, and that costs more money. As to the maintenance of electrical instruments and the introduction of improvements, this is a matter we cannot shut our eyes to. We feel ourselves bound to adopt the newest improvements, when the newest are the best; at any rate we adopt what we consider the best improvements, not only for getting more speed out of our cables, but also for the avoidance of errors, which are not only irritating to the recipients of the messages, but also to the companies sending the telegrams. I think we may congratulate ourselves on having kept well abreast of all modern requirements in that direction, and we can claim to carry our messages with as few complaints as are received by any company.

With regard to the repairs and renewals of cables, the expenses in the past half-year were £39,000, as against £46,000 in the corresponding period of 1901, showing a decrease of £7,000, which, of course, in dealing with the whole cost of our work, has to be deducted from the former increase of £14,000 to which I referred. This £7,000 is a saving, however, which may not be realised in another half-year, because it depends entirely upon circumstances beyond our control. The number of days on which our ships have been in harbour has been rather larger than in the previous year, owing to the fact that less frequent interruptions of the cables have taken place. Our ships, generally speaking, are, we may say, fully employed either upon our own cables or those of other companies, who remunerate us for the services we render them in this matter. Abstract C in the report will give you the full particulars of that matter. The average relation of the total expenses to revenue for the last 10 years was 34·85 per cent., whereas the present financial year works out as 34·10 per cent. showing that although our expenses have an upward tendency, their relation to revenue this year is rather below the average. You must also remember that in dealing with expenses of this kind we have to look to the income tax, which I am sorry to say has been constantly growing; but we may hope in future that with peace we may see a diminution in that item of our costs.

The broad result of the half-year's working is that, after paying the interest on the preference and debenture stocks, and meeting ordinary expenses, we are able to declare the same dividend and bonus as usual, and to carry to the general reserve fund the sum of £175,000, as against £205,000 in the corresponding period of last year. We have applied from the general reserve fund an equal sum of £175,000 in the reduction of the expenditure on account of new cables, leaving in the suspense account for new cables the sum of £950,000 still to be dealt with.

I have on several occasions referred to the tariff between Great Britain and India and to the protracted negotiations with Continental Administrations interested in this correspondence. I am glad, therefore to be able to state now that we have at last been able to persuade that Administration which had deferred its decision to agree to the reduction, and the tariff of 2s. 6d. a word came into operation on March 1 last. I might, perhaps, take this opportunity of saying that a very unjust sort of insinuation has been made against this Company in the public prints—under the name of a well-known Member of Parliament—that this Company, although it has stated for the last 18 months that it was willing and anxious to make the reduction, was really unwilling to do so, and was very glad that obstacles were placed by other Administrations in the way of the reduction being made. I may say for this Board and for the Company at large that that is entirely untrue. We have been working perfectly bonâ fide with the India Office for the last 18 months to make this reduction, and the reduction has come about in consequence of the efforts of this Company and of the India Office; and we feel rather aggrieved that we should be accused of having set about this work in a half-hearted way. I think that the India Office fully realises that we have completely done our duty in the matter. In order to earn the same amount of revenue from India, and to make up for the reduction in the tariff, we must carry about 60 per cent. more words, and up to the present the increase has been about 17 per cent. It is gratifying to notice any increase in traffic as the result of tariff, and we may, perhaps, say that this increase is the result of tariff, but it does not follow that it is, because the increases and decreases depend on other circumstances altogether sometimes, but assuming that a diminution of tariff has resulted in an increase of 17 per cent. in words, you will see that we have realised about one-fourth of the additional number of words necessary to produce the same amount of money that we had before

In regard to another matter of tariff, you are, perhaps aware that on January 1 last the tariff between Great Britain and certain colonies in Australia was reduced from 3s. 6d. to 3s. per word under an agreement with those colonies, and as those telegrams had to pass through the Straits Settlements and the Dutch Indies, we naturally had to take into consideration whether it was not fair and right that the rates between Europe and those places which are on the road should be made somewhat less, and after much consideration it was decided to make the reductions notified in paragraph 7 of the report. These reductions, I may say, have been much appreciated by the merchants in the places benefited, and we have reason to hope that the increase of traffic will, after a time, recoup us for the loss of revenue which has been occasioned. There again, we shall hope that the tariff will have the effect of reinstating us in our former position, but at present we are suffering some loss.

The Eastern Extension Company, you may remember, entered into an arrangement some time since with the colonies of South and West Australia, New South Wales and Tasmania for reduction in tariffs on the principle of a Standard Revenue. Of course, anything which affects the Eastern Extension Company in that respect affects us also. One of the clauses in this agreement prohibited the company from extending the same tariffs as would exist under the agreement in the contracting colonies, to Victoria, Queensland and New Zealand, who would not join the contracting parties. Well, these conditions which we had with the contracting parties were really very simple. We had an agreed standard revenue, and we had an undertaking on the part of the respective colonies which secured to us the right of negotiating directly with our customers, having our offices in the principal cities, and having wires by which we could transmit the messages. In a very similar way we enjoy the same privileges in the chief cities of Great Britain and in almost all parts of the world. It was the more necessary that we should be particular on this point on account of the Governments of some of the States having entered into telegraphic business by laying a Government cable between Australia and Canada. These very reasonable requirements—as I think everyone will admit them to be—in the nature of the "open door," were refused by Victoria, Queensland and New Zealand; thus, on the Commonwealth taking over all the telegraphs of Australia, the Associated Companies were in the position of charging preferential rates with certain States of the united Commonwealth, and we were forced to continue this anomaly under the terms of our agreement with the contracting States. Negotiations took place in Australia with the Governmant of the Commonwealth, and it was eventually decided that these negotiations, which dragged on at considerable length, should be transferred to London, and that is the present position of affairs. The Premier of Australia is now in London, and no doubt we shall continue our negotiations; but meanwhile a tentative arrangement has been made—at the instance of the authorities of Australasia—holding us harmless under our agreements if we assimilated the rates to Victoria, Queensland and New Zealand to those hitherto enjoyed by the contracting States of the Commonwealth who had previously entered into the standard revenue agreement to which I have referred. This was done on June 1 last, but the arrangement is merely tentative and pending the final negotiations in London; but we are in hopes that the arrangement may be confirmed if our negotiations with Sir Edmund Barton and his colleagues turn out satisfactorily and are successful.

Notwithstanding all these reductions of tariff to Australia I cannot help saying that it is a most disheartening circumstance that the actual number of words carried remains practically the same as before the alterations in the tariff. We have got, in fact, no increase in the traffic, and a more unsatisfactory thing is, that the actual number of words is less—or, at any rate, very little more—than before the reductions took place. I think this is a circumstance which should be rather laid to heart by those who talk rather glibly of the immediate answer to a reduction which the traffic will show. It is not the fact. In the case of Australia there is no answer to the reduction, and all we can hope is that with increased prosperity to the colony—which is, no doubt, to some extent passing through a severe trial from drought and other circumstances—the business will become larger, and we may be reimbursed for the sacrifices we have made. It is also unsatisfactory that these circumstances are to be looked at in view of the fact of the very large amount of money we have spent for a direct cable to Australia. That cable is in full working order, and it has no

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doubt a subsidiary important rôle to play from the fact that it connects the colonies of South Africa direct with the colonies of Australasia, and the traffic may be expected to be developed in that direction. But as a matter of fact we have spent a very large sum of money in connecting Australia direct through the Cape with Great Britain, and at present, as I have said, we do not see any corresponding increase in the traffic. I do not wish to be at all despondent in the matter; I only mention the fact to show that the circumstance of reducing tariffs does not in all cases produce a correspondingly increased volume of traffic.

Another matter of great interest, I think, to the holders of telegraph securities is the report of the Inter-Departmental Committee on Cable Communications which was appointed by the Government. That Committee issued its report on March 26 last in the form of a Blue Book. The subjects dealt with are of very considerable interest, not only to this and to the other Associated Companies, but to the commercial world in general. The Associated Companies have received the report with very considerable satisfaction, as it has shown to the public—or ought to show to the public if they will study it—that the accusations made against the companies by certain persons and irresponsible complainers were unfounded. The report of that Committee gives no uncertain sound; it is in all respects a report which recognises the services of these Companies, and the matters of complaint are disposed of in a way which, I think, is eminently satisfactory. The fact is that we have always courted the fullest inquiry, because we knew that the criticisms which appeared from time to time were really quite unfounded, and were due to ignorance of the actual state of affairs. We cannot, therefore, help welcoming this report as a gratifying recognition of the position which these Companies hold *vis-à-vis* to the public, and it is also a vindication of the policy pursued by the Companies in all respects. The report of the Committee, apart from its being a Committee of the Government, must, I think, command universal respect from its constitution. It consisted of Lord Balfour of Burleigh, who was chairman; the Postmaster-General; Mr. Hanbury, the President of the Board of Agriculture, who was formerly well acquainted with all Post Office matters; the Earl of Hardwicke, who is Under Secretary of State for India, and, therefore, well acquainted with what is wanted there; the Earl of Onslow, the Under Secretary of State for the Colonies, who, again, is in complete touch with all the requirements of the Colonies; Major-Gen. Sir John Ardagh, the Director of Military Intelligence, who looks at cable communications from his own point of view, as advising the Government on the matter of defence; and Rear Admiral Custance, the Director of Naval Intelligence, who, again, looks on the question much from his point of view in the interests of the Royal Navy. I think it is impossible to suggest a stronger Committee for the investigation of all the circumstances in connection with cable communications. Well, notwithstanding all that has been said as to excessive rates charged by these companies, the Committee, after carefully weighing the whole mass of evidence given on this subject by all the gentlemen who criticised them, came to the conclusion, and stated that they are not prepared to say that any of the rates are excessive with one exception—namely, the rate to the Gold Coast and Nigeria, which they considered ought to be further reduced. The tariff to the Gold Coast and Nigeria is not controlled by our Company, and the only interest we have in it is in transmitting this correspondence between Great Britain and Lisbon, for which we receive about 4d. a word. The whole traffic is very small, and is carried on at a great cost to the companies concerned, but I have no doubt that those companies will attach every importance to the recommendation of the Committee, and for our part, when they come to any conclusion on the subject, I feel equally certain that we shall give the matter our consideration, and see if our share can be reduced. It will not hurt us very much, and the whole matter is a bagatelle. I dealt with the entire subject of the Committee's report at considerable length at the Eastern Extension Company's meeting in May last. My remarks were published to some extent in the press, and they were circulated among the shareholders. I do not, therefore, propose to go any further into the matter to day, but I should like you to refer to the Blue Book, which can be purchased for a few pence, which will amply repay you for perusing it, and from the point of view of shareholders in any of the great cable companies you will, I am quite sure, be greatly interested in the evidence, and still more in the verdict which the Committee gives.

I suppose that no one ought to speak at any cable company's meeting at the present time without referring to the subject of wireless telegraphy, which is looming so much on one's attention at the present time; but I have very little to add—nothing, in fact, to add of any weight—to what I said when I last addressed you. Certain improvements have been announced, and will probably continue to be announced, but I have nothing to withdraw from what I said at our last meeting. We are interested in the subject, and if any practical new developments are brought into use, and they answer our purpose—as possibly they may, for comparatively short distances—we should no doubt utilise them, as we have done other inventions in the past. At the present moment we cannot say that any system of wireless telegraphy is of any commercial utility. No one can say what may be in store for us, of course, and we can only judge of what may happen in the future from what we see in the present or the past, which leads us to the conclusion that the cable companies have nothing to fear from the competition of wireless telegraphy. You will have noticed, I daresay, that nearly every country is experimenting with wireless telegraphy, and they all have their own particular system, which is believed by each to be the best. Some swear by one inventor, some by others. The principles involved are in all cases much the same—that is to say, the waves of ether are made to carry signals. Different inventors have different modes of utilising etheric telegraphy, but nothing has transpired, so far as we are aware, to alter the opinion I laid before the shareholders at our last meeting, that it cannot be utilised for the receipt and transmission of any paying traffic over long distances. I think that this belief is not only shared by our Companies, but also in a remarkable way by the home and foreign Governments as well, and this can be best judged by the fact that submarine cables are now being laid by all the important Governments—for example, by the British, French, German and Dutch Governments. The British Pacific Cable Board, which is a Government concern, will soon have completed 8,200 knots; an American company has partly manufactured and contemplate laying another 8,000 knots; the German and Dutch Governments are subsidising companies, who propose to lay between 6,000 and 7,000 knots; and the French have several projects under their consideration. Therefore, I think one may, with some amount of confidence, say to you, as I have said before, that although wireless telegraphy is an extremely interesting discovery, and may be of use as a handmaid to cables, yet our opinion is fortified by that of the experts of all these Governments, who have got all the information before them, and who are all experimenting with different systems of wireless telegraphy. It is hardly likely, with the knowledge they possess on the subject, that their experts would advise the laying of extensive and costly submarine cables if they thought that there was any likelihood of their being superseded by wireless telegraphy. I think we may leave the matter there, and I have nothing more to say on the subject. We shall watch it, and we hope, as I said on a former occasion, that we may find it of use to us. If so, it will be adopted by us, and, of course, we are in a position, perhaps unrivalled, for making use of any of these adjuncts to our system of communications.

I should not like to sit down at a meeting of this kind without saying one word on the recent death of a very distinguished gentleman; I refer to Mr. Mackay, of America. We had been brought somewhat closely into touch with Mr. Mackay of late, and during the past year I had the pleasure of numbering him as one of my friends. I should not like the meeting to pass by without saying how deeply the Directors lament the death of Mr. Mackay, who since 1884 was associated with some of the most important telegraphic enterprises in the world, and who to the day of his death was interesting himself in the extension of cables in the Pacific Ocean, holding out, as it were, an opportunity of connecting America with the system of the Eastern Extension Company, with which this Company is so intimately allied.

I will now conclude by moving the adoption of the report and accounts in these words:—

"*That the printed report and accounts of the Directors to March 31, 1902, submitted to this meeting, be and the same are hereby received and adopted; that the dividend to be paid on the preference stock of the Company to June 30, 1902, at the rate of 3½ per cent. per annum, less income tax, be approved; and that, in accordance with the Directors' recommendations, a dividend be and is now declared of 1½ per cent., with a bonus of 2 per cent., both free of income tax, on the ordinary stock of the Company, making, with previous payments by way of dividend on account, a total payment of 7 per cent. on that stock for the year ended March 31, 1902.*"

The VICE-CHAIRMAN and MANAGING DIRECTOR (Sir John Denison-Pender, K.C.M.G.), briefly expressed his pleasure at seconding the motion.

A short discussion followed, and in reply to questions,

The CHAIRMAN stated that he would not like to say a word as to the validity or otherwise of anyone's patent for wireless telegraphy, but it was being carried out by a large number of persons. So far as he could judge, the differences under which the system was carried on were differences of apparatus. The Directors had come to the conclusion that it would be to the interests of the Company to make some experiments themselves, and they had set to work to make an installation of wireless telegraphy near their station at Porthcurnow. The desire of the Directors was to ascertain the facts of the case for themselves; and apart from this they hoped that, if they could judge from the evidence of others, it might be possible to communicate from their station at Porthcurnow with their ships on approaching or leaving our shores. They might thus, perhaps, be able to save some hours, or even days, in giving the vessels directions when the latter wanted to proceed to a particular place. He did not look forward to wireless telegraphy being a competitor with cable communications.

The motion was carried unanimously.

Mr. NEWTON then proposed a vote of thanks to the Chairman and Directors.

Mr. CROCKFORD seconded the motion, and incidentally congratulated the Right Hon. W. L. Jackson, M.P., on his elevation to the peerage.

The CHAIRMAN briefly acknowledged the vote, and expressed a hope that the Directors would always be able to present the shareholders with as satisfactory a report as that submitted on the present occasion.

The proceedings then terminated.

City and South London Railway Co.

The report of the directors for the half-year to June 30, announces that the receipts from all sources for the past half-year were £80,362. 17s., and the cost of working £35,957. 6s. 11d., leaving a profit of £44,405. 10s. 1d. Inclusive of the amount brought forward, the net revenue shows a total of £45,830. 2s. 9d. After making provision for interest and the transfer to renewal fund of £2,000, there is a balance of £34,199. 19s. 10d. The directors recommend the payment of the 5 per cent. preference dividend and a dividend at the rate of 3 per cent. per annum on the consolidated ordinary stock for the half-year, leaving £1,749. 19s. 10d. to be carried forward.

The number of passengers, exclusive of season ticket holders, carried during the half-year was 9,192,120, compared with 5,887,786 in the corresponding half-year of 1901, and the dividend on the ordinary stock compares with 1¼ per cent. for the half-year to June 30, 1901. The total number of passengers carried since the line was opened in December, 1890, is 88,980,570.

The working of the railway since its completion to Islington in November, 1901, has resulted in a large increase of traffic, and this, coupled with

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a considerable decrease in the percentage of working expenses, has enabled the payment of the largest dividend that has been earned since the opening of the line. The subways at the Bank and at London Bridge have been extensively used and fully justify the cost of their construction.

The directors regret that the bill for the extension to King's Cross, St. Pancras and Euston was rejected by the House of Lords Committee. As this extension will be of great public utility, and is supported by all the public bodies and the large railways concerned, it is proposed to re-introduce the bill next session. The bill promoted by the City and Brixton Railway for the abandonment of a portion of their undertaking has passed most of its Parliamentary stages, and should shortly be ready for Royal Assent. The arbitrator's award in respect of St. Mary Woolnoth Church has not satisfied the directors, and they have decided to take the matter before the Court of Appeal. The agreement with the Great Northern and City Railway Co. for the joint ownership and working of the Old-street station has been finally settled, and that company has paid its agreed share of the cost.

Direct United States Cable Co. (Ltd.).

The report of the directors for the six months ended June 30 states that the half-year's revenue, after deducting out-payments, amounted to £46,610. 6s. 11d., compared with £50,649. 19s. 10d. for the corresponding period of 1901. The working and other expenses, including income tax, amounted to £21,515. 17s. 1d., leaving £25,094. 9s. 10d. as net profit, making, with £3,350. 1s. 11d. from the previous half-year, £28,444. 11s. 9d. Working expenses and other payments were £21,124. 17s. 4d. for the same period in 1901. Three quarterly interim dividends of 3s. each per share (absorbing £27,319. 10s.) have been paid, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, making 3¼ per cent. for the year. After transferring £5,000 to reserve, the balance of £2,196. 1s. 9d. is carried forward. The reserve, after being credited with interest on investments and amount transferred from revenue, now amounts to £460,383. 13s. 11d., taking investments at cost price.

Anglo-American Telegraph Co. (Ltd.).

The directors' report for the half-year to June 30 states that the total receipts including £1,265. 2s. 2d. brought forward amounted to £169,908. 4s. 6d. The traffic receipts show a decrease of £13,167 compared with the corresponding half-year of 1901. The total expenses, including repair of cables, &c., were £58,930. 12s. 4d., a decrease of £6,048. 10s. 8d. compared with the corresponding period of 1901. Before declaring the net profits the directors have set apart £12,000 to renewal fund, leaving a balance of £98,977. 12s. 2d. One quarterly interim dividend of 12s. 6d. per cent. on the ordinary and of £1. 5s. per cent. on the preferred stock was paid on May 1, absorbing £43,750, and a second quarterly dividend of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock amounting to £52,500, will be paid on Aug. 1. £2,727. 12s. 2d. will be carried forward. All the main cables and land lines of the company are in good working order.

National Telephone Co. (Ltd.).

The directors' report for the half-year ended June 30 states that the income for the half-year amounted to £821,743. 8s. 7d., compared with £774,714. 10s. 4d. for the corresponding period of 1901, an increase of £47,028. 18s. 3d. Working expenses amounted to £479,122. 9s. 9d., compared with £453,913. 4s. 3d., an increase of £25,209. 5s. 6d. The net result, after deducting the Post Office royalties (£75,577. 6s. 7d.) is a profit balance of £267,043. 12s. 3d., compared with £247,645. 19s. 8d., an increase of £19,397. 12s. 7d. Rentals carried forward for unexpired terms of running contracts amount to £821,397. 12s. 8d., compared with £784.755. 14s. 11d., an increase of £36,641. 17s. 9d. Out of the available balance of £209,838. 4s. 9d. the board recommend the payment for the half-year of the dividend on the first and second preference, 5 per cent. third preference, 6 per cent. preferred shares and stock, and at the rate of 4½ per cent. per annum on the deferred stock, being equivalent to 5 per cent. per annum on the ordinary shares now divided into preferred and deferred stock (less tax in all cases). £70,000 is transferred to reserve and £8,588. 4s. 9d. carried forward.

£303,029. 15s. 3d. has been expended on capital account during the half-year in the erection of 9,600 additional exchange and private lines, and in the construction of underground works.

British Electric Transformer Mfg. Co. (Ltd.).

The directors' report for the year ending June 30 last states that the business continues to show satisfactory and steady increase. After paying all manufacturing costs and expenses of administration, and providing for repairs and depreciation, the result of the year's working is a net profit of £7,194. 12s. 11d., which, with £1,960. 14s. 11d. brought forward, makes available £9,155. 7s. 10d. A dividend, making, with the interim, 10 per cent. for the year, is declared, absorbing £4,000, £2,500 is put to reserve and £2,655. 7s. 10d. carried forward.

The new works at Hayes, Middlesex, were completed and manufacturing commenced in November last, and the removal of the whole of the plant and machinery from the old factory was satisfactorily effected by the end of the year.

Crompton & Co. (Ltd.).

The directors' report for the year ended March 31 states that the net profit for the year was £22,456. 7s. 6d., and after providing for debenture interest, payment of interim dividend and other items, there remains £9,852. 1s. 4d. It is proposed to pay a final dividend at rate of 6 per cent. per annum for the half-year, tax free, making 6 per cent. for year, and to carry forward £2,202. 1s. 4d. The reduction in net profits is accounted for by the fact that during the second half of the year the competition for orders for electrical plant was keen, and prices ruled lower than usual. The new arc lamp and instrument shops at Chelmsford are completed and occupied, and it is expected that the result will be increased economy and efficiency in those departments. The accounts of the Chelmsford Electric Lighting Co. show a satisfactory increase of profits.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD CO.—At the meeting on Friday the directors' report was adopted. Mr. E. J. Sang, who presided, referred to the successful application to Parliament for powers to construct a line on a viaduct from the borough boundary to Rottingdean, under the cliff, and hoped the necessary capital would be raised and the line constructed ready for the summer season of 1903. Mr. Magnus Volk, the deputy-chairman, said the company's powers were now much greater than they had been, in fact, were practically the same as those possessed by the great trunk railways. The Brighton Council had met the company very fairly with reference to boundary matters.

DUBLIN AND LUCAN ELECTRIC RAILWAY CO.—The directors' report for the half-year to June 30 shows that, after providing for debenture interest, there remains £857. 8s. 3d., out of which it is proposed to pay the usual half-yearly instalment of £100 due to the electrical contractors, to allocate £200 towards payment of balance due on electrical equipment, to pay the 5 per cent. preference dividend (£475), carrying forward £82. 8s. 3d. The receipts show an increase of £125, and expenditure a decrease of £24.

DUBLIN UNITED TRAMWAYS CO., 1896 (LTD.)—The report for the half-year to June 30 states that the directors have declared the 6 per cent. preference dividends for the half-year, and at the rate of 5 per cent. per annum, tax free, on the ordinary shares, absorbing £31,912. 10s., and leaving £2,015. 9s. 4d. to be carried forward, after writing off £552. 1s. 7d. (balance of preliminary expenses) and providing £1,000 in respect of the action brought by Dr. Fitzgerald against the company, the appeal in which is now pending in the House of Lords. The amount claimed against the British Thomson-Houston Co. has been debited to capital.

EAST LONDON RAILWAY CO.—At the half-yearly meeting on Tuesday the chairman (the Hon. A. E. Gathorne Hardy, M.P.) said the reason for the withdrawal of the proposals of the Metropolitan and District Railway Companies to adopt electric traction on the East London system was that the companies wished the South-Eastern, Great Eastern and London and Brighton Companies to bear the cost of the change, which these companies declined to do. The Metropolitan and District Companies, however, had two years in which to make up their minds, and he did not think they could afford to disconnect themselves with the districts south of the Thames.

GENERAL ELECTRIC CO., 1900 (LTD.)—The report of the directors for the year to March 31 states that the net trading profits and income from investments, &c., amount to £85,947. 10s. 11d. After deducting depreciation and interest (£20,800. 4s. 5d.), there remains £65,147. 6s. 6d., out of which the 5 per cent. preference dividend has been paid, absorbing £12,500, leaving £52,647. 6s. 6d. Out of this sum the directors recommend the payment of managing directors' and employés' bonus (£5,264. 14s. 8d.), a dividend on ordinary shares at the rate of 10 per cent. for the year (£26,416), and transfer to reserve of £20,966. 11s. 10d., bringing this account up to £39,051. 2s. Considerable portions of the new works at Witton, Birmingham, including the engineering shops, power house and carbon works, are now in operation, and the foundry and tube works are expected to be in working order within the next few months. During the year further 724 ordinary shares have been allotted to the members of the staff at par.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—The report of the directors for year ended July 18 states that the net revenue, after deduction of expenses, was £199,370. 16s. 9d., making, with £1,101. 16s. 7d. brought forward, £200,472. 13s. 4d. From this there has been distributed £130,467. 2s. 3d. in interim dividends, leaving £70,005. 11s. 1d. The directors recommend payment of a final preference dividend of 3s. per share, and of 4s. 9d. per share on the ordinary shares, making, with previous distributions, the full 6 per cent., less tax, on the preference, and 5⅜ per cent. net on ordinary shares (against 5¼ per cent. for 1901), leaving £1,586. 12s. 2d. to be carried forward. During the year the directors issued, at a premium, 300 ordinary and 485 preference shares, being part of the authorised issue, and the proceeds have been invested in telegraph securities.

GREAT NORTHERN AND CITY RAILWAY CO.—In the report of the directors for the half-year ended June 30, it is stated that the railway between Drayton Park and Finsbury Pavement is completed so far as tunnelling is concerned. The laying of the permanent way and the erection of the stations at Drayton Park, Essex-road, Old-street and Finsbury Pavement are making rapid progress. The generating station is in a forward condition, and the British Thomson-Houston Co., under their contract for the electrical equipment, are providing an instalment which, it is believed, will embody all the latest improvements. Messrs. S. Pearson & Son are pushing fotward with the extension from Drayton Park to Finsbury Park station. An agreement has been entered into with the City and South London Railway Co. for joint user of the station at Old-street.

E. W. TARRY AND CO. (LTD.)—At the recent annual meeting of this company (electrical and mechanical engineers and agents, &c.), the chairman (Mr. Augustus Durant) explained that the delay which had taken place in preparing the balance-sheet was due to the company's branches at Johannesburg, Kimberley, and Jagersfontien, being more or less in a state of siege. The local committee in South Africa reported that it was impos-

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sible to estimate the company's losses there, but the board hoped that adequate compensation would be obtained from the British Government. The net profit for the two years covered by the accounts was £20,845, to which had to be added the amount brought forward, making over £40,600. It was proposed to pay the ordinary shareholders 5 per cent. for the 12 months ended Aug. 31 last, and a similar distribution for 1900. The preference dividend of 6 per cent. per annum had been regularly paid. Sales from Jan. 1 to June 30 showed an increase of about 50 per cent. over those for the previous six months.

NEW COMPANIES, STATUTORY RETURNS, &c.

IMPERIAL ELECTRIC LAMP AND BATTERY SYNDICATE (LTD.)—Reg. July 16, capital £2,000 in £1 shares, to adopt an agreement with P. Plater and E. Munk, and to carry on the business of vendors, patentees, or manufacturers of electric lamps and batteries, &c.

LONDON ELECTRO-MOBILE SYNDICATE (LTD.)—Reg. July 12, capital £6,000 in £1 shares, to acquire and work patents for inventions, &c., relating to electric and other motor cars, to buy, sell and deal in and with electric and other motors and cycles, to provide and supply power and light, &c. The subscribers are E. J. Clack, electrical engineer, G. J. Anderson, contractor, C. Gordon, chemist, H. Grimsdall, H. Base, contractor, G. A. Saunders and J. Higson, engineer. The first directors are E. L. Clark (chairman), G. J. Anderson, H. Base, H. Grimsdall and C. Gordon. Reg. office: 85, East India Dock-road, E.

MINEHEAD ELECTRIC SUPPLY CO. (LTD.)—Reg. July 18, capital £2,000 in £1 shares, to carry on in Somerset, or elsewhere, the business of electricians, suppliers of electricity, manufacturers of and dealers in cables, wires, lines, accumulators, meters, generators, distributors, insulators, lamps, fittings, &c., and also electrical and mechanical engineers, &c.

SHEPPEY WATER AND LIGHTING CO. (LTD.)—Reg. July 16, capital £12,000 in £1 shares, to supply the island of Sheppey, and especially the parishes of Minster and Eastchurch, or other places in Kent with electricity for lighting and power, &c., and to carry on the business of waterworks proprietors, electricians, electrical and mechanical engineers, &c. The first directors are W. A. Benson, G. H. Wills, F. F. Ramuz, L. Seager, M. Pierson, J. R. Bligh and G. F. Ramuz. Reg. office: 4, Edward-street, Sheerness, Kent.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 7/16d. per oz. (July 24). Consols (2¾ per cent.) 95½—95⅝ for money, 95 13/16—96 1/16 for account; 2½ per cent. 95⅜—96¼ (July 24). Consols Pay Day, Aug. 7; Stocks and Shares Continuation Days, July 28 and Aug. 12; Ticket Days, July 29 and Aug. 13; Pay Days, July 30 and Aug. 14; Mining Share Carry-over Days, July 25 and Aug. 11.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)—The transfer books and register of members will be closed from Aug. 2 to 14 inclusive, preparatory to the payment of dividends on the first and second preference shares for the half-year to June 30.

BULUWAYO (SOUTH AFRICA).—In the report of Willoughby's Consolidated Co. (Ltd.) for 1901 it is stated that the business of the Buluwayo Waterworks and Electric Light Co. had steadily improved, the capacity of the electric lighting plant had been more than doubled, and from the number of applications on hand a large increase in revenue might be expected during the current year.

CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.)—At an extraordinary meeting, on Friday, to approve a resolution to increase the capital to £500,000, the chairman (Sir A. G. Filgate) said the company had 840 customers and 7,062 8 c.p. lamps connected, and their agents reported that they found great difficulty in supplying the requirements of consumers of electric current.

CENTRAL LONDON RAILWAY CO.—The directors have declared a dividend at the rate of 4 per cent. per annum for the half-year on the undivided ordinary, preferred ordinary and deferred stocks, carrying forward £25,600. This is the same rate as for the corresponding period last year, but there is a considerable increase in the amount carried forward.

LIVERPOOL OVERHEAD RAILWAY CO.—Subject to final audit, the accounts for the past half-year show an available balance of £9,293, and the directors recommend payment of the 5 per cent. preference dividend, and at the rate of 1 per cent. on ordinary shares, against 2 per cent. for the corresponding period last year. The balance carried forward is £3,793.

NEW GERMAN ATLANTIC CABLE.—We learn that the debenture issue of 20,000,000 marks required for the second German Atlantic cable has been applied for more than 15 times over. The subscription amounted to considerably over 300,000,000 marks.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LTD.) — The accounts for the half-year ended June 30 show a profit of £2,548, against a loss of £791 for the corresponding period of last year.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed Aug. 7 a special settling day in the provisional certificates for 7,500 6 per cent. cumulative second preference £10 shares (£7 paid, of which £1 is premium) of the *Bournemouth and Poole Electricity Supply Co. (Ltd.)*, and 40,000 "city undertaking" 4½ per cent. cumulative preference £5 fully-paid shares of the *Charing Cross and Strand Electricity Supply Corporation (Ltd.)*. The latter securities have also been ordered to be quoted. Application has been made to the committee to appoint a special settling-day in and to grant a quotation to the 5 per cent. first mortgage debenture stock of the *Colombo Electric Tramways and Lighting Co. (Ltd.)*, and to allow 30,000 £5 5 per cent. cumulative preference shares (£3 paid) and 30,000 £5 ordinary shares (£3 paid) of the *Urban Electric Supply Co. (Ltd.)* to be quoted.

SWANSEA IMPROVEMENTS AND TRAMWAYS CO.—This company has made an issue at par of £26,250 first mortgage debentures.

WATERLOO AND CITY RAILWAY CO.—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended June 30, carrying forward £458, compared with a like dividend and a deficiency of £1,567. 6s. 5d. for the corresponding period last year.

WEST AFRICAN TELEGRAPH CO. (LTD.)—A list is given on another page of 1,393 5 per cent. mortgage debentures of £100 each in this company drawn for payment at par on Sept. 1 at Messrs. Glyn, Mills, Currie & Co.'s bank, 63, Lombard-street, London, E.C. The directors subsequently announced that the payment of these debentures will be made at any time prior to Sept. 1, on presentation to the bankers, as the first instalment from the sale of the cables connecting the French possessions has been received by the company from that Government.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.)—An interim dividend for the half-year ended June 30 at the rate of 11 per cent. per annum has been declared.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	July 19	1,668	657	7	7,903	+ 2,134
Ayr Corporation	„ 19	448	...	9	2,952	...
*Birmingham Tramways.	„ 19	5,008	+ 105	2	10,249	+ 440
*Blackburn Corporation..	...	...	...	...	...	...
Blackpool Corporation...	„ 17	1,529	− 239	16	12,591	+ 959
Blackpool and Fleetwood	„ 19	1,179	− 187	3	2,350	− 843
Bolton Corporation	„ 20	1,615	+ 8	16	25,130	+ 1,641
Bradford Corporation ...	„ 20	4,307	+3,175	16	53,731	+37,056
Brighton Corporation ...	„ 20	909	...	31	22,552	...
Brisbane Tramways.....	June 4	2,357	+ 353	23	52,511	+ 4,212
*Bristol Trams & Carriage	July 18	5,264	+ 163	2	10,415	+ 251
*Buenos Ayres & Belgrano	June 22	2,731	+ 56	...	...	...
Burnley Corporation ...	July 19	791	+ 304	‡16	11,455	+ 4,066
Calcutta Tramways Co...	„ 19	R25,080	+R5,120	3	R 73 855	+R14,015
Cardiff Corporation	„ 19	1,623	...	16	19,902	...
Carlisle Tramways Co....	„ 19	227	+ 8	†29	4,849	+ 357
Central London Railway	„ 19	6,330	+ 112	3	20,373	+ 1,951
City & South London Ry.	„ 20	2,569	+ 769	3	8,176	+ 2,552
Cork Elec. Tramways Co.	„ 17	801	+ 187	§23	13,796	+ 977
Devonport & Dist. Trams	„ 11	501	+ 138	27½	11,311	+ 323
Doncaster Corporation...	...	...	...	6	930	...
Dover Corporation	„ 19	266	− 13	16	3,584	− 73
Dublin & Lucan Railway	„ 20	132	− 10	3	372	− 72
Dublin Southern Dist....	† „ 18	1,192	− 145	†3	2,887	− 340
Dublin United	† „ 18	4,134	− 74	†3	10,454	
Dudley—Stourbridge	„ 11	769	− 13	27½	19,373	+ 2,680
*Dundee Corporation ...	„ 16	718	− 17	...	...	...
East Ham Council	„ 19	526	+ 82	4	2,209	+ 353
Gateshead & Dist. Trams	„ 11	795	+ 170	27½	19,122	+ 2,646
Glasgow Corporation ...	„ 19	12,132	+1,257	...	...	...
Greenock & Port Glasgow	„ 11	574	+ 321	27½	12,718	+ 7,454
Hartlepool Tramways ..	„ 11	317	+ 28	27½	6,429	+ 714
Hull Corporation	„ 19	1,816	+ 29	16	27,774	+ 959
Isle of Thanet Co.	„ 12	1,097	− 89	28	13,124	+ 3,505
Kidderminster & Dist....	„ 11	147	− 6	27½	3,134	+ 52
Leeds Corporation	„ 19	5,530	+ 627	17	85,761	+13,788
*Liverpool Corporation...	„ 12	10,407	+ 203	28	254,493	+22,719
Liverpool Overhead Rly.	„ 20	1,633	− 168	‡3	4,812	− 436
Manchester Corporation	„ 19	5,598	+3,160	§57	146,554	...
Merthyr.....	„ 11	214	− 50	27½	5,538	− 715
Middleton	„ 11	310	...	15½	4,853	...
Newcastle-on-Tyne Corp	„ 19	2,783	...	...	...	...
Oldham, Ashton & Hyde.	„ 11	571	+ 18	27½	13,973	+ 450
Perth (W.A.) Elec. Trams	„ 18	1,035	− 19	¶28	30,634	+ 5,766
Poole & Dist.....	„ 11	292	− 25	27½	6,335	− 90
*Portsmouth Corporation	„ 19	2,026	+ 970	...	...	...
Potteries	„ 11	1,436	+ 37	27½	39,526	+ 1,534
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ...	„ 20	4,156	+ 399	3	12,949	+ 1,689
Southampton Corporat'n	„ 17	1,152	+ 179	...	...	...
Southend Corporation...	„ 16	372	...	15	3,904	...
Southport Tramways ...	„ 11	289	+ 98	27½	6,120	+ 2,082
*S. Staffordshire Trams...	„ 11	793	− 28	27½	21,108	+ 700
Sunderland Corporation.	„ 20	1,356	+ 5	16	18,756	+ 1,713
Swansea Trams.....	„ 11	513	+ 12	27½	12,488	+ 1,415
Taunton Trams.....	„ 11	65	...	27½	1,645	...
Tynemouth & Dist.	„ 11	389	+ 20	27½	6,781	+ 559
Weston-super-Mare	„ 9	207	...	9½	1,676	...
Wigan Corporation	„ 17	294	+ 74	16	3,729	+ 1,676
Wolverhampton District	„ 11	161	+ 100	27½	4,007	+ 2,579

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 16.	Price Wednesday, July 23.	Rate per Cent. Yielded.	Dividend Due.	Business during Ending Highest
			ELECTRICITY SUPPLY.			£ s. d.		
100,000	1	...	El'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ ¼	¾ ¼		...	
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	100 104	103 106	4 6 0	...	105
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	5 12 0	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	10
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101 104	101 104	4 6 7	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9 9½	9 9¼	4 4 3	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9¼	3 13 8	March and September	...
30,000	5	3 6	Calcutta Elec. Supply Ordinary	8½ 9½	8½ 9½	3 3 2	...	8¾
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105 107	105 107	3 15 2	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9 10	9 10	5 0 0	February and August	9¾
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	,, ,,	1 1/16
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105 107	105 107	3 14 9	...	106⅝
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½ 5¾	5½ 5¾	2 2 2	March	5⅝
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109 112	109 112	4 0 6	June and December	...
70,595	10	10/0	City of London Electric Lighting Ord.	8¾ 9¼	8¾ 9¼	5 5 3	February and August	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref. xd	11¼ 12¼	11½ 12½	4 13 0	January and July	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December	...
£300,000	Stock	4¼%	Do, 4½% 2nd Deb. Stock Certs. (all pd.)	101 104	101 104	4 6 7	...	...
10,000	10	4/0	County of London and Brush Prov. Ordinary	8 9	8 9	4 9 0	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11¼ 12¼	11½ 12½	4 16 0	March and September	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	108 111	1 9 11⅛	4 1 1	...	111
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5¾ 6¼	5¾ 6¼	3 12 0	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	7⅛
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10 11	4 10 11	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½ 6¾	6½ 6¾	4 8 11	January and July	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105 108	105 109	3 14 6	...	...
£111,000	3	...	London Electric Supply Ordinary	1¼ 1⅜	1¼ 1⅜		...	1⅛
49,340	5	3/0	Do. 6 per Cent. Preference	4 4½	4 4½	6 13 4	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	94 99	94 99	4 0 10	Mar., June, Sept., Dec.	95½
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	16 17	16½ 16¾	3 18 9	April and October	1 1/16
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	109 113	109 113	3 19 8	June and December	11 ½
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	98 101	98 101	3 10 0	...	99
10,852	10	6/0	Notting Hill Electric Ordinary xd	13¾ 14¼	13¾ 14¼	4 2 9	March	...
12,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	,,	...
£50,000	Stock	4%	Do. 4% Debenture Stock xd	97 100	97 100	4 0 0	...	...
300,000	1	...	Rand Electric	⅜ ⅝	⅜ ⅝	...	...	
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70 5	70 75	...	January and July	71
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103 105	103 105	4 7 0	April and October	...
40,000	5	9 6	St. James's and Pall Mall Electric Ordinary	14½ 15¼	4½ 5½	4 13 7	February and August	15⅜
20,000	5	8/6	Do. 7 per Cent. Preference	8¾ 9¼	8¾ 9¼	3 13 8	,, ,,	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97 100	97 100	3 10 0	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝ 2⅛	1⅝ 2⅛	...	...	...
£50,000	Stock	6%	Do. 6% Debentures	80 90	80 90	6 8 11	...	...
65,000	5	...	South London Electric Supply Ordinary	2⅛ 3	2½ 3	...	...	2⅛
110,000	5	5 6	Westminster Electric Supply Ordinary	0½ 11⅛	0½ 11⅛	5 0 0	March and September	1⅛
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5¾ 6¼	6¼ 6¾	4 0 0	...	5⅛
			ELECTRIC RAILWAYS, TRAMWAYS, &c.					
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	3⅞ 4⅛	3⅞ 4⅛	4 17 0	April and October	4⅛
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125 130	125 130	4 12 2	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9½ 9¾	9 10	3 0 0	...	9⅝
10,000	10	5/0	Do. 5% Cumulative Preference	8¾ 9¼	8¾ 9¼	5 5 3	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95 100	95 100	4 10 4	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13¾ 14½	13½ 14¾	4 9 8	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3¾ 4¼	3¾ 4¼	...	...	...
75,000	5	2/6	Do. 5% Cum. Pref.	4½ 5	4¾ 5	5 0 0	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	102 105	102 105	4 5 9	...	102¾
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21 22	21 22	3 13 4	February and August	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures xd	105 107	105 107	3 14 9½	February and August	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7 7½	7 7¾	2 13 4	...	...
20,000	10	5/0	Do. 5% Preference	9½ 10	9¼ 10	5 0 0	May and November	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102⅛ 104⅞	102⅝ 104⅞	4 6 9	...	
100,000	10	12/0	British Electric Traction Ordinary	12 13	12⅛ 13⅛	6 13 4	...	12⅛
100,000	10	6/0	Do. 6% Cum. Pref.	12 12⅛	12¼ 12⅝	4 14 0	February and August	12⅛
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝ 1⅞	1⅝ 1⅞	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4¾ 5⅛	4¾ 5⅛	5 14 3	...	...
27,500	5	10/0	Do. "B"	5 5⅛	5 5⅛	5 9 1	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	102 105	102 105	4 15 3	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	95 98	96 98	5 2 0	...	...
70,000	10	6/0	Calcutta Tramways	...	7 7¼	4 0 0	...	7⅛
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	106 108	106 108	4 3 7	...	10
£80,000	1	1/2⅞	Cape Electric Tramways Shares xd	2⅝ 2⅞	2⅝ 2⅞	3 16 2	...	...
£1,810,014	Stock	4%	Central London Ordinary Stock	106 109	105 108	3 14 0	June and December	10⅞
£494,993	Stock	4%	Do. 4% Preferred Stock	107 110	107 110	3 12 9	...	10⅞
£494,993	Stock	4%	Do. Deferred Stock	103 106	103 106	3 15 6	...	10⅛
£698,201	100	4%	Do. 4% Deb. xd	115 118	115 118	3 7 8	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	4¾ 5¼	4¾ 5¼	4 10 11	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...
£1,330,000	Stock	2½%	City and South London Railway Con. Ordinary	73 75	72 74	2 14 1	February and August	74½
37,500	10	1/0⅜	Do. Ordinary (Nos. 22,501 to 60,000)	...	...	...	,, ,,	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	...	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 133	128 133	3 15 5	,, ,,	...
£200,000	Stock	5%	Do. (1896)	129 132	129 132	3 17 0	...	...
£150,000	Stock	...	Do. (1901)	122 126	123 127	...	...	126
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115 118	115 118	3 9 7	May and November	...
60,000	10	6/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛ 12⅛	11⅛ 12⅛	3 16 11	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½ 15⅛	14½ 15⅛	3 17 5	...	...
£80,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½ 4¾	4½ 4¾	6 6 4	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99 102	99 101	4 18 0	...	...
78,000	10	3/0	Great Northern and City Railwy Pref. Ord. (2%)	8 9	8 9	3 6 8	...	8⅝
30,000	10	8%	†Imperial Tramways Ordinary	23 24	23 24	2 17 2	March and September	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½ 13¾	13½ 13¾	4 7 3½	,, ,,	...
£80,000	Stock	4½%	† Do. 4½ per Cent. Debenture xd	108 110	108 110	4 1 9	January and July	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½ 5	4½ 5	5 0 0	...	...
37,600	10	1%	Liverpool Overhead Railway Ordinary	4 1/16 4 5/16	4 1/16 4 5/16	3 0 0	February and August	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅛ 11	10⅛ 11	4 11 1	,, ,,	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture xd	97 99	99 101	3 9 3	January and July	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	10½ 11	10½ 11	4 10 11	...	1 1/16
10,999	10	2/3	Do. (£7. 10s. paid)	8 8½	8 8½	4 8 6	...	...
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	107 109	107 109	3 13 3	...	108½
£169,659	Stock	18 0	Do. Prov. Certs. (£75 paid)	81 83	81 83	...	...	...
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	xd 112 117	112 117	4 5 7	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	104 106	104 106	4 14 9	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	104 106	104 106	4 6 1	...	...
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 13 4	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3¾ 4¼	3¾ 4¼	6 13 4	May	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93 98	93 98	5 2 0	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100 103	100 103	4 17 5	...	101¾
3,334	10	8/0	Potteries Electric Traction Ordinary	8½ 9½	8¾ 9¼	4 4 3	...	...
10,000	10	5 0	Do. 5 per Cent. Cumulative Preference	9½ 10½	9¼ 10¼	4 15 2	February and August	...
£320,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	107 110	108 111	4 1 10	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...	...	...
51,182	1	...	Do. 6% Preference (12/0 paid)	...	...	...	April and October	...
50,000	1	...	Do. 6% Preference (fully paid)	...	...	...	,, ,,	...
500,000	Stock	...	Do. 4½% Debenture Stock (60% paid)	...	...	...	January and July	...
£540,000	Stock	8%	Waterloo and City Ordinary	92 95	92 95	3 3 0	June and December	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 16.		Price Wednesday, July 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 23	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£82,300	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98	102	98	102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅛	4⅛	3⅛	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£788,840	Stock	12/6	Anglo-American	46	49	48	49	5 17 3	Feb., May, Aug., Nov.	48⅜	...
£3,105,580	Stock	25/0	Do. Preferred	90	92	90	92	6 7 1	,, ,,	92	90½
£3,105,580	Stock	2/0	Do. Deferred	6⅜	7⅛	6½	7	1 8 7	,, ,,	...	...
$13,333,300	$100	$13	Commercial Cable Capital Stock	165	170	165	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	95	97	95	97	4 2 6	,, ,,	96	95½
16,000	10	4/0	Cuba Submarine Ordinary	4⅛	5⅛	4⅛	5⅛	7 5 6	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½	13½	12½	13½	7 8 2	,, ,,	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅜	3⅜	2⅜	3⅜	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7⅞	8⅛	7⅞	8⅛	5 17 8	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	97%	103%	99%	103%	4 7 8	January and July	...	...
60,710	20	3/0	Direct United States Cable	10	11	10	11	5 18 2	Jan., Apr., July, Oct.	...	...
196,303	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	25/0	Eastern Ordinary [to 1,200) (red.)	120	130	130	130	5 7 8	Jan., Apr., July, Oct.	124⅛	122
£1,955,565	Stock	17/6	Do. 3% per Cent. Preference Stock xd	88	91	87	90	3 17 8	,, ,,	89½	88
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108	112	103	112	3 12 2	May and November	110½	109½
300,000	10	2/6	Eastern Extension xd	12	13	12	13	5 7 8	Jan., Apr., July, Oct.	13⅜	12
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109	114	109	114	3 11 4	February and August	111	110½
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100	103	100	103	3 19 0	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red	100%	103%	100%	103%	3 18 3	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen [1 to 1,200) (red.	25	27	25	27	5 11 1	January and July	...	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos.	99	102	99	102	4 8 1	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	37	41	37	41	6 1 11	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100	104	100	104	5 15 4	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3½	4½	3⅜	4⅜	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	100	103	100	103	4 18 5	March and September	...	...
30,008	5		West Coast of America	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97	100	97	100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	⅜	⅝	⅜	⅝		May and November	½	⅜
34,563	10	£/0	Do. 6 per Cent. 1st Pref.	5⅜	5⅝	4⅜	5⅛	11 8 6	,, ,,	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3⅝	4⅜	3	4		,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	11⅛	12⅛	11½	12½	5 16 4	Mar., June, Oct., Dec.	11⅞	11⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	101	104	101	104	4 16 2	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	98	101	98	101	3 19 6	...	100	98
			TELEPHONES.								
44,000	£5	5 0	Chili Telephone (fully paid)	4¾	5¼	4¾	5¼	5 18 0	August	4½	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6	2/6	1/6	2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	⅝	½	⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	,,	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95	99	95	99	6 1 3	...	97	95
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	4⅝	4⅞	4⅝	4⅞	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	55	59	57	60	7 10 0	...	59	57
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	14	12	14	4 5 9	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	12	14	11	13	4 12 4	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	4⅞	5⅛	4 17 6	,, ,,	5⅛	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	94	97	94	97	3 12 0	June and December	97⅛	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6	...	...	...
171,504	1	0/8⅓	Oriental	1⅜	1 1/16	1⅜	1 1/16	5 12 11	April and October	...	...
58,000	5	4/0	United River Plate xd	4⅜	5⅛	4⅜	5⅛	6 13 4	July	5	...
40,000	5	2 6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	4 16 3	June and December	5⅛	...
£179,947	Stock	5	* Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 16 2	June and December	1 2⅛	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛	¼	⅛	¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛	¼	⅛	¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜	½	⅜	½	9 12 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7⅜	8⅛	7⅜	8⅛	5 17 8	July and February	...	...
70,000	5	3/0	Do. 6 per Cent. Preference xd	5⅛	6	5⅛	6	5 0 0	January and July	...	...
£250,000	Stock	4%	Do. 4½% 1st Mort. Deb. Red.	101	104	101	104	4 6 1	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	6⅛	6⅜	5⅞	6⅛	4 18 0	...	6 1/16	6
105,731	2	...	Brush Electrical Engineering	1⅜	1⅝	1⅜	1⅝	...	March	1⅝	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅞	2⅛	1⅛	2	...	March and September	1⅞	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	101	104	102	105	4 7 5	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	94	99	94	99	4 10 10	January and July	...	...
30,000	5	5/0	Callender's Cable Construction Ord. xd & bonus	15⅛	16⅛	15⅛	16⅛	4 10 11	,, ,,	...	...
40,000	5	4/0	Do. 5 per Cent. Cumulative Preference	5⅛	6	5⅛	6	5 0 0	,, ,,	5⅜	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109	113	109	113	3 19 8	November and May	109	...
450,000	1	3 9⅜	Castner-Kellner Alkali Co. (fully paid)	1	1⅛	1	1⅛	4 16 0	...	1 1/16	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	95	100	95	100	4 11 9	...	...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	⅜	½	⅜	½	9 2 0	March	...	...
85,000	3	1 9⅜	Crompton and Co. (Nos. 1 to 54,000)	2⅜	3⅛	2⅜	3⅛	6 19 0	January and July	3	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	101%	106%	101%	106%	4 14 4	,, ,,	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅛	⅜	⅛	⅜	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1⅛	2⅛	1⅛	2⅛	...	,, ,,	...	...
£344,022	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	76	78	76	78	5 3 0	June and December	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	76	81	76	81	6 3 5	...	...	...
35,500	5	4 0	Edmundson's Electricity Corporation Ord. xd	6	6⅛	6	6⅛	5 7 8	Half-yearly	...	...
30,000	5	3/0	Do. 6% Cumulative Preference	6	6⅛	6	6⅛	4 12 4	...	6⅛	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.) xd	105	108	105	108	4 3 4	...	107	...
112,100	2	1/2½	Electric Construction Co. xd	1⅛	1⅜	1⅛	2	6 0 0	January and July	1⅜	...
31,390	2	2/9⅜	Do. 7 per Cent. Cumulative Preference xd	2⅜	3	2⅜	3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) xd	97	100	97	100	4 0 0	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent Cumulative Preference	¾	1⅛	¾	1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	9⅜	10⅛	9⅜	10⅛	4 17 7	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98	101	98	101	3 19 3	...	...	...
35,000	5	5 0	Henley's Telegraph Works Ordinary	15	17	16	17	4 8 3	February and August	1⅛	...
35,000	5	2 3	Do. 4½ per Cent. Preference	5⅛	6	5⅛	5⅞	3 18 3	,, ,,	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	115	111	115	3 18 3	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	20⅛	2 ½	4 13 0	,, ,,	21⅜	20⅜
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	103	1 0	103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary xd	14½	15½	14½	15½	6 9 0	July	...	...
37,350	12	12/0	Telegraph Construction and Maintnce. xd	35	38	35	38	6 6 5	March and July	38	37⅛
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	January and July	102¾	...
25,000	5	8/0	Do. Manufacturing Ordinary	...	...	...	...	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	...	...	...	...	4 8 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	...	...	...	...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	...	...	...	...	...	,, ,,	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3 0	Electric and General Investment 6% Cum. Pref.	5⅛	5⅜	5⅛	5⅜	5 9 1	...	...	...
180,327	10	2/6	Globe Telegraph and Trust	8⅜	9⅛	8½	9½	5 10 6	Jan., Apr., July, Oct.	9⅛	9
190,043	10	3/0	Do. 6 per Cent. Preference	12⅛	13⅛	12⅛	13⅛	4 8 11	,, ,,	13⅛	12 1/16
11,839	8	4/0	Reuter's	6⅜	7⅛	6½	7⅛	5 6 8	April and October	...	...
3,303	£100 Cert	6%	Submarine Cables Trust	110	120	110	120	5 0 0	,,	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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NOTES.

AMONG the numerous reports of meetings of shareholders of electrical companies in our pages this week, our readers will find several points of unusual interest. For instance, the Chairman of the Direct United States Cable Co. states that the single cable owned by this submarine telegraph company has now been in the Atlantic for 27 years. Yet, during the last financial year not one penny was spent upon repairs, and the company's electrician reports that the cable is working as well as if it had only just been laid. The recent reports of the tube railways we hope to deal with more fully later, but in the meantime it is encouraging to notice how uniformly successful this class of railway has become.

THE international conference proposed by the Russian Government for the discussion of commercial trusts has been received with general coldness, and in some quarters with positive disfavour. All the same, something will probably come of it, and that something can hardly fail to be good. Like the conference for disarmament emanating from the same quarter, no direct or immediate consequences may result from a discussion on commercial warfare; but a free-trading nation has nothing to fear, and may have much to gain, from a thorough ventilation of the extremely important questions which divide us from the rest of the world in the matter of trade, and which are bringing about a state of acute hostility between all the commercial nations of the earth. A conference on trusts could not avoid discussing the questions of protective tariffs and bounties, much to the enlightenment of the countries who indulge in these expensive luxuries, and much to the advantage of the one country that foregoes them. Our own trade and industries are undoubtedly suffering from the economical heresies of our rivals; but already there are signs that they are beginning to see the folly of cheapening their own exports at the expense of their home consumers; and we are not without hope that Russia's proposals may meet with acceptance, if not exactly of the enthusiastic sort. Meanwhile our own manufacturers should awaken to the necessity of enlarging their plants, and meeting the demands of new markets, which we have made such enormous sacrifices to open. Free trade is on its trial just now in more senses than one; and it rests with ourselves mainly whether the verdict shall be wholly in favour of the nation which alone has preached and practised that doctrine against all odds and despite all discouragements. It may please us to see protective nations talking over the consequences of their own foolishness; but while they are confabulating they are also acting, and will, if we do not forestall them, take possession of markets which ought to be peculiarly our own.

IN the interests of justice and equity there is cause for thankfulness that the decision of the great Manchester tramways arbitration case has gone against the Corporation, who are now compelled to pay for the whole of the Manchester Carriage and Tramway Company's tramway plant and stock, and not merely that portion of it which the Corporation can utilise for the electrically converted lines. A vital principle was at stake in this arbitration, the decision in regard to which now imposes an additional charge of £266,535 upon the Corporation funds, making the total amount payable no less than £496,068.

THERE is still a serious hitch in the negotiations for through communication between the two systems of electric tramways in Wolverhampton—the one owned by the Corporation, the other by the British Electric Traction Co. Indeed, it looks as if negotiations would altogether fall through. Taking this as an illustration or type of a large number of places in the country, and of an even greater number of places where, ere long, through communication will be a necessity, it is regrettable that the statutes of the land do not allow of such inter-communication being enforced by law. Whether the adjacent tramway lines forming a through route belong to

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local authorities or to companies, or to both, it is in the interests of the travelling public that an unified and organised through traffic be maintained. This ought to be compelled by statute, and disputes arising as to the allocation of expenses and traffic receipts should be settled by a permanent arbitration board. As regards the ordinary financial matters, a clearing house on the lines of that which disposes of railway business would be a satisfactory solution of the problem. At any rate, whatever might be settled as to details, there can be no doubt that the public ought to have a legal right to insist on through communication between adjacent tramways.

PROF. PERCY FRANKLAND has been making some experiments to test the relative suitability of arc lamps and incandescent gas lamps for lighting art galleries, the question being as to which produces the least deleterious effect on the pictures. Oddly enough he gives his decision in favour of the incandescent mantle. The electric arc is charged with the offence of generating ozone and other gases which are injurious to paintings. We cannot allow Prof. FRANKLAND'S decision to go unchallenged. Fortunately, there is a greater variety of lamps to choose from than the two he selected. No doubt a small quantity of ozone and of nitrogen oxide is generated by an open arc; but even this small amount is reduced to a very much smaller proportion when the arc is enclosed, as it should be for all interior lighting of this description. Has Prof. FRANKLAND tested the relative suitability of the incandescent gas mantle and the enclosed arc? We think that if he would do so, he would be in favour of enclosed arc lighting. Then, again—far superior to the gas-burning, fumes generating mantle—is the Nernst lamp, which generates practically nothing except light.

MR. CHARLES BRIGHT, in a letter we publish this week, carries the motor omnibus versus trolley car controversy into a startlingly original stage. We are all to go to business, not on tramcars or omnibuses, but each on his own familiar motor-bike. Mr. BRIGHT asks us to picture a highway packed with such passengers, and he evidently believes the carrying power of the road in these circumstances would be higher than with either 'bus or tramcar. Presumably, all the travellers are to go at the same pace, and none must turn aside. Now an electric tramcar can carry from 50 to 60 passengers. Does Mr. BRIGHT think that this number of motor-cyclists can travel together without occupying more road space than a tramcar?

THE mania for making the passing of scholastic examinations the criterion of all knowledge and capacity has, we hope, reached its climax in the creation by the Birmingham University of a totally new faculty—the Faculty of Commerce. It was, of course, quite in keeping with the creation of any new faculty that its exponent in the University should have its highest degree conferred upon him. Dean ASHLEY, the Professor of Commerce and Public Finance, therefore worthily received the degree of Master of Commerce. As an ornament to a chair of theoretical business and text-book commerce this kind of degree may have its uses, but as a token in the highways of the world's commerce a big price is not likely to be set upon it. The successful masters of commerce are those who have graduated in financial lore outside the walls of universities. Moreover, how ludicrous it would be for a Master of Commerce to appear in the Bankruptcy Court! He might, perhaps, be described as a past master.

Personal.—Mr. William Watson, F.R.S., of the Royal College of Science, London, has graduated as a Doctor of Science in the University of London.

Encouragement to Inventors.—The city of Dresden offers prizes of £250, £150 and £100 for protective devices for electric street railways, promising also to pay royalty for the use of such designs.

A Costly Snowstorm.—The heavy snowstorm last winter cost the National Telephone Co. no less than £35,422, as reported in the account of the meeting of shareholders on another page this week.

Berlin–St. Petersburg Telephone.—Arrangements have now been made between the Russian and German postal authorities to connect Berlin and St Petersburg by telephone. The distance is just 1,000 miles, and the line is expected to be in working order by the beginning of the winter.

Electrical Engineers R.E. Volunteers.—Two companies, consisting of four officers and 100 men, are expected to arrive home from South Africa to-morrow. The members of the corps are to parade at head-quarters at 10:30 a.m. on Saturday to receive them. The drum and fife band will be in attendance, and will play the detachment from Waterloo to headquarters.

Major A. Bain, Capt. J. E. Pearce and Capt. D. Brady have the honour to be mentioned in Viscount Kitchener's despatches.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Bolama	April 19, 1902 ...	—
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Santa Cruz—Teneriffe	July 7, 1902 ...	—
Puerto Plata—Martinique	July 10, 1902 ...	—
Cap St. Jacques—Haiphong	July 12, 1902 ...	July 28, 1902

Prof. Bell on Wireless Telegraphy.—*Electricity* of New York states that in an interview with a Chicago reporter Prof. Alexander Graham Bell says: "Wireless telegraphy will never be made practicable for service on land. I believe the invention will supplant the oceanic cables when it is sufficiently developed to be reliable for the transmission of messages. But it can never take the place of the telegraph or the telephone. Marconi's invention will find usefulness confined to the water. The many stations would interrupt each other on the land, and make it practically an impossibility to transmit connected and accurate messages."

Obituary.—We regret to record the death, on Sunday, at his residence at New Barnet, Herts., of Mr. Arthur Dennis, senior partner of the firm of W. F. Dennis & Co, of Billiter-street, London, E.C. Mr. Dennis, who was in his fiftieth year, was only ill a few days, and his death was quite sudden and unexpected.——We regret, also, to announce the death, at the age of 63 years, of M. Gustave Trouvé, the well-known French physicist. M. Trouvé was a most prolific inventor, and as early as the eighties was a conspicuous member of the French electrical profession. He manufactured a large variety of the electrical apparatus invented by himself.

Telpherage in America.—The United Telpherage Co., of New York issue some interesting pamphlets containing facts with reference to the handling of trunks and baggage in railway work, and the conveyance of limestone, cement, &c., across

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country. The receptacle is a sort of bucket, which is suspended from a steel track and is operated by electricity. For cross-country work cable is used, above which runs the trolley-wire attached to brackets and hangers. The curves are of solid rail, and the track is of considerable height where it crosses the road. The speed of the "telpher" is reduced at any point where the curve is extremely sharp. Twelve miles per hour is attained with ease, and on a 12 per cent. grade the speed is 6 miles per hour.

New Railroad Signal System.—The New York Central Railroad Co. has contracted for the equipment of the Putnam Division of the Hudson River road from 155th-street to Yonkers, N.Y., with a new system of electro-gas block signals, to be operated on the normal danger plan. The signal blades or semaphore arms are positively held by gravity to a horizontal position by carbonic acid gas pressure in a cylinder placed in each signal post. The valve controlling the flow of gas from the tank to the cylinder is closed or released by an electric current passing through the rails. This is done automatically by the presence, or otherwise, of a train from behind. The electric connections are such that the signal blade stands normally at danger.

The Edison Storage Battery.—Mr. Edison, in an article entitled "The Storage Battery and the Motor Car," published in the *North American Review*, states that a real storage battery must be reversible, like a dynamo, which converts power into electricity and vice versa. A storage battery, to deserve the name, should be a perfectly reversible instrument, receiving and giving out power like a dynamo motor, without any deterioration of the mechanism of conversion. The present lead battery in an automobile, he alleges, does not meet this condition. The author states that his battery will enable those of only moderate means to possess an automobile. His experiments on the present battery have been continuous for a period of over three years.

The Electrical Conductivity of Air.—Recent experiments on this subject by Prof. J. J. Thomson are described in the *Electrical Review* of New York. It was found that by bubbling air vigorously through water its conductivity was increased tenfold, and, moreover, it did not lose this increased conductivity, but retained it for some considerable time, even when a current of very high pressure was applied. The effects of the passage of the air through water are similar to those which would be produced if the bubbling produced a radio-active emanation similar in properties to those emitted by thorium and radium. The conducting gas can be passed from one vessel to another, or through a porus plug, and still retain its conductivity, but passage through a long tube heated to redness destroys it. The temperature must be greater, however, than 400°C. If the gas is passed very slowly through a long tube filled with beads moistened with sulphuric acid the conductivity is lowered. If a negatively-electrified conductor be kept in the gas for sometime it becomes radio-active.

Institution of Junior Engineers.—The summer meeting of this Institution commences on August 11th, the north-east Lancashire district being the locality to be visited, with Blackpool as headquarters. The meeting opens with an excursion to Barrow to inspect the works of the British Griffin Chilled Iron and Steel Co., the Barrow Hematite Steel Works, and the Kellner-Partington Paper Pulp Works. On Tuesday, after being received by the Mayor of Blackpool, the power station of the Blackpool and Fleetwood Tramroad Co., and the Lancashire and Yorkshire Railway grain elevator at Fleetwood are to be seen. On Wednesday an excursion will be made to Furness Abbey, Lake Windermere, &c., and on Thursday the members will travel to Preston to visit the cotton spinning and weaving works of Messrs. Horrocks, Crewdson & Co., the Electric Tramway and Railway Carriage Co.'s works, and the works of the English Electric Manufacturing Co. Friday will be devoted to an inspection of the engineering features of the Blackpool Tower, &c., and in the evening the summer dinner of the Institution will take place at the Queen's Hotel, South Shore, Blackpool. Mr. F. S. Pilling, M.I.E.E., 39, Victoria-street, Westminster, has been appointed hon. local secretary of the meeting.

B.E.T. Staff Dinner.—The British Electric Traction Co. gave their annual staff dinner in the Grand Hall of the Criterion Restaurant last Friday evening, and among those present were many distinguished members of the electrical profession. Representatives of no less than 60 companies connected with electrical engineering were there, and supporting Mr. Garcke were Sir Rivers Wilson, G.C.M.G., C.B., Lord Vaux of Harrowden, Sir Ernest Spencer, M.P., Mr. C. A. Atherley-Jones, K.C., M.P., and many others. The speakers after dinner mainly referred to defective legislation, which prevents the electrical industry from making that progress which it would do if not hampered by unfair laws and regulations. Mr. Garcke, in proposing "Success to the British Electric Traction Company," referred in an exceptionally fine speech to the progress of the company. He said they had 16,000 shareholders, and gave employment to 10,000 persons, to whom they paid annually in wages a sum of not less than £700,000. In that room there was no less than 6½ millions of capital represented, and the traffic receipts from electric traction amount to 1¼ millions per annum, while the various companies carry a number of people, annually, equal to six times the entire population of the United Kingdom.

Polyphase Motors for Electric Traction.—At a recent meeting of the American Institute of Electrical Engineers two Papers were read on the above subject by Mr. C. L de Muralt and Mr. E. Danielson. The former quoted instances of polyphase railways in Europe, and gave illustrations of the lines in actual practice. Mr. Danielson entered into the question of motor control, and described an arrangement giving three economical speeds by means of two motors. These were arranged with a different number of poles—six and four in the instance quoted—and with a frequency of 50 cycles three speeds were possible. Four-pole motor alone (six-pole running idle) ran at 1,500 revs. per min., six-pole alone had a speed of 1,000 rev. per min., and a combination equalled 600 revs. per min. This applied to induction motors coupled mechanically together, and having concatenated connections—secondary circuit of one motor to the primary of the other. The combination gave a speed corresponding to half the regular speed of each motor, and the torque of each would be the same when used singly or in concatenation. An illustration of a motor having 10 and 4 poles, and capable of running at speeds of 428, 600, 1,000 and 1,500 revs. per min., was given. The author pointed out, in conclusion, the drawbacks of the alternating system, such as the use of a double trolley, lag, &c., but he considered the drawbacks as probably outbalanced by the greater economy.

The "Automotor" and Col. Crompton.—Our motor vehicle contemporary the *Automotor* is very angry with us for what we have said about Col. Crompton's letters. We reprint below the terms of its reproof:—

> COL. CROMPTON AND "THE ELECTRICIAN."—Our esteemed contemporary *The Electrician* has this week departed to some extent from its usual attitude of fairness towards opponents in devoting several columns to a highly disingenuous criticism of Col. Crompton's recent letter to the technical press. This letter refers to the evidence Col. Crompton gave on behalf of the Roads Improvement Association, before a Committee of the House of Commons. Col. Crompton favours the automobile, and particularly the electric automobile, at the expense of the electric tram, and this it is, we presume, what has excited *The Electrician's* animosity. In the first place Col. Crompton is made to say that considerable numbers of accumulator omnibuses are running on the streets, and our contemporary ejaculates—"This statement makes us rub our eyes and ask "Where?—which streets?' We cannot find these 'buses anywhere." But what Col. Crompton really said was that we now see considerable numbers of electrically-driven cars running satisfactorily in our streets, and that is as undeniable as anything well can be. Col. Crompton's almost self-evident proposition that the carrying capacity of a street is not increased by laying tramlines, is met by the question—"Who ever heard of a trolley car with a clear headway causing obstruction?" As if under modern conditions it ever has a free headway. To anyone familiar with the Kew and Ealing roads, and the congested procession of trams with which they are at most hours of the day adorned, this disingenuous and irrelevant question must appear highly diverting. The whole situation is simply this—Col. Crompton recognises the superior future capabilities of the automobile for dealing with suburban traffic. *The Electrician* holds a brief for the electric tram. Col. Crompton's position being really unassailable, it is necessary to misrepresent what he says in order to make a case. We have often had occasion to allude to the lack of encouragement and tacit opposition which the electromobile has experienced at the hands of the electro-technical press. The remarks of our contemporary go a long way towards explaining the inner meaning of this attitude.

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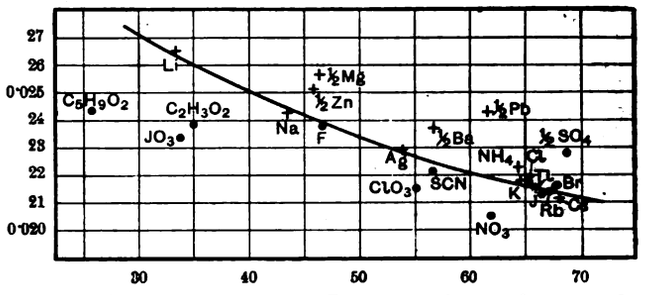
A New Ozone Producer.—An apparatus for the production of ozone has recently been invented and patented in England, America and the Continent, by Mr. William Elworthy. It consists of a number of glass tubes, each of which contains a rod of conducting material separated from it by an air space. A conducting spiral is wound around the outside, and this also does not touch the tube, so that in addition to the tube itself there is considerable air space between the two conductors. A current at any pressure from about 2,000 to 10,000 volts is turned on to the rod and spiral, and air or oxygen is passed first along the inside of the tube and then along the outside. A transformer to raise the voltage from that of the supply to the necessary pressure for working the ozoniser, and a fan for forcing the air through the tubes, complete the equipment, which should be produced at a very reasonable price. The uses to which ozone can be put are, of course, very numerous, such as the purification of the atmosphere of the underground railways and buildings in which large numbers of people congregate. Perhaps the most useful purpose it can serve is, however, that of destroying bacilli. Water may be sterilised by the passage of ozone, and it undoubtedly possesses extraordinary powers in connection with the treatment of pulmonary tuberculosis. An ozoniser taking 0·4 ampere at 100 volts, with a fan requiring the same power and passing 76 cubic ft. per hour will produce 0·9 grammes of ozone.

Experiments on Powerful Electric Arcs.—On the 10th ult., before the Société Internationale des Electriciens, of Paris, M. Rey described his experiments with electric arcs in conjunction with M. Blondel's work on projectors in 1892–94, 1897, 1901, and quite recently with M. Jigouzo. The general conditions to fulfil for good regulation are first stated by M. Rey, and comprise, among the foremost conditions, the use of a compound machine, good carbons and a large steadying resistance. A 250-ampere arc implies the use of a steadying resistance absorbing as much as 62 volts. This figure applies to the best quality of carbons. The quality of samples obtained from the best firms is yet too unreliable, but French carbons, according to the author, offer the best average quality. It is, furthermore, stated that the intrinsic illumination of the crater increases with the intensity of current. A few years ago physicists admitted the contrary fact—*i.e.*, constancy of illumination. Careful measurements made by different methods exposed by M. Rey have proved the apparent inexactness of this view. Photometric measurements show a continuous variation of photometric intensity without any noticeable variation of current. It is quite useless to attempt to follow these changes, and the only reasonable method consists in taking average values of numerous series of readings. Referring to researches made with M. Blondel, M. Rey states that a given intensity of current sent through carbons of different diameters give different illuminations, due to the different conditions of cooling. Curves have been plotted by the author, with current densities as abscissæ and photometric intensities as ordinates, for different carbons, and with two different methods, both of which check pretty well—*i.e.*, 15 to 20 per cent. The equation of these parabolic curves is the following: $e(e+a)=Bd$, where d = density of current, e = illumination, $a=200$, $b=10{,}000$. The law of variation of current-density for a given illumination with the diameter is the following: where i = current-intensity, d = current-density, D = Diameter of carbons, then $i^2=AD^3$ or $d=\frac{B}{\sqrt{D}}$, A and B being two constants. M. Violle has investigated the variations of the illumination by photographic methods, but the interpretation of the photographic proofs is liable to great errors (according to M. Rey) due to the complex laws of variation of the darkness of the proof with the time of exposure. No credit can be given to this method, which is said to be worse than the photometric methods of investigation. Before the conclusion of his Paper, M. Rey states that the actual flux of the arc, due to occultations of the negative carbons, reaches only 84 per cent. of the theoretical flux. He states that in a near future the experimental curves will be published.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Ionic Mobilities.—F. Kohlrausch has succeeded in discovering and confirming a new law with regard to the mobility and temperature coefficient of conductivity of monovalent ions. It appears that the temperature coefficient is simply a function of the mobility, quite apart from the chemical nature of the ion. The accompanying curve shows the mobilities at 18deg. as abscissæ and the corresponding temperature coefficients as ordinates. It will be seen that the monovalent ions Li, Na, F, Ag, CN, K, Cl, Tl, I, Br, Rb and Cs are on the same curve, whereas ions of other valencies are outside. The author further states that the ratio of ionic mobilities tends towards



unity at rising temperatures. In attempting to frame a theory of this curious disappearance of the intrinsic differences of the ions, the author has recourse to the conception that the ions surround themselves with a film of water, whose thickness varies with the nature of the ion, but which has the effect of reducing its mobility to a function of the friction of water against water. This friction thus form a third element, which governs the two quantities whose interdependence the author has demonstrated.

[F. Kohlrausch, *Sitzungsber. Berlin*, May 29, 1902.]

Capillary Electrometer.—What may be called the insulation resistance of the capillary electrometer is important for two reasons—first, as to its bearing on the theory of the instrument; and, secondly, as affecting the method of using it in dealing with electrical charges or quantities of limited amount. G. J. Burch, in the course of some work on the interpretation of photographic records of the response of nerve, had occasion to study the insulation resistance of his capillary electrometer, and he found it to be of the same nature as that of a gold-leaf electroscope. On one occasion, when it was accidentally left charged for 45 hours, it retained 97 per cent. of its charge, although the circuit included no less than seven keys and switches and about 23 metres of wire. That the meniscus had not "stuck" was proved by waving a charged ebonite wand in its neighbourhood, which produced temporary oscillations of the meniscus. The author measured the minimum quantity of electricity which would produce a measurable excursion of the meniscus, and found it to be 0·01 of an electrostatic unit. The capacity of the instrument was 0·363 microfarads. He ascribes the absence of local action to the circumstance that the two liquids cannot diffuse into each other, and maintains that, in a well-made capillary electrometer, there is no electrolysis.

[G. J. Burch, *Proc. Roy. Soc.*, No. 462, July 8, 1902.]

Luminous Gas Surrounding a Wire.—J. Borgmann gives further details of the beautiful light effects observed in a vacuum tube traversed from end to end by a fused-in wire. One end of the wire is attached to a secondary pole of an induction coil, while the other end is free, and the other pole of the coil is put to earth. It is even better to insert a condenser between the tube and the coil, as this allows of the intensity of the luminosity being varied. The author describes in detail the various phenomena noticed when the tube is joined to the positive or negative pole, and when the poles of the coil are joined by a spark-gap, or are not so joined. The tube being attached to the positive pole, and a spark-gap being inserted in parallel, the wire is surrounded by a series of luminous lenses. These lenses are, contrary to the author's original opinion, subject to magnetic deflection. For, under the influence of a strong magnetic field at right angles to the

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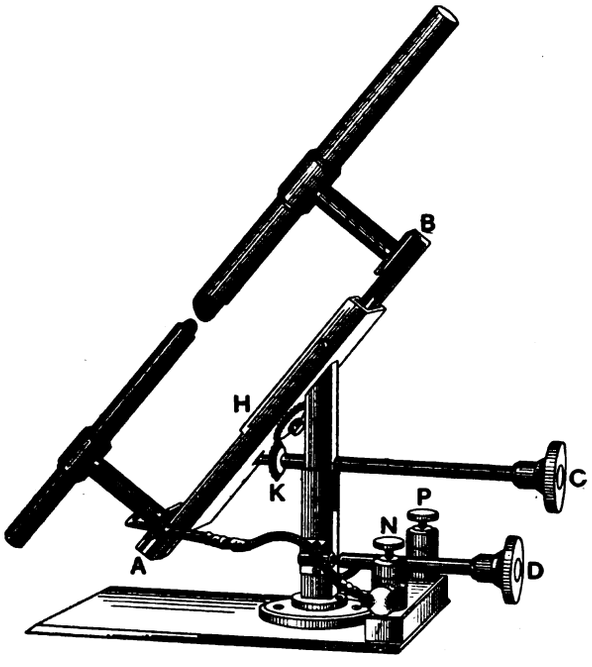
wire, the lenses incline to the axis of the tube, and then begin to move slowly in the direction of inclination. After moving a short distance they disappear, but new ones appear in their original places, and repeat the process indefinitely. The lines of force being directed towards the observer, the lenses move towards the left. With a longitudinal magnetic field, the lenses are not inclined, but they crowd towards the middle of the tube.

[J. Borgmann, *Physikal. Zeitschr.*, July 1, 1902.]

Arc Light for Projection Apparatus.—The experience gained in the electric illumination of lighthouses has shown that the carbon arc in its ordinary form does not give a sufficiently steady and uniformly distributed light to work well with mirrors and lenses designed to give a well-defined cone. Douglass, therefore, proposed to mount the vertical carbons in such a manner that the point of the negative carbon was vertically below the front surface of the positive carbon. No crater is then formed, and the positive carbon burns away in a slanting section. But since with a vertical position the light is sent out mostly below the horizontal plane, H. Krüss has further endeavoured to find an arrangement whereby the light may be distributed as evenly as possible, and he recommends that the front surfaces of the carbons should be in the



same plane, and both should be inclined at an angle of 30deg. to the vertical. He has designed a hand-regulator for projection apparatus, which is shown in the figure, where the upper carbon B can be shifted by means of the handle C, and both carbons raised or lowered by turning D.

[H. Krüss, *Physikal. Zeitschr.*, July 1, 1902.]

Spectra of Water Vapour.—Further studies by J. Trowbridge have emphasised his conviction as to the importance played by the rôle of water vapour in spectrum tubes. He brings out a fact which has an important bearing upon the interpretation of photographs of stellar spectra. In photographing the spectrum of water vapour obtained under heavy discharges, it appears that some of the lines, and these not the strongest, are reversed on the negative. This shows some selective action of the silver salt, which may play havoc with spectrum photographs, and considerably reduce their scientific value. A comparison of terrestrial and solar spectra proves, according to the author, that dissociation of water vapour takes place in the atmosphere of the sun, and that, therefore, oxygen must be present. Its presence is, at least, as conclusively established as that of sodium. The dissociation of water vapour, under the effect of powerful electric discharges in the presence of small amounts of air, results in the production of argon even in tubes presumably filled with dry hydrogen. The author has succeeded in completely obscuring the spectra of metallic electrodes of platinum, copper, silver, iron and aluminium in tubes containing water vapour, whose dissociation produces a brilliant white light, which is the nearest approach to sunlight the author has been able to produce.

[J. Trowbridge, *Phil. Mag.*, July, and *Am. Jour. Sc.*, July, 1902.]

Silver Nitrate.—It is well known that the silver nitrate voltameter, though accepted as the standard, has several sources of error. Some of these are dealt with by A. Leduc. The first is the change produced in the acidity of the solution, which is in the direction of acidity or alkalinity, according to different observers. The author shows that this is entirely a question of circumstances, such as the rapidity of the electrolysis. The nitric acid created is electrolysed at the same time as the nitrate itself, but no hydrogen is evolved, as it precipitates silver from the nitrate and also forms a complex compound with nitrogen and hydrogen. A popular misapprehension is that the deposit of silver on the cathode is corroded by the solution. The author shows, by careful weighings, that such a corrosion does not exist. On the other hand, there must be an appreciable polarisation of the cell, which is usually supposed to be negligible. The author estimates it at 0·03 volts. He mentions that if an insulated silver plate is put into the cell, it shows a slight loss of mass, but that there is no such loss when a silver needle is used instead. The loss in the case of the plate depends upon the manner in which it is immersed, being greatest when it crosses the current.

[A. Leduc, *Comptes Rendus*, July 7, 1902.]

Crémieu's Experiments.—Under the title of "New Researches on Open Currents," V. Crémieu describes some further experiments to meet objections raised against his results. He now claims to have experimental certainty that, in the electric convection experiment, (*a*) a charge is carried along with its ponderable support; (*b*) only this charge acts upon the magnetometer; and (*c*) no appreciable loss of charge occurs during the movement. The convection apparatus consists of a horizontal ebonite disc 24cm. in diameter with sectors of gilt micanite. The observations showed *impulses* upon the magnetic system whenever the sectors were charged or discharged, and usually in the sense in which a permanent deflection could be theoretically expected. Sometimes also there was a slight permanent deflection in the expected sense, but both impulses and deflections died away as the apparatus continued working. But no quantitative relation between the amount of charge and the deviation could be detected. The author concludes that the deflections are not due to electric convection, but the conclusion is by no means obvious, the appearance being rather that of an imperfect and somewhat masked result. He mentions, however, that on reversing the disc with uncharged sectors the deflections occasionally occur also, but in the opposite sense. The sectors were charged and discharged during every revolution.

[V. Crémieu, *Comptes Rendus*, July 7, 1902.]

Inductance and Spectrum Lines.—The effect of increasing inductance upon the spectrum of a spark between tin electrodes has been studied in detail by E. Néculcéa, with special reference to the violet and ultra-violet lines lying between 270$\mu\mu$ and 200$\mu\mu$. The variation of the inductance gives the physicist a new means of discriminating between lines of apparently the same series, and will, therefore, be a valuable supplement to the use of the Zeeman effect for the same purpose. The slightest inductance makes the triplet centred about 264$\mu\mu$ disappear altogether, while the doublet at 242·5$\mu\mu$ decreases very gradually with increasing inductance, showing a minimum at 0·025 henrys, and then increasing again. The inductance was varied from 0·0006 to 0·04 henrys. At the latter value 26 out of 40 lines disappeared entirely, and the remaining 14 had lost their nebulosity, being all clear and sharp. The line 233·5 showed three minima at as many different values of the inductance. It appears that an increased inductance, producing an increased amplitude in the electric oscillations, leads to a simplification of the spectrum similar to that which is brought about by a rise of temperature, and probably due to the same cause.

[E. Néculcéa, *Comptes Rendus*, July 7, 1902.]

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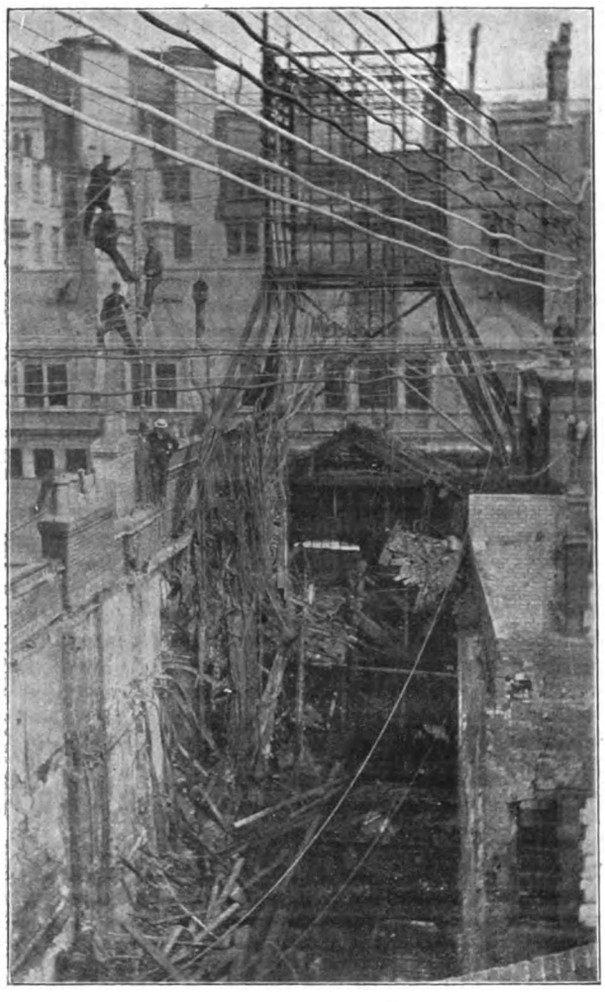
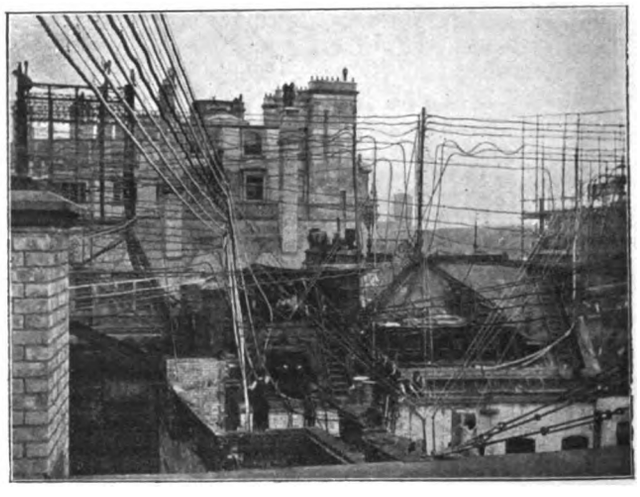
THE FIRE AT THE NATIONAL TELEPHONE CO.'S LONDON WALL EXCHANGE.

The greatest calamity that has ever befallen the National Telephone Co. in this country occurred on the evening of Wednesday, July 9th at their London Wall exchange. The alarm of fire was given about 8 p.m., and in less than one hour nearly £100,000 worth of damage was done. We feel sure that the extent of this fire has never been recognised even by electrical engineers themselves, and the general public, with the exception of the company's subscribers, are hardly aware that such a fire has taken place at all. The total loss occasioned will probably never be accurately known, because it is not simply that due to material actually burnt, but there will have to be reckoned the loss of time and business to subscribers, the extra labour thrown upon the officials and their subordinates, and various other items which have become directly or indirectly involved. The fire started at the intermediate distributing board in the test room and spread with alarming rapidity. Efforts were made by those on duty to overcome it, but these proved in vain, and the brigade was immediately summoned. They responded with great promptness, and the finest tribute that can be paid them is merely to state that, hampered as they were by falling wires, girders, &c.—the fireman's worst enemies—yet within one hour the blaze was extinguished, and there remained but a heap of ruins. Officials of the company were at once called up, and there they remained for 36 hours without a break, and even now they are working 16 hours every day. When they arrived on the scene everything was in a state of chaos; test-room, exchange, offices, stores—had all gone. Wires were hanging about without labels, and from this awful confusion the officials quietly set to work to restore order. Special arrangements were at once made with the railway company to despatch emergency boards from Nottingham, and by an early hour on Friday morning 22 subscribers were again able to use their instruments. The work was pushed forward with all speed, and those subscribers who were deprived of their service were presented with passes entitling them to the free use of call offices. The old walls of the building have been condemned and are being pulled down, but through it all the huge derrick, carrying hundreds of wires, stood on its four legs without any stays. A temporary test room has been fitted up, about 12ft. square, and in this are no less than 6 miles of double wire used for connections, and over a million soldered connections. The stores now consist of a room about 10ft. square, although before the fire they occupied a room 120ft. by 40ft.



General View after Fire.

Not merely have the London Wall subscribers' lines been thrown into confusion, but all the junction lines to other exchanges have suffered, and, of course, lost their identity. Had the fire occurred anywhere else but at the exchange, matters would not have been so bad, but all the labels were burnt up, and tests have had to be made for each individual wire. In a cable containing 104 wires there may have to be hundreds of tests made to establish the identity of one wire, and the number of tests required to satisfactorily deal with all the 104 averages out at about 9,000. When it is remembered that there is a considerable number of these cables, some idea of the labour involved may be gained. Eight female operators were present at the time of the outbreak, but there was no panic, some of them assisting in passing water to extinguish the fire. An informal meeting of principals was held on the night of the fire, and policy of re-organisation decided upon. The total length of outside wire which had to be run amounts to 421 miles 305yds., the number of outside joints made was 16,744, and, in addition, 334 miles of wire were used on the switchboard alone. New offices for the engineering and instrument departments were secured in the premises adjoining, and the staff, with all the office furniture, moved into them by 12 o'clock on Thursday. The transfer of the training school for operators also had to be effected, and test boards which were being erected at a new exchange in course of construction at Holborn were taken down and re-erected at London Wall.



District Offices.

It would be well if those subscribers who have been inconvenienced in any degree by loss of service, would exercise a little patience and rest assured that everything possible is being done to expedite matters. The National Telephone Co. are to be congratulated on the way in which their admirable staff have acquitted themselves at a period when so much depended upon their energy and resource. We publish photographs of the scene, taken by the Corporation overhead wire inspector, one of which shows the intermediate distributing board, with line

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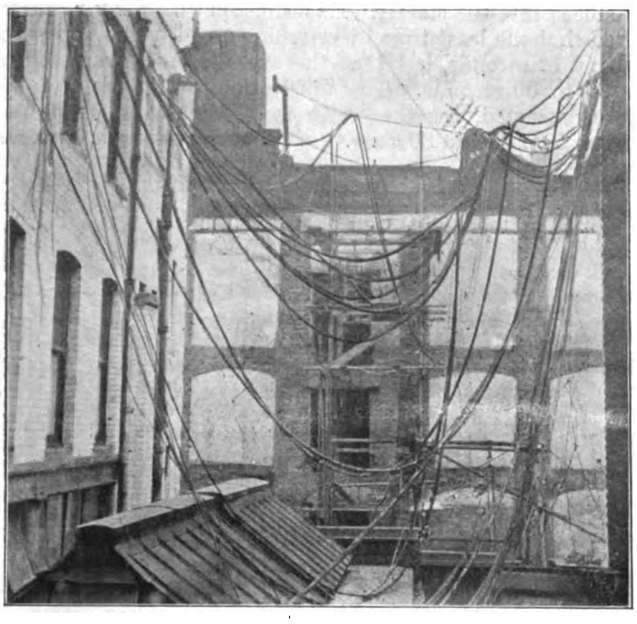
and cut-off relays, immediately behind which the fire originated. The cables showing in the general view were erected after the fire, and it will be observed that they are not supported by the derrick, but by a new pole, owing to the derrick being unsafe.



CABLES AND WIRES DROPPED AFTER FALL OF POLES.

The cracked walls have been condemned, and are coming down. We believe that the damage is covered by insurance.

It may be mentioned that every subscriber whose service was interrupted by the fire has now been re-connected.

INTERMEDIATE DISTRIBUTING BOARD.

The following is a list of repairs which have had to be carried out since the fire, and which are by no means temporary in the sense that temporary work is not so efficient as permanent work; on the contrary, everything has been done as though it were for ordinary use, and subscribers need have no fears of continual breakdowns owing to hasty erection.

There have been fitted on the new London Wall exchange:—

2,600	answering jacks.
8,400	outgoing jacks.
15,600	multiple jacks.
215	cross connecting jacks.
60	busy backs.
26,875,	on each of which there will be six soldered connections.
6	
161,250	soldered connections and 5,071 cable lacings.
2,600	indicators, each of which had to be re-wired.
576	ring-off indicators, making a total of
3,176	to be adjusted and tested.
1,512	three-way cords.
1,512	plugs on to same.
1,512	caps and springs.
4,536,	with three soldered connections on each.
3	
13,608	connections.
576	retardation coils, with 1,728 connections.
63	primary leads, with 126 connections.
32	ringing leads.
20	earth leads.
20	outgoing current leads.
15	visual lamp leads, making 174 connections.
360	relays, eight lines on each, 2,880 connections.
360	lamps joined up, with 1,440 connections.
1,040	call-wire keys = 4,160 ,,
72	fuses = 216 ,,

Power plant of two motors and two generators—104 connections.

Test Room.

2,600	test jacks, with 10,400 connections.
400	outgoing jacks, with 1,600 connections.
400	incoming jacks, with 1,600 connections.
200	through-line jacks, with 800 connections.
300	private-wire jacks, with 1,200 connections.

THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

(*Continued from page 551.*)

Messrs. Holden and Brooke, of Sirius Works, West Gorton, Manchester, had a comprehensive variety of steam apparatus at stand No. 97. Their patent exhaust steam feedwater heater, of which we give an illustration, is of the closed type, in which the water is conveyed through a number of brass tubes, and the steam passing through the casing of the heater is suitably deflected through the nest of tubes. The hottest water and the hottest steam meet in the lower part of the tubes, and any deposit resulting is carried immediately into the ample depositing chamber. Access to this chamber is readily obtainable by means of a large manhole, and a blow-off cock is provided at the lowest point, the whole being supported on feet so as to be readily accessible for examination and cleaning.

In Holden and Brooke's patent "H. P." steam trap for high pressures the renewable valve seating is led into a solid valve box casting, and the valve is held down upon its seat against the steam pressure by the constant loading of a spring. So long as the trap is at the temperature of steam—that is to say, so long as water is not present—the expansion tube has no work to do beyond standing the steam pressure. When water collects in the tube, however, the tube becomes relatively shorter than a pair of steel rods placed respectively above and below and connected at the inlet end by a rocking piece pivotted on the centre line of the expansion tube. The effect of contraction, therefore, is to cause a thrust in opposite directions by the two rods, the net result of which is transferred to the short arm of a bell crank lever, which compresses the loading spring and permits the valve to rise for the ejection of the collected water.

The patent oil separator and automatic discharger or vacuum trap performs its work chiefly by centrifugal action, the steam being conducted through the separator in a circular path at a considerably reduced velocity, and with several changes of direction. The exact action of the separator is

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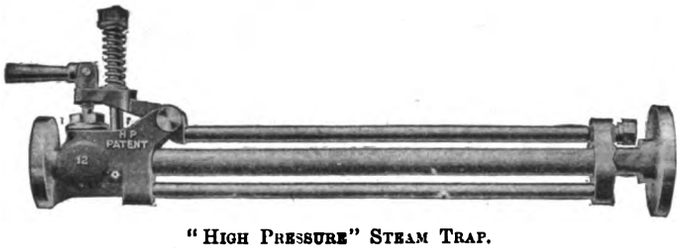
impossible to describe without several sectional illustrations, but the main idea is to make the most effective use of the tangential effect obtained when a gas such as steam, and a vapour or liquid such as oil or water are conveyed through curved passages. The automatic discharge is for use on separators under vacuum, and consists of a substantial check valve opening inwards on the grease inlet to the discharger, and a similar check valve opening outwards on the outlet from the discharger. The connection to vacuum is taken from the top of the casing and covered by an internal valve. A similar valve covering an air inlet reciprocates with the vacuum valve. Both these latter valves are connected to a tumbling gear having a weighted arm to secure rapid and positive motion of the valves, and which is set in motion by an aluminium float.

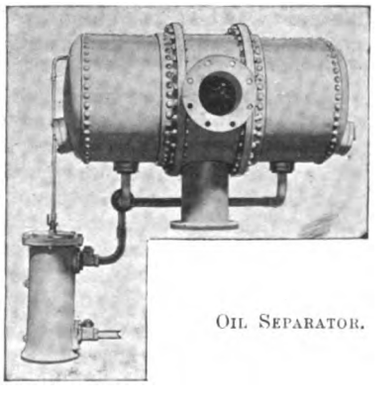
Messrs. Holden and Brooke's Exhaust Steam Feedwater Heater

Stand No. 25 was occupied by the Union Electric Co., of 151, Queen Victoria-street, who exhibited a great number of motors, arc lamps, starting and controlling rheostats, measuring instruments, &c. We give an illustration of an 8-pole 220-volt generator of the usual type, supplied by the Union Electric Co., with outputs varying between 100kw. and 500kw., and at speeds between 500 and 90 revs. per min. This machine is designed for running between no load and 25 per cent. overload without shifting the brushes, and



"High Pressure" Steam Trap.

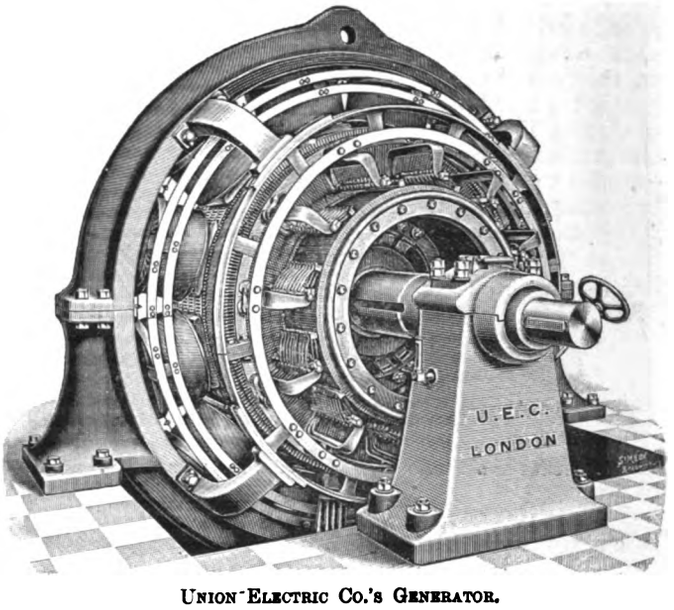
machines with a somewhat larger field excitation are constructed for running up to 50 per cent. overload, under the same conditions. Three types of motors were shows—viz., "Open,"



Oil Separator.

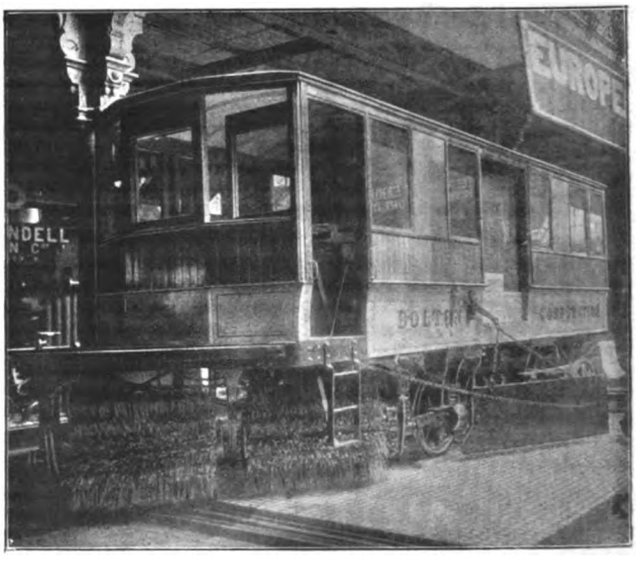
"Enclosed Ventilated," and "Totally Enclosed." The stand was brilliantly illuminated with "Flame" arc lamps with an entire absence of shadow immediately beneath them, this being a very objectionable feature in many ordinary lamps.

The "Perfecta" motor starter, with a "step-by-step" motion, was exhibited by this firm for the first time at the Tramways Exhibition. A complete throw-over of the handle displaces the contact lever of the switch only one stop, and this motion has to be repeated for each stop, so that a time element is automatically introduced into the starter. Experiments with a 5 H.P. starter proved that the least time in switching on with this apparatus is about 12 seconds, but that the average time is something like 25 to 30 seconds. The illustration shows the simplest type constructed, together with the dimensions for powers between 5 B.H P. and 30 B.H.P. without any automatic features.



Union Electric Co.'s Generator.

At the exhibition various types were shown, some with overload and with no-voltage release, and some with combination arrangement, enabling the overload device to act at any time after the first step of the resistance was switched on. It will be seen in the illustration that there is a bridge contact of laminated copper from a centre boss to the last contact stop, so that there is no spindle current in the apparatus.



European McGuire Company's Snow Sweeper and Plough.

This company also exhibited specimens of the improved Atkinson meter. It will be remembered that the old form consisted of a solenoid which sucked up a piece of iron wire contained by a hydrometer floating in liquid. The new type consists of a much shorter instrument with a hydrometer made of some composition instead of glass, thus enabling it to be carried about without fear of breakage. It is remark-

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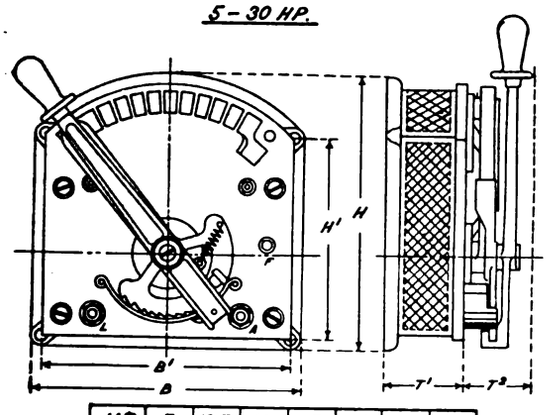
ably dead-beat, and the price compares most favourably with other instruments for similar purposes.

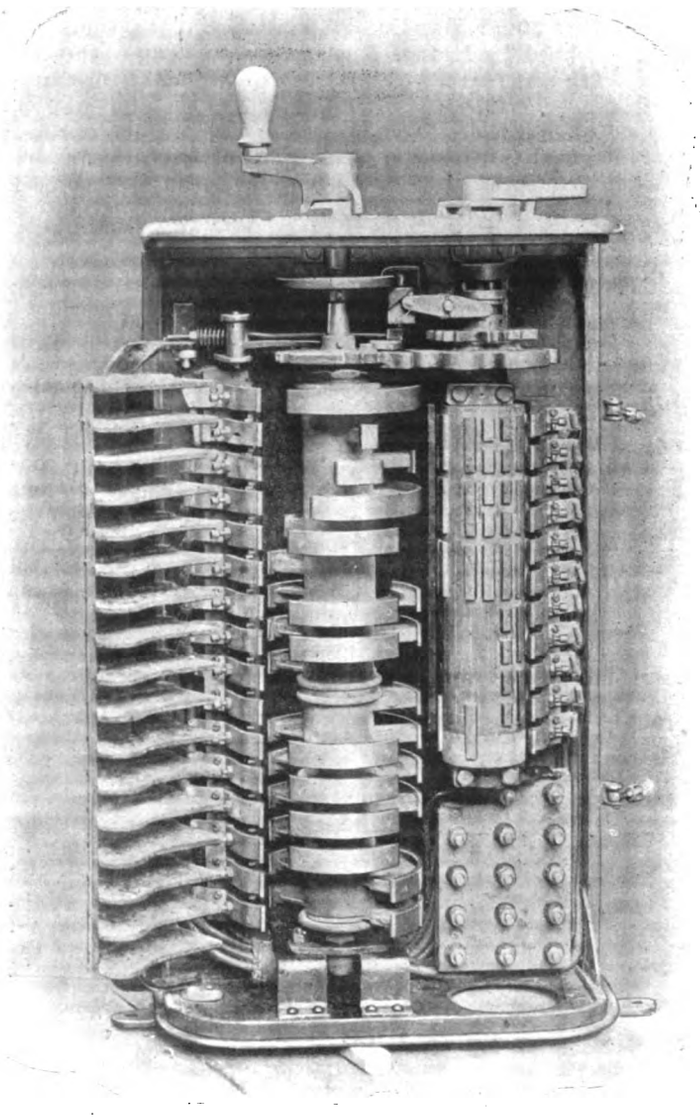
The Johnson-Lundell Electric Traction Co., of 16A, Soho-square, W., were well represented at stand No. 101. In the dynamo shown they claim that there has been achieved for the first time a scientific and commercial correction of the tendency of armature currents to distort the magnetic field. This correction being effected without the employment of special windings or other supplemental devices permits of the actual reduction of size, weight, and cost of a machine for any given output. The compound regenerative type of traction motors exhibited for railways, tramways and automobiles act as dynamic brakes and return nearly all the energy to the line which they generate when being driven by the car in descending grades or when coming to a standstill on a level road, thus making use of the kinetic energy possessed by the car instead of allowing it to be dissipated by the brakes. All control, both in accelerating and retarding is effected through a single controller handle, and the motors regulate entirely by counter E.M.F., all resistances in series with the armature thus being dispensed with. A section of the now well-known Johnson-Lundell surface contact system was also in evidence, this being a combination of the magnetic "pick-up" principle and of the electro-magnetic switch. A relay is operated upon by the magnet on the car and closes a circuit of 1 ampere at 50 volts, which in turn operates the electromagnetic switch. The switch terminals are thus hermetically sealed, and, to their great advantage, are not brought to the surface. The projection of the studs above the level of the ground is very slight, and their presence in a road laid with granite setts would be almost imperceptible. It will be observed that the great feature of the system is the relay, which obviates the necessity of closing the switch by the direct means of the car magnet.

PERFECTA MOTOR STARTER.
WITH STEP BY STEP MOTION.
5-30 HP.



HP	5	7·5	10	15	20	25	30
DIMENSIONS IN INCHES. B	10¼	10¼	12⅜	12⅜	15⅛	15⅛	15⅛
H	10⅜	10⅜	13	13	16	16	16
B'	9½	9½	11⅜	11⅜	14⅛	14⅛	14⅛
H'	7⅞	7⅞	9⅝	9⅝	11 13/16	11 13/16	11 13/16
T'	3½	3½	3⅞	3⅞	4 11/16	4 11/16	4 11/16
T²	3½	3½	3¾	3¾	4 5/16	4 5/16	4 5/16
WEIGHT IN LBS.							

At stand No. 77 were exhibited some of the implements manufactured by the European McGuire Mfg. Co., of 5, Warwick-court, High Holborn, E.C. The special brake gearing on the solid steel Columbian truck exhibited is so arranged that it can be operated satisfactorily even if one brake rod should become fractured. Its sides are made in one solid piece of steel welded together to the required wheel base. The snow-sweeper and plough attracted considerable attention, and various remarks, humorous and otherwise, were made regarding the huge brushes underneath. The plough itself was built specially for the Bolton Corporation. The brushes, which are fixed at an angle of about 45deg. with the axles of the car, are driven by a separate motor placed inside. This machine and the two for propelling the whole concern were built by the British Thomson-Houston Co. The McGuire Company guarantee that this sweeper will remove snow 18in. deep, and from its appearance we do not think anyone can doubt the statement. Our illustration gives a very good idea of its general appearance. This company also exhibited a life-saving guard, which, it is said, has met with considerable success in the United States. Immediately upon being struck the guard drops upon the track and prevents any person going underneath the car. A truck for use on the Great Northern and City Railway was specially built of solid steel, which, of course gives it great strength. The brake gearing is on the inside, and the wheels are forged centres with steel rims of exceptional weight. A truck for four-motor equipments was shown so constructed that it will carry the car body as low as a maximum traction truck, and curve satisfactorily under the car body. It is of solid steel with side frames bolted firmly together with end sills, thus forming one rigid frame. The four springs over the journal boxes are specially adapted to save concussion to the axles, and saving wear and tear to the car body, thereby giving ease in riding. The bolster is a swing bolster with four spiral and two full elliptic springs. This pair of trucks carry the car body upon 40 spiral springs and four elliptics.



MESSRS. WITTING BROS. SERIES-PARALLEL CONTROLLER.

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Messrs. Witting Bros., of 49, Cannon-street, London, E.C., were well represented at stand No. 59. One of the 100 cars on order for the Bradford Corporation was exhibited. The standard double-deck car body was built by Messrs. Milnes & Co., and the staircase is of the most improved type, all fittings and accessories being quite of the latest design in every respect. The truck exhibited has forged side-bar in one piece of channel section, with all parts of brake and other gear extra strong. The semi-elliptic springs on either end of the truck which support the car body prevent the pitching motion which usually takes place with cars having short wheel bases. The special arrangement of springs between the axle-boxes and the top side-bar of the truck prevents any jolting due to irregularities in the track being transmitted to the car body.

A typical 30 H.P. traction motor was exhibited, similar to many supplied by Messrs. Witting Bros. to various corporations. The standard motors may be supplied with either side-bar, nose or cradle suspension, or a special form may be applied when it is desired to utilise the fixed cross-bars for the reception of slipper brake or other gear. Amongst the various traction accessories distributed about the stand were samples of standard canopy switches and fuse blocks. With regard to this latter piece of apparatus, no special spanners or tools are required to make renewals, and the particular point borne in mind when designing this apparatus was to obviate the possibility of the motorman obtaining a shock when replacing a fuse. The fuse proper is automatically switched out of circuit when the box-cover is opened.

We give an illustration of the series-parallel controller exhibited, with rheostatic brake but without magnetic blow-out. The necessary connections for putting the motors in series or parallel are made by means of the usual reversing and controlling cylinders, two cylinders being connected to one another by means of an interlocking gear, clearly shown in the illustration, and arranged in such a manner that it is impossible to move either one unless the other is in the correct position—that is to say, when the reversing cylinder is in the "off" position the controlling cylinder cannot be moved, and it is only when the controlling cylinder is in the "off" position that the reversing cylinder may be moved.

A special feature of the reversing cylinder is the arrangement of contacts upon it, these being so disposed that two motors may be used together either backwards or forwards, or either motor may be used individually backwards or forwards, the whole of these connections being made by means of the reversing handle, so that in no case is it necessary for the driver to open the controller cover on any pretext.

For the main controlling cylinder the usual deflecting and arc suppressing shield of moulded vulcabeston is used, a suitable shield being also placed between the reversing and controlling cylinders, so that arcing shall not take place from one to the other. The controller is arranged so that any portion can be replaced or taken out for inspection. The number of contacts are 12 in all, that is to say three resistances and one running point in series; two dit'o ditto in parallel; five brake notches, including the short-circuit position.

When either of the motors is cut out of circuit, the connecting gear between the controlling and reversing cylinder is arranged in such a manner that it is impossible for the controlling cylinder to go beyond the last series notch. The whole of the contacts are of rolled copper, so formed that they avoid undue wear-and-tear, and so proportioned that the current density in any sliding contact does not exceed 100 amperes per square inch under average conditions. The pressure on the various fingers may be easily adjusted by means of proper screws provided for this purpose. The resistances are formed entirely of metal ribbon, each layer well insulated with asbestos; each individual resistance comprises a number of discs, wound spirally, and insulated from the spindle or shaft supporting them by means of moulded micanite; the ribbon before winding is given a special shape, in order to prevent the spiral coming apart sideways, consequently the metal strip and insulation when built up are of very solid mechanical construction, that no amount of vibration or shaking can possibly injure.

(To be continued.)

STEAM TURBINES
AND
THE CORRECT TYPE OF ENGINE FOR LARGE GENERATING STATIONS.

The following discussion took place in connection with Messrs. Fedden and Day's Papers on the above subjects at the meeting of the Incorporated Municipal Association on July 3rd. The Papers were published in our issues of the 18th and 25th.

Mr. HAMILTON KILGOUR (Cheltenham) was inclined to disagree with the conclusions which Mr. Fedden had arrived at after his tour through England of those stations using turbines. Mr. Fedden made the rather sweeping statement that it was inadvisable to put in turbines to exhaust into the atmosphere. This had recently been done at a very reasonable economy. The next statement in the Paper against the use of small turbines he entirely disagreed with. He had the results of some tests upon small turbines, and for a 50kw. machine the consumption of steam per kilowatt-hour was 28lb., for a 100kw. machine from 24lb. to 26lb., for a 500kw. machine from 20lb. to 24lb., and for a 1,250kw. machine about 19lb. to 22lb. These were all run condensing. Then, again, Mr. Fedden seemed to think the use of surface condensers was essential with turbines. At Cheltenham they used Körting ejector condensers, which delivered into a hot well from which the water necessary for supplying the boilers could be taken, and the rest was sent on to the cooling pond and cooled in the ordinary way. With the statement as to the advantages of the turbine, however, he was entirely in accord. Steam turbines seemed to him to be absolutely the ideal form of engines for driving machines in which only rotation was required. Again, as had been pointed out, the higher the speed of the working parts of the conductors of the dynamos the more economically was the material used. With slow revolution of the sets it was only possible to get the necessary high linear velocity of the conductors by placing them at a considerable distance from the axis of rotation, but this led to the use of a much larger amount of material, and the occupation of a very much larger amount of space. The entire absence of cylinder lubrication was of extreme importance, and with it, the question of superheating. All engineers, he supposed, were anxious to use superheated steam. They all knew that whether with turbine or reciprocating engine the use of this steam led to marked economy. With turbines it could be used without any countervailing disadvantage. With reciprocating engines a good many makers very much disliked the use of superheated steam, and if one obtained their sanction to do so they were always advised to use a much larger amount of cylinder oil. Comparing the turbine and reciprocating engine almost as children, he said the turbine was a hardy child, whilst the other was nice in its diet. They both wanted steam, but the reciprocating engine did not want too much water with it, and, again, required its food flavoured with a thick viscous fluid. On the other hand, the turbine did not care whether it was dry or wet steam; the latter only meant that it would run a little slower. But the absence of the cylinder lubrication gave a very important advantage. The exhaust steam was absolutely clean. The whole of it could be sent back to the boilers, with the advantage that the cost of softening more water was saved, as well as the cost of cleaning the boilers so frequently. Such experience as he had had with turbines led him to agree with Mr. Fedden as to the relative times of cleaning engines and turbines, the author's estimate of about one-sixth being right. His own feeling was very much in favour of the turbine, although he had had a good many troubles which had not been inherent to the turbine, however. For instance, the railway company had been the direct cause of one trouble, and a little more care as regards accessories would have averted another.

Mr. C. H. WORDINGHAM thought Mr. Fedden had overlooked one or two points. Nothing was said about the price of the steam turbine. It so happened that he had had occasion lately to get in tenders for high-speed engines for small sets. The question of price was of some moment, and central station engineers were much too apt to look upon working costs, carefully putting out of sight the standing charges. In getting in tenders as he had mentioned, for high-speed engine sets, the turbine people, quite unasked, sent in a tender which was 50 per cent. more than for the engine set. He would like to know a little more about the use of steam turbines for continuous-current work. At one station at which he inquired they were very pleased with turbines, but he found out that after 18 months' wear the steam consumption was 57lb. per kilowatt-hour. These machines had to be inspected very often, but if frequently inspected very high economy could be obtained. Although Mr. Fedden had pointed out some very important advantages of this type of engine, he had not mentioned one—viz., the shape and low height of them. The low height enabled a reduction in the height of the engine-room, and, in consequence, the cost of the buildings. For alternating work especially there was no doubt that the steam turbine had a very large field before it. But had it quite emerged from its experimental state? No two successive turbines were ever exactly alike. No doubt they were being improved, and one would be very sorry to see people stand still, but it was necessary to arrive at some finality before really adopting the steam turbine. Passing on to Mr. Day's Paper, it was quite evident that the Lancashire practice in Bolton had very greatly impressed the author, who had referred to the good work done by horizontal engines in mills. The mill engine, however, was not the same thing under the varying load-factor and the exacting work of the central station as in the mill. No doubt the engines were very economical, but they did take up a lot of floor space. Mr. Day said, in effect, that power stations would be so placed in the future, that the cost of land did not very much matter. It was often lost sight of that a saving in floor space must not be regarded only as a saving in land. Land might be cheap, but buildings were not, and the

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matter must be looked at from the latter point of view. If an engine was put in which took up an inordinate amount of floor space, large buildings would have to be put up, as also would travelling cranes of large span, and a large number of other expenses would have to be increased, apart from the question of the cost of the land. The second point in Mr. Day's Paper was that with the horizontal steam engines the steam pipes could be reduced to a minimum. But large engines necessitated a large number of boilers, and the author truly remarked that if it was impossible to have compact boilers, there was no necessity for compact engines. However, he did not quite follow the argument that the steam pipes could be kept underground and greatly shortened with horizontal engines, because boilers which were compact in floor space were necessarily high, whatever the type, and it seemed to him that with horizontal engines the vertical length was in the boiler house instead of in the engine room. He quite agreed that the horizontal engine could be kept clean and respectable at a very much lower cost than a vertical engine. As to Mr. Day's fourth point, his own opinion was that, inasmuch as the Corliss valve gear was equally applicable to the vertical as to the horizontal engine, there was no point in this connection in favour of the latter. The author's fifth point as to the inaccessibility of vertical engines was entirely got over by the fact that they were not obliged to divide the magnet ring horizontally. It would be divided vertically, and the two pieces slipped apart or removed sideways. Then Mr. Day spoke of placing the dynamo between the two cranks. He did not know whether the author would stick to two cranks with a triple-expansion engine or not. If they did not use steam turbines, compound engines with tandem cylinders and three cranks should be used. There was a little slip in the seventh point. The author seemed to imply that the turning moment was altered by putting on a heavy flywheel. This would not affect the turning moment, but it would affect the angular velocity. This Paper looked a long way ahead, and it seemed to him that if they were going to look so far ahead as this, they should look for gas engines and not for steam engines.

Mr. HAMILTON KILGOUR remarked that when he obtained tenders for 500kw. turbine sets, the price was 20 per cent. lower than the lowest of the engine tenders.

Mr. T. P. WILMSHURST (Derby) thought the subject of Mr. Day's Paper was an opportune one, because the era of the so-called central station was passing away, and its place was being taken by the power station for all purposes. He took it that the principal points which determined the use of the high-speed engine originally were ground space, the necessity for running at a high speed in order to do away with the inefficiency of ropes and belts, and also, indirectly, on account of the low load-factors which were general in the early days, because it was considered necessary to have a large number of small engines so as to be always working any particular engine at its maximum load. There was no doubt that the tendency was to put the power stations further out from the towns, and he was rather inclined to agree with Mr. Day that the horizontal low-speed engine would be used to a very large extent in the future. There was one point which the author had rather confused. He said, in effect, that an engine should be either high speed or slow speed. Personally, he did not quite follow the reasoning of that. Why should they not have a moderate speed engine? The objection to high-speed engines was not so much the number of revolutions, but the high speed of the piston, and especially the valve gear. This latter objection, as they all probably knew, had been very ingeniously met in the Ferranti engine, in which the valve gear travelled at a considerably lower rate than the speed of the engine. He had had several years' experience with this type of engine, and it worked exceedingly well. With regard to the question raised by Mr. Wordingham as to slow-speed horizontal engines being old-fashioned, he thought those of them who went over the Shepherds Bush station would hardly call that old-fashioned. He had seldom, if ever, seen any station working more smoothly with slow-speed horizontal engines than that one. Apart from the question of ground space, the principal objection which was usually urged was the danger of uneven wear in the cylinder liner. He had seen engines in Yorkshire which had been running for 30 or 40 years in which the wear was not the thickness of a sheet of writing paper. He always thought it was a striking testimonial to the solidity and excellence of British engineering to see some of these old mill engines which had been grinding out 60 hours a week for perhaps 40 years in almost as good a condition as when they were new. At the same time, he did not go quite so far as Mr. Day, although he thought the slow-speed horizontal engine had a good future before it. He should like to hear a few remarks about large size gas engines, a subject which he thought the title of the Paper did not preclude discussion upon. Personally, he knew nothing about them, and he would like to hear the views of gentlemen who had studied them. He could only say that if large gas engines gave as much vibration as the one at the Agricultural Hall [where the meeting was being held] he should not think there would be many applications for them in the future.

Mr. S. Z. DE FERRANTI said that the subject was as important as all the rest of the subjects which electrical engineers were dealing with to-day put together. It seemed strange that there were any engines in the country other than turbines, seeing the time when these were started. Looking at the beautiful simplicity of the turbine many years ago, and what it was capable of doing even in 1894, one would have thought that there would hardly have been any business for any other class of motor for driving electrical machinery, and it was hard to form an accurate idea of why it had not met with a greater success. He had been working on the problem himself, and had just got far enough to find out what a very difficult one it was. It was easy enough to make something which would go round, but it was very difficult to make something which was fairly economical and to make something which was substantially ahead of anything that had been done before was a very difficult problem. He thought one of the reasons why steam turbines had not progressed more rapidly was because of their somewhat unsatisfactory partners in the shape of the dynamos which they drive. In the first place no good at all had been done with the driving of continuous-current generators by turbines. Small machines had been built which were fairly satisfactory, but the commutator trouble and that of balancing remained a very real and difficult matter. With regard to alternators, his opinion also was that the steam turbine had been greatly retarded through not having a better alternating-current generator to drive than it had up to the present. He did not say the machines were not efficient, or that they did not run satisfactorily, but, taking the thing as a whole, these machines did not compare well with moderate-speed generators. High-speed generators had critical speeds. Even in quite modern installations, where turbines had been installed up to 1,500kw., the vibration of the generators gave very considerable trouble one way or another, both to the turbine and to the alternator. He thought it was certainly a very great handicap for turbines that there was not a good continuous-current generator which would be as satisfactory as the moderate speed generators which were driven by reciprocating engines. It was a problem which a great many people had looked into and found very hard of solution. With regard to the question of the cost of high-speed electric generators, one naturally thought the higher the speed the lower the cost. But when they came to figure out the cost of the electrical parts of the generator it would be found that this was a most delusive thing. They did not get a very much cheaper machine. Taking a revolving-armature alternating-current generator driven by a turbine, an exceedingly cheap machine was obtained, but many people had come to the conclusion that this was not a sufficiently satisfactory form for permanent installations in any great works. These people looked towards the revolving field type, and taking a 1,500kw. generator of this type, running at 1,200 revs. per min., it would take as much material, and cost almost as much, as a similar machine running at 250 revs. per min. Still, he did not think this need be any great handicap to the development of turbine work, as the other economies which resulted from the use of them were of very great importance. There was no motor which it was more important to give dry steam to than the turbine. Prof. Thurston, in America some years ago, was making experiments with small de Laval turbines, and he found that keeping the boiler pressure and everything else constant, and superheating the steam to 100°F. only, he got double the work out of the turbine, and at an immensely increased economy. It was just the worst thing possible to give turbines wet steam; probably worse than ordinary engines. Some one had spoken about whether turbines were out of the experimental stage. The Metropolitan Electric Supply Co. used steam turbines some years ago for the purpose of saving vibration, but when they came to build their large Willesden station, they put down at first moderate speed reciprocating engines, and for their latest extension slow-speed Sulzer engines. With regard to the eventual maximum economy which it was theoretically possible to obtain with a gas turbine, scientists seemed to have very divided opinions upon this, and most of the Papers which he had been able to collect upon the matter seemed to point to a low efficiency theoretically for these machines. He thought this was wrong but had no proof that it was so. With regard to Mr. Day's Paper, steam engine practice was very much the same as electrical working. All systems could be worked, and he entirely disagreed with Mr. Day when he said that there was one thing which was right. Personally, he thought horizontal slow-speed engines were most excellent engines, if one was prepared to pay for the building which contained them. But it was possible to get just as fine a result in other ways. With other types of engine it would be possible to get equally low costs of generation with a much lower cost for interest and sinking fund, which, after all, was the great bugbear of municipal engineers on account of the repayment of loans. Mr. Wilmshurst had remarked that if the gas engines of the future were like the one at the Hall—which, by the way, proposed to be the great gas engine of the future—they would not have much chance. He thought people would stand a good deal of noise if it was cheap. Very fine gas engines were made to-day, and there were many on the Continent of over 1,000 H P. working with cheap gas, and it did seem extraordinary how, this being so, they could not be used to advantage in English central stations to-day. But there were several reasons for it. One was that for big powers they mostly wanted to drive alternators. Although some works were being driven by gas engines running alternators, there was not much general practice on the subject. He had been making enquiries on the Continent lately, and had only found one case in which low-tension alternators were being driven by gas engines. Another reason was, that it was not necessarily the engine which ran at the lowest coal consumption which would bring the total works costs down to the lowest figure. He knew one works driven by gas engines put in several years ago, where, notwithstanding very low fuel costs, they took the gas engines out and replaced them by ordinary steam engines, which relatively had a greater economy simply because of the consequential damage which arose due to failure of the gas engines. Gas engines for electrical purposes had not got out of the experimental stage, and these two reasons put together—viz., the difficulty of dealing with alternators in parallel and the unknown quantity as regards costs and maintenance of the engines and producers—were responsible for the fact that gas engines were not being used to-day for our large plants.

Mr. W. A. CHAMEN (Glasgow) said that, so far as he had been able to judge, the cost of turbine sets, as compared with high-speed engine sets, was less, and not more. With regard to the point that steam turbines were still in the experimental stage, he would like to remind them that on the Clyde there were some large steamers fitted with Parsons steam turbines. One had been put into service last summer, and had been such a success that another had been added to the same service. If marine engineers were coming to the conclusion that the steam turbine would suit them, it might be expected that electrical engineers would also get something suitable. There had been some difficulties with regard to the dynamos used, and undoubtedly at the present time the commutator was a trouble, and possibly an expense. One of the peculiarities of the com-

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mutators of continuous-current dynamos driven by steam turbines at high speeds was that it was quite impossible to use carbon brushes with them. It appeared that the friction was so great that when the necessary pressure was put on to keep the brushes in place the carbon took fire. In spite of this and other difficulties, however, it was interesting to know that the Manchester Corporation—at least, so he was assured from two independent sources—had ordered two 1,800kw. sets of Parsons turbines with continuous-current dynamos. With regard to gas engines, it was possible that, while on first reverting to the use of gas engines they might have to be content with slow speeds, it was quite possible—if the makers were properly encouraged to put all their energies forward—that the same stages as regard speed would be gone through with gas engines as was being done with steam. He thought, therefore, that in the end gas turbines would be reached. At present no one knew how to start to make a gas turbine. He had had several talks during the past few months with various people of considerable authority, and unless it was that they did not care to divulge their secrets, he was bound to say that there was not a single man who seemed to have the least idea of how to start. He understood that the problem was one following on the line of what was called the continuous-combustion gas engine, and when he said that there was not a single one of these in use at the present time, it would be seen that there was some distance to travel before the gas turbine was arrived at. He could not help thinking that here again they had lost tremendously by the death of Mr. Willans several years ago. He was the man who brought the high-speed gas engine into its present condition. The question of drainage had been referred to in Mr. Day's Paper, and he need not remind his audience that there was not a more perfectly drained engine than the Willans. Some rather unpleasant remarks had been made regarding the vibration of the gas engines in the meeting hall, but he was sure no more would be made when he said that he put in the first three of those engines some years ago. When erecting them he had specially designed the foundations with a view to the avoidance of vibrations in the Berner's Hall [in which the meeting was being held], but when the machines were put into operation they danced about to such an extent that when the contractors left the authorities filled the foundations up with cement, and so made them solid instead of elastic foundations. The installation had been running for seven years now, and there must be something in gas engines, because the Agricultural Hall authorities, who were the keenest business people he knew of, had increased the size of the installation since then.

Mr. F. A. NEWINGTON (Edinburgh) said he was very well satisfied with high-speed engines.

Mr. C. P. MARTIN (of Messrs. C. A. Parsons & Co.), taking up Mr. Wordingham's remark that the price of 100kw. turbine sets was about 50 per cent. higher than reciprocating engine sets, said that, as a rule, his firm's price for that size was about the same as the best class of English engine. It was considerably higher than the Continental types of engine, however. With regard to the commutator of continuous-current machines, they were now making movable brush gear which was connected through a relay with the steam chest, so that the brushes were moved round according to the steam pressure in the chest, and he had 1,000kw. sets upon which the whole load could be put on or taken off with practically no sparking. With regard to alterations in the turbines themselves, he said there was very little difference in different machines. The bearings and valves were all absolutely duplicate in the same sizes, and very little change had been made during the last five or six years—merely detail arrangements in the blades. There was more alteration in the dynamos and alternators, but it was necessary to make alterations to keep up to date. Nowadays revolving field alternators were being made, and probably they would not make any more large-sized alternators with revolving armatures. Some revolving field machines were working already, and were very satisfactory indeed. In regard to the vibration of the turbine there was a certain amount occasionally when running them up to critical speed, but when properly balanced this was very little indeed, and only lasted for a second or two. As to wet steam it was merely a question of efficiency. Wet steam had the same effect upon a turbine as it had upon a reciprocating engine. Water coming in with the steam could not do any damage. It cleared itself very rapidly. At the present time the speed of the machines was too fast to allow of the use of carbon brushes. Later on they would be tried with larger continuous-current machines. Mr. Ferranti had raised the question of turbines not being put in at the Willesden station of the Metropolitan Electric Supply Co., but he thought the reason why that company went abroad was because at that time no one in England had made engines or dynamos of that size.

Mr. WORDINGHAM said, on the question of price, that the sets he referred to were not cheap Continental engines, but Belliss engines and Westinghouse dynamos.

Mr. MARTIN replied that there must have been something out of the way. Usually for 100kw. sets the price was about the same.

Mr. A. B. MOUNTAIN (Huddersfield) said that he could not help thinking that high speed was essential whenever electrical work came in, and sooner or later turbines must win the day. He could not agree with Mr. Day, as he did not for a moment believe that horizontal engines were the correct thing. Mr. Wilmshurst had mentioned an engine in Yorkshire which had been running for 40 years without any new liners being necessary. He would suggest that that engine had had about half-a-dozen liners, and the one Mr. Wilmshurst saw was the latest. Some time back he was getting tenders for plants where the makers guaranteed different steam consumptions, but he had never yet seen a figure which would compensate him for an increase of capital. In round figures 1lb. of steam represented £760 additional capital. He would suggest that if it were possible to get some really reliable tests of their different plants, and have them compiled for future discussion, this would give a basis upon the true merits of different engines could be calculated. His experience of engine builders had been a little bit unfortunate. Perhaps it was his own fault. It was almost impossible to take the guaranteed figures as the figures which would be obtained on their own works. Mr. Fedden had mentioned the question of vacuum in the turbine, and started his column with 29in. If there was any electrical engineer present who actually got 29in. he was a very lucky man. It was nearly always about 22in. or 24in.

Mr. CRAWFORD (Messrs. Belliss and Morcom) said that from an experience with turbines since 1892 he was convinced that it was all right, and that the fault lay with the electric generator, and he was prepared to say that as soon as electrical engineers in this country produced an electrical generator to enable the turbine to run at its proper speed, he could introduce one firm of mechanical engineers in this country who could build a satisfactory turbine to couple up with it. At present the conditions were not altogether fair for the turbine. Turbines must necessarily run at one given speed and output. The valves could not be set for half load. There was one well-known comparative instance of this kind—viz., the torpedo-boat destroyer "Viper," which was fitted with turbines, and another ship fitted with expansion engines. The results of the official trials were, roughly, that the ship fitted with the turbines got about half a knot more speed than the other, but the consumptions were something like 6¾ to 7¾ in favour of the triple expansion. But the half-load trial produced a consumption on the part of the turbine of about twice what it was with the other, and the result was that both turbines and engines were to be fitted, the one for cruising and the other for full speed. It was very difficult to follow Mr. Day in what he meant by high and low speed. High speed might mean high revolution or high rate of piston operation. Mr. Ferranti had drawn attention to the fact that the question of high and low-speed engines was altogether a commercial one, and he (the speaker) thought that if people used slow speed, the time when they would regret it would be seven years after purchase.

Mr. LEONARD ANDREWS (Hastings) said that at Hastings 18 months ago a steam turbine had been put in, not because is was believed to be the best thing, but because the space at their disposal was not sufficient to allow of anything else. But up to the present time they had had no reason to regret the step. Mr. Kilgour had mentioned that it was not absolutely necessary to have a good vacuum. (Mr. Kilgour: I did not say anything of the sort.) This had not been his experience. He had found that unless there was a good vacuum the economy was not very good. The only water they could get at Hastings was town water, and the only way to get a vacüum was to use a cooling tower. This entailed the use of a fan, and in order to get a good vacuum they had, at any rate during the summer, to spend about 20 per cent. of the coal necessary to generate steam in other respects on driving the fan and turbine. This steam consumption had appeared to him to be such a very heavy portion of the total that he had tried the experiment of working an eight-hour shift without the vacuum, and it might be interesting to give the results obtained. The coal necessary for generating the steam and driving everything, with the exception of the fans, cooling tower, &c., was 64cwt., the coal used for driving the fans and circulating pump was 12cwt., a total of 76cwt. condensing. The following day he tried a similar experiment under the same conditions but non-condensing, and the total coal used was 91cwt. The plant he had was very satisfactory so long as it was running by itself; but it also went into parallel perfectly with a Mordey alternator, which was probably a good test of its capabilities. At the same time, all the while it was in parallel there was a certain amount of surging current passing between the machine. The contractors said they could get over this, but up to now they had been making such use of the turbine set that no chance had been given the makers to overcome the trouble. But no doubt it would be got over. One speaker had referred to the economy not being good at light load, and probably he was referring only to the use of them on board ship. The light load there was slow speed, and a turbine was only economical at top speed, and no comparison could be formed between its use on ships and in central stations. His experience was that the most economical thing he could do was to run the turbine set from one year's end to another, for the steam consumption came out less than it did when working the 100kw. sets. He was nervous, however, as to what would happen if the plant broke down. He had an experience shortly after it was put in. The contractors arranged the barrel so that it was slightly nearer the top of the cylinder than the bottom, so as to allow for wearing. They had adjusted it rather too finely, however, and the blades just touched the top, and some of them broke. But this had not been noticed, and the machine had been going on working without affecting the supply at all, and it was only when the set was taken to pieces and overhauled that it had been found out. It only took a little more steam. As to price, he had not got tenders from engine builders in competition for this turbine because the turbine was the only thing he could use, but the impression he got at the time was that the price of a 500kw. turbine, with condenser, was practically the same as a reciprocating type of engine without the condenser. No reference had yet been made by any of the speakers to an interesting type of engine which he had seen running at the Manhattan station in New York. On this engine the low-pressure cylinder was vertical, and the high-pressure horizontal. This engine appeared to be working very satisfactorily, and he should like to hear if anyone else knew anything about it.

Mr. W. W. BOOTH thought the question of condensation was not so important to a turbine when it was working at constant load and full power as when it was working underloaded. When it was working underloaded and taking its steam in gusts, air was apt to get back into it and be churned up by the blades, and this caused considerable friction, and to that cause was due the loss of economy when working non-condensing. Mr. Day had spoken up for the horizontal engine, and had made a very good case for it. The vertical engine was a very badly drained engine. It was almost impossible to drain the top of the cylinder. Some vertical engine makers had placed holes round the cylinder at the lower end of the travel of the piston, and that certainly drained all the water that got down there, but in the case of high-speed the water did not get down there. The

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water entered with the steam, and before it had time to fall by gravity to the bottom of the cylinder it was caught by the cylinder on its return stroke. Personally, he could not see where the great saving in space on the part of the high-speed engine came in. It was only high speed with regard to rotation; its piston speed was low, and it must, therefore, occupy as large a space as a low-speed engine. The horizontal engine had one great benefit—viz., with Corliss valves fitted it could be completely drained. The water which entered the cylinder dropped straight through into the exhaust valve, and was drained completely away at once.

Mr. J. S. HIGHFIELD (St. Helens) said it had always puzzled him why the builders of turbo-alternators did not go in for the inductor type of machine. The mechanical construction of this type was peculiarly suited for the high speed of revolution obtained with the turbine, and there were a large number of electrical reasons why this machine, which was not a very good one at slow speed, would be satisfactory at very high speeds. It seemed to him that slow-speed engines had had altogether too good a time during the discussion. The very excellent high-speed engines on the market had not been given sufficient credit, and he could not help thinking that the high-speed reciprocating engine was equally as good a type to use as any other. With regard to drainage, Mr. Chamen had put it very clearly that there was one pattern of high-speed engine on the market which had practically a perfect drainage, and although, as the last speaker pointed out, the piston speed of the quick revolution engine was not great, at the same time the number of impulses per minute was very large. It was all very well for Mr. Day to refer to pumping stations as models of what an electric power station should be, but there were a great many points of difficulty in a power station which did not in any way apply to pumping stations. One thing was that 200 H.P. or 300 H.P. was a decent sized pumping station, whereas in an electric power station there were often a number of units of this size. As far as cleanliness was concerned, he considered that with high-speed engines a station could be kept at least as clean—and even cleaner—than with horizontal slow-speed engines, and he could only refer to Mr. Holmes' big stations at Liverpool as cases in point. As to gas engines, he quite expected to use large machines of this class at an early date. There was no question at all that there were great difficulties with the gas engine, but he could not help thinking that we were on the right road to have gas engines of a very large power in electric stations, possibly up to 500 H.P., and the use of them would get rid of a whole lot of steam pipes and troubles, as well as an immense amount of auxiliary plant, such as condensing plant, which was getting to be a very serious matter.

Mr. W. H. TITTENSOR (Dundee) said that at Dundee plant was being put up pretty rapidly, and he had been disappointed to find that in the quarters in which he made inquiries everyone seemed to think that the turbine was the engine of the future only. His station had some historic surroundings which could not be done away with, and he would either have to put up a second generating station at his present rate of increase or face difficulties which could not be got over if he had to put in steam engines. He had been very much struck when he visited Bristol with the system adopted with the boilers. If the extra space was not available what were they to do; he could only say put one station on the top of the other, on the principle adopted at Bristol. He would like to have some information upon the steam consumptions which had been quoted to-day. Were they the results of trial tests and runs, because, if so, he was afraid they would not help much? The figures which were wanted should be taken from the weekly report sheets of coal and water consumed.

Mr. W. M. ROGERSON (Halifax) particularly referred to Mr. Wordingham's mention of one station where turbines were used which consumed 57lb. of steam per kilowatt. He said Halifax was the culprit. These turbines had been running for about 2½ years, and had practically never been overhauled, and he was very anxious indeed to find out what the turbines took after some years' running. Unfortunately, at Halifax they were very badly off for condensing water. The vacuum he could get in the run in question was about 4in. or 5in., and the result was that the pounds of steam per kilowatt were 57. He wrote to the makers and pointed it out to them. They came down and overhauled the thing, and at the present time, with a vacuum of about 9in. or 10in., the pounds of steam per kilowatt had come down to 33lb. Considering the fact that this was the figure guaranteed some 2½ years ago this was very good. Another point which struck him was that turbines could be got running in a quarter of the time taken for any of the steam sets. If anything broke down he flew to the steam turbines.

Mr. V. A. H. McCOWEN (Belfast) said there were a number of points in favour of the gas engine with cheap gas. He had always been able to get on to load from nothing in half a minute, which could not be done with steam. His sizes were about 100 H.P., but he had to pay the same price for gas as the ordinary consumers had to pay, and he had to compete against that price with his current, so that naturally he did not do very well. He had since gone in for steam and the fuel costs were about 1¼d. per unit for the fuel alone, against ½d. for steam. When a cheap power gas was available gas engines would really be the engine of the future.

Mr. MARTIN, reverting to the question of steam consumption mentioned by Mr. Crawford, said the turbine was not economical when running at varying speed, and for cruising purposes a special cruising turbine was used which was not in action at full speed. The "Viper" was specially built to run at 31 knots, and showed better steam consumption than other engines running at this speed.

Dr. PANTON (Bolton) said this Convention seemed to have been mainly designed for the amusement and instruction of the engineering members, and it seemed that none of the Papers contained anything which chairmen of committees could very well discuss. The matters which had been discussed were undoubtedly of immense interest to the chairmen of committees, whore presented the proprietors of municipal undertakings, and as had been wisely pointed out the questions of price, &c., were very important. In connection with this he would like to mention that in most stations the interest and sinking fund charges were quite as great, if not in some cases greater, than the cost of generating. Living in Bolton as he had done for some years, he had been immensely struck by the exceedingly low costs obtained in mills, and it was all very well for engineering gentlemen to jeer at mill engines. After all, would it not be better, instead of jeering at mill engines, to try and improve the load in electric lighting and power stations approximately more nearly to the conditions of even load. Chairmen of committees came to the annual meetings to be instructed what they should do in connection with the sets which would be put down in the future, and they wanted to get a lead from the engineering members as to what should be done. Personally, he was afraid he had not come to any conclusions from this discussion, and, seeing the very low costs which were obtained in mills in Bolton, he was still, for the time being, in favour of standing by Mr. Day and his slow-speed engines.

Mr. J. F. C. SNELL (Sunderland), who was in the Chair, said that not very much had been said for such moderate-speed engines as Willans or Belliss. With respect to the long life of the mill engines and the low steam consumption, there could be no question as to the value of both, but he questioned whether, after an experience of 25 years with high-speed engines, there would be any gain in the low-speed engine so far as wear and tear was concerned. He, himself, had known of a well-known high-speed engine of which, after nine years' use in a lighting station, it was almost impossible to gauge the wear of the cylinder. He did not think that the question of space occupied was of very vital importance, because recently he had had occasion to prepare plans for a station, and he tried both low-speed horizontal and also high-speed engines. Of course, the space occupied by high-speed engines was less, but the question of boilers came very largely into play, as Mr. Day himself pointed out, and if it was a question of vertical engines and moderate speed as compared with horizontal engines and moderate speed, practically both of them took the same amount of floor space. He had recently heard of a test of a horizontal engine in the North of England in connection with an electric lighting station in which, with the use of superheated steam, the steam consumption was extremely low, and showed considerable economy over other engines of a high-speed nature, but while this engine only used 6d. of coal, it used oil to the extent of 2s. 9d. He hoped that would not stand for the usual horizontal low-speed engine. In the case of vertical engines of high power, there was no question that there must be a greaser on each gallery of the engine, and in the case of a horizontal engine of the same power a certain amount of saving would be found in that respect.

Both Mr. Fedden and Mr. Day, who will reply in the *Journal*, were accorded a hearty vote of thanks at the conclusion of the discussion.

NOTES RE EARTHING.*

BY H. FARADAY PROCTOR.
(City Electrical Engineer, Bristol.)

To avoid the constant repetition of somewhat extended phrases, it may be stated that in these notes the following expressions have been used with the somewhat limited application set opposite to them respectively:—

Installation.—Consumer's wiring.

Distributing System.—The distributing system external to consumer's premises belonging to the suppliers of energy, and from which several consumers are supplied direct.

An Earthed Conductor.—Any conductor which is itself earthed or is joined to another conductor which is earthed.

An Uninsulated Conductor.—A conductor which is not intentionally insulated from earth at any point.

An Unearthed Conductor.—A conductor which is itself insulated, and is nowhere joined metallicly to an earthed conductor.

Return Conductor.—The uninsulated or earthed conductor.

It is with a certain amount of diffidence that this Paper is written and presented to the members of the Incorporated Municipal Electrical Association. The consideration of earths intentional and earths accidental brings out some problems of very great interest—first, to suppliers of electrical energy, who probably think they know all about it; second, to consumers, if they were to know all about it; and third, to the insurance companies who, of course, do know all about it.

The writer has given a considerable amount of time to the consideration of the different problems, more especially in connection with the work of the Wiring Rules committee of the Institution of Electrical Engineers, and he has come to the conclusion that he knows little or nothing about the matter at all, since on that committee (it is probably no breach of confidence to admit) he was quite alone in his views touching this question. His complete ignorance and thirst for enlightenment must, therefore, be pleaded as the extenuating circumstances under which a subject on which all the engineering members of this association have already been circularised is brought to your notice. The following notes are intended to apply only to risks or inconveniences that may arise from work carried out on a consumer's premises, as affecting other work on the same or other premises supplied with electrical energy from the same generating system. As so many here have already considered the points in a certain order, perhaps the wishes of those present will be best served by that arrangement being now adhered to.

* Paper read before the Municipal Electrical Association, July 4th.

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1. Where one conductor of a two-wire installation is uninsulated throughout its length, and is joined to a similarly uninsulated conductor of a two-wire supply system, it is obviously advisable to have the uninsulated conductor so arranged that it cannot be accidentally interrupted, and, therefore, all switches and fuses should be inserted in the insulated conductor only. Were the uninsulated conductor severed at any place at a time when there would be a tendency for a current to flow, such current would take any path left open to it, and there would be a risk of electrolysis at gas or water pipes, either on or off the premises containing the installation, and also of earth currents possibly causing other electrical disturbance.

If the distributing system were to be earthed at one place only, instead of having one uninsulated conductor, the connection of installations with one pole uninsulated would not be permissible, since the fall of potential between the single earth on the distributing system and the multiplicity of earths on consumer's premises would lead to troubles. The use of an uninsulated conductor buried in the ground is probably out of the question, owing to the difficulties that would arise due to rust and corrosion. If, however, a sufficient number of good earth plates were well distributed and connected up, no ill results should arise from the connections of installations with only one pole insulated. The greater the number of earths the less would be the risk of troubles from earth currents.

As regards the risk of interruption to supply on consumer's premises when one conductor is uninsulated from earth, the points for and against appear to be as follows:—

1. There is only one-half the length of conductor to be kept insulated.
2. If an earth develops on the otherwise insulated conductor something is sure to happen, whereas if the same occur and the other conductor is insulated something is not "sure to happen," although in all probability it will, since it is likely that a friendly neighbour, who also has "the supply," will provide the earth on the other pole.
3. If there be any fault it probably develops at once, whereas if both conductors are supposed to be insulated the fault may only develop when an earth occurs on the other pole at some different part of the system. Since most irregularities on installations are caused at times when some alteration is being made, it is distinctly desirable that a fault should show itself at once rather than await some inopportune moment, as is too often the case under existing conditions.
4. Economy as regards first cost of installation.

2. Where the neutral conductor of a three-wire installation is uninsulated throughout its length the arguments set out above all apply.

Reverting to two-wire installation (as in No. 1), consideration must also be given to the question of a change-over from one side of a three-wire distributing system to the other. If a two-conductor installation be connected to a three-wire distributing system where the neutral is connected to earth at one or more points (presumably the earthed conductor will be intermediate to the other two as regards electrical potential), and it is desired to change over such installation to the other side of the system, say for the purposes of balancing, the following points arise:—If one conductor of the installation be earthed or uninsulated, the change-over must be so arranged that that conductor shall continue to be joined to the neutral or earthed conductor of the distributing system, but if the supply be continuous current this means a reversal of polarity on the premises necessitating a change-over of each arc lamp, Nernst lamp and any other selective apparatus there may happen to be on the premises, and where arc lamps have one pole to frame, and the frame has been earthed, the frame under the new conditions must be carefully insulated.

These troubles do not appear if alternating current is used.

To ensure criticism and afford the members as much amusement as possible, the writer ventures to express the opinion that where a distributing system can be properly equipped with a sufficient number of earths, it is admissible from every point of view (with the exception of that allowing for the inconvenience of a change-over from one side to the other of a continuous-current system), and desirable from reasons of economy, to allow the connection thereto of installations having one conductor uninsulated from earth throughout its length, and that on such a conductor there should be no switches or fuses. It is only under such conditions as these that the use of a complete three-wire system should be permitted.

3A. Where on a two-wire system one conductor is earthed at one place only, say at the generating station, it is, as previously pointed out (see No. 1), inadmissible to allow any earth or uninsulated conductor on a consumer's premises, for if an earth fault occur on the earthed conductor, the two earth connections will shunt the return current, not only of the particular installation on which it exists, but of all other installations on the same disiributing system, and if this conductor is not protected by fuses on the supply side as well as the lamp side a dangerous amount of current may be carried through it in the vicinity of the earth fault; and for this reason it appears desirable that fuses be used. Suppose, however, that fuses are used, and that the fuse on the supply side of the earth fault were to operate, the flow of current to earth at this fault would cease, except from that portion of the installation *away* from the supply side of the fault. This portion of the installation would, however, have to pass the whole of its return current through the earth fault; it is, however, improbable that the fault should have so low a resistance that there would not be some conspicuous fall in the voltage, consequently the fault would soon be observed and remedied, whereas if there were no fuse there would be no result to indicate the irregularity until an actual burn-out on the conductor had occurred.

Let us revert to an hypothetical example with figures.

Let us suppose that an earth having a resistance of 5 ohms develops on a conductor of a 5-ampere circuit of an installation.

This earth fault, and the earth at the generating station, will shunt the cables lying between them, current will flow to earth at the fault, not only from the installation on which it occurs, but also from all other installations in the neighbourhood; if the circuit be fused for 10 amperes, and the resistance between other connections in the vicinity and this fault be $\frac{1}{10}$th ohm less than the resistance between such connections and the generating station earth, then the shunt current from the flow of 600 amperes would sever the fuse, if the resistance back to the station earth were higher, say 1 ohm, then the shunt current from a correspondingly less flow—viz., 60 amperes—would suffice to blow the fuse. Suppose, however, that the fuse were non-existent, a greater flow would cause a dangerously large current at the earth fault, and, possibly, even the melting of the small conductors leading up to it.

Consider now the behaviour of the current from the particular 5-ampere circuit on which the fault exists, the leakage to earth will be comparatively small so long as the return circuit is unbroken; should it become interrupted, due to a large flow from other portions of the system or from any other cause, then the whole of the return current from this small circuit must pass through the fault.

It is, however, contended that this evil is less in extent than that of passing the much larger current to earth from other installations, especially having regard to the fact that such is as likely to occur when the faulty circuit is switched off at the non-earthed main as at any other time, and that the leakage to earth under these conditions will not be noticeable until a burn-out takes place.

A fault having a resistance of 5 ohms has been taken as an example in the endeavour to show that with even so high a resistance fault, the current from neigbouring sections of a system may be expected to burn out either the fuse or conductor of a 5-ampere circuit.

With a lower resistance fault, the probabilities would be correspondingly greater.

3B. The whole of the remarks made above with reference to 3A apply also to 3B where the system of supply being a three-wire one with the neutral conductor earthed at one place only, the installation is carried out on a two-wire system.

3C. Where an installation is carried out partially or wholly on a three-wire system it is preferable to avoid the risk of burning out lamps by not employing fuses on the neutral conductor which will be *likely* to give way and sever the circuit, but to avoid the more serious risk above referred to (see 3A), it still becomes desirable to insert fuses, and these, as before, should be of such size that they will protect the smallest conductor between them and the source of supply. If, however, the amount of three-wire distribution is very small in proportion to the two-wire work—for instance, if three conductors be taken from the supply mains direct to a board from which the distribution is carried out on a two-wire system—then it is better not to insert fuses on the earthed conductor until after it is split up into two-wire systems. These fuses, if inserted where the splitting up takes place, will protect the neutral conductor, right back to the supply service, from any heavy return current arising from an earth, as they will be placed practically on the ends of this neutral or third wire at the distributing board.

4. Where a conductor is joined to the neutral conductor of a supply system which is not intentionally earthed, it should always be borne in mind that such conductor may become earthed at any time, either at some point of the distributing system, or on any consumer's installation, and under such conditions it should be treated as though the earth existed.

4A. On two-wire installations fuses should therefore be used on both conductors.

4B. Where only a small portion of the work is carried out on the three-wire system—as mentioned under clause 3C—fuses should not be used on the intermediate conductor except beyond the point where it is split up into two-wire circuits. Where the whole is carried out on a three-wire system fuses should be used on all conductors, those on the neutral being proportioned as before described. Should, however, a person be nervous as to the burning out of lamps, or should the pressure across the outers of the three-wire system be such as would be dangerous when applied across the terminals of any apparatus used on one side alone of the system, then three-wire work should not be entertained.

Since the chief advantage of a three-wire system arises in connection with the use of pressures across the outers higher than it is permissible or desirable to give to the ordinary lighting consumer, one of the chief advantages disappears if the neutral conductor is not earthed, for under such conditions the public may become "shocked" to an extent that would surprise them; but the earthing of a continuous-current system in a manner that will obviate all forms of obnoxious earth current, both external to and within consumers'

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premises, is a problem which requires a certain amount of consideration. Mr. Snell may have a solution, but the writer is disposed towards the view that :—

1. Three-wire distributing systems are chiefly useful when the neutral conductor may be earthed.

2. The neutral conductor of a distributing system to be earthed in the safest of all manners, from the consumer's and fire office point of view, should be earthed at as many points as possible.

3. Where a distributing system is earthed at many points it is probably much to the advantage of all parties concerned that the current be alternating, as, although troubles might then be experienced if earth-return telephones were used, a state of equipotential can be most easily arranged for from a transformer-fed system, when no troubles from electrolysis can exist.

DISCUSSION.

Mr. F. C. RAPHAEL said that, looking at the matter from the point of view of the heat generated by the leakage current, if there was a fault from any main to earth there was a current passing from that fault to earth equal to the actual pressure of that main divided by the resistance. The heat generated at the fault was, therefore, proportional to the square of the volts divided by the fault resistance. On adding together the risks from faults on either main it would be found from this that there was the least risk if one of the mains was at earth potential. However, whether one of the mains in a house was at earth potential or at two or three volts potential practically made very little difference to this, and Mr. Proctor was risking a great deal, on the other hand, by suggesting that there should be earths all over the system. There was one point which was quite overlooked. Supposing there was a fault on a system, how was it to be localised, or how was its distance from the station to be found out if there were earths all over the place? By having a single earth connection at the station it could be allowed for and it was even possible to remove it to make a test. As to the question of putting a fuse on the middle wire, Mr. Proctor's numerical example could be made to show that in certain circumstances the fire risk would be much greater if there were no fuse on the middle wire. As to the earth return troubles affecting telephone systems, he thought Mr. Proctor was quite right. Let the telephone people use metallic circuits and put them underground if possible.

Mr. J. S. HIGHFIELD (St. Helens) said he thought there was no question that for safety of supply with a three-wire system it was better to have the middle conductor earthed only at one point, because, as the previous speaker had pointed out, if they had got a bad earth on the conductor, the earth connection for the time being could be severed, although this certainly put a very heavy stress on the insulated positive conductor. With regard to the fixing of the circuits connected to a three-wire direct-current system with the neutral conductor earthed, it appeared to him that the main fuses should be only on the two outer conductors and not on the neutral. He did not advocate the use of a three-wire system inside houses—*i.e.*, connecting the lamps across the conductors. Very nearly all practice inside consumers' premises was on a two-wire system. If the three conductors were taken into the houses, the whole of the lamps should be divided up into two two-wire circuits, with double-pole fuses on all the circuits. The reason that he liked the double-pole fuses was because when the negative conductor developed an earth, and the earth on the middle was disconnected, the potential of the middle wire rose to 200 volts above the earth. Going from the three-wire to the two-wire system, he said he had recently used circuits for motive power purposes with 500 volts with the negative conductor earthed, and in this case he liked to have the earth absolute. The negative ought to be earthed the whole time, owing to osmosis. In the North they had colleries on the mains, and they hoped to get more. In such systems it was much easier to keep the circuits insulated, whether supplied at 500 volts or any other pressure, with the negative absolutely earthed and using concentric conductors. Such a system gave most excellent security against rock falls, &c. He thought Mr. Proctor was not quite correct in his statement that with alternating-current systems no troubles could happen from electrolysis. It was a very great question as to whether this was so. He had in his mind some experiments made by Prof. Wilson, of King's College, on alternating-current electrolysis, and in these there was an enormous amount of energy absorbed in the electrolyte and electrodes. This being so, something happened somewhere, and he himself fancied that the plates would have been found to be eaten away.

Mr. F. A. NEWINGTON (Edinburgh) agreed with Mr. Highfield that it was very necessary to have fuses on the middle wire. One reason was that contractors were not always as careful as they might be. He himself would go a step further than Mr. Highfield in the matter of fuses at the entrances to buildings and have two complete circuits with four fuses. He thought Mr. Proctor did not make his own ideas on this subject quite clear.

Mr. L. ANDREWS (Hastings) had held the view for some time that it was much safer not to fuse the middle wire or the wire connected to the middle wire of a three-wire system. All the other speakers had seemed so strongly in favour of this that he did not know whether he might change his views or not. But they should keep this point in view—viz., that if the fuse went all the current went to earth. It seemed to him that for alternating-current work the simplest way out of the difficulty was to do as the author suggested, and earth the system throughout. He did not see that there were any peculiar drawbacks to this. At Hastings they were earthed. In tramway systems they were earthed throughout, and apparently the only objection to this was electrolysis, but with alternate-current work there did not appear to be any difficulty from this latter cause. At present, at Hastings, they were working with fuses on one pole only.

Mr. V. A. H. McCOWEN (Belfast) questioned the advisability of putting a number of earths in a system. He should certainly be rather afraid of it, as there would probably be a good deal of trouble in the localisation of the faults. With a system earthed at the station it was certainly much easier to localise, and he had found, by making an intermittent make and break there, and following up faults by means of a compass, that they were very easily found ; but with earths all over the system great difficulties were put in the way. With reference to the fusing of the middle wire, he thought that with the increased pressure the whole of the three-wire system should not be brought into the house, and that the supply should be divided and taken on both sides of the system with double-pole fuses throughout.

Mr. A. P. TROTTER said that the whole question of continuous earthing and continuous insulation of the middle wire was a matter of a good deal of interest at present. In every town in this country, except one, the practice now was to earth the middle wire at one point only, and in starting off from a sub-station with a new third wire, that wire was earthed at that sub-station. Until his attention had been drawn to the matter by this association he had only looked at the question from the point of view of house-wiring with concentric wires, the outer being earthed. This was a favourite practice in the North and was excellent for private house-wiring, and also the wiring of hospitals, ships, &c., but he could not find any engineer of large practice who would connect such a system to his mains. But since his attention had been drawn to the matter from a totally different point of view he had obtained a most surprising list of towns on the Continent where there was said to be no insulation at all on the middle wire. This list he had sent round to six or eight engineers privately, asking for their opinion on the subject. One hesitated to give any, and another said it might do for small jobs, but none of the rest would look at it. He also showed this list to Mr. Kapp, who said it was rather new to him, and on looking into it said it did not represent the whole of the load in some of these towns. In Berlin he understood the mains were very largely laid in dry clean sand, and thus it did not matter whether there was any insulation on any of them. One of the advantages strongly put forward was that if a fault occurred the fuses blew at once. But he asked, "Which fuses?" If they were going to shut down a street or so, they might stand this sort of thing on the Continent, but we would not have it here. When a fault occurred on the house-wiring here, it was only a short job for a man to put it right. But on the mains, were they going to fuse on their streets or their feeding points? Some of the serious troubles lately had been owing to the whole system being connected up solid with no fuses at all. He had not been convinced yet that abandoning the insulation on the middle wire was going to cause fuses to blow quickly. The idea seemed to be that if an earth was obtained it was a thoroughly good one. But was this electrically right? He did not see that it was. The whole question of the drop on the middle wire was vital in the consideration of this question. There used to be a regular condition in the Board of Trade for earthing, under which approval was given for connecting a circuit to earth. This said that there should be no fuses on the branches of the intermediate conductor. He had taken over this condition from Major Cardew, who had told him of the difficulties that might arise, and there were a good many conditions which were arising, and which were causing many engineers to think it was better to have no fuses at all, and that a conductor from the third wire to the switch should be treated as if it were earthed. But he was not at all sure of the difficulties that might arise, and he should like the discussion to go a little more into this. On the question of the middle wire, supposing it was well earthed at the central station, he said this condition of having no fuses had caused a good many questions to be put to him, as to where these "no" fuses ought to be put. He had been asked if they should go on the consumers' premises, but the Board of Trade had nothing to do with that. He had been asked if they should go in the service box between the mains and the house. He could not say that they should, because he knew there were no fuses placed at these points. The question had also been put as to whether they should be further back on the feeders. He often wished they could. Then he had been asked, "Could they be at the works?" But there were no fuses on the feeders coming out from the works. Not being quite clear, the condition in question had been knocked out at the suggestion of Dr. Kennedy, who had suggested instead a condition saying that the network should be cut up into separate sections connected by fuses. But people did not always like fuses, and the condition now was that fuses or links should be placed for connecting the various districts of a system. He was not at all sure, however, that they would not have to knock out the links and go back to fuses. This condition having been knocked out, people had come to him and said that as there were now fuses they ought to be put on the middle wire. But any risk in doing this was entirely the supplier's. With regard to the idea that there ought not to be any insulation on the middle wire, whenever insulation was asked for in the Board of Trade regulations, the question was, "How many volts are there?" and this was a matter which must be taken into consideration. Perhaps with a tolerably good system, the insulation on the middle conductor was not necessary. He was waiting to find some one who was willing to try this on fairly big jobs. It was hardly fair to introduce a thing of this sort into small towns, and after they had been working for some time to impose new conditions. As far as villages were concerned, he would much rather see them generally supplied by overhead wires. The whole object of earthing the middle wire was to prevent the volts on the main rising when the faulty main went to earth. This had been gone into very carefully in a Paper published some time back, full of numerical calculations, and it was easy to calculate from that Paper the resistance which should be put into the middle wire in order that with a heavy fault on the one outer the other outer did not rise too much. It depended upon the size of the job. The first thing, therefore, was to put as small a resistance as possible between the middle wire and earth. The next thing was to have an ammeter, and those engineers who did this got very useful results. There was one large job that

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he knew of where they had not earthed through an ammeter but simply had the good old-fashioned couple of lamps in series. When one went sufficiently bright, out went the man to find the fault. They must have good mains in that town because the faults were found very quickly. Fire insurance people were greatly averse to three wires being taken into a house. They must split up the wires into two pairs at once, and, as the Board of Trade regulations said that no system should ever give a chance of a 250-volt shock, a memorandum had been issued to the effect that when the three wires came into the house they should be split up and placed 6ft. apart, so that one could not get a shock. The wire which was connected to the middle wire was electrically the middle wire of the three-wire system all the way through. It was improper to put a fuse upon the neutral wire of the two-wire system which was led off from the three-wire system. Mr. Trotter then dealt with the last words of the Paper to the effect that troubles from electrolysis could not exist in connection with alternating currents, and referred to the experiments, an account of which we have already given in our issue of July 11, p. 458.

Mr. S. F. WALKER said that in the case of a mine, earth was the whole mine and the whole of the seams which were worked in the mine. His theory was that if earth was allowed to form part of an electrical system this introduced a series of conductors over which no control could be exercised. They had currents frolicking about all over the place, and the one way to get over the difficulty was to keep earth out completely. Mr. Highfield had said that for mining work the uninsulated return gave absolute security, but, unfortunately, this was not so. There had been two deaths, one of which had been absolutely due to the uninsulated return. One man got a shock from a 440-volt circuit for 10 minutes, and it killed him. With all respect to the Board of Trade and Mr. Trotter, he thought the regulation on this point would be altered by-and-bye. The remedy appeared to him to raise the whole standard of insulation, and particularly the standard of mechanical strength of the insulating envelope. Another point was that he understood it to be the general practice to burn out short-circuits. He could quite understand the joy with which engineers saw a little smoke coming up when the short was found, but it was a practice which could hardly be sufficiently condemned, and it was also a practice which was leading to a great many of the earth troubles. Every time a short was burned out by an engineer a considerable something was taken out of the life of the cables. Several of the explosions on electric lighting mains had not been caused by the illuminating gas. The various constituents of insulating materials were all hydro-carbons, and of the same nature as the gas of which they were afraid of in coal mines. With a substance of that nature it was only necessary for a sufficient quantity of heat to be delivered in it to convert it into gas, and in the City case the specific heat was comparatively low.

Mr. J. H. CLOTHIER (Stafford) did not agree with Mr. Trotter's statement that it came to the same thing whether a fuse were put on the middle wire where it entered the house or on the two branches taken from the middle wire.

Mr. F. BATHURST asked for "yes" or "no" with regard to this possibility of earthing, because of the high initial cost of wiring. Wiring contractors left the engineers to their own business in getting the power into the house, but if they (the wiring contractors) were allowed to use the earthed return in the houses, this would decrease the cost of wiring, so as to increase the supply of the power stations.

Mr. W. B. ESSON thought the "yes" or "no" for which the last speaker asked really depended upon whether it was possible to get an efficient method of making an earth connection all through the system. With the earth only at the station, other earths in the houses would not be any good. The whole system must be earthed. There was no objection, save on the part of one speaker to the principle of earthing. The only objections had been made to the method of carrying it out. Mr. Proctor's statement that "where a distributing system can be properly equipped with a sufficient number of earths it is admissible from every point of view (with the exception of that allowing for the inconvenience of a change-over from one side to the other of a continuous-current system), and desirable from reasons of economy, to allow the connection thereto of installations having one conductor uninsulated from earth throughout its length, and that on such a conductor there should be no switches or fuses" was the whole gist of the matter; but even this did not express quite all they wanted to do. They wanted to make the middle wire of the system, or the one wire of the two-wire system, an efficient and complete earth throughout, not a number of earth connections here and there. Putting in earth plates would not quite do the business. And he was afraid that if they were allowed to earth throughout, it would require a considerable amount more of copper in the middle wire than at present, and he did not know how far the introduction of earth plates would be efficient. Certainly the copper would be increased. The basis upon which Mr. Proctor made his proposition was economy, and what they had to consider was how much more copper or how much more expense they would have to go to in providing efficient and complete earth returns throughout, and whether that would not over-balance the advantage of the present system.

The PRESIDENT, in proposing a vote of thanks to the author, intimated that the reply would be published in the *Journal*.

Electrical Inventions in Germany.—In 1900 there were 1,565 patents taken out for electrical inventions in Germany. For telegraphs and telephones the patents numbered 283; for primary batteries and accumulators, 208; thermopiles, cables, and distributing system, 368; motors and distribution accessories, 199; meters, &c., 149; lighting, 250; auxiliary apparatus, 58; heating and cooking, 50.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Fortschritte der Elektrotechnik." No. 4. 1900. Edited by Dr. Karl Strecker. (Berlin: Julius Springer.)

"La Traction Electrique par Contacts Superficiels du Système Diatto." By C. Julius. (Paris: Gauthier-Villars.)

"Annual Calendar of the McGill College and University, Montreal." Session 1902–1903. (Montreal: The Gazette Printing Co.)

"The Scientific Writings of the late George Francis FitzGerald, F.R.S., D.Sc." Collected and edited, with a Historical Introduction, by Prof. J. Larmor, F.R.S. (London: Longmans, Green & Co.)

"Dynamo-Maschinen ihre Berechnung und Construction Electromotor durch praktische Beispiele erläutert." By J. P. Bradwell. Nos. 6–12 inclusive. (Berlin: A. Stein) 2m. each, or 20m. complete.

"Science Abstracts." July. No. 55. (London: The Feilden Publishing Co.) 2s.

ELECTRICITY WORKS ACCOUNTS.

Sunderland Municipal Electric Supply Works.

Very few municipal undertakings can show a better all-round position than that held by the Sunderland electric supply works. During the last two years not only have the working expenses been reduced to splendidly low figures, but, what is quite as important from a financial standpoint, the capital involved has been kept down to a correspondingly creditable value in relation to the output.

The several items of cost are all consistently low, so that it is sufficient to point out that, compared even with the averages of concerns having similar outputs and load-factors, the works and the total costs are lower at Sunderland by quite 0·25d. per unit sold. An indication of the influence of low capital is seen in the ratio of the working profit to the mean capital—viz., 7·06 per cent.—with the remarkably low total revenue from all sources of 2·68d. per unit. In the year ended at March 31st last the traction supply constituted the largest part of the output. Of the total, 51·9 per cent. was sold for traction, 42·2 per cent. for private lighting, and 5·9 per cent. for public lighting.

Southampton Municipal Electric Supply Works.

In the Southampton undertaking we have another where the traction load forms a very material proportion of the total. Greatly improved results are shown by the accounts for last year, as compared with the results of 1900–01. The costs are still, however, somewhat higher than we should have expected them to be—the generating and works costs being, perhaps, too high by just the abnormal amount of the item of repairs at the station. These expenses are nearly double what they ought to be. However, the reduction in the costs had the satisfactory effect of giving a small net profit instead of the deficit which marked the operations of 1900–01, and, besides, there was paid in capital charges a total amount representing 6 per cent. on the mean capital.

Although the capital expenditure per kilowatt capacity of plant installed—£138—appears high, it is necessary to point out that, in relation to the output, the mean capital is most reasonable.

REMARKS.

SUNDERLAND.—*a* 1,350kw. lighting and 980kw. traction capacity. *b* Includes value of lands appropriated £2,500. *b* Repaid during year only. *c* Revenue from supply for traction included in "Revenue from Supply." *d* Buildings £44, engines and boilers £238, other machinery, instruments, &c., £9, and accumulators and accessories £120. *e* Engineers £720, clerical staff £355. *f* Insurance. *g* Wright system. *h* In summer; 2-hour period per diem in winter. There is an alternative tariff scale of discounts varying from 2½ per cent. to 20 per cent. *i* For traction 2d. per unit. *j* Includes lands appropriated £2,500 and lands purchased £4,500. *k* Over-expended. *l* Buildings £32, engines and boilers £647, accumulators £72, electrical and other plant £58. *m* Engineers £857, clerical staff £437. *n* Law £56, insurances £283. *o* Receipts per unit sold for traction and private supply combined was 3·26d. in 1900-1 and 2·7d. in 1901-2.

SOUTHAMPTON.—*a* Includes £21,100 on purchase of Southampton Electric Light and Power Co.'s undertaking. *b* Expended since purchase March 31, 1901. *c* Over-expended. *d* Traction power 2d. per unit. *e* After *adding* £276 "repayment of balance of maintenance of electrical equipment of tramways," and *deducting* £521 repairs to cars and overhead construction of tramways. *f* Buildings £45, engines and boilers £179, dynamos and motors £158, accumulators and accessories £65, other plant £320 and £526 hire of Westinghouse engine. *g* Of mains £661, transformers, meters, &c., £4 [illegible]. *h* Engineer's department £657, clerical staff £241. *i* Insurances £154, expenses of stock £73. *j* Buildings £108, engines and boilers £961, dynamos and motors £117, accumulators £261, other plant £180. *k* Of mains £457, meters, transformers, &c., £274. *l* Engineer's department £753, clerical staff £247, proportion of borough engineer's department £50. *m* Insurance £159, auditing £23, law £29, stock management £167.

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	SUNDERLAND.		SOUTHAMPTON.	
Undertaking Worked by	Sunderland Corporation.		Southampton Corporation.	
Date of Commencement of Supply	March, 1896.		1891.	
System of Supply	3-w. con.-curr. with batteries, alt. H.T. for out-	[lying districts.	3-w. con.-curr., with batteries and alt.-curr. with	[transformers in pits.
Chief Engineer	John F. C. Snell.		H. F. Street.	
YEAR ENDED	MAR. 31, **1901.**	MAR. 31, **1902.**	MAR. 31, **1901.**	MAR. 31, **1902.**
QUANTITIES—				
Units generated	1,331,844	2,646,315	1,252,078	1,856,216
„ **SOLD (TOTAL)**	**1,218,768**	**2,375,557**	**1,063,124**	**1,430,222**
„ sold to consumers	879,336	1,002,147	524,795	589,042
„ sold for public lighting, &c.	83,192	140,500	114,205	117,701
„ sold for traction	256,240	1,232,910	424,124	723,479
„ used on works	57,468	144,097	47,156	56,421
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**22·6**	**27·1**	**43·4**	**50·0**
Actual maximum supply demanded	1,114 kilowatts	1,640 kilowatts	568 kilowatts	1,143 kilowatts
Load factor	12·5%	16·5%	21·4%	14·3% [glow
Number of public lamps	54 arc	156 arc	74 arc, 92 glow	75 arc; 146 32-c p., 108 8-c.p.
Number of consumers	640	721	—	526
Connections to mains in 8-c.p. lamps at end of year	50,092	66,932	37,500	41,080
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	2,330*	**3,280**	**790**	**1,041**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	— —	— —	£121,326 £155	£126,066 £138
Share	— —	— —	— —	— —
Loan (including Debenture charges)	— —	— —	121,326 155	126,066 138
RECEIVED (TOTAL)	£122,805[a] £52·7	£199,670[a] £60·9	109,326 139	109,326 119
Share	— —	— —	— —	— —
Loan (including Debenture charges)	120,305 51·6	197,170 60·1	109,326 139	109,326 119
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— —	— —	12,000 15·3	16,740 18·3
Share (unissued)	— —	— —	— —	— —
Share (uncalled)	— —	— —	— —	— —
Loan (including Debentures)	— —	— —	12,000 15·3	16,740 18·3
REPAID (TOTAL)	8,822 3·79	13,565 4·13	2,192 2·79	2,269 2·48
RESERVE OR SINKING FUND	— —	— —	7,722 9·84	11,544 12·6
DEPRECIATION FUND	— —	1,346 0·41	— —	— —
EXPENDED (TOTAL)	122,433 52·6	199,782 60·9	115,638[a] 147	125,941[a] 138
Lands and buildings	17,866[a] 7·67	44,076[j] 13·4	20,721[b] 26·4	20,677[b] 22·6
Plant	57,948 24·9	90,660 27·6	45,403[b] 57·8	51,456[b] 56·2
Mains	44,538 19·1	62,747 19·1	24,312[b] 31·0	28,955[b] 21·6
Miscellaneous	2,082 0·894	2,300 0·701	4,102[b] 5·23	3,752[b] 4·10
BALANCE OF CAPITAL ACCOUNT	372 0·160	−112[k] −0·034	−6,312[c] −8·04	−16,615[c] −18·1
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£16,496 3·248d.	£26,543 2·682d.	£16,753 3·784d.	£20,872 3·504d.
Revenue from supply	15,441[c] 3·039d.	25,115[c] 2·540d.	11,622 2·625d.	12,709 2·133d.
„ meters, &c.	331 0·065d.	353 0·036d.	229 0·052d.	272 0 046d.
„ public lighting	718 0·141d.	1,071 0·108d.	1,309 0·296d.	1,760 0·295d.
„ supply for traction	—[c] —	—[c] —	3,532[c] 0·798d.	6,029 1·012d.
„ miscellaneous sources	6 0·001d.	5 0·001d.	61 0·018d.	102 0·017d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£9,242 1·820d.	£15,177 1·533d.	£13,085 2·956d.	£12,916 2·168d.
TOTAL WORKS COSTS	6,915 1·361d.	11,442 1·156d.	11,427 2·582d	10,388 1·744d.
Generation of electricity	*6,360 1·252d.*	*10,639 1·075d.*	*10,145 2·290d.*	*9,036 1·517d.*
Fuel (including cartage, &c.)	4,190 0·825d.	7,194 0·727d.	7,332 1·656d.	5,579 0·936d.
Oil, waste, water, stores	422 0·083d.	699 0·071d.	450 0·102d.	719 0·121d.
Wages at station	1,337 0·263d.	1,936 0·196d.	1,069 0·242d.	1,161 0·195d.
Repairs and maintenance at station	411[d] 0·081d.	809[l] 0·082d.	1,293[f] 0·292d.	1,577[j] 0 265d.
Distribution of electricity	*340 0·067d.*	*394 0·040d.*	*993 0·224d.*	*907 0·152d.*
Wages, &c.	340 0 067d.	394 0·040d.	84 0·019d.	161 0·027d.
Repairs, renewals of mains, &c.			909[g] 0·205d.	746[k] 0·125d.
Public lighting	*215 0 042d.*	*410 0·041d.*	*289 0·065d.*	*445 0·075d.*
Attendance	215 0·042d.	410 0·041d.	289 0·065d.	445 0·075d.
Renewals				
MANAGEMENT AND PROPERTY CHARGES	2,328 0·458d.	3,735 0·377d.	1,658 0·375d	2,528 0·425d.
Net rents	*99 0·019d.*	*273 0·027d.*	— —	*789 0·132d.*
Rates and taxes	*592 0·117d.*	*1,163 0·117d.*	*337 0 076d.*	
Management	*1,637 0·322d.*	*2,300 0·232d.*	*1,321 0 298d.*	*1,739 0·292d.*
Salaries	1,155[c] 0·227d.	1,436[m] 0·145d.	899[h] 0·203d.	1,051[l] 0·176d.
Stationery, &c.	47 0·009d.	182 0·018d.	72 0 016d.	108 0·018d.
Establishment charges	458 0·090d.	343 0·035d.	112 0·025d.	177 0 030d.
Law charges &c.	177[f] 0·003d.	339[n] 0·034d.	238[i] 0·054d.	403[m] 0·068d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£7,254 7·09%	£11,366 7·06%	£3,668 3·56%	£7,956 6·59%
Sum carried to Depreciation Fund	— —	1,346 0·836%	— —	— —
Sum carried to Reserve Fund	3,023 2·95%	4,743 2·94%	3,151 3·06%	3,516 2·91%
Net interest on loans (incl. Debenture charges)	2,974 2 91%	4,685 2·91%	3,310 3·21%	3,722 3·08%
Net profit for the year	1,257 1·23%	592 0·368%	— —	718 0·595%
BALANCE FROM LAST ACCOUNT	nil —	1,257 0·780%	— —	— —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	1,257 1·23%	1,849 1·15%	— —	— —
Deficit	— —	— —	*2,793 2·71%*	— —
ORDINARY DIVIDEND PAID	— —	— —	— —	— —
PERCENTAGE OF TOTAL COSTS TO REVENUE	56·0%	57·2%	78·1%	61·9%
Expenditure per mean kilowatt capacity	£5. 7s. 1d.	£5. 8s. 2d.	£16. 13s. 5d.	£14. 2s. 5d.
REVENUE PER MEAN KILOWATT CAPACITY	**£9. 11s. 5d.**	**£9. 9s. 5d.**	**£21. 7s. 0d.**	**£22. 16s. 5d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**7s. 9d.**	**9s. 1d.**	9s. 3d.	7s. 8d.
Price charged for lighting, per unit	5d. (1½ hrs.) to 2½d.[g]	5d. (1 hr.) to 2½d.[h]	6d. to 4½d.	6d. to 4½d.
Price charged for power, per unit	2½d.	2½d.[i] [ann.	3d.	3d.[d] [incan.
Price charged for public lighting	£16 per arc per ann.	£13. 18s. 8d. per arc per	£20 per arc	£20 per arc, £2. 2s. per
Receipts per unit for private supply	—[o]	—[o]	5·32d.	5·18d.
„ „ public lighting	1·45d.	1·13d.	2·14d.	2·68d.
„ „ traction	—[o]	—[o]	2 00d.	2·00d.

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WIRELESS TELEPHONY.

As we have frequently announced in our pages, a number of scientists scattered all over the civilised world are eagerly seeking the solution to the problem of wireless telephony. The achievements of Mr. Marconi and other workers in the field of wireless telegraphy have naturally suggested that, if Morse signals can be transmitted by ether waves, it ought to be practicable to use these waves for the wireless transmission of speech. From time to time, indeed, the report is circulated in the daily Press that some one or other investigator has actually succeeded in transmitting speech across several miles of space. Further inquiry, however, usually elicits the information that the method adopted does not correspond to the Hertzian method employed in wireless telegraphy. In fact, the wireless telephony of these scientists is in no real sense an extension or adaptation of Hertzian telegraphy. It follows quite a different line of research, depending upon entirely different principles. Thus, on Tuesday, the Berlin correspondent of the *Standard* described the wireless telephony experiments recently carried out by Herr Ruhmer, over a distance of 4½ English miles, between an accumulator boat moored off a small islet near Babelsberg and Karsberg, in the Grunewald. Loud and clear speaking is reported to have been heard. The method which Herr Ruhmer adopts is essentially optical, and consists in the action upon an electro-optically sensitive body, or "electric eye," of a beam of electric or other powerful light projected from the sending to the transmitting station. The prototype of this method was the so-called photophone, which Prof. Graham Bell invented years ago, in early telephone days. It is stated that in Prof. Ruhmer's experiments a parabolic reflector, only 35cm. in diameter, has been used, no reflector being employed at the receiving end. Success, however, has encouraged him to extend the range of his researches, and he will shortly repeat the experiments between stations 20 to 25 miles apart, using a reflector of much larger size at each station. We wish him every success; for, in spite of its obvious limitations, this optical method of wireless telephony has its uses, and it certainly is an improvement upon the ordinary heliograph. In military and, possibly, also in naval service work, it may find a field of application; and it is even conceivable that it might be used, in calm waters, between two distant ships or between ship and shore. For island lighthouses, also, it might afford a ready means of communication with the mainland. One of the chief merits of the method is that it can be carried on simultaneously between several pairs of stations within the same area without the possibility of messages interfering or going astray. There are, however, obvious limitations to the use of this method; principally, we may notice, that a clear and uninterrupted straight line, for the passage of the beam of light, must be maintained between the two stations, and the atmosphere must be free of rain or fog. Moreover, the cost of maintaining two powerful beams of artificial light between stations would be prohibitive for

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the purposes of ordinary commercial messages, and sunlight, of course, could not be relied upon always.

Another method of electrically transmitting speech across space is that employed by Sir WILLIAM PREECE. In this method the speech is transmitted across the intervening space between two parallel aerial wires, one of which acts as a transmitter upon the other as a receiver. A battery and a microphone in the circuit of the transmitting wire, and a telephone in the receiving wire, suffice to complete the simple equipment. But this is scarcely *wireless* telephony, the amount of aerial wire used being often much greater than the distance over which messages are transmitted. Nevertheless, for routes which cannot readily be spanned by an ordinary wire or cable this method is found to be serviceable and effective. We may note, in passing, that Sir WILLIAM PREECE, who has largely experimented on this system, has never conclusively settled the question as to whether it operates by electromagnetic induction or by the stray return currents through the earth. A very simple re-arrangement of the aerial wires would, in favourable weather, completely settle this interesting point. We trust he will adopt our suggestion at the next opportunity.

Neither of the foregoing methods of wireless telephony bears any real relationship to Marconi telegraphy. Unfortunately, the efforts of scientists to evolve a Hertzian system of wireless telephony, corresponding to Marconi telegraphy, have hitherto been futile. The difficulties are great; some of them appear almost insuperable. Imaginative persons have pictured a state of civilisation in which promiscuous conversation could always be carried on by means of pocket wireless telephones. Prof. AYRTON, for instance, has given us the pathetic picture of a man of those days, who, when unable any longer to call up a colleague in some far-distant country, would then "know that his friend was dead." Wireless telephony will have to make prodigious strides before we can rise to that degree of certitude; even, with the ordinary telephone exchange, it is by no means a safe assumption that a man is dead because he does not answer our call. Peradventure he sleepeth, or is on a journey; but more likely the exchange is not attentive. We publish, as illustrations to one of our articles this week, photographs of the London Wall exchange of the National Telephone Co., taken shortly after the disastrous fire by which this exchange was reduced to a complete wreck. The havoc which was wrought by this calamity, in the deprivation of hundreds of business men of an accustomed and almost imperatively necessary means of communication, is eloquent testimony to the immense advantage which would result from the invention of a wireless telephone system, such as Prof. AYRTON and others have described in language so imaginative. Yet we are compelled to admit that these things belong to fairyland and the world of dreams; not to the matter-of-fact everyday world in which we live. Nothing in existing lines of research, whether with Hertzian waves or otherwise, gives the slightest warrant for the inference that urban and inter-urban telephony will ever be carried on without the aid of conducting wires. It is, of course, quite true, and as trite as it is true, that we cannot claim to be able to perceive the limits of possible future scientific inventions. But that is not the point. A generation ago no one could foresee the telephone; less than three generations ago the electric telegraph was no more than the idle dream which wireless telephony is to-day. A future generation, therefore, may conceivably accomplish as much in wireless telephony as is dreamed of to-day by visionaries. But if it does, it will be by means of discoveries hitherto not even suspected, and by methods not even the germ of which can be detected in the wireless telegraphy of to-day.

THE FINANCIAL BASIS AND DESIGN OF ELECTROLYTIC METAL REFINERIES.*

BY ARNOLD PHILIP, B.SC., A.I.E.E., F.I.C.

Introductory.—If one takes up any treatise on the electrolytic refining of metals, or if one reads some of the admirable and detailed descriptions of some particular refinery such as from time to time have appeared in the technical press, one must be struck by the fact that in spite of the large number of figures given concerning current-density, size of vats, anodes, cathodes, &c., distance between the anodes and cathodes, H.P. of engines and dynamos employed, the output of metal obtained per year and many other important points, these figures appear to have little or no connection between themselves. There seems to be no underlying scheme or law of design. If, for instance, an electrical engineer is desirous of designing an electrolytic refinery (with a given amount of capital at disposal) in such a manner as to obtain the most satisfactory financial results, he must depend, at least in so far as published information is available, upon a hazardous and probably unnecessarily costly method of tentative trials which must be constantly modified subsequently. Or, if a new process of electrolytic refining is proposed and the details are given, there are at present but scanty means available to enable a technologist to check the claims on its behalf, or to predict in what direction improvements in the economy of the method are likely to be found.

The present writer has long been of the opinion that the seeming confusion of the large masses of apparently disconnected figures relating to electrolytic metal refineries which have appeared during the past 15 years and more, overlay a really simple set of relationships, and some years ago an effort was made by him to collect and tabulate all the available details in order to elaborate a connected scheme by means of which the task of designing an electrolytic refinery upon a sound financial basis might be successfully undertaken, and by whose aid a well-directed criticism upon the performance of any particular refinery or new process might be made with more certainty of success than has hitherto been possible.

The general method adopted has been to arrive at a formula for any given item of outlay, expressed in terms of all the variables involved, and then to insert in this a constant or constants obtained by calculation from all the available trustworthy figures hitherto published with regard to the particular item of outlay under consideration. This method of procedure will, perhaps, be more readily followed in a concrete example. Thus it is clear that the power employed in an electrolytic copper refinery must vary directly as the number of tons output per year if the current density is kept constant, and, on the other hand, that if the output is kept constant, then if the current density is doubled (neglecting the back E.M.F. at the electrodes which is small and constant), the voltage must be also doubled, whilst only half the total number of vats will be used; hence the power required must be doubled; but these are the only variables involved, and the required formula must be—

Cost in pounds of power plant = aTD.

Where a = a constant.

T = the annual output in tons of refined copper.

D = the current density employed in amperes per square foot.

If, then, we obtain from the published data, given for as many refineries as possible, the values of T and D and the cost of the power plant installed, we can choose the most probably satisfactory value to adopt for a.

It is, perhaps, not quite clear that T and D *are* the only variables involved, but a little reflection will, I think, show that such is the case. In order to keep within the limits of the space available for this Paper, I have not in any case discussed at length the question as to the reason for concluding that the variables involved are those selected, and those alone, but I think that it will be found that the formulæ are fairly

* Copyright. From a forthcoming work by the Author, entitled: "The Electro-plating and Electro-refining of Metals."

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self-evident. It is, however, true that in the case of some financially somewhat unimportant items, such as the cost of offices, the cost of electrolytic circulating and purifying plant, and the annual salaries of the management and clerical staff, a rather arbitrary method of estimation will be found to have been adopted. Generally, however, I think I may claim that I have clearly brought out the quantitative relationships which exist and which must always be true. I have, moreover, I consider, selected the most probable values for the constants involved, but if from personal bias or experience some other values for these constants are thought more reasonable, such change of constants in no wise alters the general scheme of the investigation.

Although the formulæ here given refer to electrolytic copper refineries, many of them may either be directly or with slight modification applied to electrolytic refineries for lead, silver, gold, or any other metal, and, as a matter of fact, all the formulæ, can be so used if proper and usually evident alterations in the constants are made. This has, indeed, already been done by the author, but the space limits prevent these results being included in the present investigation.

With this short introduction we may, then, pass directly to the substance of the Paper.

The Establishment of an Electrolytic Copper Refinery.—The first point to be considered when contemplating the establishment of an electrolytic copper refinery is the question of the amount of capital available for the undertaking. This important point being fixed, the other quantities necessary for making an estimate can be obtained, and should be considered in the following order:—

1. Current-density required.
2. Area of ground required.
3. Tons of copper to be refined per annum.
4. Profit available per annum.

From the order in which the above quantities are considered it might be imagined that the current-density is the ruling factor, and this is undoubtedly the case.

Capital Expenditure.—Each of the four quantities enumerated above will be considered separately further on, but in the first place the capital outlay, and the annual charges under every head of expenditure in an electrolytic copper refinery must be discussed.

The capital outlay in an electrolytic refinery must be made under the following nine chief headings:—

1. Cost of offices.
2. Cost of refinery buildings.
3. Cost of power plant.
4. Cost of dynamo and switchboard.
5. Cost of electrolytic vats.
6. Cost of electrolytic solution.
7. Cost of copper anodes.
8. Cost of copper in stock, with copper leads, &c.
9. Cost of electrolyte circulating and purifying plant.

The annual costs of refining may be considered under the following six chief headings:—

1. Interest on capital invested and depreciation and repairs on plant.
2. Total annual cost of labour required in refinery.
3. Total annual cost of melting refined copper into ingots.
4. Total cost of fuel used for power per annum.
5. Annual salaries of management and clerical staff.
6. Annual rent of ground covered by works.

Cost of Offices.—The cost of offices will, to some extent, depend upon the output of the works, and if T is the number of tons of copper refined per annum, the cost of the necessary works' offices may be reasonably represented by the expression

$$\text{Cost of offices in pounds} = 150 + 0{\cdot}1\,T \quad . \quad . \quad . \quad (1)$$

This would make the cost of offices £250 for a works having an output of 1,000 tons per annum.

Cost of Refinery Buildings.—The area of buildings required for a given output per annum depends upon the current-density employed in the works—that is, upon the number of amperes per square foot of anode surface, and, in fact, is inversely proportional to this density. The following data, obtained from various sources, will enable us to come to a conclusion as to the correct area necessary for a works dealing with an output of T tons per annum.

Table I.—*Particulars concerning the Area Covered by Various Copper Refineries.*

Works.	Authority.	Area sq. ft.	Output in tons.	Current density.	Sq. ft. per ton per year	Sq. ft. per ton per year per unit current density.
Hamburg, North Germany Refinery	Gore	7,104	330	1·11	21·53	23·68
Oker	,,	861	125	...	6·889	...
Marseilles	,,	3,228	89	0·77	36·27	27·92
Bridgeport, Connecticut	,,	12,000	5,720	15 (?)	2·098	31·47 (?)
Stolberg	,,	3,498	216	...	16·194	...
Anaconda	* *Electrician*	141,000	†64,280	10 (?)	2·194	21·94 (?)

* *The Electrician*, Vol. XXXVIII., p. 144, *et seq.*

† This is not the actual output of the Anaconda Works, but is the output they are designed to yield.

In the above table the areas of the works have been taken from Gore's "Electrolytic Separation of Metals," but the other details, as to current density, &c., are from Watt's accounts of the same works. (Watt's "Electro-Deposition," 1889 edition.)

From these results it appears that the area of the works required may be reasonably represented by the expression:

$$\text{Area of works in square feet} = 30\frac{T}{D}. \quad . \quad . \quad (2)$$

Where T = output in tons per annum, and D = the current density employed in amperes per square foot.

Now if the height of the building is 15ft., and if it costs 4d. per cubic foot, the cost of the building over the area $30\frac{T}{D}$ square feet $= \frac{30T \times 60}{D \times 240}$ pounds $= \frac{30T}{4D}$ pounds. That is, the expression for the costs of works building is:

$$\text{Cost of works buildings in pounds} = \frac{7{\cdot}5T}{D}. \quad . \quad (3)$$

The cost of the works buildings, therefore, for an output of 1,000 tons of copper per year, and employing a current density of 10 amperes per square foot, is £750.

Cost of Power Plant.—The power required in an electrolytic copper refinery varies directly as the output in tons per annum, and also varies directly as the current density employed.

The following results as to the power required in electrolytic copper refineries are obtained, partly by recalculation, from figures given by Watt, Gore and others:—

Table II.—*Particulars concerning the Power Plant Installed at Various Copper Refineries.*

Works.	Annual output of copper in long tons.	Output of dynamo in kilowatts.	Actual H.P. of engines employed at works.*	Calc. B.H.P. of engines reqrd. for dynamos.	Current density.	A.	B.
Pembrey ...	643·0	38·5	65 I.H.P.	60·362	10·0	0·01011	0·009367
Hamburg (1)	282·9	11·248	16	17·633	1·925	0·02939	0·03238
,, (2)	321·5	7·263	12	11·387	1·11	0·03459	0·03283
Marseilles ...	88·41	...	5	...	0·77	0·07345	...
Anaconda Wks., 1896†	64,280·0	1,620·0	3,000·0	2,540·0	10 (?)	0·004668	0·003952

* With the exception of the Pembrey return, it is not stated whether indicated, brake or nominal H.P. is intended.

† See note to Table I on Anaconda output.

In the column marked A in the above table the figures represent the H.P. (whether indicated, brake or nominal is not stated, except in the details concerning Pembrey) which is *actually* installed at the works, per ton of copper output per annum at unit current-density. In the column B the figures given represent the B.H.P. which it would be *necessary* to instal in the works per ton of copper refined per year at unit current density to obtain the electrical output which it is stated is used. This has been calculated from the kilowatt output of the dynamos, allowing a commercial efficiency of 90 per cent.

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for the dynamos and 95 per cent. efficiency of transmission for the belt, the dynamos being supposed to be belt-driven.

From these results it appears that if gas engines and gas-producer plant is installed, and if the prime cost of supply and erection of this plant is £15 per B.H.P. installed, then the prime cost of the plant may be fairly represented by the following expression :—

$$\text{Cost in pounds, including erection, of gas engine and producer plant} = 0{\cdot}12TD. \quad (4)$$

(To be continued.)

CORRESPONDENCE.

ELECTRICAL TRAMWAYS AND OMNIBUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From the further notes in your current number on the above subject, I cannot help thinking that you still misunderstand one of Col. Crompton's main points in speaking of the superior "overtaking powers" of self-contained motor vehicles as against vehicles tied to rails, so to speak.

Whilst no one will deny that motor omnibuses are at present open to much improvement, it is, nevertheless, considered by many as a more ideal vehicle to work at for improving the carrying capacity of the road than an electric tramway. The road's carrying capacity would surely be at its maximum where traversed solely by a number of self-contained motor vehicles, in form as nearly as possible approaching a bicycle, by virtue of the small space occupied by that class of machine and its overtaking power with a given speed. To illustrate the point, I would ask you to picture the road traffic being effected entirely by bicycles, and then —on that basis—to calculate, with a given speed, the road carrying capacity.

Motor omnibuses have also the advantage of being independent of rails, though, of course, occupying more space than bicycles; but with the improvements that may naturally be expected, the advantage they have in overtaking powers over any traction plant should be capable of being turned to account.—Yours, &c. CHARLES BRIGHT.

Westminster, July 29.

PARLIAMENTARY INTELLIGENCE.

LONDON UNDERGROUND RAILWAYS.

Mr. Seale Hayne's Committee.

The other Committee of the House of Commons to which tube railway bills have been referred is one presided over by Mr. Seale Hayne, the bills being the Great Northern and City Railway, Baker Street and Waterloo Railway, Charing Cross, Euston, and Hampstead Railway (Nos. 1, 2, and 3), Great Northern and Strand Railway, and the North-West London Railway. The proceedings commenced on Thursday last week, July 24.

Great Northern and City Railway.

Mr. E. MOON, K.C., described the objects of this bill, as given in our report of Lord Ribbleadale's Committee (*The Electrician*, May 16, p. 149).

Sir CHARLES SCOTTER, chairman of the company, and deputy chairman of the South-Western Railway Co., said there was no intention to close the station at Finsbury-pavement in favour of Lothbury station, and he was prepared to give a pledge as far as he could that the Finsbury-pavement station would be kept open for all time. The passengers at Lothbury would get out at the surface at four different places, which would be better than if they went out at one place. What they proposed also was that the public generally should be allowed to use the subways. There was nothing in the suggestion that there would be any difficulty about the capital. He believed the shareholders of the existing railway would guarantee that. The Committee might depend upon it that it was no bogus scheme.

Sir Henry Oakley, chairman of the Central London Railway, Mr. Bartley, M.P., and Mr. Claude Hay, M.P., spoke of the need for a station on this railway nearer to the City than Moorgate-street.

Mr. C. L. VIGERS, surveyor, said he made out the estimates for the land, as he also did for the Central London Railway. In the latter case the Corporation were paid 1s. per foot run for that portion of the subsoil in their area, but they were paid, not as the Corporation, but as the owners of the Bridge House estate. Half of the area it was proposed to take here was vested in the Bank of England, and did not belong to the Corporation at all.

Sir DOUGLAS FOX, the engineer to the company, said they did not propose to do anything different to what had been done at the existing Bank station, and they were quite prepared to do anything reasonable to meet the Corporation.

Mr. LITTLER, for the Corporation of London, in reply to the chairman, said that what they wanted was payment for any subsoil taken.

This completed the case for the promoters.

For the opponents, Mr. A. C. MORTON, a member of the City Corporation and of the Streets committee, said it was the opinion of the Streets committee that this extension was unnecessary in the public interest, and it would probably be a nuisance. But if the extension was made they contended that their property should not be taken for it without compensation. The proposed subway in Princes-street was certainly not required. The subway at the Mansion House was used by only 8 per cent. of the pedestrians independent of those who used the railway; and the iron railings and projecting staircases were considerable obstructions. People would rather run the risk by dodging the traffic than go down and up the steps of a subway.

In reply to a question from the Committee, Mr. MOON said the promoters would agree to a clause which would enable the Corporation in years to come to lease a part or parts of the tube. Provision was now being made for all the existing pipes under the streets, and, if necessary, reasonable provision would be made for the addition of others.

Mr. Ross, engineer to the Corporation of London, and Mr. Painter, a member of the Corporation, also gave evidence for the opponents, and the Committee then adjourned for the day, the chairman suggesting that, perhaps, counsel could come to an arrangement.

Friday, July 25.

Sir RALPH LITTLER summed up the case on behalf of the Corporation of London, contending that they should be paid for the subsoil in Princes-street.

Mr. ACWORTH said the promoters admitted that they should pay where they took a permanent occupation of a portion of Princes-street, and they were prepared to make that clear in the bill.

Sir RALPH LITTLER said he would be perfectly satisfied if the Committee could not only do this, but could also assess the amount to be paid, so that the whole matter could be settled at once; but unfortunately they could not do that. The Corporation contended that they had a right in the subsoil, and they asked the Committee to decide that their right to compensation for its disturbance, if any such right were proved hereafter, should not be affected by anything in the bill.

Mr. ACWORTH, having replied on behalf of the promoters,

The CHAIRMAN said the Committee found the preamble proved. The clauses were then dealt with, and the bill was ordered to be reported to the House.

Charing Cross, Euston and Hampstead Railway.

Mr. FREEMAN, in opening the case on behalf of the promoters, said the object of the bill was to extend the present authorised railway from Hampstead Heath to Golder's Green, where it would form an end-on connection with the Edgware and Hampstead Railway, which proceeded to Edgware. There would also be an extension of the Kentish Town branch to Highgate, and a substituted line down Villiers-street instead of the authorised line down Craven-street, for giving connection to the District Railway. As to the damage to the surface of Hampstead Heath it was alleged by certain residents of Hampstead that the line would require shafts to the surface, and, secondly, would cause the drainage of water from the surface. The promoters would be able to satisfy the Committee that neither of those things could possibly arise. They bound themselves under the bill, not to put any opening whatsoever upon Hampstead Heath, and also not to go nearer the surface than 200ft. It was impossible that there should be the slightest effect upon the Heath. An instruction had been moved in the House to the Committee to consider the question whether damage would be done to the heath, and he understood there were certain representatives of the inhabitants of the neighbourhood who desired to offer their evidence if the Committee wished to hear them. The promoters were so confident in the strength of their case that they invited any inquiry into the matter. (For the proceedings before the House of Lords Committee see *The Electrician* for May 9, p. 110.)

Mr. TALBOT said the London County Council, in whom Hampstead Heath was vested, were satisfied with the bill so far as it dealt with that.

Mr. W. R. GALBRAITH, engineer with Sir Douglas Fox to the scheme, described generally the route proposed.

Sir Alexander Binnie gave similar evidence.

Mr. FIGGIS stated that he was chairman of the committee of residents of Hampstead formed to oppose the proposed tunnel. They deplored the chance of damage to the heath, and contended that there was a better route round Child's Hill. Although the company now said there would be no shafts or stations so as to cause openings on the heath, yet in a few years he thought there would be a public outcry for both. It was notorious that on the Metropolitan District lines the public were nearly suffocated, and they would not tolerate that in regard to the tube lines.

Mr. Francis Heath, a resident of Kew Gardens, and Mr. Basil Champneys, an architect, were not satisfied that no damage would be done to the heath.

Mr. TENNANT (a member of the Committee) pointed out that nothing in the nature of scientific evidence had been given to show that the apprehensions of the residents were well founded.

Mr. GALBRAITH was then recalled.

Mr. LOWE (one of the members) asked for the witness' views with regard to the ventilation, stating that some of the Committee had certain doubts as to the possibility of ventilating that length of tunnel without communicating with the surface.

The Witness gave as an instance the Waterloo and City Railway, of which he was one of the engineers. That line was 1½ miles long and there was no intermediate station. There was a strong draught through the tunnel. That was natural ventilation. The line was at the level of the street at Waterloo, and went down under the river and rose again on the other side. It was, therefore, a sort of switchback. The gradient was 1 in 60 on one side of the river, and 1 in 70 on the other. There was no air opening.

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Mr. TENNANT: I suppose the gradient creates the draught?—Yes, and there is the same gradient under Hampstead Heath.

The CHAIRMAN: The Committee are of opinion that the preamble is proved.

Mr. TALBOT then brought up certain amendments on behalf of the London County Council. The first was a clause to compel the promoters to widen the Strand at the site of their proposed station, which was opposite the Charing Cross station.

Mr. WALTER EMDEN, chairman of the Highways committee of the City of Westminster, and also a member of the London County Council, said that those two bodies in conjunction were making arrangements to widen the Strand all the way through. If the station were put where proposed, the neck of the Strand would be permanently only 67ft. instead of 80ft., as it would be elsewhere.

Monday, July 28.

Mr YOUNG, valuer to the Council, said that arrangements had been made with the Corporation of Westminster by which the Strand and Fleet-street were to be widened to 80ft. as buildings were removed at the joint expense of the two authorities. The amount already spent upon the Strand alone represented 2¼ millions. Unless some provisions were inserted there would be a narrow neck of 67ft. The proposed site of the station was directly opposite the South-Eastern station, where there was already a great deal of traffic.

Mr. BALFOUR BROWNE, for the Piccadilly and City Railway, who have made an agreement with the promoters to have a joint station at Charing Cross, said he had withdrawn his opposition to the bill because of that agreement.

Mr. TALBOT did not think it would be disputed that on the whole of the property scheduled by the two companies there was ample room for the joint station. The Piccadilly and City had scheduled a large block immediately to the east and north of the Charing Cross and Euston Company's site.

The CHAIRMAN: I am chary of expressing an opinion, but from what I know of the views of the Committee, they would wish that the widening of the Strand, which I understand is to be made ultimately to 80ft., should be preserved at that point, in the interests of the public.

Mr. TALBOT said that was what the County Council asked. In face of that he need not pursue the matter further.

Mr. BALFOUR BROWNE said that could not really affect himself or the promoters so long as only the surface of the road was taken and the companies were allowed to have the space underground for the purpose of the station. If Mr. Young and the promoters' engineers would put their heads together, he thought the matter could be easily arranged so that the County Council should have the widening they desired, upon arbitration terms, and the companies should use the under-surface.

The CHAIRMAN agreed to that suggestion, which was embodied in a clause, and accepted by the Committee.

Mr. TALBOT then raised the question of workmen's fares. He asked the Committee to strike out the sub-clause by which the liability of the company for injury to workmen travelling with workmen's tickets was limited to £100. He contended that that was wholly illogical and not to be defended.

Mr. CLODE said that on its merits he was prepared to argue that it was not illogical and that there was good reason for it. But he pointed out that, inasmuch as the clause was contained in all the other "tube" bills, it was not reasonable that the Committee should be asked to make a distinction in that particular case.

In reply to the Committee,

Mr. TALBOT admitted that there was no precedent for what the London County Council was asking.

The committee room was then cleared. On the re-admission of the public,

The CHAIRMAN said the Committee had decided to pass the clause, but they desired him to say that they did so because the clause was in accordance with precedent. They did not wish to be understood as expressing an opinion upon the merits of the case generally.

The remaining clauses were adjusted, and the bill was ordered to be reported to the House for third reading.

Sir Lewis McIver's Committee.

Friday, July 25th.

The consideration of the **Brompton and Piccadilly Circus Railway (New Lines, &c) Bill** was continued.

Sir JAMES SZLUMPER, engineer to the company, described the scope of the railway as it now remains after consideration by Lord Windsor's Committee (see map, *The Electrician*, for June 6, p. 263). The latest estimates were, for lands and works in connection with the ¾ mile of new line from Piccadilly to Holborn (the only piece of new line remaining), £511,199, the subway at Duke-street, £11,115, and two subways at Piccadilly-circus, £38,412. In confirmation of Sir Ralph Littler's opening statement on the question of the construction of the already authorised line, he said his instructions were to proceed with the work as fast as possible. The two shafts at Brompton were down to 65ft., and notices to treat had been served for all the other station sites along the entire route—viz, six other stations, or 12 shafts. The shafts were 23ft. in diameter, and each would accommodate two lifts. With regard to the levels in Piccadilly, he undertook not to interfere with the London County Council's subways in that neighbourhood without the consent of that body.

Witness was cross-examined at great length by Mr. LEWIS COWARD, K.C., for the London County Council, on a number of matters relating to giving the latter body control in respect of hoardings, &c., erected during the construction of stations, the protection of their sewers, and payment for an easement under the new street from Holborn to the Strand. Practically, all these matters were eventually put on one side for consultation between the parties.

Re-examined: He considered that if the London County Council were to get their suggested clause with regard to the easement under the new street, the construction of that portion of the railway—about 50yds.—might be delayed until the new street was completed—something like five years.

By Mr. MONTAGUE (member of the Committee): The Brompton and Piccadilly Railway, where it crossed the Baker Street and Waterloo line, would go above it, and where it crossed the Charing Cross, Euston and Hampstead Railway it would go below it.

The CHAIRMAN asked for an average figure per yard of the total tunnelling work of the railway (including stations) for the purpose of comparison with a similar figure for the Central London Railway. He also asked for details of the contracts which have been let for the construction. These were promised.

Sir Hugh Owen, a resident at Crouch End, and Mr. George Spicer, residing at Enfield, Mr. Henry Jones, town clerk to the Holborn Borough Council, Mr. W. Grinling, chief traffic manager of the Great Northern Railway Co., Mr. Alexander Ross, chief engineer of the Great Northern Railway Co., and engineer to the Great Northern and Strand Railway and Mr. Hugh Allen, member of a firm of auctioneers in connection with Covent Garden, all supported the bill from the local point of view.

Mr. R. W. PERKS, M.P., chairman of the District Railway Co., said the Brompton and Piccadilly Circus Railway, as authorised in 1897, would have been of very little assistance to the District Company. Its usefulness was increased in 1899, when powers were given to connect it with the authorised deep-level railway from Earl's Court to Mansion House, utilising for the time being the section of the latter from Brompton to Earl's Court. The new extension to Holborn now gave the very connection with the northern suburbs which was so much desired. All the contracts were let for the conversion of the whole of the District Company's lines to electric traction, the Metropolitan Railway Co. had made all the arrangements for the conversion of their portion of the Inner Circle, and he believed that the Great Western and the Metropolitan Companies had agreed to convert the Hammersmith-City line from Baker-street to Hammersmith-broadway to electric traction. Next year the District Company intended to introduce a bill for a line from Piccadilly-circus to Charing Cross, which this year was refused by Lord Windsor's Committee on the ground that the proposed curve was too sharp to ensure absolute safety.

Monday, July 28th.

Mr. PERKS, continuing his evidence-in-chief, proposed to go into detail concerning the financial relations of the Underground Electric Railway Co. of London with the District Railway Co., with the object of showing that the holdings of the former company in the District were totally insufficient in themselves to influence the policy of that concern, and, further, to demonstrate that a very large amount of English and Continental money was invested in the Underground Railways Co.

The CHAIRMAN intimated that it was unnecessary to elaborate this point. Further, the Committee did not care much where the money came from so long as it was good money.

Witness then went into the question of the revised estimates for the line. The cost of the railway now, as compared with what was anticipated in 1897, would be much greater, due to several causes. First, the cost of land had increased enormously, and land which could originally have been obtained for £70,000 now cost £150,000, which were the figures in respect of the land for the Lot's-road generating station. Again, the cost of the ironwork was now about 25s. per ton more than in 1897, whilst labour had very greatly gone up in cost. The total cost of the works was put at £260,000 per mile for the 11ft. 8½in. tunnel, which included all the underground and overground construction works. The total cost of the Lot's-road generating station would be £1,250,000, and of this 10 per cent. was allocated to the Brompton and Piccadilly Circus Co. as its proportion of this expenditure. As the outcome of the proceedings before Lord Windsor's Committee upon tube railway bills this year, a new item had had to be added to the estimates—viz., compensation for vibration during two years after the opening of these railways, and for this a sum of £160,000 had been put in. In this matter he complained that electric tramways were not put under such an obligation, and in the west of London the electric tramways did cause very considerable vibration.

By the COMMITTEE: Originally the District Company were to pay a rental of 5 per cent. to the Metropolitan District Electric Traction Co. on the whole cost of the generating station, but under a new agreement this 5 per cent. would only be paid upon half the cost, the remainder being allocated to the other tube railway taken in hand by Mr. Yerkes. The District Company would take power as required similarly with the other companies, and in return for this rental would get power at cost price.

The CHAIRMAN: But you are only really transferring capital expenditure to working expenses to the extent of 5 per cent. by doing this?—Yes, I think we do.

Assuming you get your electrical energy at cost, the additional amount which is put upon your working expenses will be 5 per cent upon £625,000, or £30,000 a year?—Yes, that is practically what it will be.

And the whole of these arrangements are in perpetuity?—Yes, as long as we pay our rent.

Is electric power to be supplied to all the other railways concerned at cost price?—I do not know. It will be to the District Company.

Are the different percentages of the cost of the generating station which have been allocated to the various railways taken over by the Underground Electric Railway Co. proportional to the separate capitals?—No, they are proportional to use—*i.e.*, the number of trains which they will run and the power they take.

By Mr. WHITELEY (member of the Committee): Is there any probability of the deep-level line being built?—We are making the piece from Earl's

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Court to South Kensington as part of the Brompton-Piccadilly line, but we have not yet let the contracts for the other portion from South Kensington to Mansion House, and the construction of this will depend upon whether we get the powers which will be asked for next year to go further east, and also our new proposal for the spur from Piccadilly-circus to Charing Cross.

Mr. C. T. YERKES dealt mainly with the methods of operating the railway, which have already been very fully given in *The Electrician* for May 2, p. 55. The trailer cars on the tube railways under his control would accommodate 52 passengers, and the motor cars 46 passengers. The signalling would be automatic, so that if a driver ran beyond a signal the current would be cut off. The signals would be placed at every station, and also at every curve, so that one would never be out of sight. The ventilation of the tunnels would be such that 1 mile of line would be completely "refreshed" in 45 minutes. The foul air would be drawn up a shaft at each station, 4ft. in diameter, by means of a 4 H.P. fan, and the fresh air would naturally come down the stairs at the stations. The rail for the permanent way would be 5½in. in height, mounted upon a chair, and the whole would weigh 105lb. per yard. Each wheel of the motor car would carry something under 1 ton, whereas on the Central London locomotive each wheel had to carry some 11 tons. The average speed would be 15 or 16 miles per hour. The power house would have a capacity of 55,000kw., and the cost of this was estimated at £22 per kilowatt-hour, of which £19 per kilowatt-hour was for building and equipment and £3 per kilowatt-hour for land, which latter, by the way, had already been paid. The total mileage of railway to be supplied from this power was some 60 miles. The Traction Company had guaranteed 4 per cent. per annum on the capital of all the other railways which had been absorbed by it by an agreement with Messrs. Speyer, and the capital of the Traction Company was guaranteed by Messrs. Speyer whenever required.

The CHAIRMAN: You say there is an agreement between the Traction Company and Messrs. Speyer, but you do not put it before us, and it is not scheduled to your bill?—No, it is simply a private agreement.

What guarantee have we that there will be sufficient funds to meet this 4 per cent. guarantee?—We expect to make profits out of these railways, and we expect to make a profit on our shares in the District Company.

By Mr. WHITELEY (member of Committee): The only money which it was expected to spend out of the £5,000,000 capital of the Traction Company was the cost of building the power house, £625,000, and if any of the subsidiary companies required funds in the meantime, apart from their own capital, they would draw upon the balance through Messrs. Speyer. As to whether Messrs. Speyer would appeal to the public for any of the necessary £15,000,000 of money which was involved in all these railways, he said the manner in which it would be obtained was entirely a matter for that firm to decide.

The CHAIRMAN: The value of any agreements between the Traction Company and Messrs. Speyer must necessarily depend upon the manner in which they are scheduled to the bill, and the manner in which they are presented to the Committee. If we could see what balance of the £5,000,000 guaranteed capital would be available in the future to meet this 4 per cent. guarantee to the other companies it would materially affect the opinion of the Committee. We cannot attach any value to it at all until we see it on paper, and we must practically ignore the suggestion of such a guarantee if you do not schedule it to the bill. In adopting this course we are following an instruction to the Committee which will be applied to all the bills.

Sir RALPH LITTLER, K.C.: I think it will be impossible to schedule it now.

Mr. YERKES said for himself he would agree to put the matter in any shape the Committee wished to make it binding upon the Traction Company.

The CHAIRMAN: The matter will come up on clauses, and we will adjourn until Wednesday, so that you may decide upon your course of action. With regard to the subways at Piccadilly, we think it would be advisable if you can come to some arrangement with the London County Council to throw these open to general public use, in order to help relieve the pedestrian traffic there.

Mr. YERKES said that this had been his intention from the beginning.

Wednesday, July 30.

Mr. BALFOUR BROWNE, K.C., made an application on behalf of the London United Electric Railways Bill, and the Piccadilly, City and North-East London Railway Bill to have the consideration of them postponed until the autumn session if there was no possibility of completing the case for them before the recess. He greatly deprecated cutting his case into two, and although there was a great deal of railway opposition he personally considered five days ought to be sufficient to see the thing through.

Some discussion took place between the counsel appearing for the opposition, by which it was made clear that five days would be quite inadequate, and

The CHAIRMAN said the two bills in question would be postponed until the October session.

Mr. BALFOUR BROWNE, in answer to the Chairman, said that if his attitude in not opposing the Brompton and Piccadilly Circus Railway had led to an impression that a combination between Mr. Yerkes and Mr. Morgan was possible in the future, he wished to emphatically repudiate it. His reason for adopting the course which he had was because he considered that throughout the short length which his line and the Brompton and Piccadilly line were under each other they did not compete. He also wished to state that there was not an atom of truth in the statement which had got into the daily papers that the fares on the Morgan lines had been increased. This was absolutely fallacious, and he did not want it to go to the public as the truth.

Sir RALPH LITTLER, K.C., replied that throughout 2 miles the two railways had stations cheek by jowl. Further, he said he could prove that the fares had been raised. Continuing, in respect of the explanation asked for by the Chairman at the last sitting as to the 4 per cent. guarantee given by the Underground Electric Railways Co., he said he thought it would meet the objection of the Committee if he inserted an additional clause in the bill. At present, clause 51 made it optional for the undertaking to be leased to the Underground Electric Railways Co., which power, however, was not to be made exercisable until a certificate had been obtained from the Board of Trade that the company had paid up one-half of its own capital and expended a sum equal thereto, and also that the Traction Company had paid up one-half of its share capital. He now proposed to add as clause 51A the following, which would make it compulsory for the undertaking to be leased upon the granting of the same certificate by the Board of Trade as before:—"The company shall lease their undertaking to the Underground Electric Railways Co. of London, and the last-mentioned company shall take on lease or work the same upon a rent or upon a guarantee of a dividend of not less than 4 per cent. per annum on the amount of the debenture and share capital of the company." This could be included in the bill without further trouble, but with regard to the other railways included in the scheme of Mr. Yerkes, an emergency bill would be introduced this session if possible, providing for the inclusion of the same clause in their bills. Failing that, a new bill would be introduced next session.

Mr. WHITELEY (member of the Committee): What proportion of the £5,000,000 capital of the Underground Electric Railways Co. will there be available for the 4 per cent. guarantee.

The CHAIRMAN said that this £5,000,000 could not be regarded as the capital of the undertakings absorbed by the Traction Company, in so far as it was already mortgaged for so many purposes. The Committee, of course, regarded this sum as a very powerful lever for the raising of further capital, but what was wanted in binding form was an undertaking to place the stock. Were the promoters prepared to schedule the agreement with Messrs. Speyer, or would they prefer to place a representative of that firm in the witness box to give a personal undertaking, which would be taken as an equivalent?

Sir RALPH LITTLER preferred the latter course.

Mr. EDGAR SPEYER, senior partner in the firm of Messrs. Speyer Bros, said that he and his associates were ready to undertake to furnish the necessary money for the four tube railways taken over by the Underground Electric Railways Co. of London. He had satisfied himself from his own inquiries that these railways could be built for the estimates which had been prepared. With regard to the funds available for the 4 per cent. guaranteed to the tube railway companies, the £5,000,000 which was already available was practically a reserve fund for contingencies. It was considered that the money forthcoming by the debentures and stock of the tube companies would be sufficient to build the four lines, and some bankers would be prepared to go on with the work without the formation of another company. But the £5,000,000 company had been formed to have a reserve to be called upon at any time money was required.

By the CHAIRMAN: His firm and its associates contemplated taking up and placing the whole stock and debentures of all these companies, and the intention was, without doubt, to see the matter through. Of course, if the public did not respond to any applications that might be made for money, his firm would find it all. The only money which would have to be expended at once out of the £5,000,000 capital of the Underground Electric Railway Co. was the half cost of the Lot's-road generating station, and this would eventually be repaid by the District Company by means of the yearly rental of 5 per cent. on that amount.

After consideration,

The CHAIRMAN said the preamble of the bill was proved, subject to the insertion of a clause, merely for the sake of uniformity with all other tube bills this year, that the works should make a substantial commencement within 12 months of the passing of the bill, otherwise the powers given under the bill should lapse.

Clauses were then adjusted. Among the more important ones was a clause by the Piccadilly, City and North-East London Railway Co. to fix the levels of this latter line (in the event of its being passed) and also the levels of the Brompton-Piccadilly Railway down Piccadilly, to prevent the latter being so constructed as to block the building of the Piccadilly, City and North-East London Railway. It was agreed that the Brompton-Piccadilly Company should not deviate below the working plans which had been prepared. Another clause on behalf of the Piccadilly-City line was that joint stations should be constructed wherever convenient down Piccadilly. This was strongly opposed by the Brompton Company, who argued that, with reference to the Haymarket station site, the land had been treated for, and, if this clause were granted, no less than three railways would be using this particular station—viz., the Baker Street and Waterloo, the Brompton-Piccadilly and the Piccadilly, City and North-East London Railways. The Committee decided that, under the circumstances, separate stations should be built, and that both companies should share the expense of building subways for the convenience of passengers wishing to exchange.

Thursday, July 31.

Sir RALPH LITTLER, K.C., said a clause for the protection of the Marble Arch-Clapham Junction section of the London United Electric Railways had been agreed upon by which no deviation would be made below 3ft. of the levels shown on the working plan (to be signed by the Chairman), there being an interval of 5ft. between the tunnels of the respective companies. All this was, of course, in anticipation of the passing of the London United Bill and the subsequent formation of a company.

Among a number of clauses brought forward by the London County Council, one providing for the provision by the company of a map showing the underground works of the railway was agreed to. The Council of the City of Westminster was also included in this clause. Clauses for the protection of the Council's tramways, subways and sewers, the definition and limitation of workmen's tickets, and others with respect to certain lands for street widenings which have already been acquired by the company having been adjusted, the bill was ordered to be reported to the House for third reading.

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LONDON UNITED TRAMWAYS BILL.

Lord Yarborough's Committee resumed consideration of this bill on Friday last.

Lord R. CECIL, K.C., for frontagers on both groups of lines, said he did not propose to go on with his opposition to the Wimbledon part of the line With regard to the Richmond and Hammersmith line, he said it was a matter of doubt if the embankment which the company proposed to make at Barnes-terrace would be altogether a benefit, and the fact that the company proposed to build the embankment should not entitle it to make the tramway unless it would be for the public benefit. He should be able to show that, while the Barnes Urban Council were by no means unanimously in favour of the lines, the majority of the Barnes people were opposed to them.

Evidence was then called.

Mr. Samuel Keene, a member of the Surrey County Council; Mr. Morley, solicitor, of 26, The Terrace, Barnes; Dr. Barber, another Barnes resident; Mr. Lambert, chairman of the Barnes Urban District Council; Mr. Alfred Smith, C.E., and several other local witnesses were called, who testified to the interference with the quietude and attractiveness of the district which the tramways would be.

The case for the London and South-Western Railway Co. was then proceeded with, and Mr. C. J. Owens, general manager of that company, gave particulars of the effect of the West London tramway competition on his railway, similar to the evidence reported in our issue for June 20, p. 356, and June 27, p. 395, before a Committee of the House of Commons on this bill, and he contended that the additional lines asked for would increase this loss.

After hearing counsel, the Committee unanimously found the preamble proved, and, the clauses having been adjusted, the bill was ordered to be reported to the House in due course.

PONTYPRIDD URBAN DISTRICT TRAMWAYS BILL.

On Friday last, the consideration of this Provisional Order Confirmation Bill was continued.

Mr. Hugh Bramwell, a member of the Pontypridd Urban District Council, Mr. Thomas Mayberry Williams, and Mr. H. S. Davies, secretary of the Market Company, all supported the scheme.

Mr. R. P. WILSON, consulting engineer to the Council, said the Council were this year proposing tramways which they were unable to get in their last year's scheme. The population they would serve was 32,000. In reply to the Chairman, Witness said that the cost of that new piece of line—*i.e.*, electrical equipment, construction and cars—would be about £16,000.

Other evidence having been given,

Mr. BALFOUR BROWNE, K.C., for the Taff Vale Railway Co., asked the Committee not to confirm the order, as the tramway would serve no great public purpose. Counsel went on to criticise the action of the Board of Trade in what he described as "tying the hands of that Committee," and he submitted that that Committee was similar to an appeal court. They were not constituted merely to hand back to the Board of Trade something they wanted. He also complained of the "sharpness" of Lord Newton on when the matter was before the House of Lords.

On Tuesday, Sir Herbert Jekyll, of the Board of Trade, was called by the Committee.

The CHAIRMAN: The Committee is anxious to know whether it is usual to grant an order for a tramway over a road which is not public, but leased.

Sir HERBERT JEKYLL replied that such powers had rarely been given, because the occasion for them had been rare, but the Board of Trade had never refused to give such powers when applied for. He gave the precedent of the Barrow-in-Furness tramways. That was a company, and not a local authority.

The CHAIRMAN: It is said that tramways cannot be constructed over land, excepting land taken by agreement.

Sir HERBERT JEKYLL said the Board of Trade always held that land leased came under that head.

Sir JAMES SZLUMPER, on behalf of the frontagers, said that the roads upon which it was intended to lay the tramway were all narrow roads, and were, in his opinion, the very worst roads upon which a tramway could be laid. If it was a single line throughout it was all very well, but to run a line in one direction only and on one side of the road was objectionable. He thought "cross-overs" would be very dangerous indeed. He quite agreed that this tramway was not wanted.

Five local witnesses gave evidence to the effect that the tramways would greatly inconvenience business, and that there was no great demand for them.

Mr. PAGE, in the course of his address, said that the words of the Tramways Act were that land taken by agreement was land purchased. He really thought that the attention of the Speaker's counsel and Sir Herbert Jekyll could hardly, in an adequate way, have been directed to the matter. Both the Tramway Act and the Lands Clauses Act were clear upon the question, and he submitted that, under those circumstances, the scheme must be rejected.

Mr. RAM, K.C., replied that his friends asserted that land taken by agreement must mean land bought out-and-out. He asserted that it also meant land taken by lease. He was quite sure they were not asking to do what the Board of Trade and Parliament had not power to allow them to do.

The CHAIRMAN: You hold that the word "taken" does not necessarily mean "purchased"?

Mr. RAM: Certainly.

The CHAIRMAN: You say that the word "taken" was a wider term than "purchased."

Mr. RAM replied in the affirmative, and said he hoped he was right in saying that they were equally at liberty to lay tramways on lands taken by lease as with lands purchased. He submitted that the frontagers' opposition in this case was nothing but "Taff Vale" (railway) opposition under another name. Between 3,000 and 4,000 of the ratepayers had petitioned the Council in favour of the bill.

The CHAIRMAN said the Committee had decided to confirm the order subject to the signing of the lease with Messrs. Thomas, over whose land it is proposed that a portion of the tramway should pass.

A small portion of line, for the convenience of the whole scheme, was passed, being unopposed.

OTHER ELECTRICAL BILLS.

In the House of Lords on Thursday last week, the Cavehill and Whitewell Tramways, the London, Tilbury and Southend Railway, the Whitechapel and Bow Railway and the Metropolitan District Railway Bills were read a third time and passed. In the House of Commons on the same day the Hastings Tramways Bill and the Rhondda Urban District Council Tramways Bill were read a third time.

The Lords amendments to the following bills were agreed to in the House of Commons on Friday last: Croydon and District Tramways Bill, the Metropolitan Railway Bill, the North Metropolitan Tramways Bill, and the West Ham Corporation Bill.

The Garston and District Tramways and Electric Supply (Transfer) Bill was read a third time and passed in the House of Lords on Monday, and the following were read a third time in the House of Commons on the same day:—North and South Shields Electric Railway, Rossendale Valley Tramways and the Wrexham District Tramways Bills.

On Tuesday in the House of Lords the London County Council's (Subways and Tramways) Bill, and the London County Council (Tramways and Improvements) Bill were read a third time.

ELECTRIC LIGHTING ACTS AMENDMENT (SCOTLAND) BILL.

This bill passed through the House of Lords Committee on Thursday last week without amendments, and has been reported to the House.

AN 80,000-VOLT TRANSFORMER.

The *Journal of Electricity* of San Francisco describes an 80,000-volt transformer built by the General Electric Co. to the order of the local lighting and power company of Butte, Mont. It has a capacity of 330kw., and was built in six weeks.

The coils of which the winding is composed are wound with flat copper strip, and are remarkably strong and rigid considering the small conductors that must be used for such small high-voltage units. They are covered with only sufficient waterproof insulation to exclude any moisture that might be deposited on them during transportation. The heat generated in the winding can, therefore, escape as easily as from the coils of a low-voltage transformer.

Oil, specially refined for this high-voltage work, is relied upon mostly for insulation. The spaces between the high-voltage coil and all other parts, however, are subdivided into separate ducts by diaphragms of solid insulation, so that any conducting particle that by accident might fall into the oil can bridge but a small percentage of the oil space. This construction, it will be seen, also subdivides the solid insulation into thin layers, so that any heat that might be generated in it, due to dielectric hysteresis, is promptly dissipated by the free moving oil in the ducts.

The transformer case and cover, including all bushings and cables, are made with airtight joints. Previous to filling the transformer with oil it is exhausted of all air with a vacuum pump and the winding heated to expel any moisture that might be on the coil surfaces. While in this vacuous condition oil specially treated to expel all foreign particles, air, or moisture, is allowed to flow into the transformer from the oil-treating tank, this method of filling being repeated when the transformers are started in commercial operation.

By the use of these novel methods the insulating quality of commercial oil is so improved as to require much less thickness of oil to withstand these high voltages than would otherwise be the case. Reduction in transformer costs and improvement in its constants are the natural results. Tests showed the following performance at 60 cycles:—Efficiency, 97·5 per cent.; regulation, 1 per cent; reactance, 4 per cent.; heating by resistance, 30°C.

When the small capacity and high voltage are considered, also the fact that the greatest reliability rather than extreme efficiency, &c, was especially aimed at, these figures prove that 80,000-volt transformers are an assured commercial success. The test included an insulation test at double voltage—namely, 160,000 volts, which failed to develop any weakness.

To determine the possible presence of losses due to dielectric hysteresis or actual leakage through the oil or other insulation at this very high voltage, transformers were excited to double their normal voltage on the low potential side. The losses were then measured with the high potential windings separated into several sections, so that the maximum voltage generated was so low that no such losses could take place. The high potential windings were then connected in series and the losses again measured. They were found

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to be identical with those first observed, indicating the entire absence of any such losses. The terminal cables have soft rubber discs projecting from them. These were necessary in order to break up the static discharge that took place over the surface of the insulations when the transformer was under a strain of 100,000 volts between winding and ground. The insulation on these cables was ample to withstand this strain, but the static charge on the surface was so heavy as to reduce the effective length of the insulation to but a small fraction of the actual length. The test potential would cause an arc to form between the uninsulated end of a cable 5ft. or 6ft. in length and the transformer tank before the soft rubber discs were added. The rubber was so moulded that it could be securely cemented on the insulated cable for a distance of 1in. or more. The disc, therefore, served the purpose of breaking the continuity of the static discharge and prevented the short-circuiting of the test voltage. At operating voltage there was no brush discharge whatever, consequently the discs were useful only in connection with the test.

LEGAL INTELLIGENCE.

Manchester Carriage and Tramway Co. v. Manchester Corporation and other Local Authorities.

Mr. Justice BIGHAM, in the King's Bench Division on Monday, delivered a considered judgment in this case, the facts of which were fully reported in *The Electrician* for July 18. This was a special case stated by Sir Frederick Bramwell, the arbitrator appointed to settle the amount payable by the respondents to the claimants in respect of the acquisition of their undertaking. The arbitrator stated that a legal contention took place between the parties as to how much of the respective depôts and the horses, cars and other plant used by the claimants for the purposes of working was to be paid by the different purchasing authorities under the provisions of sec. 43 of the Tramways Act, 1870.

His LORDSHIP, in giving judgment, said the question was whether the arbitrator, in making his award, was bound to exclude from his consideration some part of the properties in question by reason of the fact that, though the whole of such properties were used with the tramways now being acquired, they were also used for the purposes of the leased lines which are not being acquired. The arbitrator found that all the depôts and plant were suitable to and used for every part of the system, and that finding his lordship could not disturb, and would not if he could. The arbitrator having arrived at that conclusion of fact was of opinion that he ought to accede to the demands of the claimants, and his lordship thought he ought not to differ from him. He was of opinion that the first of the arbitrator's alternative awards was right, and that the claimants were entitled to be paid the sum found to be due on that footing—viz, £469,068.

Judgment was entered accordingly.

Electric Tramways Construction and Maintenance Co. (Ltd.) v. Rutherford.

In the Chancery Division, on Friday, before Mr. Justice Buckley, a motion was made by the defendant that all proceedings be stayed upon terms of an agreement that had been entered into.

Mr. BUCKMASTER, K.C., said the action was brought to obtain specific performance of certain agreements relating to electric construction. The action was in the paper for hearing before Mr. Justice Byrne on July 7, and certain terms were agreed between defendant and two persons who, it was said, had power to act for the company (Mr. H. Lawson and Mr. Osborne). It was now denied that either of those gentlemen had authority to bind the company. He was not in a position at present to move the motion effectively, and, therefore, he asked that it should stand till the trial.

His lordship ordered the motion to stand till trial of the action.

Tramway Stopping Places.

Birkenhead Corporation, as owners of the electric trams in the town, was sued on July 23 by a tobacconist named Gregory, who sought to recover £10 damages for personal injuries caused through alleged negligence of a tramcar driver.

Plaintiff attempted to get on a tramcar in motion at a point where the road was taken up. He was struck by a projecting barricade, thrown down and injured.

For the defence it was contended that no liability rested with the Corporation, as the point where the plaintiff attempted to board the car was not a stopping place, and that the accident was due to plaintiff's negligence.

The jury found for the Corporation. Judgment accordingly.

Re Electric Lamp Regenerating Co. (Ltd.).

Mr. Justice Buckley on Friday heard a petition by Messrs. Howard and Jones, stationers, for the winding up of the above company.

Mr. WHINNEY, for the company, said a scheme of reconstruction had been proposed, and holders of 55,000 out of 80,000 shares had approved the scheme in principle. It provided for further capital, and a sum was subscribed which was sufficient to cover the claims of creditors. Mr. Milne, the chairman, would give his personal undertaking to pay the creditors.

His lordship ordered the petition to stand over.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Oldham Corporation Electricity committee require an assistant engineer. Applications to town clerk (Mr. A. Nicholson) by Aug. 11. See advertisement.

An assistant engineer is required for the Colchester electric light and power department. Applications to the borough electrical engineer (Mr. Alfred R. Sillar) by Aug. 12. See also advertisement.

There is a vacancy for an improver at Barnsley electricity works. Applications to borough electrical engineer (Mr. S. E. Bastow). See advertisement.

A junior shift engineer is required for a London alternating-current station. Applications to resident engineer, electricity works, Causeway, Wandsworth, London, S.W., by Aug. 6. See advertisement.

A lecturer and demonstrator in physics is required at the University College, Bristol. Applications by Aug. 30.

A head master is required for Newry Technical School. Applications to Hon. Sec, Town Hall, Newry, by Aug. 16.

On the recommendation of the Highways committee Mr. E. L. Pope, resident engineer to the Callender Company, was appointed distribution engineer in the London County Council tramways department, on Tuesday, at a salary of £350 per annum.

Mr. George George, F.I.C., F.C.S., of Sutherland Institute and Longton High School, Longton, Staffs., has been appointed director of the Auckland (New Zealand) Technical School. There were 73 applicants (35 from Great Britain, 30 from the Australian colonies and eight within New Zealand).

Bradford City Council Technical Instruction committee have appointed Mr. H. Bohle lecturer in electrical engineering at the technical college. Mr. Bohle held for several years a similar appointment at Birmingham. He received his scientific training at Hagen, in Westphalia, and was afterwards apprenticed with Messrs. Schuckert. He has had some experience in the States and with a Midland firm.

Wigan Town Council have appointed Mr. James Slevin as borough electrical and tramway engineer in succession to Mr. H. Collings Bishop. Mr. Slevin has hitherto held the position of tramway traffic manager.

Mr. W. C. S. Phillips, B.Sc., has been appointed assistant lecturer in physics and electrical engineering at the Municipal Technical College, Derby.

Mr. J. G. Griffin, of Burnley, has been appointed resident electrical engineer and tramways manager at Swindon at £250 per annum.

Swindon Guardians have appointed Mr. Alfred Whiteley resident electrical engineer.

Alleged Embezzlement.—At Bilston, on Tuesday, W. R. Jolly, cable superintendent, was charged on remand with embezzling £34. 15s. belonging to his employers, the British Insulated Wire Co. Committed for trial

Aston.—The Tramway and Electric Light committee recommend the Council to adopt the overhead system of electric traction on the tramlines when they come into the Council's possession.

Barnsley.—The British Electric Traction Co. are applying for extension of time to comply with the terms of the Barnsley District Light Railway Order, 1900.

Barrow in Furness.—Application has been made for a loan of £20,000 for electric lighting extensions.

Bath.—The Council have decided to expend £300 on electric baths, and to experiment with electric radiators for heating the baths.

Belfast.—An inquiry was held here last week into the application of the Corporation to borrow £20,000 for electric lighting extensions. Mr. V. A. H. M'Cowen, the city electrical engineer, gave particulars of the very considerable orders on hand for the extension of electric lighting to works premises in the district and to the Royal Victoria Hospital at Belfast. The works contemplated include a large extension for Messrs. Harland and Wolff in the Alexandra Dock district. He pointed out that with electric lighting it was necessary to provide a supply before a demand was created. The total amount spent on electric lighting was £202,357 up to Dec. 31 last, and £212,250 was the total amount borrowed. The gross profit after paying working expenses was £9,053. 19s. 1d. After charging interest and sinking fund there was a loss on the past year of £347. They had a net profit the previous year of £476. 9s. 2d. and £2,000 for 1899, but they had been continually reducing the charge for current. The inquiry extended over two days, and there was some opposition.

Blackburn.—There was a net profit of £71 on the working of the municipal electric tramways for the June quarter.

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Blackpool.—In a report presented to the Electricity committee the borough electrical engineer (Mr. C. Furness) recommends the provision of condensing plant for the generating station at an estimated cost of £3,800.

Bradford Technical College.—During the past season the classes of the engineering department of this college, under the direction of Mr. G. F. Charnock, A.M.Inst.C.E., have been very successful, 90 regular day students having attended the various branches. The evening classes have been correspondingly large, the total number of individual students reaching nearly 350.

Brighton.—The accounts of the electric tramway department for the year ended March 31 will be presented to the Council to-day. The actual period of working is 18 weeks and a day. The total capital expenditure is £181,378. 4s., the receipts £9,687. 4s. 8d., working expenses £8,172. 11s. 4d., leaving £1,514. 13s. 4d. to meet interest and sinking fund, so that there is a net deficiency of £3,051. 5s. 11d

A report from Mr. H. F. Parshall on the cost of electric energy supplied by the Lighting committee will also be considered. The report states that the Tramways committee cannot themselves generate electricity at a less cost than the Lighting committee. Assuming that the lighting department is not entitled to make any profit upon current supplied to the Tramway committee, Mr. Parshall thinks the proper charge should be 1·32d. per unit, and that it is in the best interests of the tramways department to continue to take their supply from the Lighting department, with such adjustments as may from time to time be found necessary, in order that the energy may be supplied at cost. The Tramways committee have informed the Lighting committee that they are willing to take energy at an inclusive flat rate of 1·4d. per unit.

Bristol.—The City Council on Wednesday authorised extensions of the Avonbank electricity works at an estimated cost of about £64,000. Estimates of £19,733 for erecting 365 5-ampere arc lamps, with the necessary mains, and £1,500 for the purchase of additional transformers for private lighting were also passed.

Broadstairs—Public electric lighting was inaugurated on 23rd ult. Current is supplied by the Isle of Thanet Tramways and Electric Lighting Co. who have supplied and erected the arc lamps, &c.

Bury (Lancs.).—The chairman of the Tramways committee (Ald. W. Sykes) last week laid the foundation stone of the tramway car shed, to hold 48 cars and to cost about £10,000. The cost of the complete municipal electric tramway system will be about £200,000.

Chile.—In the presidential address, on the occasion of the opening of the National Congress, it was announced that the Government of Chile are contemplating the establishment of telegraphic communication between the port of Punta Arenas, in the Straits of Magellan, and the central districts of the Republic.

City and Guilds of London Institute.—The Council have awarded the diploma of Associate of the Institute to the following matriculated third-year students in electrical engineering of the Central Technical College:—J. D. Griffin (Siemens medal and premium), H. F. Bayley, L. Calisch, A. B. Duncalfe, L. T. Edwards, C. H. Finnis, C. G. Friedeberg, E. L. Gosset, C. J. Hopkins, C. B. Kinnes, E. M. Langley, E. de Latour, J. E. M. McGregor, W. J. Percey, W. G. T. Pope, and C. T. Wilkinson. Certificates have been awarded to 21 matriculated third-year students at the Central Technical College and to 47 students who have completed a full course of instruction at the Technical College, Finsbury.

Companies Struck Off the Register.—The following have been struck off the register of joint stock companies:—

Great Oceanic Telegraph Co.
Scilly Islands Telegraph Co.
United Kingdom Telegraph Co.

The following will be struck off in three months if cause be not shown to the contrary:—

I.E.S. Accumulator Co.
Dowson Economic Gas Co.
Nalder and Harrison Construction Syndicate.
New-Mayne Electric Rudder-Motor Syndicate.
St. Martin's Electrical Mfg. Co.

Corea.—During 1901 447 miles of overhead telegraph lines were added to the system of Corean Imperial telegraphs, bringing the total mileage in operation up to 2,170 miles. 152,485 messages passed over the lines in 1901, compared with 125,410 in 1900. The Corean telegraph system, like that nearer home, is in the hands of the Government, and is, similarly, said to be "a charge on the Imperial revenue."

Electric tramways now run through a large portion of the city of Seoul and suburbs, and the principal thoroughfares are lighted electrically, as are also the palace and many private dwellings.

At Chemulpo, amongst the improvements being introduced, is the inauguration of a telephone service, which is being organised by the Japanese Post Office.

In the Japanese settlement of Fusan electric lighting works are being established.

The importation of machinery and railway plant and material into Corea shows large increases in 1901 over 1900.

Darlington.—The Council have confirmed the recommendation of the Electric Lighting committee to increase the salary of the borough electrical engineer (Mr. Lunn) from £200 to £350 per year if he agrees to retain his position for three years.

East Ham.—A preliminary statement of the results of the first year's working of the municipal electric tramways is issued. The traffic receipts were £20,141. 9s. 11½d., or 9.61d. per car mile, or 0·665d. per passenger; 502,942 car miles were run, and 7,261,667 passengers were carried; 479,457 units of current were used, or 0·95 per car mile. The average number of passengers carried per day was 19,895, and the average receipts per day £55. 3s. 7d.; the miles run were 1,377, the units used 1,313. The cost of power per car mile was 2·38d. There are 5·3 miles of route open. The percentage of passengers carried at ½d. was 74·9, at 1d. 18·9, at 1½d. 4·5, and at 2d. 1·7.

Eccles.—An inquiry was held last week into the application of the Council to borrow £22,115 for electric lighting extensions. It was stated that the loss on the first year's working of the undertaking was £65, in 1900 it was £789, in 1901 £1,606, and in 1902 £867.

Epsom.—The Council have received an application from Lord Rosebery for a supply of electric current to the Durdans. About 450 8 c.p. lamps will be required, bringing the equivalent number of 8 c p. lamps up to 3,011.

Falkirk.—The charge for electric current for lighting has been fixed at 6d. per unit, and for power at 3d., with a discount of 1 per cent. for each 1,000 units up to 30,000 per annum.

Festiniog.—The Council is in negotiation with the Yale Electric Power Co. for street lighting.

Goods Traffic on Tramways.—The Board of Trade have consented to the Potteries Electric Traction Co. running baggage waggons over their tramways, and the delivery and collection of parcels has been commenced.

Gravesend.—The Council have decided to adopt electric lighting for their municipal buildings.

Halifax—The Council have decided to extend the electric tramways to Brighouse, Hipperholme and Greetland.

Hertford—The Shire Hall is to be wired at an estimated cost of £350.

Hove-Worthing Tramways.—West Sussex County Council has approved the scheme of the British Electric Traction Co. for the construction of electric tramways between Hove and Worthing.

Ilford.—The Local Government Board have sanctioned an additional loan of £31,718 for electric lighting.

Java.—In 1901 a long-distance telephone service was inaugurated, which it is stated has proved a boon to merchants, as messages are taken for transmission over these lines at the same price as for telegraphing over the Government wires, and reach their destination in much less time.

Launceston.—The Council are considering proposals for the erection of electricity works.

Leeds.—The Co-operative Society are putting down generating plant for supplying current for lighting and power for their new warehouses in David-street.

Light Railways.—The adjourned inquiry into the application of the Southend Town Council for powers to extend their light railway system to Shoeburyness was resumed on Tuesday. The Commissioners reserved their decision.

Extension of time (to March 8, 1903) for the construction of the Welshpool and Llanfair Light Railway Co. is sought. Objections by Aug. 23, 1902.

London County Council.—At Tuesday's meeting it was agreed to loan for electric lighting—Poplar, £28,170; Woolwich, £96,170 and £23,960; St. Pancras, £20,000; Hampstead, £5,100.

Tramways.—It was agreed to expend £981,497 on capital account for the reconstruction for electric traction of the Westminster to Tooting line, the establishment of a generating station at Greenwich and sub-stations at Brixton, Clapham and near the Elephant and Castle, car sheds at Clapham and Balham, and a temporary electricity generating station at Loughborough. It was also agreed to spend £152,000 on capital account in erecting car sheds, &c., at New Cross Gate and a sub-station at Camberwell depôt.

It was resolved to apply to Parliament for powers to run omnibus services along the routes of any tramways while under reconstruction for electric traction.

The proposals of the Highways committee to apply for Parliamentary powers to construct 26 miles of new tramways were discussed. (Particulars were given in last week's *Electrician*.)

Mr. BEACHCROFT urged the Council to proceed more cautiously in its tramway policy. They were putting all their eggs in one basket by adopting the conduit system, and should it not prove the best system the Council would be involved in heavy expenses. He urged that wherever possible the overhead system should be adopted. He suggested that the Council

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should admit private enterprise into the provision of tramways for London, and in the north they might leave the North Metropolitan Company to electrify their lines. He would extend their lease for a further period. The Council were now committed to very heavy expenditure on tramways, and should consider carefully if they were on the right lines. He held that the policy of the Council with regard to widening of streets for tramways was hardly honest if they charged one-third of the cost of the widening to the local authority, one-third to the Improvement committee, and one-third only was charged to the tramway account.

Mr. BENN said the Council already had power to have overhead traction in London, but the local authorities objected to it.

The whole of the committee's recommendations were then agreed to.

It was agreed to spend £31,000 on the acquisition of additional land in connection with the Greenwich electricity generating station and with the Clapham depôt.

It was resolved that the Works department be instructed to proceed with the erection of the chimneys for the generating station at Greenwich at a cost of £16,750; with the foundations of the same station at the architect's estimate; and with the erection of substations at Clapham, Brixton and the Elephant and Castle at a cost of £22,500.

Telephones.—It was resolved to establish a telephone room at the County Hall.

Traction of Fire Brigade Appliances.—The Fire Brigade committee reported that the chief officer had recently brought before them a suggestion in connection with the mechanical traction of fire appliances. It was proposed to use a tractor constructed to draw either an engine or a ladder mounted on a van.—The matter is under consideration.

Longton.—The gross profit on the electricity undertaking for the past half-year amounted to £382. 7s. 5d. Interest came to £357. 4s. 4d., and sinking fund £274. 5s. 6d., leaving a deficit of £249 2s. 5d. There are 50 customers.

Manchester.—The accounts of the tramways department for the year ended March 31 have been issued. The total car mileage run was 1,831,126, the number of passengers carried 23,590,288, and the receipts £91,619. 8s. 4d., average receipts per car mile 12d. The average receipts per car mile by electric traction were 12·20d. and by horse traction 9·79d. The total receipts were £91,619. 8s. 4d., rent of lines £19,477. 12s. 1d., other revenue £210. 12s. 2d, total £111,307. 12s. 7d. Working and other expenses (including payment to tramways company under the agreement) were £78,110. 15s. 9d., leaving gross profit £33,196. 16s. 10d. With the addition of interest (£3,289. 14s. 3d.) and transfer from surplus account of £13,548. 2s. 1d., the sum available was £50,034. 13s. 2d This was applied in payment of interest (£17,086 6s. 1d.), sinking fund (£678. 12s. 3d.), instalment of loans (£1,669. 14s. 10d.), contribution in relief of rates (£20,000), and reserve, renewals and depreciation (£10,600). The electric traction operating expenses per car mile was 8·10d., made up as follows:—Electrical energy, 1·45d.; traffic expenses, 4·24d.; management expenses, 1·80d.; and repairs and maintenance, 0·61d. As the tramway system is extended the operating expenses per car mile decrease. Good progress has been made with the re-construction of existing lines and with the construction of new lines authorised. About 1,000 workmen have been employed on permanent way work during the year. For the first three routes the committee employed contractors to erect the overhead equipment, but determined to complete the remainder of the system by their own staff. The work was progressing satisfactorily. The Manchester tramway system, with its 150 miles of track, is now connected with a system of tramways aggregating about 500 miles.

The Corporation have given notice of appeal against the judgment of Mr. Justice Bigham in the case of the Manchester Carriage and Tramways Co. *v.* Manchester Corporation.

Margam.—Mr. C. A. L. Prusman, of Swansea, is preparing an electric lighting scheme for the Council.

Market Drayton.—An electric lighting licence has been granted to the Market Drayton Electric Light and Power Co.

Municipal Telephony.—The Tunbridge Wells Ratepayers' League have joined issue with the Corporation telephone department as to the "profit" of £130 on the first year's working of the municipal telephone exchange. According to a printed document issued by the league, the actual facts are:—

1. The accounts are for a period of eight, not 12, months.
2. Not a penny is written off for depreciation or renewal of plant, although in the engineer's estimate a renewal fund of 3¼ per cent. per annum on the capital outlay was provided for.
3. The sum of £35. 1s. 4d. only is charged in respect of interest on the capital sum of £19,773 spent on construction prior to March 31, 1902, the date of the account.
4. Nothing is charged for sinking fund provided for in the estimates, which, on a loan of £19,773, repayable in 25 years, would amount to a considerable sum for the eight months.
5. An undue proportion of expenditure in respect of wages, salaries, and disbursements has been debited to capital.

The Postmaster-General has granted Hull Corporation a licence to establish a municipal telephone system, and on Monday the Telephone committee fully discussed their differences with the National Telephone Co. It appeared that at a conference between representatives of the Corporation and the company on the 16th ult. an effort was made to come to an agreement, and the following alternative proposals—one being upon a competitive and the other a non-competitive basis—were agreed to:—

1. The company to give inter-communication with their subscribers within the Hull area from the commencement of the municipal service, and the Corporation to allow the underground wires of the company to remain until 1920, the company's licence being extended to that period, and the wayleaves to be on the terms of the previous agreement as to rentals and other matters, except as to the notice to terminate.
2. The company to reduce their unlimited service rate to £7 all round, so long as the Corporation refrain from competition, the company's licence to be extended to 1925, and underground wires to remain for that period on a nominal acknowledgement, the Corporation reserving absolute right to establish a municipal service in competition with the company at any time.

On Friday last the manager of the National Company (Mr. W. E. L. Gaine) stated that his directors were compelled to withdraw the second proposal, owing to an unexpected legal difficulty. After a long discussion the committee decided not to accept the offer of the National Company, but it was decided to advise the Corporation to allow the underground wires of the company to remain until the expiration of the company's licence in 1911 on the following terms:—

1. That there shall be mutual free inter-communication between the subscribers of the Corporation and the subscribers of the company from the commencement of the municipal service, including inter-communication with other towns through the trunk wires of the Postmaster-General, without any terminal or other charges being made by either the Corporation or the company in respect of such inter-communication.
2. That the cost of the junction line in the Hull telephone area necessary to connect the two systems for the purpose of local inter-communication shall be borne equally by the Corporation and the company.
3. That the terms and conditions under which the underground wires of the company shall remain shall be the same as those contained in the agreement of March 18, 1899, with such modifications as may be considered necessary for protecting the rights of the Corporation.

The town clerk reported that the Postmaster-General had met the views of the Corporation by modifying certain rates in the schedule of charges in the draft licence. The consulting engineer (Mr. A. R. Bennett) was instructed to prepare the necessary specifications and to advertise for tenders.

Naples.—Reporting upon the trade of the South of Italy for the year 1901, Mr. Consul Neville-Rolfe states that tramcars drawn by horses have become a thing of the past in the Naples district, their place having been taken by electrically-driven vehicles, there usually being one closed motor car and an open trailer. The gradients on the tramway routes being numerous and in some cases heavy, the change has come as a boon to travellers, who now get over the ground at a much more rapid pace than formerly. Besides increased accommodation, many additional routes have been opened. The new cars are all well lighted by electricity. It has been decided to introduce an important modification in the working of these lines—namely, that the cars shall only stop at regular points, which have been fixed at short distances apart. The introduction of electrically-driven vehicles has caused a great reduction in the number of other passenger-carrying vehicles.

In this district the telephone system has lately been much improved and extended. Unlimited day and night service is provided at £8 per annum on a three years' agreement. In the event of a subscriber changing his residence or place of business, the telephone transfer is made free of charge.

In electric lighting matters this district is well to the front. Upon a consumer entering into a 10 years' agreement, the supply company will wire his premises free of charge, and in the event of removal will transfer the installation without charge. This generous method of dealing with consumers is said to have become very popular, more particularly as, owing to the high cost of oil and other illuminants, the electric light is actually the cheaper illuminant. The use of electric light is extending by leaps and bounds, both in Naples and in the suburbs. A project is under consideration for utilising the waterfall of Piedimonte d'Alife, situate about 30 miles from Naples, for the generation of current to serve the district.

Newton Abbot.—The Council have referred to a committee an offer by the Urban Electric Supply Co. for public electric lighting.

New Westinghouse Works.—A few days ago the Lord Chief Justice (Lord Alverstone), and a party including Mr. Justice Wills, Mr. J. K. Bythell (chairman of the Manchester Ship Canal Co.,) Sheriff Agnew and others visited the new works of the British Westinghouse Company at Trafford Park, Manchester. The visitors exhibited keen interest in the lay-out of the works.

Pocklington (Yorks.)—At their next meeting the Council will consider proposals for the supply of electricity in bulk.

Pontypool.—The local electric lighting company has submitted proposals to the Council for public lighting for seven years, with an offer to substitute incandescent electric for the existing gas lamps.

Presentation.—Mr. O. A. Pilcher, chief assistant at Blackburn, who is leaving to become engineer and manager of the Ilkeston electric tramways, has been presented by the staff of Blackburn Cor-

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poration electricity and tramways department with a travelling bag and a dressing case.

Preston.—During Guild week the town hall is to be illuminated electrically. The contract has been let to Messrs. Gilchrist & Co., of St. Anne's-on-Sea. About 700 lamps will be employed.

The Tramways committee have decided to appoint a resident engineer to prepare plans and specifications and to superintend the construction of electric tramways.

Prestwich.—The Council have approved the agreement with Salford Corporation for the construction and working of the electric tramways.

Rawmarsh.—The local tramway company has agreed to pay the Council £2,800, the estimated cost of obtaining electric lighting powers to be transferred to the company.

Royal Assent.—The following acts of Parliament received the Royal Assent yesterday :—Central London Railway, North Metropolitan Electric Power Supply, West Ham Corporation, North Metropolitan Tramways, Metropolitan Railway, and London County Council (General Powers).

Sierra Leone (West Africa).—The *Anglo-African Argus* states that Mr. S. T. A. Buckle, of Freetown, Sierra Leone, has obtained a 60 years' concession for electric lighting and electric tramways in this town.

Southwark (London).—Last week the chairman of the Electric Lighting committee (Councillor Edwards) presented the accounts of the electricity undertaking for the year ended March 31, and regretted the expectations of three years ago had not been realised. On March 31 the undertaking had been running two years and nine months, and it was hoped that during that time it would have developed a sufficient connection to be on a sound footing before repayment of loans commenced. The equivalent of 23,568 8 c p. lamps were connected on March 31 last, and at present the total was 25,943. Several unanticipated items of expenditure were largely responsible for the deficit of £3,213. Since the commencement of the financial year the total revenue had been approximately £19,833 and the total expenditure £17,277. Interest at 3 and 3½ per cent. amounted to £5,579, which, with other charges, left a deficit of £3,213. They did not expect to be able to clear the debt and provide for repayment of capital during the next two years, and would, therefore, be obliged to ask for assistance from the general rate. Although such a course was not originally anticipated, they felt assured that the modified policy in favour of future efficiency afforded ample justification. The accounts were passed after discussion.

Speed Indicators on Tramways.—In the House of Commons on Wednesday, Mr. Weir asked the President of the Board of Trade if he would take steps, under the Glasgow Tramways Act, 1899, to require the provision of speed indicators on the Glasgow tramways? —Mr. G. Balfour said the requirements as to the provision of speed indicators on the Glasgow Corporation tramways were those contained in the statutory regulations of the Board of Trade. Under these regulations, speed indicators must be fitted on all cars after Oct. 3 next, unless the Board should see fit to prolong the time. Governors must be fitted if the Board so require, but, as at present advised, the Board are not convinced that it is in the interest of public safety to make such requirement.

Stoke-on-Trent.—The Council have adopted the electric lighting scheme prepared by their borough electrical engineer, Mr. P. J. S. Tiddeman. Application has been made for sanction to borrow £30,640, the estimated cost.

Sydney (N.S.W.)—After particularly keen international competition, Messrs. Dick, Kerr & Co., 110, Cannon-street, London, E.C., have been successful in obtaining the contract for the supply and erection of the whole of the machinery for the electricity station of the Corporation of Sydney. Alternating three-phase current is to be generated at the station, and transmitted at a pressure of 5,000 volts by underground cables to two sub-stations to supply the three-wire network of distribution mains. At four other sub-stations the E.M.F. will be reduced to 240 volts between each of the outer conductors and the central point of the three-phase star-connected system of conductors. The distributing mains will in this case be four-core, the lamps being connected in approximately equal numbers between each of the three outer conductors and the conductor which is connected to the central point of the star; this point is also to be connected to earth at each of the sub-stations. Messrs. Preece and Cardew are the consulting engineers, and devised the scheme after a personal investigation by Major Cardew into the whole of the local conditions.

The plant to be supplied by Messrs. Dick, Kerr & Co. comprises five water-tube boilers (Babcock and Wilcox), each capable of evaporating 10,000lb. of water per hour, mechanical stokers, economisers, superheaters, feed pumps, feed-water storage tank, condensers and various air and circulating pumps. There are three steam alternator sets, two of 600kw. capacity and one of 300kw. The engines are of the Ferranti type, and the generators, to be manufactured at Preston, will be of the standard design adopted by Dick, Kerr & Co. in their machines for the London County Council, the Fulham Borough Council, and other contracts. The Sydney contract covers the whole of the pipe work, travelling crane, storage battery, and sub-station plant. The latter comprises five sets of motor generators, each set capable of giving an output of 150kw. continuous current. Three of the sets consist of an induction motor driving two 75kw. continuous-current generators, the other two sets consisting of an induction motor driving a 150kw. continuous-current dynamo. A number of static transformers are also being supplied under the same contract. The main switchboard will be of the Ferranti type. The total amount of the contract is between £50,000 and £60,000.

Taunton.—The Council are extending the electric lighting mains outside the compulsory area to give supply in the Haines Hill and Wilton district.

Telegraphs in the Transvaal.—From to-day (Aug. 1) the telegraph department of Transvaal Colony will be amalgamated with the postal department, both being under the control of the Postmaster-General. The rate of 10 words for 1s. will be reverted to, in place of the 12 words inaugurated with the military occupation. Overland communication with the Cape will also be resumed to-day.

The Recent City Fire.—After a lengthy hearing, and after taking two hours to arrive at their verdict, the jury which, in the City of London Coroner's Court, has investigated the circumstances attending the recent fatal fire on the premises of the General Electric Co., have arrived at the conclusion that the origin of the fire is unknown. A good deal of "legal" blame was attached by the jury to the General Electric Co. in connection with the private alarm system erected on the premises, and, in fact, blame was liberally distributed by the jury to all except the actual firemen and salvagemen engaged in extinguishing the conflagration.

Warrington.—The Board of Trade have extended the time for the completion of the Council's electric tramways until Aug. 6, 1903.

Water Power in France—In an instructive report on the trade of the year for the district of Marseilles (France), Mr. Consul-General Gurney states, on high authority, that "the enterprising American is investigating the district of the Maritime Alps with a view to the utilisation of the water power." Certain negotiations have been proceeding for the control of this power, but, it is said, without success, as the Americans found a French company already in the field being organised to utilise all the water power available in the Alpes-Maritimes from Marseilles to Mentone, the object of the company being to generate electric current for light and power supply to the towns on the south-east coast of France, and also to generate power for the electric locomotives which are to be tested by the Paris-Lyons-Mediterranean Railway Co. on their Cannes to Monaco branch line during the coming winter season. M. Noblemaire, a director of the P.L.M. Company, is said to be much interested in the subject of the introduction of electric traction on the company's Mediterranean coast line.

Wellington (N.Z.)—The City Council have decided to invite tenders for materials and plant for the proposed system of electric tramways in their city from London. Mr. W. R. Wright who was appointed to carry out the work has been instructed to proceed home for the purpose of calling for tenders as soon as the order in council is granted. It is expected that he will be associated with a small advisory body to be formed in London.

West Bromwich.—Sanction to a further loan of £10,000 for tramway generating plant has been obtained.

Wirksworth.—The question of obtaining a provisional order and of getting electricity supply in bulk from the Derby and Notts Electric Power Co. has been referred to the Gas and Water committee.

Workhouse Lighting.—Salford Guardians have decided to wire the nurses' home and the hospital.

York.—The salary of the city electrical engineer (Mr. C. A. Midgley) has been increased from £300 to £400 per annum.

Mr. C. H. Wordingham, who was recently called in to report upon the present position of the electricity undertaking, has presented his report. He approves the site selected for the station and the system of supply adopted, but the first plant installed was inadequate in view of the subsequent demand for current. The equivalent number of lamps connected in March last was 32,700, while the capacity of the generating plant was only about 24,000. The only remedy, Mr. Wordingham advises, is to carry out further immediate extensions, in addition to those actually in hand at the present time.

The accounts of the electricity department for the past year show total revenue £6,110. 4s. 8d., against £3,802. 15s. 5d. in the previous year. Cost of generation and management was £3,518. 8s. 10d., against £2,276. 9s. 7d., and gross profit was £2,591. 15s. 10d., against £1,526. 5s. 10d. Interest and sinking fund absorbed £2,242. 0s. 3d., leaving a net profit for the year of £349. 15s. 8l., against £98. 15s. 9d. last year.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

The directors of the *North-Eastern Railway Co.* announce in an advertisement that they are prepared to receive tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders must be divided into two sections—viz, electrical equipment of coaches and permanent way, and high-tension cables and sub-station equipment, but tenders for either section separately will not be considered. Specifications, &c., may be obtained after 29th inst. from the company's chief mechanical engineer (Mr. Wilson Worsdell), Gateshead-on-Tyne, or from Mr. Charles H. Merz, consulting engineer, 28, Victoria-street, Westminster, S.W., from whom further information may be obtained. Tenders, addressed to the secretary (Mr. C. N. Wilkinson), must be delivered at his office in York by noon, Oct. 7.

Malvern Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work), engines, alternators exciters and switchboard, high and low-tension concentric cables and transformers. Specifications, &c., from the engineer and surveyor (Mr. H. P. Maybury), Council House, Malvern. Tenders (addressed chairman of the Gas, Water and Electricity committee) by Aug. 23. An advertisement contains further particulars.

Rugby Urban District Council invite tenders for the supply and erection of one 150kw. and one 60kw. high-speed steam alternators (three-phase), switchboard, underground mains, arc lamps, public incandescent lamps, &c., and meters. Specifications from the consulting engineer (Mr. W. H. Trentham), 39, Victoria-street, London, S.W., and tenders to the clerk (Mr. T. M. Wratislaw), by 3 p.m. Aug. 20. An advertisement contains further particulars.

Plymouth Corporation invite tenders for overhead-line construction &c. Specifications, &c., from the borough electrical engineer (Mr. E. G. Okell), Prince Rock, to whom tenders by Aug. 23. An advertisement contains further particlars.

Pemberton Urban District Council invite tenders for feeder cables, and overhead electrical equipment, engines, dynamos, &c., boiler, &c., rail bonds, rails, fishplates, &c., and switchboard. Specifications from the electrical engineer, and tenders to the clerk (Mr. P. Partington), Council offices, by noon Aug. 20. Further particulars are given in an advertisement.

Leicester Tramways committee invite tenders for steel girder tramway rails and fishplates; bolts, nuts and tie-bars; points, crossings and special track work; stoneware pipes and conduits; feeder cables; telephone and test wires; roadway frames and covers; overhead electrical equipment and copper bonds; steam-raising plant, engines, generators, batteries, boosters, switchboard, overhead travelling crane, &c., and also for electric tramcars. Tenders to chairman by noon Sept. 3.

Coventry Corporation require tenders for supply of single or two-phase electric motors (½ to 50 H.P.) for hiring. Tenders to town clerk by 10 a.m. Aug. 5.

Cork District Lunatic Asylum committee require tenders for electric lighting plant for the Youghal Asylum. Tenders to medical superintendent, Eglinton Asylum, Cork, by Aug. 12.

Newport (Mon.) Corporation require tenders for tramway reconstruction, rails and fishplates, tie-bars, bolts, nuts, &c. Tenders by Aug. 7.

Warrington Tramways committee require a set of car-lifting jacks, an armature removing bogie and two 12-ton travelling jacks. Tenders by Aug. 4.

Ilford District Council invite tenders for a combined track-watering and sweeping car on maximum traction truck with complete electrical equipment. Tenders to chairman of Council by noon Aug. 19.

London County Council invite tenders for seven tubular fuel economisers and seven motors, and also for dampers and frames for flues and chimney openings. Tenders to clerk by Aug. 15.

Bexley Council require tramway and lighting cables, switchboards, accumulators, motor booster, rotary converter and motors. Tenders by Aug. 9.

Wolverhampton Guardians invite tenders for electric lighting plant, and for wiring their new workhouse. Tenders to clerk by Aug. 13.

Warrington Corporation invite tenders for cables. Tenders to town clerk by noon Aug. 6.

Elmton-with-Creswell Parish Council invite tenders for electric street lighting.

Tenders will be received by the Deputy Postmaster-General *Brisbane*, up to noon, Sept. 1, for the supply and delivery of insulated wire, sheet zinc, glassware for batteries, salammoniac, instrument ink, &c. Conditions, samples, and all particulars are obtainable at the Post and Telegraph Departments of Sydney, Melbourne, Brisbane, Adelaide, Perth and Hobart.

Tenders will be opened at noon Sept. 27 at the Ministry of Public Works, *Madrid*, for a concession for 60 years for an electric tramway between Vigo and Bayona. Particulars (in Spanish) are given in the *Madrid Gazette* for July 27.

Up to Sept. 3 tenders will be received by the municipal authorities of *Calarisi-Stirly*, Roumania, for the concession for the electric lighting of the town. Particulars can be obtained from the municipal offices.

TENDERS RECEIVED AND ACCEPTED.

Manchester Corporation have accepted the tender of Messrs. Rowland Carr & Co., Lime-street-square, London, E.C., for supply and delivery of the whole of the bitumen required for electrical work during the year ending June 29, 1903.

Accrington Corporation have accepted the tender of Yates and Thom for supply of a steel Lancashire boiler at £741, and for steam and other piping at £214, the work to be completed in three months. Nine firms tendered, Yates and Thom and J. Foster & Sons both tendered at £741, the highest tender being that of T. Beeley & Son at £870. The lowest tender for piping was sent in by E. Heaton & Sons at £173. 7s., and the highest (Musgrave & Co.) at £272

The British Insulated Wire Co. have placed with Messrs. Willans and Robinson an order for engines for direct coupling to alternators of Johnson and Phillips' make for the Prescot electricity works.

The contract for the construction of the Great Northern and Strand Railway has been secured by Messrs. Walter Scott and Middleton. The contract price is stated to be about £1,000,000.

Chester Council have accepted the tender of Crompton & Co. for a reversible booster at £357; that of the Tudor Accumulator Co. for a storage battery at £1,268, and to maintain same for 10 years for £77 per annum; and that of Callender's Company for cables at £2,799. 2s.

Chester Council have also accepted the tender of R. W. Blackwell & Co. for the reconstruction and equipment of the tramways at £40,182, and that of Callender's Company for cables at £2,799.

The following tenders have been received by the London County Council:—

Travelling Cranes for Temporary Electricity Generating Station at Loughborough Junction:—

J. Hitchen & Son (alternative) (*accepted*)	£1,474	J. Booth & Bros.	£1,995
J. Hitchen & Son	1,387	A. Chaplin & Co.	1,980
Craven Bros.	2,370	Higginbottom and Mannock.	1,966
J. M. Henderson & Co.	2,144	Morris and Bastert	1,962
Rushworth Bros.	2,085	Carrick and Ritchie	1,928
Thos. Broadbent & Sons	2,000	C. and A. Musker	1,787
		T. Larmuth & Co.	1,745

The successful tenderers will sublet the manufacture of certain parts of the crane girders to Messrs. C. C. Dunkerley & Co. and the electrical equipment to the British Thomson-Houston Co.

Electric Lighting of Horniman's Museum.

The tender of the Electric Construction Co., at £62. 10s., for the provision of a small emergency electric light installation was accepted.

London County Council Tenders. *Rolling Stock Streatham Line* (80 cars).

Tenderers.	Amount.	Delivery from date of order. Weeks.	Proposed sub-contractors. Truck.	Body.	Plough.	Equipment and motors.
Dick, Kerr & Co. (*accepted*)	£47,686	24	J. G. Brill Co.	Elec. Rail. & Tram. Car. Co.	J. G. White & Co.	English Elec. Mfg. Co.
Brush Co.	52,768	26	None	None	J. G. White & Co.	None.
British Westinghouse Co.	50,128	20	J. G. Brill Co. or European McGuire Mfg. Co.	G. F. Milnes & Co.	J. G. White & Co.	None.
Siemens and Halske	49,800	40	J. G. Brill Co.	G. F. Milnes & Co.	None	None.
British Electric Car Co.	49,307	26	None	None	J. G. White & Co.	B.T.H. Co.
Brit. Thomson-Houston Co.	48,288	21	European McGuire Mfg. Co.	G. F. Milnes & Co.	J. G. White & Co.	None.
G. F. Milnes & Co.	47,855	17	None	None	J. G. White & Co.	B.T.H. Co.
Witting Bros.	46,162	20	Brush Co.	G. F. Milnes & Co.	Elec. et Hydraulique	Elec. et Hydraulique.

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The Electrical Power Storage Co., 4, Great Winchester-street, London, E.C., have obtained contracts for the supply of storage batteries to the Corporations of Falkirk and Newport, and also to the Windsor Electrical Installation Co.

Cheltenham guardians have accepted the tender of Messrs. R. E. and C. Marshall for providing intercommunication telephones at the workhouse at £87. 10s. Six tenders were received, varying from £87. 10s. to £149. 10s.

Heckmondwike Council has accepted the tender of Messrs. Ed. Bennis & Co. for an ash elevator for the electricity works.

Salford Town Council has accepted the tender of Ferranti Limited for resistances on the traction switchboard at Strawberry-road station at £288, and that of Messrs. Graham, Morton & Co. for 12 coal shutes at £298.

The Perth Gas Co. have placed an order with Messrs. Willans and Robinson for an 850 H P. compound engine for the electric lighting of Perth (Western Australia).

Gravesend Council have accepted the tender of Ferranti Limited for 50 electricity meters.

Bristol Corporation have accepted the tender of the British Insulated Wire Co. for cables at £6,080 and that of Dick, Kerr & Co. for a dynamo at £840.

For the electric lighting of Monte Video, Messrs. Willans and Robinson are supplying engines for direct coupling to General Electric dynamos.

Pemberton Urban District Council recently received 12 tenders for the supply of cables, &c, for their Little-lane tramway extension. These varied from £630. 15s. 6d. to £1,396. 2s., and the lowest, that of Messrs. Johnson and Phillips, was accepted. Two tenders were for a portion of the work.

Linde British Refrigeration Co. is supplying an electrical refrigerating plant for the Cape Orchard Co., Cape Town. The electrical portion of the contract is being executed by Messrs. Siemens Bros. & Co.

City of London Common Council have accepted the tender of Messrs. Lund Bros. for wiring and fittings at the City of London School for Boys at £631. 8s.

BUSINESS NOTICES.

The address of the British Crown Lamp Co. is now 230, Pentonville-road, King's Cross, London, N.

The telephone number of Mr. A. P. Lundberg, Pioneer Electrical Works, 477 to 487, Liverpool-road, London, N, has been changed to 1,746 North (Nat.).

The works of Arc Lamps Limited will be closed from Aug. 2 to Aug. 9 inclusive, for stocktaking

BANKRUPTCIES AND LIQUIDATIONS.

At the London Bankruptcy Court on Tuesday the public examination of A. J. Sanderson was concluded. Debtor stated that he assisted in the promotion of the Electrical Inkless Printing Syndicate, formed to take over from debtor and another a contract to purchase the invention for £15,000, the syndicate paying £60,000. He became managing director. He attributed his insolvency to lack of income since 1898, to loss on buildings and the invention for electrical printing. Gross debts £31,245, of which £19,945 is unsecured, assets nil.

A first and final dividend of 2s. 0½d. will be payable on Aug. 8, at Brighton-chambers, Bristol, in the bankruptcy of G. J. Lloyd (trading at G. J. Lloyd & Co.), electrical and mechanical engineer, late of 109, Chesterfield-road and Castle Mill-street, Bristol.

In the liquidation of Dobson and Curtis Bros. (Ltd.), a second dividend of 10d. in the £ has been declared, bringing the total payment to date to 5s. 10d. in the £. This exhausts the funds in court (and the assets of the company), save for a small debt which is unlikely to make any material difference in the division.

The Imperial Electric Supplies (Ltd.) is being wound up voluntarily, and Mr. E. P. Harvey, 86, Charing Cross-road, London, W.C. is liquidator.

A first and final dividend of 10s. will be payable on 2nd inst., at 58, Wind-street, Swansea, in the bankruptcy of H. G. McIntyre, electrical engineer, &c., 15, Werter-road, Putney, and Glanamman Colliery, Carmarthenshire.

Mr. E. H. Hawkins, 3, Barbican, London, E.C., has been appointed trustee in the bankruptcy of Carl Vigant de Falbe, lately carrying on business as the Electrical and General Contracting Co., 17, Shaftesbury-avenue, London, W.

Plant, &c., for Sale.—A dynamo by P. R. Jackson & Co., giving 160 amperes at 200 volts, is advertised for sale.

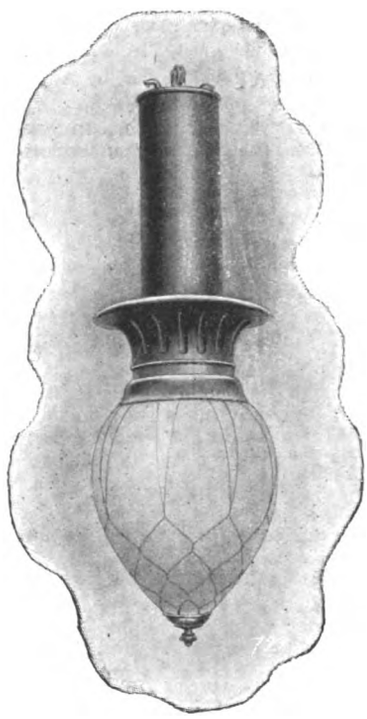
Particulars of some electric lighting plant for sale, are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Works' Sites.—Particulars are given in an advertisement of land, with railway siding, which Messrs. H. Arnold & Son, Doncaster, have for sale.

Patent for Sale.—A patent relating to generation and regulation of electricity supply is advertised for sale on another page.

Electric Driving.—Messrs. W. Whitwell & Co. (Ltd.), Thornaby-on-Tees, have decided to adopt electric driving at their works. Two generating sets of 250 H.P. each will be installed. The engines will be of the Belliss quick revolution type, coupled direct to Pieper multipolar compound-wound dynamos, supplying current at 240 volts. Six steam wharf cranes will be converted to electric driving, and motors will be applied to straightening machines, shears, punch, and overhead traveller in the mills. In addition, the whole of shops, comprising fitting, smiths', roll turners', and joiners' shops, will be driven electrically, as will also the testing machine, a slag stripping machine, mortar mill, and power hammer. For lighting the works including blast-furnaces and mills, 40 arc lamps and over 400 incan, descents will be employed. Messrs. Warren, Beattie & Co. have the contract for the work.

Crompton Arc Lamps.—We illustrate below the "SS" type of Crompton double-carbon arc lamp, which is a development of the "S" type single-carbon lamp. The "SS" lamps are made in two sizes, "short" and "long" patterns. The lamp has few working parts, and these are readily accessible. The "short" lamp burns for 32 hours with Crompton's standard carbons, and this period can be extended to 40 if carbons of a slightly larger diameter are used. In the "long" lamps 50-hour carbons are used, although, if desired, carbons can be fitted to last for 80 hours. The lamps are supplied for any current from 5 to 20 amperes, can be supplied with fittings suitable for various positions, and either globes or lanterns can be provided. A new list of these lamps is now ready.



Crompton "SS" Type Double-carbon Arc Lamp.

Nernst Lamp Illumination.—We are informed by the Electrical Company, 122-124, Charing Cross-road, London, W.C., that in the coming illumination of the Canadian Arch at Whitehall, London, the lighting will be chiefly carried out with Nernst lamps. The illuminations will, we understand, take place on the 9th, 10th and 11th inst. Double the number of these lamps will be used as was used when the arch was lighted on June 30. We are informed also that after the first lighting of the arch the Electrical Company received large orders for Nernst lamps.

"How to Become an Electrical Engineer."—Mr. F. H. Taylor, a member of the consulting firm of Taylor and Field, is contributing a series of articles on the above subject to the "Model Engineer and Amateur Electrician."

Catalogues.—Lists Nos. 10, 13 and 15 of the main catalogue of the Electrical Co. (Ltd.) are just issued. No. 10 deals exhaustively with accumulator apparatus, No. 13 with lightning arresters and sundry safety devices, and No. 15 with measuring instruments. In the last-mentioned list a large variety of instruments are illustrated and priced. A handy marginal index is a feature of the lists.

Award.—At the Tunbridge Wells and South-Eastern Counties Agricultural Show, at Tunbridge Wells last week, Messrs. W. H. Willcox & Co. (Ltd.), of Southwark-street, S.E, were awarded first prize, with silver medal, for their collection of Willcox semi-rotary patent double and quadruple acting pumps, "Record" convertible pumps, patent wire-bound suction and delivery hose, Penberthy patent injectors and their "X-L" ejectors, &c.

Export Duty on Rubber.—It is announced that sanction has been granted by the Foreign Office to the imposition from Sept. 1 next of a duty of 4d. per pound on exported rubber from British Central Africa and North-East Rhodesia.

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Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 23 to 29, with the ports of destination :—

Africa—Alexandria, £635 (including £580 telegraph material); Cape Town, £156; Delagoa Bay, £336; Durban, £1,046; Larache, £840; Port Elizabeth, £1,090; Zanzibar, £150. *Argentina*—Buenos Ayres, £719 (including £80 telegraph material). *Australasia*—Christchurch, £209; Fremantle, £354; Melbourne, £147; Sydney, £787; Wellington, £162. *Belgium*—Ostend, £108. *Chili*—Boca, £141; Valparaiso, £49. *China*—Shanghai, £71. *Colombia*—Santos, £22. *Denmark*—Copenhagen, £3,080. *Hawaiian Islands*—Honolulu, £20. *Holland*—Amsterdam, £87; Flushing, £25; Hamburg, £25 (telegraph cable). *Hong Kong*, £158. *India*—Bombay, £93; Calcutta, £721. *Italy*—Naples, £210. *Japan*—Nagasaki, £137. *Mexico*—Vera Cruz, £8,553. *Portugal*—Lisbon, £10. *Russia*—St. Petersburg, £35. *Spain*—Grenada, £86 (telegraph material). *Sweden*—Gothenburg, £183; Stockholm, £174. *U.S.A.*—Boston, £80. Total £20,699, against £26,551 in the corresponding week last year (July 24 to 30).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

June 4, 1902.

12,733. F. E. Linnett. Northampton. Electric door contact.
12,737. A. Swan. Leeds. Blowing-off machines for electric lamp bulbs.*
12,738. A. Swan. Leeds. All-glass seal between stem and bulb of incandescent lamps.*
12,739. A. Swan. Leeds. Bases for incandescent lamps.*
12,749. C. M. A. Culverhouse and F. V. Culverhouse. Plaistow. Electrical communication on railway.*
12,752. E. A. Claremont and C. J. Beaver. Testing insulation of electric cables.
12,755. E. Kolben. Reducing or suppressing synchronising currents of single or multiphase alternators working in parallel.*
12,764. H. H. Lake. Brush-holders. (General Electric Co., U.S.)
12,765. H. H. Lake. Distribution of electricity. (General Electric Co., U.S.)
12,766. H. H. Lake. Cleaning electric lamp filaments. (General Electric Co., U.S.)
12,767. H. H. Lake. Control of electric motors. (General Electric Co., U.S.)
12,780. P. Hardegen. Telephone installations*
12,783. Siemens Bros. & Co. and A. Siemens. Electromagnetic detents.
12,793. Metals Corporation (Ltd.) and Sherard Cowper-Coles. Electrolytic refining of copper.

June 5, 1902.

12,817. M. Mercier and W. O. Andrews. Manchester. Switches.
12,823. A. C. Heap and W. O. Smith. Electrical measuring instruments.
12,846. J. Bush and M. T. Medway. Controller and switch for electric motors.
12,857. W. E. Winship. Storage batteries.*
12,870. Société l'Espagnol and Mériguet. Charging accumulators. (Date applied for, Nov. 14, 1901, date of application in France.)*
12,881. G. H. Fawcus. Electric resistances and safety fuses.

June 6, 1902.

12,951. O. Schwimmer, I. Schön and M. B. Schwimmer. Electromagnetic switches.
12,956. P. M. Justice. Transmitting apparatus for telegraphs. (Rowland Telegraphic Co., U.S.)*
12,958. H. H. Lake. Switches for electric motors. (General Electric Co., U.S.)
12,959. H. H. Lake. Machines for winding insulating tape on coils of electrical apparatus. (General Electric Co., U.S.)
12,960. H. H. Lake. Electrical conductors. (General Electric Co., U.S.)

June 7, 1902.

13,037. J. Jofeh. Coin-freed machine or apparatus for administering electricity.

June 9, 1902.

13,047. W. Waddington and W. Wainhouse. York. Electrical hot-air or vapour baths.
13,064. R. W. Cooke and J. Scott. Newcastle-on-Tyne. Electrical fire alarm.
13,082. M. Railing and J. H. Collings. Combined electrical switch and cutout for street poles and the like.
13,088. H. Hoppelt. Arc lamps.
13,115. J. H. Thomson. Wireless telegraphy.
13,119. D. Perret. Electrical testing apparatus.

June 10, 1902.

13,154. H. Oppenheimer. Electromagnetic annunciators. (A.G. Mix and Genest., Germany.)
13,155. C. J. Pepper. Transmitting sight and speech by magnetic pulses.
13,161. H. Leitner and R. N. Lucas. Regulating electric light circuits on trains.
13,170 and 13,171. E. Hill and E. Hill, jun. Trolley wire support.*
13,175. Siemens Bros. & Co. Equalising appliances for inter-connected polyphase-current systems. (Siemens and Halske A.G., Germany.)*
13,181. J. Wetter. Trolleys of electric railway and tramways. (Paul Pfeiffer, Germany.)
13,205. J. Bühler. Electric clocks or time-pieces.*
13,207. A. J. Boult. Electric telephotographic apparatus. (L. Semat, Egypt.)

June 11, 1902.

13,255. A. C. Heap. Electrical measuring instruments.
13,267. W. P. Burke. Fusible electric cutouts.
13,275. E. Parry and F. W. Bidder. Safety device for electric railways.
13,791. L. Kusnick. Apparatus for indicating time at various places from a principal time-keeper.

June 12, 1902.

13,297. J. J. Carter. Dublin. Trolley-head, arm, posts and safety appliance.
13,308. D. Newton. Liverpool. Lifeguards for electric cars.
13,357. British Thomson-Houston Co. Trolley.

June 13, 1902.

13,438. H. H. Lake. Electric railway systems. (T. E. Murray and J. van Vleck, U.S.)*

June 14, 1902.

13,491. H. R. Webb. Nottingham. Intercommunication switch for telephones.
13,500. C. E. and H. M. Peel (Ltd.). Swansea. Commutating electric current, applicable to combined arc and incandescent lamp circuits.
13,517. E. C. A. Andreen and O. Stalhane. Continuous-current generators or motors with open winding.
13,521. O. J. Lodge, A. Muirhead and E. E. Robinson. Coherers.
13,526. British Thomson-Houston Co. Electrically-operating countershafts. (N. C. Bassett, U.S.)
13,527. British Thomson-Houston Co. Electrical measuring instruments. (L. T. Robinson, U.S.)
13,528. British Thomson-Houston Co. Inertia dampers for electric measuring instruments. (W. H. Pratt, U.S.)
13,529. British Thomson-Houston Co. Electric starting rheostats. (C. E. Harthan, U.S.)
13,530. British Thomson-Houston Co. Brush-holders. (N. C. Bassett, U.S.)
13,531. British Thomson-Houston Co. Snap switches. (H. Geisenhouer, U.S.)
13,532. British Thomson-Houston Co. Condensers. (W. S. Moody, U.S.)
13,533. British Thomson-Houston Co. Armature bands. (J. J. Wood, U.S.)
13,534. British Thomson-Houston Co. Electrical motor control systems. (C. E. Barry, U.S.)
13,539. W. H. Hyatt. Electric wires.
13,545. K. Weinert. Arc lamps.*
13,556. C. Ilgner. Control of current to motor apparatus requiring intermittent supply.*

June 16, 1902.

13,572. H. B. Stocks and T. McClelland de Bingham. Manchester. Electric hammer.
13,593. C. H. Prött. Germany. Commutators.*
13,604. G. Bellina. Incandescent lamp.
13,612. H. Hawthorn. Electric fire alarms.
13,626. O. Imray. Manufacture of hydroxylamine and chlorine by electrolysis. (Farbwerke vormals Meister, Lucius and Brüning.)
13,658. W. Sevenoakes. Switches.
13,663. G. C. Fricker. Differential thermometers adapted as maximum demand indicators.

June 17, 1902.

13,713. T. Chalmers. Manchester. Lamp-holders.
13,727. British Thomson-Houston Co. Electric snap switches. (F. L. Fenn, U.S.)
13,728. British Thomson-Houston Co. Push-button switches. (E. G. Kastenhuber, U.S.)
13,729. British Thomson-Houston Co. Trip coils for electric circuit-breakers. (J. D. Hilliard, jun., U.S.)
13,731. British Thomson-Houston Co. Globe-holders for electric lamps. (J. J. Wood, U.S.)
13,732. British Thomson-Houston Co. Arc lamps. (C. E. Hartham, U.S.)
13,733. British Thomson-Houston Co. Train signal systems. (A. G. Davis, U.S.)
13,734. British Thomson-Houston Co. Transformers. (W. S. Moody, U.S.)
13,737. H. H. Lake. Electrical distribution. (General Electric Co., U.S.)
13,738. H. H. Lake. Electric hoisting apparatus. (General Electric Co., U.S.)
13,739. H. H. Lake. Insulating material. (General Electric Co., U.S.)
13,740. H. H. Lake. Electric traction. (General Electric Co., U.S.)
13,741. H. H. Lake. Switches. (General Electric Co., U.S.)
13,742. H. H. Lake. Electrical distribution. (General Electric Co., U.S.)
13,743. H. H. Lake. Motor controlling devices. (General Electric Co., U.S.)
13,749. C. H. Graham and G. D. Bouton. Galvanic batteries.*
13,759. C. Portillo. Electric current-taking devices. (Date applied for March 14, 1902, date of application in Spain.)*
13,787. E. W. Farnham. Electric railways.*
13,789. C. Dietz. Connecting telephones and telegraphic instruments to overhead conductors.

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

6,454. CLARK. Grid or electrode for retaining plumbic oxides in accumulators.
11,254. STEAD. Incandescent light fittings.
11,257. QUAIN and TURNBULL. Electrolytic incandescence lamps.
11,315. MACKAY and SCLATER. Regulators for electric motors.
11,545. HEYES and HEYES. Safety device for trolley wires.
12,382. CAMPBELL and ISHERWOOD. Portable electric drilling apparatus.
12,469. BERTHELON. Current transformer for telephones.
13,239. WUST-KUNZ. Alternating-current motors.
13,468. WESTINGHOUSE BRAKE CO. and MALAN. Electrical interlocking apparatus for railway signalling.
13,665. SHEPPARD, RAM and NERNST ELECTRIC LIGHT. Holders for Nernst lamps.
14,624. ECKSTEIN and PANTER. Moving coil measuring instrument.
14,813. MENLOVE. Current collectors for electric tramways.
14,825. TOSSIZZA. Electro-metallurgical treatment of zinc ores and especially blende.
14,826. IMRAY (Scharf). Exhausting glow lamps.
14,930. PARSONS. Holding and working trolley poles.
15,045. EVANS. Arc lamps and means for stopping heat radiation in optical apparatus.
15,195. CHAPMAN. Supporting conductors in conduit systems.
15,239. BARTLETT. Cutouts and partly applicable to switches.
15,258. IRWIN and WILLANS AND ROBINSON. Raising, lowering and suspending arc lamps.
15,290. SMITH. Electric ignition.
15,371. HODGES. Electric switches.
15,524. GRÜLL. Electrically-driven blast fans.
15,691. BETTS (Betts). Electric railways on road contact system.
16,122. DORSEMAGEN. Working zinc and substances containing silicic acid in electric furnaces.
17,711. MAICHE. Transmission of telegraphic and telephonic signals. (Date applied for Feb. 19, 1901.)
18,530. MARSHALL. Dynamos and motors.
19,811. CLAREMONT. Apparatus for testing insulation of cables.
20,515. NOCK. Protectors for car brake handles.
24,816. KINTNER. Electric railways. (Date applied for, May 6, 1901.)
25,000. DE BLANCO. Electro automatic advertising devices.
25,270. BOADER and RAU. Electric valves and gas lighters.
25,710. BAILLY. Electric ignition device for motors.
25,754. STOVER and SUREN. Apparatus for use in charging storage batteries.
26,203. SCHNEIDER. Electromagnetic motors.

COMPANIES' MEETINGS AND REPORTS.

Direct United States Cable Co. (Ltd.).

The fiftieth ordinary general meeting was held on Tuesday, under the presidency of Mr. E. M. UNDERDOWN, K.C.

The GENERAL MANAGER AND SECRETARY (Mr. T. Finnis) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the revenue for the six months to June 30 last, after deducting outpayments, amounted in round figures to £46,610, while the working and other expenses, including income tax (I beg you will take note of that item for a moment) absorbed £21,516, leaving a balance of £25,094 as net profit, making, with £3,350 brought forward from the previous half-year, a total of £28,444. This has been appropriated as follows: Interim dividend of 3s. per share to March 31, £9,106; the proposed final dividend for the financial year of 3s. per share to June 30, with a bonus of 1s. per share, will require £12,142; we transfer to the reserve account £5,000, and we propose to carry forward the balance of £2,196, making together the total of £28,444. The revenue shows a decrease—£4,039—as compared with that in the corresponding period of last year, owing to the additional cables now in operation. There are at the present time 14 effective cables working for the North Atlantic business. The working expenses in London require no remark—they are practically the same as they were previously; at the stations they also remain very much the same as they were last year, but there is a small increase in respect of foreign agencies. It is necessary in foreign places to keep someone to look after our business, because great energy is shown by our rivals in collecting business, and we think that that expenditure is very well covered. The remaining items of expenditure are either fixed charges or show no appreciable difference in amount. The reserve fund is in a very satisfactory condition. It has been credited with £7,366 from interest on the investments and with £5,000 transferred from revenue account, and now amounts to £460,383, at cost, the actual value of the securities being larger. The question of the reserve brings me to a very interesting and, I should say, pleasing incident. You know that we deal with the reserve fund in this way: We put all the interest upon the investments to that fund, and when we want any repairs or renewals we take the expenses that are necessary for those purposes out of the reserve fund, replacing the amount as we are able to do so. We do not carry the interest from our investments into our general revenue. Singular to relate, during the whole of the 12 months under review and up to the present time, we have had to spend nothing upon the repair and renewal of our cables. It is a very remarkable thing, after the cable has been down for so many years, that we should have incurred no expense upon it for more than 12 months, and it is working now perfectly, both simplex and duplex. Our investments have been increased by £11,346 during the half-year, and they stand at cost. Taking the results for the whole financial year, the receipts were £96,199, and, less expenses and other payments amounting to £43,074, we have £53,125 to deal with. We pay in dividends £39,461 and place to reserve £15,000, making together £54,461, less the reduced balance in hand as compared with June, 1901, £1,336, making the total £53,125. The reserve fund has been increased by £29,386, as under: From interest, &c., £14,433 and from revenue £15,000, together £29,433, less a balance charge on repairs of £47—an item that has nothing to do with the year under review. The investments have been increased by £29,479.

Now, so far, what I have told you is very favourable, and, in point of fact, I need not occupy your time much further, because all that I have to say is extremely favourable, except, of course, that if you have more cables, you will have a larger division of the Atlantic traffic. I should say that the whole question of cable communications has been before an inter-departmental committee, which was a very strong one, and by which it has been most thoroughly inquired into. Most of us have been before that committee, and have given evidence in defence of our various interests, and it is satisfactory to know that the report just issued says this: "The Atlantic companies have not formed the subject of much public controversy. They have received no subsidies. They provide, under the influence of competition, an efficient service at a low rate, and no complaints against them have been laid before us."

Now, that is extremely satisfactory, because we have heard from time to time bitter attacks upon those who were at one time thought to be great public benefactors—those who are interested in Atlantic telegraphy and telegraphy in general. Their services seem to be forgotten now, and attacks have been made upon them, which, however, I am glad to say, have met with no success. There seems to be a sort of inhuman joy when something comes forward which is likely adversely to affect cable property. This is to be regretted, but it appears to be the case. This brings me to the question of wireless telegraphy. If anything has ever been advertised in every possible direction, that subject has been now for some years. I think, however, the words of Sir John Wolfe Barry to the shareholders of the Eastern Telegraph Company may be taken to heart. [See *The Electrician*, July 25, 1902.] We know perfectly well that these inventions may be of value, but it seems to have escaped the attention of our rivals that if they are of value, there is nothing in the world to prevent us—who have large staffs and communications with the principal companies in the United States and with our own Government—from making use of them in so far as they may be useful. I do not think that the attacks on cable property are warranted, and I may say that I have had an interview with the greatest authority on the subject (Lord Kelvin) who is strongly of opinion that however valuable wireless telegraphy may be for certain purposes, it cannot affect the transmission of messages over great distances through cables. Although it has made people nervous with respect to cable property, I do not think their fears are justified.

I should like to refer to the death of Mr. Mackay, the chairman of the Commercial Company, which, of course, is one of our great rivals. As a man of very remarkable energy and very considerable business qualifications his death is to be regretted. I see it is reported that he is succeeded by Mr. George Gray Ward, who is a very able gentleman, whom we ourselves were once connected with. It is impossible for us to keep all the Atlantic traffic to ourselves, and therefore we can only express our sympathy for the loss which has been sustained by the public through the death of Mr. Mackay, and I trust that our relations with this company may go on in a satisfactory manner. I now move the adoption of the directors' report and accounts, and the payment of the dividends set out therein. I might have mentioned, in support of what I said in connection with the attacks on our property, that we have a very large amount of the capital of our Company now represented by our reserve fund. There is something like £7. 15s. a share in it, and our shares at this moment, I see, are quoted at from 10 to 10½. It is a very remarkable thing that they should not be quoted rather higher, seeing that £7. 15s. is in sovereigns, so to speak, and the balance is represented by the goodwill of the Company.

Sir JAMES PENDER, Bart., seconded the motion, which was carried unanimously.

The retiring Directors, Mr. E. M. Underdown and Sir James Pender, and the auditors, Messrs. Deloitte, Dever, Griffiths & Co. and Messrs. J. and J. Sawyer & Co., were re-elected, and a vote of thanks to the chairman, directors and staff terminated the proceedings.

City and South London Railway Co.

The thirty-sixth ordinary general meeting was held on Tuesday Mr. C. G. MOTT presided.

Mr. W. F. KNIGHT (the Secretary) read the notice calling the meeting.

The CHAIRMAN said: We meet to-day under much more satisfactory circumstances than we have ever met before. It is now nearly 12 years ago since His Majesty the King opened this line for public traffic. We had then completed and inaugurated a railway of an entirely new description, and we were in the position to prove that an electrical line could be made and worked in the interest of the public, that it would add largely to the convenience of the public, and as such was worthy of public approbation but we had not proved, and it remained for us to prove, that such a railway could be made, not only to serve the public interest, but also to return an adequate remuneration to the shareholders. We were then face to face with a difficult problem. The route that had been adopted, and which we had no choice in connection with, was not one with a very large amount of traffic capabilities; we had, therefore, to look forward to making the traffic for ourselves to a large extent, and we had to complete a railway of which only a small section—about one-half—was then finished and opened for traffic. Well, it was a difficult task, and we have had, year after year, to ask your patience—the patience of the shareholders—while we have been carrying that out. That patience has been granted to us in an unmeasured manner, for which the Directors of this Company will always be grateful. We have, at last, in the past half-

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year, completely solved the problem of making this line a profitable one—that is to say, a fairly profitable one—to the shareholders. Now, ladies and gentlemen, that work has not been brought about without a vast amount of labour and thought and anxiety on the part of everyone concerned in connection with this, and it would not have been brought about at all had it not been for the thorough co-operation that has been exercised by all parties concerned in it. I have to thank my colleagues on the Board for their constant and steady support, and the thorough attention which they have given for so many years to the Company's work. We have had, as you all very well know, an excellent general manager in Mr. Jenkin, and in addition to that we have had other excellent officers, and, indeed, the whole staff from the top to the bottom has worked well, and worked with the desire to make this line a great success. We have also been favoured in having very excellent solicitors, and as to engineers the best that were possible, and last, but by no means least, we have had good financial friends in the City, to whom we owe an immense debt of gratitude, for they always did their best to help the railway in the difficult task of raising money from time to time for the extensions which we have undertaken in connection with the company. We have brought this railway to the state that it is in now—a remunerative line—and we recommend you to-day to pay upon the ordinary shares a dividend at the rate of 3 per cent. per annum. Well, now, in view of the question of the extension of electrical railways and the expenses, it may be as well to look rather closely into the question of what the return upon the capital of this Company has been. Now, the capital expenditure upon this line, as you will see by the capital account, has been up to the present time £2,464,000, and the net revenue for the half-year will amount, after the deduction of the working expenses, to £44,405, or at the rate of £88,810 per annum. That is the return upon our expenditure. If you take the £2,464,000 you will find that the £88,810 gives you a return of 3·60 per cent. upon the capital expended. That is rather more than equal to 3½ per cent. But in regard to that capital, that is the amount which appears as capital in the accounts, but you must bear in mind that it is not really the amount of capital money that we have either received from the shareholders or spent. We have, as you all know, been obliged to issue from time to time a great portion of the capital of this Company at a very heavy discount; and although, of course, we have not received the full amount of the money from the shareholders, it has had to appear in the accounts as the capital cost. The shareholders have not paid the money in because we have had to issue the shares at a lower rate, and I think that you may take those discounts altogether as amounting to £264,000, so that the net expenditure upon the cost of the line comes out at £2,200,000, and that £88,000 per annum would give an annual return of 4 per cent. upon the capital cost of this line. Well, ladies and gentlemen, a railway such as this, affording a permanent return, and one not likely to be altered, at the rate of 4 per cent., is, as you know, one that should always be able to command its money in the market. Therefore, I say that we have to-day solved the last problem which was left to us—we have made the railway, and we have proved that the railway is one that it is worth while to invest in. With regard to the public, they have had the benefit of it at the expense of the shareholders for the time being, for we have not received this return during the period that the line has been open up to now. We were the pioneers in this matter, for when we started there was, as you are aware, no other practical electric railway in the world. We have shown the way to work the system, and that it can at once be worked as an expeditious and exceedingly safe line for the public, and it has been appreciated by the public, and this has been shown by the great number of those lines which are being made not only in this country, but also all over the world, and more so abroad than in the country of their original birth. The appreciation of the public is proved by the innumerable applications which have lately been made to Parliament for extensions in London, and also for extensions in the country districts; and, further, as you will have seen from the various reports which have appeared within the last few days in the papers, that a great many of the principal railways lines in England are now considering the question of the adoption of electrical traction upon various parts of their systems. We may, therefore, I think, claim that we have done a vast public service, not only for this country, but also for the world. This little line has achieved this, and we have the pleasure of feeling that we have done so without any loss to ourselves in the end.

With regard to the capital account, you will see that we have received during the past half-year £49,434 for debenture stock and £9,890 for premiums, and we have also received £12,500 as the half cost of the Old-street station and a portion of the land in connection with the widening of the street. The total that we have received on capital account is £71,824, and there has been an expenditure on capital account in the half-year of £46,768, so that the excess of the receipts over expenditure in the half-year has amounted to £25,056, and that balance has gone to reduce the balance at the debit of capital account. With regard to the revenue account you will see that as to the passenger traffic we have increased in numbers by no less than 3,304,334, and the amount of money received therefrom shows an increase this year, as compared with the corresponding period of last year, of £25,137. In addition to that there is a further increase from season tickets of £692, making up the total increase from passenger traffic to £25,829. Parcels show an increase of £104, transfer fees an increase of £41, rents an increase of £554, and sundry receipts an increase of £108, making up a grand total increase of £26,708 in our receipts. Now let us see what it has cost us to get that. In maintenance we show an increase of £92, in locomotive and generating power an increase of £2,694. In traffic expenses there is an advance of £3,924, and in general charges an increase of £399, and passenger duty a growth of £18. Rates and taxes are an ever-growing quantity, and show an increase of £756, but, on the other hand, there has been a diminution in the cost of repairs to carriages of £15, and in law charges of £8, making a net increase in the cost of working of £7,860 to earn £26,708; so that, as a result, we show a net increase of £18,848 in our revenue, but against that we have to deduct the increased amount of interest which we have had to pay on our debenture stock, £877, and an increase of interest upon various outstanding loans and other things, amounting to £911, making a total of £1,788, which has to be deducted from the £18,848, leaving a balance of £17,060, to which is added in the accounts the difference between the balances carried forward at the two dates—viz., £176, making a net increase of £17,236. How this is dealt with you will see if you look at the last page of the accounts. You will see that we carry a balance forward from net revenue account of £34,199. Of that, £3,750 is for the first preference stock dividend, £5,000 for the second preference stock dividend, and £3,750 for the third preference stock dividend, and a dividend at the rate of 3 per cent., if you approve it, on the ordinary stock requires the sum of £19,950, and this leaves a balance to carry forward to the next half-year of £1,749. 19s. 10d., against only £733 at this time last year, so that we have increased the balance which we carry forward by more than £1,000 on this occasion. We have also paid off a further sum of £2,000 to the renewal fund, which was much larger this time last year, and we have thus reduced it down to only £1,034 in the present accounts, and if, on the next occasion, we can again carry £2,000 to that fund, as I hope we may, we shall then have something to the good. Now, perhaps, the most interesting thing is that which I have to come to now—viz., the question of the various percentages and details of that kind, which I usually give you, and first of all, with regard to the train miles run. We have this past half-year run 618,470 train miles, which is an increase over the corresponding half of last year of 173,910 train miles, and much of this increased mileage is due to the Islington extension. The number of trains has also increased, and we have ran the vast number of 100,975 trains in the half-year, an increase of 7,383 trains over the previous year for the same period. The number of passengers carried was 9,192,120, an increase, as I have already told you, of 3,304,334. The number of passengers carried per train has also, of necessity, increased in consequence of the increased length of the trains. The number of passengers carried in each train has been 91·03 in the past half-year, against only 62·91 a year ago. The receipts per train have, in consequence, risen this year to 15s. 3d. as against only 10s. 10·8d. last year, and the receipts per train mile have risen to 2s. 5·82d. this year against only 2s. 3·54d. a year ago. The receipts per passenger are, however, very slightly less than a year ago—viz., 1·93d. this time against 1·98d. at June last year, but then there has been a very large addition in the number of short-distance passengers carried. The most important item is the percentage of working expenses, and that has been reduced from 52·36 per cent. this time last year to 44·74 per cent. on the present occasion. That is a most satisfactory thing. We have had from time to time our traffic increasing and we have been able to get our percentage of working expenses constantly going down, and I hope that in the future we shall get them still further down. The expenses per train mile have been 1s. 1·95d. against 1s. 3·19d. this time last year, and the locomotive charges for power 4·59d. against 4·93d. last year, so that you will see that there is a decrease everywhere; we are working the line upon a more economical percentage in every way. The traffic expenses were 6·13d. against 6·40d. last year. There is one thing you must remember with regard to what I have been saying, and that is, that the line has only lately been completed and the half-year under review is the first complete half-year in which the whole of the line has been in working order. That is why we have never before enjoyed a definite position. We have never before perfectly understood the exact position—what was really capital expenditure and what was revenue expenditure—and, therefore, at times it has been difficult to divide the items quite rightly. We have, however, had nothing of this in the past half-year, and I think that we may very well and fairly congratulate ourselves upon the results. I now come to the most unsatisfactory part of my statement to-day, and that is the rejection of the bill of the Company which we promoted for the extension of the line to Euston. The bill came before a Private Bill Committee of the House of Lords and it was supported by public bodies and it was also supported by the large railway companies concerned—that is to say by the London and North-Western Railway, the Midland Railway, the Great Northern Railway, and the London, Brighton and South Coast Railway. There was no opposition to it by anyone except as regards the King's Cross Station of the Metropolitan Railway, but the result was that the Committee threw out the preamble of the bill. They did not discuss the question, but simply threw out the bill. Why they did this it is very difficult indeed to say. They were not acting in the public interest when they threw the bill out, and we therefore propose to re-introduce this bill in the coming session of Parliament, and we have very little doubt that when this bill comes before an ordinary Committee it will pass that bill, because it is eminently in the public interest. The connection which will be given by this line between the whole of the north of London and the south of London railways and their stations will be of enormous benefit and an advantage which cannot be given and which is not now given by the Metropolitan Railway itself. I can see no reason whatever why that bill should not have been passed. The next bill is that promoted by the City and Brixton Railway Co. You will remember the arrangement which we made with the City and Brixton Company by which they were to make only a small portion of their authorised line, and we further entered into an agreement to work that portion in connection with our own line. They were to obtain the funds for the making of their line. That bill is still before Parliament. The matter has been delayed because of a paragraph which, no doubt, you have seen in the advertisement of the prospectus of a company calling itself the "City and Surrey Electric Railway Provisional Syndicate (Ltd.)," I think, or something of that sort. We have had no connection whatever with that railway, nor do we know anything of the people. It is formed, apparently, to take over the position of the promoters of the City and Brixton Bill and to find the capital, and, therefore, of course, if they are able to so—if they carry it through—they will stand in

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the same relation to us as the promoters of the City and Brixton Bill do at the present moment. I may say that, as far as I read and understand the prospectus, and it is not, really, a very easily understandable document, it appears to me that they propose to drop the present bill, which is now before Parliament, for the carrying out of the Brixton scheme, and to carry out instead the new proposal. Whether or not this can be done we do not know, but if it can, and the money can be raised, then undoubtedly it would bring additional traffic to the existing portion of our line. With regard to the City and Brixton Bill, therefore, we do not know quite what their intentions are, but the bill is still before Parliament, and it must either be dropped or passed within the next few days. With regard to the award of the arbitrator in respect of St. Mary Woolnoth Church, which has been a very worrying question, we were not satisfied, and we have, therefore, made up our minds—and we hope that you will approve of our decision in this matter—to carry the matter to the Court of Appeal. There were three awards, and different amounts of money in each, and it is difficult to say which one is to be adopted. We may—and I hope it may be so—come to some arrangement with the parties for a reasonable and fair settlement, for that is what we desire to do. I now move the adoption of the report and accounts.

Mr. C. S. GRENFELL seconded the motion.

Mr. CLAPCOTT enquired if the 44 per cent. rate of working costs was including the lifts?

The CHAIRMAN said yes; if they deducted the lifts it would bring the amount down to some 38 per cent. of the receipts of the railway.

Mr. DAVIS asked when the Great Northern and City expected to open its line?

Mr. S. GURNEY SHEPPARD congratulated the Company on having carried 88,000,000 of passengers without loss of life, and with no accident worth mentioning.

The CHAIRMAN said the Great Northern and City Co. had only just begun the last connecting link at the other end of the line. The rest of the line, however, was well forward, and would, he believed, be completed by the end of the current year. They anticipated getting a considerable amount of traffic over their own line when the Great Northern and City was completed. They also looked for a large amount of additional traffic from the Baker Street and Waterloo Railway at the Elephant and Castle by the connection at Baker-street with the Great Central and the Great Western at Paddington, and they would also have traffic from the busy centres around Piccadilly-circus, Regent-street and Charing Cross. By the Baker Street and Waterloo system and the proposed extension to Euston all the great railways north of the Thames would, by the Company's line, be put in connection with the railway companies' termini south of the river. The Great Central would be connected by the Baker Street and Waterloo line, which will pass that station and also the Great Western station.

The resolution was then carried unanimously.

The dividends were then approved, and a vote of thanks to the chairman and directors terminated the proceedings.

Globe Telegraph and Trust Co. (Ltd.).

The twenty-ninth ordinary general meeting was held on Wednesday, under the presidency of the Most Hon. the MARQUIS OF TWEEDDALE, K.T.

The SECRETARY (Mr. Sidney Collett) read the notice convening the meeting.

The CHAIRMAN then said: Gentlemen, those who have perused the report and accounts will, I think, regard them as disclosing a very satisfactory state of things. Our receipts, after deducting the usual expenses, amounted to £199,370, being an increase over those of the previous year of £2,234. This enables us to pay our usual 6 per cent. on the preference shares and a final dividend of 4s. 9d. upon the ordinary shares, or at the rate of 5⅜ per cent., which is the largest dividend this Company has paid since its foundation 29 years ago, with the exception of the first year, when ½ per cent. more was paid. We have issued during the past year 300 ordinary shares and 458 preference shares. The object of this issue was to take advantage of the low market prices of some of the best telegraph companies, whose shares, to which I shall refer later on, we have acquired. These ordinary shares realised 11¼, while the prices we received for the preference shares ranged from 12½ to 14⅜. In every case the proceeds were re-invested profitably, and the premium, amounting to £1,657, has gone to reduce the item "Differences on Securities Realised." The shares we issued were not offered to the shareholders, but were sold in the open market. As to our investments, the first company that I will refer to is the Anglo-American Telegraph Co., our receipts from which amounted this year to £16,297, or a diminution of £860 as compared with the amount received in the preceding year. This is accounted for by the fact that in the March quarter this company only paid 25s. per cent. against the usual 30s. per cent. on their preferred stock. It is satisfactory, however, to know that, in declaring the last quarter's dividend they reverted to the 30s. per cent., or at the rate of 6 per cent. per annum. The Anglo Company have, no doubt, suffered somewhat from the new German competition in the Atlantic, but, as you know, the traffic in the Atlantic is constantly increasing, and probably in the long run the companies having cables across the Atlantic will recover their dividends. Our receipts from the Direct United States Cable Co. show a diminution amounting to £497, and this is attributable, I have no doubt, to the cause I have just referred to. As throwing light on the "life" of cables, it may be interesting to the shareholders to know that, although the Direct Company has only one cable, and that that cable has been working for 27 years, the electricians who have recently tested it have reported officially that it is working as well as if it had only just been laid. I do not mean to infer that all cables are in such a happy condition, but I have no doubt that the average "life" of a cable, where great care has been exercised in placing it at the bottom of the ocean, is much greater than was anticipated when submarine cables were first laid. On our investment in the Submarine Cables Trust there is a small diminution in receipts of £55 odd, owing to nine of our certificates being drawn for payment. We retain the coupons, which will some day become a valuable asset, I have no doubt. The interest on our Western Telegraph debenture stock is £43 less than last year, owing to our having sold some of this stock, and re-invested the proceeds in the shares of the same Company. We have disposed of nearly the whole of our holding in the West Coast of America Co's. debentures, which accounts for the difference in our receipts. On the other hand, our preference holding in the Direct Spanish Telegraph Co., has been increased by 50 shares, but the dividend on these is not included. In Eastern Telegraph stock we have invested a further £1,500 nominal, and interest on this company's stock shows a small increase. There is the considerable increase of £5,293 from our holding in the Eastern Extension Telegraph Co., and from our holding in the Telegraph Construction and Maintenance Co. our receipts are £1,094 higher. With regard to the West African Telegraph Co., although as yet we have received no dividend from this company, I am glad to inform you that the negotiations with the French Government, to which I referred last year in a hopeful spirit, have at length been satisfactorily concluded, and we may therefore look forward to receive some return on these shares during the coming year.

As intimated in the report, the Directors recommend that the financial year of the Globe Company shall in future end at April 30, instead of, as at present, July 18. I have only one more observation to make, which is, that while our dividends have not only been maintained but increased during the last two or three years, the market values of our shares have, on the other hand, suffered somewhat severely. This is, no doubt, due mainly, if not entirely, to the threatened competition by wireless telegraphy. On this subject I have nothing to add to the remarks which have fallen from the lips of the chairman of the Eastern Company, Sir John Wolfe Barry, one of our Directors, who is not with us to-day, I regret to say, through illness. The opinion Sir John expressed was that wireless telegraphy would very probably prove of considerable use for certain purposes and within certain limits, but that he did not think it would interefere with the system of submarine telegraphy, and that it would certainly not supplant it. This is the opinion which we, the Directors, all hold, but whether it is a well-founded opinion or the contrary, time can only show. There is one fact to be noted, however, which is of considerable interest—namely, that telegraph manufacturing companies were never more active than they are at this moment, making cables not only for companies, but for governments, both home and foreign, who are very careful, or are presumed to be very careful, of the money of the taxpayers. I now move the adoption of the report and accounts and the payment of the dividends therein set out.

Sir JAMES PENDER, Bart., seconded the motion.

Mr. BAINES congratulated the Directors on the satisfactory report, but held that the ordinary and preference shares that had been issued ought to have been first offered to the shareholders.

The CHAIRMAN replied that the shares in question were so small in number as to have rendered it practically impossible to distribute them among the shareholders of the Globe. Of course, if there were a large number to be issued—say 100,000 of each—the Directors would very carefully consider how the issue should be made in the interests of all concerned. In the present instance your Directors secured in the open market comparatively very high prices for the shares in question and invested the proceeds in some of the best telegraph companies whose shares were very low, so that the shareholders generally will derive the full benefit therefrom. If, however, any of our shareholders wished to increase their holding in this Company they could buy both the ordinary and preference shares on the market to-day at a very much lower price than we obtained for the issue in question.

The motion was then unanimously adopted, and the retiring Director, the Marquis of Tweeddale, and the auditors, Messrs. Deloitte, Dever, Griffiths & Co. and Mr. John Newton, were re-elected.

A vote of thanks to the Chairman and Directors terminated the proceedings.

National Telephone Co. (Ltd.).

The thirtieth ordinary general meeting of the company was held yesterday, Sir HENRY FOWLER, M.P., presiding.

The SECRETARY (Mr. Albert Anns) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: Ladies and gentlemen, there are, I am happy to say, some very encouraging features in the report, and I hope that the light in which the directors regard the figures will meet with the approval of the shareholders. The income which has accrued in respect of business during the half-year is £821,743, and that compares with £774,714 in the corresponding period of 1901, showing an increase of income of £47,028. The increase has been gradual, and has taken place in all our departments. The working expenses, £479,122, compare with £453,913 last year. Of course the meeting will at once see that an increase of business and of income means a corresponding increase in the working expenses. After deducting the Post Office royalties, which amount to the very considerable sum of £75,577, the net result on the half-year's working is a balance of £267,043, or £19,397 more than in the corresponding period last year. The meeting will recollect that six months ago I called attention to the fact that we had had a serious snowstorm, and we put by a considerable sum towards the cost of repairing the damage caused thereby. We have now settled up all the accounts, but I have to tell you that in addition to the sum put by on that occasion we have had to pay during the current half-year a further £17,749. That will give you some idea of what an expensive calamity a snowstorm is to the company. The rentals

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carried forward amount to £821,000, against £784,000 in the corresponding six months. Out of the available balance of £209,000 the directors recommend the payment of a half-year's dividend at the rate of 6 per cent. on the first and second preference shares, of 5 per cent. on the third preference shares, 6 per cent. on the preferred shares and preferred stock, and 4½ per cent. on the deferred stock, which is equivalent to 5 per cent. on the ordinary shares now divided into preferred and deferred stock. Out of the income the board also propose to transfer £70,000 to the reserve fund, against £65,000 in the first half of 1901, and, in fact, if our business increases, and as as time runs on and we get nearer and nearer to 1911, it is the intention of the board to increase the reserve to the utmost extent of their power. The capital expenditure of the half-year amounted to £303,029—very much the same amount as 12 months ago. We have expended that capital in the erection of 9,600 new lines. The maintenance and renewal of our lines and instruments have cost us £133,719, which is about £10,000 more than we spent on that item last year. With reference to the general position of the company, I should like to say a word or two. We have now had a very fair testing period as to the effect of the Post Office competition in London. Taking it from the start, in November last, up to to-day, I find that the company have had an increase of orders in London of 7,598, and I think perhaps that that is as large an increase as we have had in any half-year. I see that the public are complaining that their orders are not executed as quickly as they wish by the Post Office. Well, of those 7,500 orders to which I have referred, there are about 3,000 still unexecuted, but we are executing them with the greatest speed possible. I repeat what I said at the last meeting as to the Post Office competition—I have no fear of it. I am satisfied that it is not at present within the power of the Post Office or of this company, or of the two combined, to supply the telephonic necessities of London, unless the Government is prepared to spend more money—and they have the nation's purse behind them—and this company are prepared to spend more money. We are working amicably with the Post Office. The rivalry which was supposed to exist between the two is a rivalry of accommodation. We are both doing our best to supply the public with what they require. There is only one other matter on which I should like to say a word, and that is the terrible fire, which took place about a month ago, on our premises in the City. I have seen no fire at any of our buildings or works which compared so far as the ruin caused is concerned with that terrible fire, and I think you will pardon me if I read a report which the manager has laid before me as to what he has done and is doing to repair the mischief that fire caused, and to prevent as much as possible the inconvenience caused to our customers. The report says:—

"The fire started at eight o'clock on the night of Wednesday, July 9, and by half-past ten the place was gutted. The same night it was decided to clear out the adjoining offices occupied by the company for the district engineering and instrument departments, and the same night reserve switchboards and other materials were ordered by telephone from the Nottingham factory and put on rail in trucks attached to passenger train. This material was delivered and placed in the temporary exchange premises early on the next day, Thursday, other premises having been secured for the staff displaced, and the staff in the meantime moved into them. All men for whom work could usefully be found were collected from London and other parts of the country, and were fitted into day and night gangs, and the work of fitting up the temporary boards and joining up with the outside work has proceeded day and night and on Sundays continuously, with the result that a large number of subscribers were connected each day, and the whole of the subscribers, some 2,600 in number, were got working again within 16 days from the time of the fire. The outside work was rendered difficult owing to the destruction of the records, and the fact that the derrick on the roof could not be used necessitated other arrangements to carry the cables. 100 outside cables had to be erected, and for this purpose three double and six single poles had also to be erected to carry the cables, and in two cases piers had to be built and girders put up to support the poles. Upwards of 420 miles of outside wire and 334 miles of inside wire had to be put up. A satisfactory part of the business is that the new exchange, although in a sense a temporary one, will give a thoroughly efficient and good service."

I speak with some feeling on this question, because I need hardly say to you there is no credit due to the board in connection with the matter, but it is due to our manager and to the London engineer and superintendent and to all their subordinates, who displayed conspicuous zeal and ability in grappling with the calamity. What, perhaps, the board are entitled to take credit for is that they had fully insured the premises, and I hope, if we are spared to meet at the next half-yearly meeting, I shall not have to plead for extra consideration on account of additional expense incurred in connection with this matter. I now move that the report and accounts be adopted.

Mr. GEORGE FRANKLIN, vice-president, seconded the motion.

Mr. LEE SMITH said he thought they ought to congratulate the directors upon the increase in the profits and the growth of the business generally. He asked for particulars with regard to the globe or common battery system. He did not like it himself so well as the old system, but he should like to know if it was answering.

The CHAIRMAN: With regard to the globe or common battery system, scientific men regard it as the simplest and best of the discoveries yet made. I can appreciate the difficulties which those meet with who have not fallen into the way of using it, but have been accustomed to the use of the magnetic system, which involves ringing off and on. It is a great nuisance to have the two systems at work, but as the Government introduced the common battery into their exchanges we were compelled to follow suit, and are doing so as rapidly as we can. The exchange which was burnt down in London Wall was on that system, and was, I may say, fitted up in the most modern manner possible. As to our general policy, we shall go on and do what we can with the money at our disposal; but we are not going to spend money unless we see our way clear to get it back. Our licence expires in 1911, and we have to look at every expenditure in the light of that fact. There is a good deal of grumbling at times as to the charge for the telephone in London, but, as bearing on this, I should like to say that one of our customers, in claiming compensation owing to the damage at London Wall, said that the telephone was worth to him £3 a week. As you know, the charge is £17 per annum. We should be very well satisfied to compensate any subscriber at that rate if they would pay us £3 a week for the service. The messenger service rate is increasing, but considerable further development will be necessary before it will be what he might call fairly remunerative.

A SHAREHOLDER asked whether the board could make any statement with regard to the wireless telephonic system.

The CHAIRMAN: As to the wireless system of telephony, I do not think it has yet passed into the commercial atmosphere, but when it does we shall have to consider it. Of course the board, and especially our general manager and engineers, have their eyes on everything that is going on so far as it bears on the telephone service.

The report was then adopted.

The retiring directors, Lord Harris, Sir Albert Rollit, M.P., Mr. C. S. Agnew and Mr. G. H. Robertson, were re-elected, and the proceedings terminated with a vote of thanks to the chairman.

Sir Hiram Maxim Electrical and Engineering Co. (Ltd.)

The third annual ordinary general meeting (which had been deferred for eight months) was held yesterday, Mr. JULES DE MERAY presiding.

The SECRETARY (Mr. W. J. Wheatley) read the notice convening the meeting and the auditor's certificate.

The CHAIRMAN said Sir Hiram S. Maxim, the founder of the company, was absent owing to serious illness, and expressed the sorrow of the board at the cause of his absence, which, he was sure, was the feeling of everybody present. He (the chairman) asked the shareholders to permit him to start an innovation in the order of proceedings, as instead of delivering a lengthy address from the chair, he had arranged to have information relating to the respective branches of their business given by the chiefs of the departments, and had requested Mr. Howard T. Wright, the manager of the contract department, to prepare a report for the branch of the business under his control, comprising the whole of the period under consideration, and a similar report would be submitted by Mr. A. W. Hill on the lamp department. These gentlemen had received instructions to disclose unreservedly the position of their special branches of the business to the shareholders in the same manner as they supplied the board from time to time with details of the business in hand.

Mr. HOWARD WRIGHT then read his report, which stated that he had looked carefully into the position and prospects of the engineering department of the company. In arriving at the true position it should be remembered that 1901 was practically the third year's trading of this particular department. In introducing a business of this special character a considerable time must always be allowed for laying down what might be termed the foundations or the goodwill. Very rapid strides had been made in this direction, and the staff, which had been working at high pressure, had had to be increased to cope with the growing business. The figures in the balance-sheet did not, he thought, give a correct impression of the real amount of business done in the year, as most of the contracts were for large amounts, and could not be taken fully into the accounts until completed. In most cases these extended over long periods. The turnover taken into account amounted to about £20,000, while the orders not taken into account or taken since amounted to about £69,000. In addition to these actual orders, they had sent in during the eight months some 300 tenders amounting to over £600,000, and they would doubtless secure a certain proportion of these. They had also under consideration several large schemes in connection with electric traction. The orders received included contracts for the London County Council electric tramways and for the local authorities of Manchester, Cardiff, Hampstead, Battersea, Worcester, Newport, Belfast, Wakefield, Wolverhampton, Leytonstone and Islington, for the Guernsey Railway Co., for the Electrical Power Storage Co., Babcock and Wilcox, Ferranti, Vickers, Sons and Maxim, Macartney, McElroy and others. Many of these had been completed. The great speed with which their work (amounting to about £14,000) at the new Manchester generating station had been carried out created a very favourable impression in influential quarters and had called forth favourable comments in the Press. He considered the department was in a thoroughly sound condition.

Mr. A. W. HILL read his report on the lamp department, and stated that he was appointed works manager in July, 1901, and received instructions to organise the factory to make it capable of manufacturing 40,000 lamps per annum. They had now over 500,000 lamps in stock, which enabled them to despatch all orders at once. The factory was thoroughly organised, and fitted with up-to-date machinery and tools. Data which he had had prepared showed that their lamp was now being manufactured at 3½d. per lamp less than when he first took over command. On Jan. 9 last it was decided to cancel the concession to the Maxim Lamp Co., and he then undertook the commercial as well as the manufacturing portion of the business. They were now on the lists of the War Office, India Office, London County Council, and most of the municipal authorities. Their customers had steadily increased. He looked to the coming autumn to show a considerable increase, and provided they maintained their name for the highest quality of work a bright future was before them.

The CHAIRMAN said the meeting had heard the reports of their heads of departments. He thanked Mr. Hill for his efforts to carry out successfully the hard task with which he had been entrusted. Mr. Wright's report, also, was so full and comprehensive that he had little to add, except that he thought even now their most sanguine expectations from

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that department would be realised. The company were developing a new arc lamp. Over £3,000 had been spent by a Mr. Johnson on experimental work on this lamp, which could be supplied at a low price. The making of cables and steel troughing had become a regular part of their business, and an order for £20,000 for this material was secured last year. In reply to a question, the chairman said the whole of their capital had been called up, and the partly-paid shares would be paid up by quarterly instalments of 2s. 6d., one of which had been paid. He moved the adoption of the report and accounts.

The Hon. W. F. B. MASSEY-MAINWARING, M.P., seconded the motion, which was carried.

The retiring directors and auditors were re-elected, and the proceedings terminated.

Crompton & Co. (Ltd.).

The fourteenth annual meeting was held on Wednesday.

Mr. JOHN TROTTER presided, and said a point which naturally interested shareholders was the slight reduction in the dividend and the cause of it. The real reason for the falling off in profits was very easily explained, although the remedy was not quite so simple. The shareholders would see from the accounts that the gross profits for the year amounted to £65,901, against £68,633 last year. This result was disappointing, because the year under review had been one of singular activity, and one in which the sales had exceeded those of any previous year; in fact, showed an increase of 7½ per cent. Under these circumstances the shareholders might have hoped that the gross profits would have risen correspondingly, but this had not been the case. The trade expenses, on the other hand, had risen, but not abnormally. The gross profits had decreased owing to competition prices. The falling off in demand for electrical appliances, at any rate at one part of the 12 months, had caused the company's competitors to seek, at all hazards, to keep up their output in order to diminish the proportion of establishment expenses. The consequence was a falling off in prices. If that had been all the shareholders would not have had so much to grumble at, but during the year a kind of competition had sprung up to which the company had not been so much accustomed. There had been a large publicity given to all electrical enterprises, and there had been a good deal of speculation in new concerns in the electrical world. This had brought into the country, partly from abroad and partly from new starters, a number of people who were investing large sums of money in electrical things of a new description, and who were exceedingly anxious to obtain part of the market, and were willing to compete at prices which the company had no intention of following. Those prices were not remunerative, and there would have to come an end to selling at a loss. By putting aside in past years a portion of the profits, the company was in a comfortable position to meet this competition. There was another effect of this new departure in the electrical world. There had been a very great demand for expert electrical workmen and officials, and the general effect was, so far as the company was concerned, that there had been a rise both in the salaries of officials and in the wages paid to workmen. The board had been enabled to effect some economies, but what they had been able to do had been counter-balanced by the increase in the cost of labour. Under these circumstances it was very satisfactory to find that the ratio of expenses had not gone higher than it did last year. The question might be asked whether the present condition of things was likely to be permanent. If he thought it was absolutely permanent he should take a less sanguine view of the future than he did. The board were not afraid in the slightest degree of honest competition, and the keenness of that at present prevailing was only temporary. The board had always set their faces against taking anything in the shape of paper for work that had cost solid sovereigns, so they found themselves, to a certain extent, cut off from that class of work, which entailed practically taking a large interest, and subsequently unloading the security taken in place of cash. He believed these paper payments could only be disastrous to those who embarked in such methods. The slight diminution in the volume of business had, to a certain extent, passed away, and orders were now coming in more freely. The company's order book was fairly full, although not so overloaded as it was a year or two ago. Turning to the balance-sheet, the capital was now fully paid up and, be hoped, settled for some time to come. Stock-in-trade amounted to £157,717, against £141,232 last year. They had at last got the Chelmsford Company in a satisfactory condition, and it now had its own generating station and officials. Patents account, which last year stood at £5,658, was now written down to practically nothing. Goodwill remained at £10,000. Altogether, he thought the shareholders would agree that the balance-sheet stood in a satisfactory condition. He moved the adoption of the report and accounts.

Lieut.-Col. R. E. CROMPTON seconded the motion, and said there was no cause for fear because the dividend showed a slight reduction. He thought the company was in a far better position than ever before to meet the manufacturing difficulties at a time when prices were low. They never were so well equipped for working economically as they were now, and, consequently, they need not fear a time of low prices which had set in.

The motion was adopted.

General Electric Co. (1900) (Ltd.).

An ordinary general meeting was held yesterday, Mr. G. BYNG presiding. In moving the adoption of the report the chairman said it was most unfortunate that fate had singled them out to prove to what dangers they were exposed in the carrying out of their daily work. It was doubly hard upon the directors, because in the many years during which they had guided the undertaking they had ever been mindful of their responsibilities towards those who worked with them. During their 22 years' existence they had never, until the recent lamentable fire, had to deplore the loss of a single life. Their City premises had been inspected many times by fire experts, at whose recommendation hundreds of pounds had been spent upon a private fire brigade, hydrants, &c., and none of their experts had ever recommended them a permanent ladder for exit to the roof. Turning to the business of the day, the financial year had, as regarded the general conditions of trade, suffered as the previous one from the continuation of the war and the ever-increasing foreign competition to which manufacturers were exposed. Their organisations throughout the country had worked well, and, considering all things, he thought they might consider the result of the year's working satisfactory. Of the £47,400 investments, £7,500 represented debentures in the Uxbridge Electric Lighting Company, acquired shortly before the close of the financial year. An influential local body in Uxbridge subscribed about £10,000 for the purpose of lighting the town and offered the company the contract under the condition that they supplied the remainder of the capital required. They estimated the total cost at about £22,000, and had undertaken the contract for the machinery and materials, taking in payment debentures, with the option of exchanging them for ordinary shares. The installation was now working successfully, and promised soon to become a source of income. In connection with this undertaking the company had acquired a concession for the lighting of Northwold, West Drayton, and the district round Uxbridge, which was rapidly developing. The balance of appropriation brought down showed an increase of £11,000. The net result of trading was that they proposed to declare the same rate of dividend upon the ordinary shares as last year, but to place in reserve £3,000 in excess of that then placed to this account. The company had increased its gross profit by 15 per cent. without appreciably increasing the capital, a fact which he thought showed well for the general management of the business. The goodwill and patents at £92,000 was the same as in last year's balance-sheet. Any money expended upon patent accounts had, ever since the formation of the company, been charged to general expenses. The company held some good and useful patents, but he looked upon them, as upon goodwill, as an intangible asset. It was the policy of the board to build up a reserve fund to cover this item. The reserve now stood at £39,000, or nearly half the amount standing against goodwill and patents. The increase shown under the heading of freehold land, buildings, &c., of £97,000, had almost entirely been expended for the purpose of developing the company's Witton estate and works. The site covered 106 acres. In removing their engineering shops from Salford the works there had obtained much-needed extra space for the extension of the principal departments, telephones, switchboards, &c. The fact that out of £273,000 for property and freehold about £150,000 did not start working during the last 12 months should inspire them with confidence that their earning powers would not be less in future than they had been in the past. He then moved the adoption of the report and accounts.

Mr. H. HIRST seconded the motion, which was adopted, and the dividends recommended by the directors were agreed to.

Central London Railway Co.

The report of the directors for the half-year ended June 30 states that £107,099. 3s. 8d. has been received on account of debenture stock (including premium), and the amount expended on capital account has been £21,537. 3s. 6d. The receipts from all sources amounted to £185,118. 4s. 4d., and working expenses to £93,099. 10s. 5d., leaving £92,018. 13s. 11d.

The number of passengers carried since the opening of the railway is as follows:—

Five months to Dec. 31, 1900.....14,916,922	Half-year to Dec. 31, 1901..20,802,650
Half-year to June 30, 1901.20,385,739	Do. do. June 30, 1902..22,879,334

During the week in which in which it was intended to hold the Coronation 1,256,000 passengers were carried over the railway.

After providing for debenture interest, there was a balance of £82,603. 8s. 11d., including £5,874. 7s. 7d. from last half-year. Interim dividends of 4 per cent. are recommended on the undivided and preferred ordinary stock. The dividend on the deferred ordinary stock is not payable until the result of the working of the year to Dec. 31 has been ascertained, but £9,994. 12s. 5d. has been carried to "dividend suspense account," and will be dealt with at the end of the year, leaving a net balance of £25,603. 8s. 11d. The results for the half-year would have sufficed to pay an increased dividend, but in view of the pending liabilities in connection with the "Vibration" inquiry, and with the promotion of a bill before Parliament and the provision for reserve, the balance is carried forward.

The work of providing additional lifts at Shepherds Bush is progressing satisfactorily, and it is hoped that two of the lifts will be available for service in September next.

The committee appointed by the Board of Trade early last year to inquire into the cause of vibration on the Central London Railway stated in their report, issued in January last, that the amount of vibration caused by the running of a motor-car train was very slight compared with that of a train hauled by one of the company's electric locomotives, and the directors determined to act upon the recommendations contained in the report, and to remove all cause of complaint by adopting the motor-car (multiple-unit) system. The motor cars have been ordered, and it is anticipated that by the end of the year most of them will have been delivered and put into service.

Liverpool Overhead Railway Co.

The report of the directors for the half-year to June 30 states that gross receipts amounted to £37,988. 0s. 2d., and working expenses to £29,287. 12s. 11d. The number of passengers carried during the half-year was 5,026,422, against 5,433,454, 5,382,224 and 5,655,499 in the three preceding half-years. There has been a further falling off in traffic during

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the past half-year, mainly due to competition of Corporation tramways. To render the line more attractive the directors have decided to accelerate the service, reducing the time for the complete journey from 32min. to 20min. The new service will be inaugurated in August. The working of the Crosby, Waterloo and Seaforth tramways continues to be satisfactory. The gross profit was £8,700. 7s. 3d., and after deducting interest (£3,400) there was a balance of £5,300. 7s. 3d. Adding £3,692. 12s. 4d. from December quarter, and £300 transferred from Dingle fire contingency account, £9,292. 19s. 7d. was available for distribution. Out of this the directors recommend dividends (less tax) of 5 per cent. per annum on the preference shares (requiring £3,000) and 1 per cent. on the ordinary shares (£2,500), leaving £3,792. 19s. 7d. to be carried forward.

BARCELONA TRAMWAYS CO.—An extraordinary meeting is to be held on Aug. 6 to consider a resolution confirming an agreement between the company and Senores Luis Pujol and Juan Llopart, Barcelona, whereby an option is given to purchase the company's undertaking. If approved, it is calculated that a distribution will be made to ordinary shareholders of between £11. 10s. and £12 per share. The directors recommend the acceptance of the offer. Bargain money to the amount of £4,000 has been deposited.

DUBLIN UNITED TRAMWAYS CO.—At the half-yearly meeting, on Tuesday, the chairman (Mr. W. M. Murphy) said the position and prospects of the company were satisfactory. There was an advance in the dividend on the ordinary shares from 4 to 5 per cent. per annum, an increase of £5,120 in the gross receipts, and the net result left £45,220 available, against £39,820 last year. The company carried 22½ million passengers in the half-year, an increase of nearly a million, at an average of 1·21d. per head. The local rates and wayleaves, amounting together to £15,609 in the half-year, were on a larger scale than in any city in the United Kingdom.

LONDON, BRIGHTON AND SOUTH COAST RAILWAY.—At Wednesday's meeting the chairman (Lord Cottesloe) referred to the large number of electric traction schemes which had come before Parliament and other examining bodies which affected the company's districts. He said there were many of these schemes, including tramways, light railways and tube railways, which the company had considered it necessary, in the interests of the proprietors, to oppose. The possibility of checking such schemes by improvements and extensions of their own system, and particularly the advisability of adopting electric traction on some of their lines, was occupying the attention of the directors.

METROPOLITAN RAILWAY CO.—The half-yearly report of the directors states that contracts were let in March last to the British Westinghouse Company for the supply of complete plant and machinery for the power station at Neasden and for the sub-station plant and machinery, and that plans and specifications have been prepared for the erection of the power-station building. Tenders have been received, and a contract is being settled for the work, which will proceed simultaneously with the construction of the electric plant and machinery, so that the whole may be completed in the autumn of next year. A design for new rolling stock, on the corridor principle, has been approved by the directors, and a contract for the construction of the trains and motors to be used on that portion of the railway which will be electrically equipped will shortly be let. The question of water supply for the power station at Neasden has been met by the sinking of a well on land belonging to the company adjoining the station, and the supply will, it is believed, be sufficient for both the power station and the company's other works at Neasden. The company's bill, conferring additional powers for the enlargement and improvement of Baker-street station, and for working the joint lines by electric traction, has been passed.

METROPOLITAN DISTRICT RAILWAY CO.—On Monday a meeting of the preference stockholders was held to consider a proposal of the Underground Electric Railways Co. of London. The chairman (Mr. R. W. Perks, M.P.) explained the conditions under which the 5 per cent. preference stock of the company was issued in 1869 at a discount of £548,766, and pointed out that the interest rose from ½ per cent. in 1873 to 5 per cent. in 1878, at which rate it continued until 1882, and then fell away again to nil in 1889. From that date the rate of interest gradually rose to 3⅜ per cent. in 1897, but it had now fallen again to nothing. He said that the Underground Electric Railways Co., which had a subscribed capital of £5,000,000, would be willing, under certain conditions, to guarantee to the preference proprietors 1 per cent. for the first year, 2 per cent. for the second year, and thereafter 3 per cent. in perpetuity, the Underground Company taking any surplus interest which might be earned between these figures and 5 per cent., and also having the right to vote in respect of preference stocks so guaranteed. A committee of shareholders was appointed to confer with the directors and with the Underground Company.

RAILWAYS AND THE TUBES.—At the meeting of the Great Eastern Railway Co. on Tuesday the chairman (Lord Claud J. Hamilton) dealt with the question of the competition they were threatened with by the multifarious tube railways, whose promoters were now endeavouring to get Parliamentary assent to their schemes. The directors' policy as regarded increased facilities of travel on their suburban system was to consolidate and develop to the full their existing resources and accommodation before coming to any decision as to further capital expenditure on new lines or the electrification of existing lines. Their officers were considering and had reported to the directors on improved traction, both by steam locomotives and by the electrification of a portion of their line. Those were matters which were receiving the constant attention of the board, but they had not yet come to any decision as to the method that ought to be adopted for the new decapod locomotive of exceptional power that they were building as an experiment was not yet completed, and they could not find, either in America or elsewhere, any railway working by electricity trains of 13 carriages capable of conveying 656 passengers, equal to a total weight of 210 tons, at a two-minute interval, which was what they required. It was doubtful whether a railway working such trains would, with their existing knowledge of electric traction, be commercially succes-ful—which, of course, was the principal point to be considered by them, although there was no doubt that it would be technically possible to work the traffic in the manner indicated. As regarded existing electric railways which conveyed much lighter trains, there was by no means unanimity of opinion as to the best mode of working. The directors did not consider they should yet bind themselves to any particular system, even to prevent the extension of tube lines into their districts. One tube scheme through Leyton and Walthamstow to Waltham had been withdrawn, but the promoters threatened to bring it forward again next session, while another (the North-East London), which would compete with them for their Tottenham and Edmonton traffic, had been passed by a Lords committee. The promoters had given what he regarded as preposterous figures with regard to the traffic they expected to carry. To enable them to pay a dividend of 3½ per cent. on the ordinary shares, they estimated they would carry 63,333,000 passengers per annum, which was equal, making the usual allowance of 25 per cent. for Sunday traffic, to 194,000 passengers per day, whilst the whole of the traffic carried by the Great Eastern, the North London, and the Great Northern Railways for the district proposed to be served by the North-East London project was only 27,175,147 passengers per annum, or 83,482 per day. Should these tube railways be constructed by American capital, in the hope of eventually foisting them upon the British public, it would be a serious matter for them, for even if they proved to be an absolute loss to their own shareholders, they would undoubtedly inflict considerable injury on the Great Eastern.

WATERLOO AND CITY RAILWAY CO.—The report of the directors for the half-year ended June 30 states that capital outlay to date is £605,317. 10s. 3d. Gross receipts amounted to £17,204. 5s. 11d., and working expenses to £7,714. 15s. 11d., or 44·84 per cent., compared with 54·78 per cent. for the corresponding period of 1901. The balance available for dividend after providing for debenture interest is £8,558. 10s. 1d., and a dividend at the rate of 3 per cent. per annum on the ordinary stock absorbs £8,100, leaving £458. 10s. 1d. to be carried forward. The accumulated deficiency in net revenue, amounting to £11,907. 9s. 2d. at the end of last year, has been disposed of in an adjustment of accounts with the South-Western Company. The number of passengers carried during the six months, exclusive of season ticket holders, was 2,239,394, an increase of 105,332 over the corresponding period of 1901. Season ticket holders numbered 1,197 against 1,057. The working company (the London and South-Western) have recently been enabled, by an altered system of signalling, to introduce a more frequent service of trains, which no doubt accounted, to a large extent, for the satisfactory increase in traffic.

NEW COMPANIES, STATUTORY RETURNS, &c.

BURMAH TRAMWAYS CONSTRUCTION CO. (LTD.)—Reg. July 25, capital £50,000 in £10 shares, to construct, equip and work railways, tramways, light railways, undertakings for the generation, supply or distribution of electric or other power.

CONCORDIA ELECTRIC WIRE CO. (LTD.)—Reg. July 23, capital £2,000 in £1 shares, to acquire inventions relating to generation and use, storage, accumulation, measurement, distribution or transmission of electricity, and to carry on the business of manufacturers of and dealers in electric wires, electricity meters, motors, steam condensing and water softening devices, electric lamps and switches, cutouts, batteries and appliances, &c., electricians, electrical and general engineers, &c. Mr. L. A. Frank, 31, Wiltshire-road, Brixton, is secretary.

DAVID MOSELEY & SONS (LTD.)—Reg. July 24, capital £300,000 in £10 shares (14,000 preference), to acquire the business of indiarubber manufacturers and merchants carried on as David Moseley & Sons, and to manufacture and deal in articles and goods made wholly or partly of indiarubber or other gum, &c. The first directors are D. Moseley, J. F. Moseley and O. G. Moseley (all permanent governing directors). Reg. office, Chapelfield Works, Ardwick, Manchester.

EAST ANGLIAN ENGINEERING CO. (LTD.)—Reg. July 22, capital £10,000 in £1 shares, to take over the business carried on at Stowmarket by the Anglian Engineering Co. (Ltd.), and to carry on the business of consulting, mechanical and electrical engineers, manufacturers of motor cars, &c. The first directors are F. Taylor, H. Mase and H. W. Wilson.

EAST INDIA TRAMWAYS CO. (LTD.)—Reg. July 25, capital £80,000 in £1 shares, to construct or acquire and work tramways, railways, &c., in India, including the undertaking and concessions of the East India Tramways Co. (Ltd.) (in liquidation), to equip, maintain and work by electric or other power any of the company's tramways or railways, and to carry on the business of tramway, railway and omnibus proprietors, carriers of passengers, &c., manufacturers of and dealers in locomotives, rolling stock, accumulators, dynamos, suppliers of electricity, &c.

JULIAN AND SONS (LTD.)—Reg. July 22, capital £2,500 in £1 shares, to acquire and carry on the business of wholesale and retail ironmongers, electricians, &c., carried on as Julian and Sons at Basingstoke. The first directors are H. Julian, A. Julian and J. Falconer.

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SOCIETY OF MOTOR MANUFACTURERS AND TRADERS (LTD.)—Reg. July 16, with 100 members, each liable for £1, with objects indicated by title. Management vested in a committee.

SOUTH AMERICAN LIGHT AND POWER CO. (LTD.)—Reg. July 24 capital £100,000 in £1 shares, to carry on in the Argentine Republic or elsewhere the business of electrical and general engineers, suppliers of electricity or gas, and contractors for, manufacturers of and dealers in plant, machinery, appliances and things used in connection therewith. The first directors are C. R. Thursby, C. M. Wilkins and J. Young. Reg. office: 37, Lombard-street, E.C.

SOUTH YORKSHIRE PROMOTERS (LTD.)—Reg. July 26, capital £99 in £1 shares, to carry on the business of an electric light and power supply company, electricians, electrical, metallurgical and general engineers, &c., in the West Riding of Yorks. or elsewhere. The subscribers are: A. Etchells, engineer, W. Bayliss, engineer, H. Eckersall, J. B. Hyde, engineer, C. K. Hamilton, P. A. Ramage, engineer, and V. R. Milner. Reg. office, 78, King-street, Manchester.

SOUTHERN COUNTIES MONO-RAIL SYNDICATE (LTD.)—Reg. July 24, capital £50,025 in 500 ordinary shares of £100 each and 500 deferred shares of 1s. each, to construct, equip, maintain and operate railways on the "mono-rail" or other system, to acquire railways or tramways, and to carry on the business of railway, tramway, telephone and telegraph proprietors, manufacturers of rolling stock, electricians, electrical, metallurgical, mechanical and general engineers, suppliers of energy, &c.

LEEDS COPPER WORKS (LTD.) (formerly **ENGLISH ELECTRO-METALLURGICAL CO. (LTD.)**, re-named June, 1902).—In the return to May 23 the capital is given as £700,000 in 300,000 preference and 400,000 ordinary shares of £1 each, all of which have been taken up. £1 has been called up on each of 200,000 preference shares, and £198,800 has been received, leaving £1,200 in arrears. £500,000 considered as paid on 100,000 preference and 400,000 ordinary shares. Mortgages and charges nil.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The return to April 1 gives the capital as £1,000,000 in 100,000 shares of £10 each, all of which have been taken up. £10 has been called up and paid upon 97,968. £20,320 is considered as paid on 2,032 shares. Mortgages and charges, £470,000.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 7/8d. per oz. (July 31). Consols (2¾ per cent.) 95 1/16—95 3/16 for money, 95 1/16—95 3/16 for account; 2½ per cent. 95½—96 (July 31). Consols Pay day, Aug. 7; Stocks and Shares Continuation Days, Aug. 12 and 26; Ticket Days, Aug. 13 and 27; Pay Days, Aug. 14 and 28; Mining Share Carry-over Days, Aug. 11 and 25.

BLACKPOOL AND FLEETWOOD TRAMROAD CO.—The half-yearly report shows that the balance available for dividend is £3,538, of which £3,000 is devoted to payment of a 4 per cent. dividend and £500 is written off depreciation reserve and £38 carried forward. The total receipts amounted to £9,941, and the car mileage to 189,787, against 212,695 in the preceding half-year. The number of passengers carried was 679,740.

BLACKPOOL ELECTRIC TRAMWAYS (SOUTH) (LTD.)—A meeting of stockholders will be held on Aug. 7 "to consider their position."

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—This company has made an issue of £110,000 4½ per cent. debenture stock.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)—An interim dividend of 4 per cent. per annum has been declared on the ordinary shares for the half-year ended June. The electricity supplied in the company's London districts during the half-year is estimated to realise £43,985, compared with £39,693 for the corresponding period last year. The transfer books and register of members will be closed from August 8 to 21 inclusive.

CRYSELCO LIMITED.—Mr. H. S. Deacon, hitherto secretary and general manager of this company, has been elected to a seat on the board, and has been appointed managing director.

DUNDERLAND IRON ORE CO.—In the report presented at the statutory meeting on Wednesday it was stated that Dr. Lehmann, representative of the Edison Ore Milling Syndicate at Dunderland, had entered on his duties as manager for the company. The contractors are energetically proceeding with the works.

ELEKTRIZITATS AKTIEN GESELLSCHAFT VORM. SCHUCKERT & CO.—The accounts show a deficiency of 15,500,000m. (about £775,000), owing to depreciation of material, writing off, and the formation of guarantee funds for depreciation to the amount of 9,000,000m. The meeting to be held on the 19th inst. will consider a proposal to cover the loss by drawing on the reserve.

HONG KONG ELECTRIC CO. (LTD.)—The annual report states that the equivalent of 16,300 8 c.p. lamps was connected on June 1, and there were 85 arc lamps. During the year the three original incandescent lighting sets laid down in 1890 were discarded, and a steam alternator was substituted while a duplicate steam alternator was being erected. A dividend of 8 per cent. was declared.

LONDON, TILBURY AND SOUTHEND RAILWAY CO.—At yesterday's meeting, the chairman (Mr. H. D. Browne) announced they had obtained in the bill now awaiting Royal Assent powers to adopt electric traction on their railway, but before doing anything they proposed to await the result of the electrification of the District and Metropolitan Railways. One of the company's officials had been sent to America to see what was being done there.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—An interim dividend is declared for the half-year to June 30 at the rate of 7 per cent. per annum, an increase of 1 per cent. on the interim dividend paid for the same period last year.

SOUTH-EASTERN RAILWAY CO.—Yesterday (Thursday) the chairman (Mr. H. Cosmo Bonsor) stated that the board were watching with the greatest interest the improvements that were being made in the employment of electricity for drawing trains, and as soon as they could see that it was applicable to any portion of their lines they would ask the shareholders to adopt it.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Aug. 7 a special settling day in £500,000 in 4 per cent. mortgage debenture stock of the *British Westinghouse Electric and Mfg. Co. (Ltd.)*, and has also ordered the stock as well as the further issue of 10,000 6 per cent. cumulative preference £5 fully-paid shares of the *British Insulated Wire Co. (Ltd.)*; the further issue of 5,000 ordinary £5 fully-paid shares of *Callender's Cable and Construction Co. (Ltd.)*; the further issue of 14,500 £5 fully-paid ordinary shares of *Edmundsons' Electricity Corporation (Ltd.)*, and £50,000 4 per cent. first mortgage debentures of £100 each of the *Notting Hill Electric Lighting Co. (Ltd.)* to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	...	...	...	...	...	...
Ayr Corporation	July 26	874	...	10	3,826	...
*Birmingham Tramways.	„ 26	4 533	+ 196	3	15,082	+ 636
*Blackburn Corporation..	„ 25	885	+ 178	18	14,747	+ 2,738
Blackpool Corporation...	„ 24	1,902	+ 118	17	14,177	− 840
Blackpool and Fleetwood	„ 26	1,209	+ 171	4	3,559	− 672
Bolton Corporation	...	...	...	...	...	...
Bradford Corporation ...	„ 27	3,135	+2,145	17	56,917	+39,201
Brighton Corporation ...	„ 27	869	...	35	23,431	...
Brisbane Tramways.....	June 11	2,291	+ 437	24	54,802	+ 4,649
*Bristol Trams & Carriage	July 25	4,720	+ 45	3	15,135	+ 299
*Buenos Ayres & Belgrano	June 29	2,801	+ 64	26	68,345	+ 821
Burnley Corporation ...	July 26	615	+ 218	‡17	12,070	+ 4,234
Calcutta Tramways Co...	„ 26	R23 460	+R3,419	4	R 97,315	+R17,464
Cardiff Corporation	„ 26	1,543	...	17	21,445	...
Carlisle Tramways Co....	„ 26	216	+ 8	†30	5,065	+ 365
Central London Railway	„ 26	6,218	+ 216	4	26,591	+ 2,193
City & South London Ry.	„ 27	2,715	+ 809	4	10,891	+ 3,311
Cork Elec. Tramways Co.	„ 24	986	+ 425	§29	14,782	+ 1,402
Devonport & Dist. Trams	„ 18	511	+ 40	28½	11,822	+ 363
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	„ 26	256	− 12	17	3,841	− 92
Dublin & Lucan Railway	„ 27	123	− 11	4	495	− 83
Dublin Southern Dist....	† „ 25	1,139	+ 30	†4	4,026	− 277
Dublin United	† „ 25	3,987	+ 33	†4	14,441	
Dudley—Stourbridge ...	„ 18	898	+ 189	28½	20,271	+ 2,869
*Dundee Corporation ...	„ 23	791	− 41	...	...	...
East Ham Council	„ 26	451	+ 92	5	2,660	+ 445
Gateshead & Dist. Trams	„ 18	836	+ 213	28½	19,958	+ 2,859
Glasgow Corporation ...	„ 26	9,253	−2,186	...	...	...
Greenock & Port Glasgow	„ 18	507	+ 242	28½	13,225	+ 7,696
Hartlepool Tramways ..	„ 18	333	+ 27	28½	6,761	+ 742
Hull Corporation	„ 26	1,693	+ 4	17	29,437	+ 962
Isle of Thanet Co.	„ 19	1,306	− 59	29	14,430	+ 3,446
Kidderminster & Dist....	„ 18	163	− 18	28½	3,297	+ 34
Leeds Corporation	„ 26	5,034	+ 766	18	14,524	+14,554
*Liverpool Corporation...	„ 19	10,748	+ 446	29	275,241	+23,165
Liverpool Overhead Rly.	„ 27	1,561	− 47	‡4	6,373	− 533
Manchester Corporation	...	...	...	...	...	...
Merthyr.....	„ 18	214	− 37	28½	5,752	− 752
Middleton	„ 18	338	...	16½	5,191	...
Newcastle-on-Tyne Corp	„ 26	2,864	...	...	...	...
Oldham, Ashton & Hyde.	„ 18	604	+ 57	28½	14,577	+ 507
Perth (W.A.) Elec. Trams	„ 25	926	− 664	¶29	31,560	+ 5,102
Poole & Dist.....	„ 18	322	− 9	28½	6,658	− 99
*Portsmouth Corporation	„ 26	1,794	+ 921	...	...	...
Potteries	„ 18	1,488	+ 19	28½	41,014	+ 1,554
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ...	„ 27	4,052	+ 393	4	17,001	+ 2,082
Southampton Corporat'n	...	...	...	...	...	...
Southend Corporation...	„ 23	354	...	16	4,258	...
Southport Tramways ...	„ 18	358	+ 139	28½	6,478	+ 2,221
*S. Staffordshire Trams...	„ 18	829	− 16	28½	21,937	+ 684
Sunderland Corporation.	...	...	...	...	...	...
Swansea Trams.....	„ 18	527	+ 9	28½	13,015	+ 1,424
Taunton Trams.....	„ 18	83	...	28½	1,728	...
Tynemouth & Dist.	„ 18	458	+ 53	28½	7,239	+ 612
Weston-super-Mare	„ 16	260	...	10½	1,936	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 18	277	+ 214	28½	4,283	+ 2,792

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 23.		Price Wednesday, July 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 30	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	El'ekh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾	⅞	¾	⅞				
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103	106	103	106	4 6 0	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11⅛	12⅛	11⅛	12⅛	5 12 0	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	9⅞	10⅞	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101	104	101	104	4 6 7	...	10	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9	9⅛	9⅛	9⅜	4 2 1	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9⅛	9⅛	9⅜	3 11 10	...	9⅛	9⅛
35,000	5	3/6	Calcutta Elec. Supply Ordinary	8⅛	9⅛	8	9	3 6 8	March and September	9 7/16	9⅛
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	107	105	107	3 15 2	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	10	9	10	5 0 0	...	9⅜	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9		February and August	...	...
70,000	...	2/3	Do. 4½ per Cent. Preference	5⅛	5⅜	5⅛	5⅜	...		...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 18 3	,, ,,	5⅜	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5⅛	5⅜	5⅛	5⅜	3 14 9	...	...	...
£150,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	2 12 2	March	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8⅛	9⅛	8⅛	9⅛	4 0 6	June and December	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	11⅛	12⅛	11⅛	12⅛	5 5 3	February and August	9	...
£400,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	4 16 0	January and July	...	...
£300,000	Stock	4½%	Do, 4½% 2nd Deb. Stock Certs. (all pd.)	101	104	101	104	3 18 9	June and December	...	...
40,000	10	6/0	County of London and Brush Prov. Ordinary	8	9	8	9	4 6 7	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11⅛	12⅛	11⅛	12⅛	4 9 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	109	112	109	112	4 16 0	March and September	...	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5⅜	6⅛	5⅜	6⅛	4 1 1	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	3 12 0	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	...	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary xd	10	11	10	11	5 0 0	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6⅛	6⅜	6⅛	6⅜	4 10 11	...	7 1/4	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) xd	101	104	101	104	4 8 11	January and July	...	...
£115,000	Stock	4%	Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105	109	105	108	3 16 11	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1⅛	1⅜	1⅛	1⅜	3 15 0	...	...	...
42,840	5	3/0	Do. 6 per Cent. Preference	4	4⅜	4	4⅜	...	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	94	99	94	99	6 13 4	...	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15½	16½	15½	16½	4 0 10	Mar., June, Sept., Dec.	4⅜	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	109	113	108	112	3 18 9	April and October	95½	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	98	101	93	101	4 0 5	June and December	16	15⅝
10,852	10	6/0	Notting Hill Electric Ordinary	13½	14⅛	13⅛	14⅛	3 10 0	...	109	...
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 2 9	March	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	97	100	97	100	4 3 4	,,	...	...
300,000	1	...	Rand Electric	⅜	⅞	⅜	⅞	4 0 0	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	...	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 7 0	January and July	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary xd	14⅛	15⅛	14⅛	15⅛	4 13 7	April and October	...	...
20,000	5	3/6	Do. 7 per Cent. Preference xd	8⅛	9⅛	8⅛	9⅛	3 13 8	February and August	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97	100	97	100	3 10 0	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅞	2⅛	1⅞	2⅛		...	...	...
£50,000	Stock	4%	Do. 4% Debentures xd	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2½	3	2	3		...	...	...
110,000	4	5/6	Westminster Electric Supply Ordinary xd	0½	1⅛	0⅛	1⅛	4 15 8	March and September	1 1/16	10⅞
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5⅛	6⅛	5⅛	6⅛	4 0 0	...	6	5⅛
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	3⅞	4⅛	4⅛	4⅜	4 11 5	April and October	...	...
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9	10	9	11	2 14 7	...	9⅜	9⅛
10,000	10	5/0	Do. 5% Cumulative Preference	8⅛	9⅛	8⅛	9⅛	5 5 3	...	8⅛	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.) xd	95	100	93	98	4 11 9	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½	14½	13½	14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3⅞	4⅛	3⅞	4⅛	...	...	...	...
75,000	5	2/6	Do. 5% Cum. Pref.	4⅛	5	4⅛	5	5 0 0	...	4 13/16	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	102	105	102	105	4 5 9	...	104½	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21	22	21	22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures xd	105	107	105	107	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7½	7	7½	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9½	10	9½	10	5 0 0	May and November	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	102⅝	104⅞	103⅞	105⅞	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12⅜	13⅛	12⅜	13⅜	6 13 4	...	13	12 5/8
100,000	10	6/0	Do. 6% Cum. Pref.	12¼	12¾	12⅜	12⅝	4 14 0	February and August	12⅝	12⅜
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	126	124½
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝	1⅞	1⅝	1⅞	...	...	...	...
49,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅜	5⅛	4⅜	5⅛	5 14 3	...	5 3/16	...
27,500	5	10/0	Do. "B"	5	5⅛	5	5⅛	5 9 1	...	5 1/16	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	102	105	102	105	4 15 3	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	95	98	95	98	5 2 0	...	...	...
70,000	10	6/0	Calcutta Tramways	7	7½	7	7⅜	4 0 0	...	...	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	106	108	107	109	4 3 1	...	108	...
£80,000	1	1/2⅞	Cape Electric Tramways Shares	2⅜	2⅝	2⅛	2⅛	6 4 6	...	...	...
£1,810,014	Stock	4%	Central London Ordinary Stock	105	108	105	108	3 14 0	June and December	107	106
£494,093	Stock	4%	Do. 4% Preferred Stock	107	110	106	109	3 13 4	...	107¼	...
£494,993	Stock	4%	Do. Deferred Stock	103	106	103	106	3 15 6	...	105	104½
£698,201	100	4%	Do. 4% Deb.	115	118	115	118	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	4⅞	5⅛	4⅞	5⅛	4 10 11	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	3½%	City and South London Railway Con. Ordinary xd	72	74	71	73	3 11 11	February and August	73	72
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	...		...		...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891) xd	128	133	128	131	3 16 4	,, ,,	129½	...
£330,000	Stock	5%	Do. (1896) xd	129	132	127	130	3 16 11	...	129½	...
£150,000	Stock	...	Do. (1901) xd	123	127	121	125	4 0 0	...	127	126⅜
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	...	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary xd	11⅛	12⅛	11⅛	12⅛	4 8 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference xd	14⅛	15⅛	14⅛	15⅛	3 17 5	...	...	...
£300,000	100	5½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½	4⅝	4½	4⅝	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	101	99	102	4 18 0	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8	9	8	9	3 6 8	...	...	...
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	13⅝	13½	13⅝	4 7 3½	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture xd	108	110	108	110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½	5	4½	5	5 0 0	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4 13/16	4 15/16	4½	4⅝	3 3 2	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10⅜	11	10	10⅜	4 15 3	...	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture xd	99	101	99	101	3 19 3	,, ,,	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	10⅛	11	10⅛	11	4 10 11	January and July	10 1/16	10⅛
30,999	10	2/3	Do. (£7. 10s. paid)	8	8½	8	8½	4 8 6	...	...	...
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	107	109	107	109	3 13 3	...	108⅛	107
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	81	83	81	83	...	...	...	...
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30 yr Cn. Mrt. Bonds	112	117	112	117	4 5 7	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	104	106	106	108	4 14 5	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	104	106	107	109	4 4 4	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½	4⅛	3½	4⅛	6 13 4	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93	98	93	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100	103	100	103	4 17 5	...	107½	...
£3,334	10	8/0	Potteries Electric Traction Ordinary	8½	9⅛	8½	9⅛	4 4 8	...	...	...
30,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9⅛	10⅛	9⅛	10⅛	4 15 2	February and August	...	...
£320,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108	111	108	111	4 1 10	...	...	...
950,000	1	...	South Lancashire Electric Traction & Power Ord.	...		...		...	...	...	...
51,182	1	...	Do. 6% Preference (14/0 paid)	...		...		...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...		...		...	...	...	...
500,000	Stock	...	Do. 4½% Debenture Stock (70% paid)	...		...		...	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	92	95	92	95	3 3 0	January and July / June and December	93½	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 23.	Price Wednesday, July 30.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending July 30. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£82,200	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98 102	98 102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅛ 4⅛	3⅛ 4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70 80	70 80	...		...	...
£778,940	Stock	15/0	Anglo-American xd	45 49	45 48	6 1 7	Feb., May, Aug., Nov.	...	...
£3,105,580	Stock	30/0	Do. Preferred xd	90 92	89 91	6 6 4	" "	91½	89⅝
£3,105,580	Stock	2/0	Do. Deferred	6½ 7	6½ 7	1 8 7	" "	...	...
$18,333,300	$100	$1⅝	Commercial Cable Capital Stock	165 170	165 170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	95 97	95 97	4 2 6	" "	96⅜	96⅛
16,000	10	4/0	Cuba Submarine Ordinary	4½ 5½	4½ 5½	7 5 6	February and August	5⅜	...
6,000	10	10/0	Do. Preference 10 per Cent.	12⅜ 13⅜	12⅜ 13⅜	7 8 2	" "	...	...
†12,000	5	2/0	Direct Spanish Ordinary	2⅜ 3⅜	2⅜ 3⅜	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7⅜ 8⅜	7⅜ 8⅜	5 17 8	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞ 103⅞	99⅞ 103⅞	4 7 8	January and July	...	...
60,710	20	4/0	Direct United States Cable xd & bonus	10 11	10 11	5 18 2	Jan., Apr., July, Oct.	10⅜	10½
£96,800	100	4½%	Direct West India Cable 4½% Red. Db. (within Nos. 1	99 102	99 102	4 8 3	June and December	...	...
£4,000,000	Stock	65/0	Eastern Ordinary xd & bonus ..[to 1,200) (red.)	150 180	117 127	5 10 3	Jan., Apr., July, Oct.	125	119
£1,955,565	Stock	17/6	Do. 8½ per Cent. Preference Stock	87 90	87 90	3 17 8	" "	87⅝	87
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108 112	108 112	3 12 2	May and November	110½	108⅝
300,000	10	2/6	Eastern Extension	12 13	12 13	5 7 8	Jan., Apr., July, Oct.	12⅛	12
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	109 114	107 112	3 11 4	February and August	111½	110
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100 103	100 103	3 19 0	February and August	...	...
£300,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100⅞ 103⅞	100⅞ 103⅞	3 18 3	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen	25 27	25 27	5 11 1	January and July	25⅜	...
£70,006	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos	99 102	99 102	4 8 1	June and December	...	...
17,009	25	37/6	Indo-European [1 to 1,200) (red.	37 41	37 41	6 1 11	May and November	...	...
£100,009	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	100 104	101 105	5 17 1	March and September	...	...
£100,009	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99 102	99 102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3⅜ 4⅜	3⅜ 4⅜	...		...	...
£139,309	100	5%	Do. 5% Debentures (red.)	100 103	100 103	4 18 5	March and September	...	...
30,008	2½	...	West Coast of America	⅜ ⅝	⅜ ⅝	...		...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97 100	97 100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	¼ ⅜	¼ ⅜	...	May and November	...	...
24,563	10	6/0	Do. 6 per Cent. 1st Pref.	4⅜ 5⅜	4⅜ 5⅜	11 8 6	" "	5⅛	4⅞
4,669	10	...	Do. 6 per Cent. 2nd Preference	3 4	3 4	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99 102	99 102	5 18 0	January and July	...	...
207,920	10	2/0	Western Telegraph (late Br zil'n Submarine)	11⅛ 12⅛	11⅛ 12	5 16 4	Mar., June, Oct., Dec.	11⅛	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1866)	101 104	101 104	4 16 2	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	98 101	97 100	4 0 2	...	99⅜	97⅛
			TELEPHONES.						
44,000	£5	5/0	Chili Telephone (fully paid) xd	⅛ 4⅛	3⅛ 4	6 5 6	August	...	...
224,350	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6 2/6	1/6 2/6	12 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅜ ⅝	⅜ ⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95 99	95 99	6 1 3	...	97½	95
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	4⅜ 4⅞	4⅜ 4⅞	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	57 60	56 60	7 10 0	...	58⅜	56⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12 14	12 14	4 5 9	February and August	...	...
49,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11 13	11 13	4 12 4	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞ 5⅛	4⅞ 5⅛	4 17 6	" "	...	...
£3,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	94 97	95 98	3 11 5	June and December	96⅜	96⅞
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102 106	102 106	3 15 6	...	102⅜	...
171,504	1	0/8½	Oriental	1⅛ 1⅛	1⅛ 1⅛	5 12 11	April and October	...	...
58,000	5	4/6	United River Plate	4½ 5½	4½ 5½	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜ 5	4⅜ 5	4 15 3	June and December	4⅛	4⅛
£ 79,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101 104	91 104	4 16 2	June and December	...	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛ ¼	⅛ ¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛ ¼	⅛ ¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅜ ½	⅜ ½	12 0 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7⅜ 8½	7⅜ 7⅝	6 9 0	July and February	...	...
80 000	5	5/0	Do. 6 per Cent. Preference	5⅝ 6	5⅜ 5⅝	5 4 4	January and July	...	...
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	101 103	101 103	4 6 1	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	5⅜ 6⅛	5⅜ 6⅛	4 8 0	...	6⅛	5⅜
105,781	2	...	Brush Electrical Engineering	1⅜ 1⅝	1⅜ 1⅝		March	...	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅜ 2	1⅜ 2	...	March and September	1⅝	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	102 105	102 105	4 7 5	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	94 99	94 99	4 10 10	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15⅛ 16⅛	15⅛ 16⅛	4 10 11	" "	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅝ 6	5⅛ 6	5 0 0	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	103 113	103 113	3 19 8	November and May	...	...
450,000	1	0/9½	Ostner-Kellner Alkali Co. (fully paid)	1 1⅛	1 1⅛	4 16 0	...	1⅛	1
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.) xd	95 100	94 99	4 11 0	...	...	...
60,000	1	1 0	Obadburn's Ship Telegraph Ordinary	⅜ ½	⅜ ½	9 2 0	March	...	...
85,000	5	1/9½	Crompton and Co. (Nos. 1 to 54,000)	2⅞ 3⅛	2⅞ 3⅛	6 19 0	January and July	3	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	101⅝ 106⅝	101⅝ 106⅝	4 14 4	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜ ⅝	⅜ ⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1⅜ 2⅜	1⅜ 2⅜	...	" "	...	...
£344,029	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	76 78	74 78	5 3 0	June and December	...	...
£ 00,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	76 81	78 83	6 2 10	...	...	...
30,000	5	4/6	Edmundson's Electricity Corporation Ord.	6 6½	6 6¼	5 7 8	Half-yearly	...	...
30,000	5	3/0	Do. 6% Cumulative Preference	6 6½	6 6	4 12 4	...	6½	6½
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	105 108	105 108	4 3 4	...	...	...
112,100	2	1/3½	Electric Construction Co.	1⅜ 2	1⅜ 2	6 0 0	January and July	1⅝	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅜ 3	2⅜ 3	4 13 4	July	...	...
£153,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97 100	97 100	4 0 0	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾ 1⅛	¾ 1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	9⅜ 10⅜	9⅜ 10⅜	4 17 7	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	98 101	99 102	3 19 5	...	...	...
35,000	5	5/0	Henley's Telegraph Works Ordinary	16 17	16 17	4 8 3	February and August	16⅜	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛ 5⅜	5⅛ 5⅜	3 18 3	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 115	111 115	3 18 3	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	4 13 0	" "	21 1/16	20½
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 18 5	March and September	101	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½ 15½	14½ 15½	6 9 0	July	...	...
27,350	12	12/0	Telegraph Construction and Maintnce.	35 38	36 39	6 3 1	March and July	38	37⅛
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	... ...	... ...	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	... ...	... ...	4 3 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	... ...	... ...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	... ...	... ...	...	" "	...	...
			FINANCIAL, INVESTMENT, &c.						
19,980	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛ 5⅜	5⅛ 5⅜	5 9 1	...	...	...
†80,227	10	2/6	Globe Telegraph and Trust	8⅜ 9⅜	8⅜ 9⅜	5 10 6	Jan., Apr., July, Oct.	9⅛	9⅛
†80,042	10	3/0	Do. 6 per Cent. Preference	12⅜ 13⅜	12⅜ 13⅜	4 8 11	" "	13⅛	13
11,250	8	4/0	Reuter's	6⅜ 7⅜	6⅜ 7⅜	5 6 8	April and October	6⅜	...
5,208	£100 Cert	6%	Submarine Cables Trust	110 120	110 120	5 0 0	"	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee have refused to quote these

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NOTES.

THE meeting of shareholders of the Central London Railway took place on Tuesday, when Sir HENRY OAKLEY, the chairman, brought forward a number of facts concerning the half-year's working. These should afford welcome encouragement to the advocates of tube railways, and, at the same time, be a sufficiently satisfactory answer to the croakers who have pessimistically predicted for them all manner of disasters. Evidently tubes spell neither financial ruin, devastation from vibration, nor suffocation from vitiated air. As regards finance, we are glad to record that after paying substantial dividends, the directors are able to carry forward no less than £25,606. As regards vibration, what little there is of it will soon be remedied by the introduction of the new motor coaches; while, as regards suffocation from vitiated air, we are assured there is no risk. The report of even the London County Council experts promises to be favourable. Many persons doubtless mistake for a vitiated atmosphere air that is merely warmer than that on the surface. At so great a depth the air is naturally less subject to the chilling influences of the English climate, whether of August or of December, than it is in the open; but it is not on that account deprived of its oxygen. Indeed, when the passenger has become accustomed to the temperature of the Tube any sense of suffocation entirely vanishes.

WE are able to announce officially the absorption of the English Electric Manufacturing Co., of Preston, by Messrs. Dick, Kerr & Co. Our readers will remember that in 1899 the first-named company was formed under the control of Messrs. Dick, Kerr & Co., the capital being raised privately, for the purpose of building extensive engineering works at Preston and carrying on the manufacturing business which has since turned out such a pronounced success. These works were described in an illustrated article in *The Electrician*, Vol. XLV., p. 814. The absorption will have very little effect financially outside the companies concerned, as it is effected simply by an exchange of shares and without the issue of fresh capital. It will, however, enormously strengthen the industrial position of Messrs. Dick, Kerr & Co., who are rapidly establishing themselves in the front rank among British manufacturers. As an indication of the prosperous position of this concern, we may add that the average of profits for the past three years has been over £60,000, while the estimated profit for the current financial year is stated at £100,000. We are glad to learn that this firm is undertaking several important further contracts in, among other places, South Africa, where—especially on the Rand—conditions are now ripe for British industrial enterprise.

THE scheme for the abolition of steam locomotives in the long tunnel leading into the New York terminus of the New York Central Railroad has at length taken shape. It is of much more ambitious proportions than it was at its first inception, involving, as it does, the electrical equipment of the entire railway for a distance of 30 miles from the city terminus. To operate all the heavy freight and passenger trains which crowd this busy part of the company's system will require a power station of no less than 100,000 H.P. The cost of the equipment and conversion is estimated at £2,900,000. If this scheme is ever carried out it can scarcely be allowed to remain on the present proposed basis. It is incredible that the delays and inconveniences will be tolerated which must result from the necessary halt to exchange locomotives 30 miles from New York. We may look on the project, therefore, as the first stage in the electrical equipment of the entire system of the New York Central Railroad Co.

WE learn that it has been proposed to hold a "Fire" exhibition at Earl's Court next year from May to October. This will tend to stimulate public interest, which, although vigorous at the present time, will by that time probably have died down to a large extent, unless, unhappily, another great catastrophe

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gives it new life. At this exhibition not only will the question of fire fighting be dealt with, but the more important one of fire prevention will also receive a large share of attention. "Safeguards with reference to electrical wiring" is an exceedingly important item in the catalogue, especially when some of the work carried out by so-called "electricians" is borne in mind. These men frequently know no more of electrical matters than carpenters, and are in absolute ignorance of the most elementary principles of wiring. The fire insurance companies seldom have the installation inspected; the central station engineer is powerless to refuse to connect, provided the insulation resistance comes out all right, and he—or his junior assistant—finds nothing wrong after quite a cursory examination. Then, after a short time, a fire occurs, the cause of which is either unknown or is due to defective wiring. The "unknown" causes also are, probably, defective wiring in the majority of cases.

Electrical engines and alarms will also be exhibited, but the exhibits themselves will be useless unless the public recognise the moral attached to the whole exhibition. America and the Continent are assisting in various ways, and we shall then see whether it is true that London is so far behind in the matter of fire prevention and fire fighting. If such prove to be the case, as is strongly suspected in many quarters, then the sooner the defects are remedied the better. Although fire risks and apparatus connected with conflagrations are not, perhaps, a cheerful subject wherewith to draw crowds to an exhibition throughout the summer, good will have been wrought if this exhibition should lead to real practical reformation.

In a Paper read by Mr. B. J. Arnold before the American Institute of Electrical Engineers the author states that he is constructing 20 miles of track to be worked at 15,000 volts single-phase. Each car will carry a static transformer to step down to 200 volts, the voltage of the motor. The motor will always run at one particular speed, and when not expending all its energy in propelling the car will be engaged in compressing air to be used to supplement the power obtained from the motor in going uphill or whenever occasion requires. When descending a grade the motor may utilise its full power drawn from the line in compressing air, or it may be used to compress air with the stored energy of the train, thereby acting as a brake. Each car, by virtue of the air storage, becomes an independent unit, and would be capable of travelling some considerable distance in the event of failure of power on the line, and without the aid of storage batteries.

This ingenious system presents a very pretty problem. It is not easy to balance the pros and cons, and say at once whether the final result is in its favour or otherwise. From the point of view of economy of power, there is doubtless an advantage in maintaining an uniform load on the electric motor. But, on the other hand, in addition to the extra capital outlay on compressed air plant, there is the unfortunate fact that the compressed air engine, even in the best of circumstances, has only a low thermodynamic efficiency. And the way in which it would have to work on Mr. Arnold's locomotive would be far from the best of circumstances. We fear the compressed air part of his scheme would be responsible for considerable loss of energy. Yet, setting economy aside, there might be an advantage in special circumstances in having the locomotive so equipped that, if electric power should fail, it could still propel the train for a certain distance.

Crystal Palace.—Sir William Chandler Roberts-Austen will distribute the prizes and certificates at the Crystal Palace Co.'s School of Practical Engineering to-day at 12 noon.

King's College, London.—The session 1902–3 commences on October 2nd. Some particulars of the course of instruction in the engineering, architecture and applied science division of the Faculty of Science are given in an advertisement on another page.

Glasgow and West of Scotland Technical College.—The session opens on September 23rd, and the entrance examination begins on September 15th. Some particulars of the courses of study, &c., are set out in an advertisement.

Telephones in Berlin.—The German postal authorities at Berlin have completed the fitting of the 60,000th telephonic apparatus. Considering that Berlin has only a little over 2,000,000 inhabitants, the number of telephones employed compares favourably with that in other European capitals.

Wireless Telegraphy in the American Army and Navy.—It is quite probable that the Signal Corps of the American army will use a system of wireless telegraphy in the coming joint army and navy manœuvres, and the navy will doubtless make use of some system in the large naval manœuvres to be held in the Caribbean sea next winter.

Chartered Institute of Patent Agents.—The qualifying examination of persons desirous of being registered as patent agents will be held in November. Particulars appeared in the *Illustrated Official Journal* (Patents) of 30th ult., a copy of which can be obtained on application to the secretary, 19, Southampton-buildings, London, W.C.

Electrolysis of Gas Pipes.—The *Scientific American* states that the city of Baltimore has made an agreement with the street railway company for a copper conductor of nearly 2in. in diameter to be laid in the municipal subway at an annual charge of $500. To lay the conductor will cost about $20,000, but it is confidently expected that this amount will soon be saved by the decrease of electrolysis of gas and water pipes, and in providing such an excellent return for the power.

An Electric Typewriter.—An ingenious typewriter of American invention, worked entirely by electricity, will shortly be on exhibition at the Crystal Palace. The bringing back of the paper carrier at the end of every line, which in the ordinary typewriter has to be done by hand, is done automatically by pressing a button on the keyboard. The inventors claim that the machine works 50 per cent. faster than the present typewriters in use, and reduces fatigue to a minimum.

Trolley Car Diagram of Connections.—We have received a diagram of connections of series-parallel controller and electric brake for two motors, arranged for electric tramways and designed by Mr. E. A. C. Kochs, engineer-in-charge of the Sheffield Corporation tramways power station. It is now in its second edition, and was originally brought out for the use of motormen to enable them to learn something of the complicated mechanism of which they are in charge. The price is 1s.

Wireless Telegraphy in Spain.—Elaborate comparative experiments with rival systems of wireless telegraphy are to be carried out along the northern coasts of Spain during King Alfonso's yachting cruise. A Spanish officer named Cervera has brought out an independent system, and this is to be tested against that of Marconi. The cruiser "Lepanto" has been fitted with the Marconi system, whilst Cervera's has been installed upon the King's own yacht "La Giralda." The system which gives the best results will be adopted for exclusive use in the Spanish Navy and public services generally.

An Optical Method of Synchronising.—An optical method of observing (1) synchronism in the speeds of two machines;

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(2) the increasing or decreasing variation in the ratio of their speeds; (3) the exact value of this ratio when it is such a fraction as $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c., has been brought forward by Mr. G. Gauthier. The plan adopted is to fix a mirror on the ends of each of the shafts of the two machines—the positions of which must be suitably arranged, the planes of the mirrors being slightly inclined with respect to the perpendicular to the axis of rotation. A ray of light is allowed to fall upon one of the mirrors, whence it is reflected on to the other one and thence upon a screen, where an image is formed dependent on the ratio of the speeds of the machines.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Bolama	April 19, 1902
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Santa Cruz—Teneriffe	July 7, 1902
Puerto Plata—Martinique	July 10, 1902
Anjer—Kalianda	Aug. 2, 1902
Nagasaki—Fusan	Aug. 5, 1902
Guantanamo—Mole St. Nicholas	Aug. 5, 1902

Cheap Wiring.—England is not the only country afflicted with contractors who carry out wiring at absurdly low figures. The *Canadian Electrical News* states that a contracting wireman in Montreal carried out an installation of 15 points, "skeleton concealed" work, at the rate of 75 cents. per point. This comes to 11·25dols., and out of this he paid 7dols. for inspection and certificate, leaving him net 4·25dols.! The question is then asked, "Where does he buy his material and what wages does he pay?"

Obituary.—We regret to record the death after a short illness of Mr. William Caleb Wilkinson, superintendent at Ponta Delgada, St. Michaels, of the Europe and Azores Telegraph Co., aged 50 years. Mr. Wilkinson entered the service of the Magnetic and International Telegraph Co. at a very early age, and in April, 1870, joined the Eastern Telegraph Co.'s staff. He was at Carcavellos, Portugal, for many years, and upon the establishment of the Europe and Azores Telegraph Co. was appointed superintendent at Horta, Fayal, being subsequently transferred to St. Michaels.

Largest Crane in the World.—What is said to be the largest crane in the world has recently been built for the Kaiser Dock at Bremerhaven. The total weight of the crane, including counter-balance, is 474¼ tons, and it consists of a four-legged tower supporting a revolving centre post, to which is attached a horizontal jib, one arm of which carries a counter-balance at the extreme end, and the other arm a crab capable of travelling from its extreme end to the edge of the tower. It is capable of carrying a test load of 200 tons. The maximum pressure on the foundation imported through the centre pillar is about 520 tons, and the maximum horizontal force on the top of the tower about 98 tons. The total length of the jib is 164ft., the height of the gantry rails from the ground being 114ft. 10in. The crab contains the whole of the mechanism for lifting and traversing, the speed of the traverse being about 26ft. per minute. The travelling mechanism is driven by a series motor, and the lifting mechanism by two motors.

Longitude Finding by Wireless Telegraphy.—This has been tested by the United States Coast and Geodetic Survey, with a view to its use in countries—like Alaska—where there are no telegraph lines or cables. The tests were made between the Marconi station at Sagaponeck, at the eastern end of Long Island, and the United States Survey schooner "Eagre," equipped for the purpose. From a point 30 miles east of the station half-hourly communication was kept up until the last intelligible message was received at a distance of 63 miles. The particular feature tested was the method of sending time signals by means of a break-circuit chronometer included in the battery circuit on the schooner; by this each second-break on the chronometer was transmitted to the shore station. The results are said to indicate that regularly-timed signals can be sent in this manner at a greater distance than is possible for verbal messages by the Morse code.

A Radiometric Receiver for Electric Waves.—Gordon F. Hull, of Hanover, N.H., described a radiometric receiver for electric waves at the recent Pittsburg meeting of the American Association for the Advancement of Science which has many points of interest. Two silvered strips of glass or mica, of the proper length for the waves used, are marked at their centres by a fine diamond scratch. They are mounted vertically in the focus of a parabolic mirror, with their centres opposite, and near two small, thin, mica vanes, which are at the ends of an arm of a torsion balance. The resonators and torsion balance are placed under a bell jar, from which the air can be exhausted. The radiometric action due to the heating at the mica scratches or high resistances can be observed by a telescope and scale. The sensitiveness can be made greater than that of the Klemencic thermo-element, and the deflections are quantitative.

Composite Arc Electrodes.—A new type of composite arc electrode is the subject of a patent issued to C. R. Boehm, of Charlottenburg, in Germany. This type is claimed to obviate such disadvantages as unsteadiness of the arc, formation of slag and production of smoke and injurious vapours. Finely divided fluorides, such as fluorides of sodium, calcium and magnesium, are intimately mixed. To one part of this mixture one part of pulverised carbon is added, and a paste formed by the addition of tar or other binding substance. In the case of cored carbons, the core is formed of a mixture of fluorides and carbon, to which is added a silicate. The magnesium fluoride is not reduced in the voltaic arc of the carbon, but is dissociated; the metallic magnesium thus produced being of an extraordinary reducing power, liberates the metals from their metallic salts so that the produced spectrum is a pure metal spectrum, whereas other arcs produced by metallic salts without the addition of magnesium fluoride show an impure spectrum of the salts or oxides employed, which are only partially reduced to metals. When the calcium fluoride is present an intensely yellow light is produced, which, however, becomes of a flesh colour when magnesium fluoride is present mixed with the other metallic salts in the proportion of equal or equivalent molecular weights.

Electrical Power for Mines.—An interesting description of the Kalgoorlie Electric Power and Lighting Corporation is given by Mr. C. E. Crocker in the *Mining Journal*. The work was started in June, 1901. The main building consists of an engine room 160ft. by 40ft. and 40ft. to the eaves, and a boiler house 120ft. by 43ft. No wood is employed, the buildings being constructed of steel framework and covered with galvanised iron. The condensing plant is built of jarrah framework and iron covering, and measures about 80ft. square. The evaporating plant consists of 10 cylindrical boilers 5ft. in diameter and 20ft. long, built in pairs, from which the steam is condensed in 40 vertical drums of galvanised iron. Eight 250 H.P. Babcock and Wilcox boilers, arranged for wood fuel, generate steam at 160lb. per square inch, and are connected to four steel chimneys 120ft. in height. The feed water from hot wells is passed through a Holden and Brooke feed-water heater, by which the temperature is raised to 180deg., and pumped by two of Tangyes' feed-water pumps, one steam and one electrically-driven. There are three main engines, each 22in. by 44in. by 36in., vertical cross-compound, by D. Stewart & Co., of Glasgow, of 800 I.H.P. nominal, or 1,200 I.H.P. maximum, running at 100 revs. per min. The shafts are hollow, and each carries the revolving field of the electric generator and a flywheel 19ft. in diameter, and weighing 33 tons. The revolving portion of the generator weighs about 16 tons, so that the total weight on the flywheel shaft is over 50 tons, including the crank discs. The engines are fitted with Corliss valve gear, the valve being placed on the ends of the cylinders, giving a very small piston clearance. The governor balls are driven by vertical shafting and Renold's gear belts.

Separation of Oil from Condensed Steam.—This subject was recently treated in a Paper before the Detroit Engineering Society by Mr. J. B. Bibbins, and he gave details of experiments made in the station of the Detroit Edison Co. The plant consisted of two 400 H.P. McIntosh and Seymour engines discharging their steam into a condenser which was capable of turning the condensed steam either through a coke filter into the boilers or directly to the sewer. As long as the water was

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discharged into the sewer no trouble was experienced in the operation of the plant. Then the coke filter was inserted, and the water returned to the boilers, the complete water cycle being performed, boiler-engine-condenser-boiler. Several months of successful operation followed, but at the end of this time oil was found to have accumulated in the boilers, presumably due to faulty operation of the filter. Subsequent experiments were conducted with mechanical and chemical treatment of the water, and in the latter what seemed a satisfactory solution was found. Efforts at chemical disintegration were made, but without effect, and when coagulative tests were applied very satisfactory results were obtained. The chemicals employed in successive tests were fuller's earth, powdered marl ($CaCo_3$), slaked lime and a double treatment of alum and Na_2Co_3 With the calcium compounds coagulation occurred immediately, and a milky white curd of considerable volume and weight settled slowly to the bottom, leaving the liquid quite clear but slightly alkaline. The apparatus designed for use in the station of the Edison Company comprises a mixing tank, small pump, return trap and filter, the method of operation being as follows:—Tank is filled from small pump, coagulator added from platform above, after precipation sludge valve is opened, and closed when pure water appears, finally, the trap valve is opened, allowing the contents of the tank to be forced through the filter into the pump suction of the boiler feed pumps.

Lighting by Translucent Tubes.—Patents have been granted in America to Mr. D. McFarlan Moore on his system for producing electric light which is described in the *Electrical World and Engineer*. Briefly stated, the invention claimed by Mr. Moore consists of distributing or running a translucent tube or receptacle over areas, spaces or rooms to be lighted, the terminals of the tube being brought to a source of energy outside of the areas or spaces, or in a location where the terminals may be suitably protected against danger of contact or accidental interference, the tube containing a gas which is of such character or degree of rarefaction that by the application of electrical energy or current to the terminals of the tube it will be rendered luminous by the transfer of the energy from one terminal of electrode to the other. In the practical installation of the system the translucent tube of glass may be built up in the position it is to occupy while in use, or otherwise distributed as a tube of glass over the spaces to be illuminated and its terminals, which are provided with suitable energy transferring electrodes or caps, brought to a protecting cabinet or wall pocket, in which they may be connected to the two poles of the energy supplying devices, the latter being mains or wires leading direct from the primary generator of E.M.F., which might be the terminals of suitable transformers adapted to give the required secondary voltage. In practice, alternating currents of greater or less voltage, as might be found desirable, would be used. For illuminating the interior of a dwelling or structure, the portions of the glass tubing which contain the luminous column from which the effective illumination is obtained, would be distributed in any desired way throughout the whole interior of the dwelling or structure as one or more tubes, with the conducting caps or terminals thereof brought from within the illuminated spaces or areas to an exterior cabinet or receptacle where its conducting caps would be located out of harm's way, and in immediate connection with the source of energy. Or, if desired, the energy might be carried into a building and suitable transforming devices located in sealed wall pockets within the same, the terminals of the tube being located in the same manner in the pockets, while the luminous portion of the tube would extend over or through the areas to be lighted, being distributed in any desired form or manner therethrough. Mr. Moore claims that while his invention may be carried out with any form of lamp having the characteristics above described—namely, a translucent receptacle and energy supplying electrodes at the terminals of the luminous column, he prefers to use for the purpose a form of lamp consisting essentially of a translucent tube whose conducting terminals or electrodes are metal caps or carbon paste attached closely to the exterior of the tube, and transferring their energy by electrostatic action to the contents of the tube itself.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Space Telegraphy.—Captain Jackson communicates a number of valuable observations concerning the transmission of wireless signals at sea across intervening land. He finds that some of the waves are capable of passing through, over, and possibly round the land, though in doing so their energy is reduced to an extent depending upon the height, extent and nature of the obstruction. He describes a remarkable case of an extremely precipitous, narrow, but high promontory jutting out from the mainland, and consisting of hard rock containing iron ore. Its height was 800ft., and signals were sent from a vessel 18 miles off to a ship cruising about the promontory. The distance at which signals could be exchanged in the open sea was 45 miles, but the promontory cut them off entirely. It cast, indeed, a sharp "shadow," the signals ceasing abruptly as the receiver disappeared behind the cliff. In other cases the effect was less marked. Limestone was found to be less obstructive, and sandstone still less so. A cliff of porous coral sandstone 250ft. high and 6 miles across reduced the signalling distance from 25 to 20 miles. Weather conditions also have an important influence, especially in sub-tropical regions. In the Mediterranean, a scirocco wind, holding moisture, salt and dust in suspension, absorbs the waves to a great extent. Lightning flashes always produce signals, and sometimes spell words in the Morse code, though the usual type is that of the letters *ei* in the Morse code. As regards the relative importance of the air wire and the earth connection, the author found that the absence of earthing in the receiver reduces the signalling distance by 50 or even 70 per cent., and its absence in the transmitter reduces it by 85 per cent. But a condenser of suitable capacity acts nearly as well as a good earth. The air wire, on the other hand, is practically indispensable, as the author did not succeed in signalling over more than 2 miles without an air wire, even with good earthing.

[H. B. Jackson, *Proc. Roy. Soc.* No. 462, July 8, 1902.]

Magneto-optic Effects.—W. Voigt reviews recent discoveries of magneto-optic effects in the light of his own theory, which, it will be remembered, rests on pure "phenomenology," and does not postulate either the electron theory or its rivals. The author refers especially to the observations of Corbino, and the new effect discovered by Majorana. Corbino's effects were quite amenable to the author's theory, but were imperfectly described. Later work by Corbino and Zeeman has led him to alter his views as to the nature of the Corbino rotations. Since in Corbino's own work the phenomena are confused by the superposition of several simultaneous effects, the author requested Zeeman to investigate the case in which the sodium vapour has only a slight density, and at the same time the field has such a strength that the components of the doublet are sharply marked off from each other and from the reversed lines of the source which lie between them. Zeeman carried out this work and communicated the results to the author for publication. He found that the negative rotation, which was as high as 500deg. with a field of 18,000 units, decreased considerably on increasing the field to 25,000 units. This is a confirmation of the author's theory. As regards the Majorana effect, the author mentions having received a letter from the discoverer, stating that he had obtained a preparation showing the effect 50 times more intensely that the colloid iron preparation previously described. But even now the constitution of the preparations depends so much upon accidental circumstances that not only the order of magnitude, but also the sense of the double refraction varies from one preparation to another. The author points out that the double refraction described by Majorana is demanded by his theory, and has actually been shown to exist in sodium vapour, but has been looked for in vain in heavy flint glass. The peculiar behaviour of solutions when the plane of polarisation is inclined to the direction of the field is explained as a magnetic pleochroism which is governed by the amplified theory framed for explaining the Kerr effect and the triplets of the inverse Zeeman effect. In the language of the electron

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theory, the electric field modifies the quasi-elastic forces in a polar manner, whereas the magnetic field modifies the apparent mass of the electrons in a similar manner.

[W. VOIGT, *Ann. der Physik.*, No. 8, 1902.]

Preparation of Pure Iron.—The preparation of compact masses of pure iron is of great physical interest, and L. Houllevigne has, therefore, studied the process devised by Goldschmidt, which involves the reduction of iron oxides by means of aluminium. He recommends the employment of at least 3kg. of substance, aluminium filings sifted, washed in petroleum essence and dried, and pure sesquioxide of iron, free from sulphur and carefully dried, in excess of about 15 per cent. over the amount required for the chemical reaction, and crucibles lined with magnesia. If a lesser amount of the reagents is employed, the iron remains suspended in the shape of separate globules, in a cavernous mass surrounded by small crystals of corundum. The addition of 20 per cent. of powdered cryolite to the mass increases the fusibility and raises the yield from 30 to 53 per cent. The best commercial Fe_2O_3 contains 98·2 per cent. of the oxide, but the slightest trace of sulphur is very noxious. There is even greater difficulty in obtaining pure aluminium free from fatty matter. The best way is to wash the filings with petroleum essence and then dry them in a sand-bath at 150deg. for several days.

[L. HOULLEVIGNE, *Journ. de Phys.*, May, 1902.]

Magnetic Double Refraction.—Q. Majorana has discovered in the case of magnetism an effect analogous to the Kerr effect in electrostatics. The particular effect described is a magnetic double refraction in solutions of ferric chloride and in colloidal iron oxide. The magnetic field employed was 7cm. long, and had a strength of 18,000 units. The light was an arc or incandescent lamp. After placing the liquid in a small cubical vessel in the magnetic field, the light was transmitted through it and the nicols turned to obscurity. No light was restored by a magnetic field either along or across the plane of polarisation. But a certain amount of light re-appeared when the direction of the plane made an angle of 45deg. with the direction of the field. In ferric chloride the ordinary and extraordinary ray showed a difference of path amounting to 0·02 or 0·03 of a wave-length. Dialysed iron of density 1·002 gave a much more marked effect, amounting to one-third of a wave-length in the rod with a field of 18,000 units. Bravais iron in a solution of density 1·001 showed a maximum "Majorana effect" at a field of 3,000 units amounting to 0·6 λ. The colloidal iron shows the effect the better for being old, and it must not be coagulated. The effect is proportional to the square of the magnetic field.

[Q. MAJORANA, *Comptes Rendus*, July 24, 1902.]

Mechanical Effects of Disruption Discharge.—J. Semenov describes certain mechanical effects of the electric spark, which shed some light upon the transport of matter from one electrode to another. The experiments were conducted under ordinary atmospheric pressure, and the author comes to the conclusion that, contrary to the usual supposition, there is no transport of the material of either electrode, though the transport of the gas or vapour surrounding it is well marked, and gives rise to strong mechanical effects. The discharge from an induction coil was made to pass between a positive flame and a negative saline solution enclosed in a narrow tube about 1mm. in internal diameter. The matter transported by the positive discharge impinged violently upon the solution, and made it spurt out in a luminous jet several millimetres long. The jet is spurted in the direction in which rays would be reflected. The spurting consumes energy, and consequently the cathode is much less heated than would otherwise be the case. The projected liquid is not chemically altered. That the spurting was not due to impact of the material of the anode itself was proved by making the anode consist of a jet of copper sulphate solution. This produced the same spurting, but without any $CuSO_4$ being transferred to the cathode, unless the jet was stopped and metallic vapour was formed by the heat then developed.

[J. SEMENOV, *Comptes Rendus*, July 21, 1902.]

Atomic Weight of Radium.—Mme. Curie has at length succeeded in obtaining pure chloride of radium, and has used the opportunity for determining the atomic weight of that remarkable metal. She is enabled to state definitely that it is 225 within a unit. It is, therefore, only surpassed in atomic weight by thorium (231) and uranium (238). It ranges itself among the metals of the alkaline earths, and is the superior homologue of barium, with which it is associated in nature. It also fits into the column in which thorium and uranium take their place according to Mendelejeff. The spectrum of the chloride was studied by Demarçay, who found the purest specimen practically free from barium. The amount of the substance available was 0·1 gramme, and the method consisted in estimating in the state of silver chloride the chlorine contained in a known weight of anhydrous radium chloride. To test the method, the atomic weight of barium was determined in the same manner, and found to lie between 137 and 138, the true figure being 137·4. The radium chloride is intensely radio-active and spontaneously luminous. Its effect upon the human skin and organism generally is most disastrous, as Mme. Curie has already experienced.

[MME. CURIE, *Comptes Rendus*, July 21, 1902.]

Ionisation by Ionic Shock.—J. Stark discusses the work of several recent investigations of the current in a gas and its dependence upon the E.M.F. His theory of ionisation by ionic shock maintains that, in an ionised gas, the current at first increases with the E.M.F. until all the ions generated in the gas, whether by Röntgen rays, ultra-violet light, incandescence, or other artificial means, are used up by the current as fast as they are generated. When that is the case, an increase of E.M.F. produces no increase of current. But on still further increasing the E.M.F. a point is reached at which the ions, traversing their mean free path, acquire a sufficient velocity to ionise neutral molecules by their impact. The current then becomes "independent," and rises again with increased E.M.F. The E.M.F. current curve has, therefore, an ascending branch, a horizontal portion and another ascending branch. Such curves may be obtained from the data provided by Townsend, Stotelow, Lenard, Kreuster, Schweidler, McClelland and Kirkby. In some cases the curves are not complete, as the point at which the independent current sets in depends upon the pressure, temperature and imported ionisation of the gas. The positive ionising potential is about 240 volts in air with an aluminium electrode, and 270 volts with a copper electrode.

[J. STARK, *Ann. der Physik*, No. 8, 1902.]

Unipolar Currents.—C. Christiansen describes, under the above title, a peculiar departure from Ohm's law observed in certain electrolytes. We are familiar with the unipolar currents obtained when one electrode consists of aluminium, but in this case both electrodes consist of mercury, and the author applies the term unipolar to the current through mercurous nitrate in nitric acid, because it greatly depends upon the size of the cathode, and not on the size of the anode. The irregularity observed is that under certain conditions the current is independent of the E.M.F. The nitric acid alone begins to be electrolysed at 1·7 volts. The $HgNO_3$ acts as a depolariser, and is electrolysed even at the smallest voltage. But after some time hydrogen also is evolved, giving a counter E.M.F. of p volts. The applied voltage being V, and the resistance r, the current is

$$u = \frac{V - p}{r},$$

Now, on increasing V, p also increases, and it appears that the difference $V - p$ remains constant up to 1·7 volts, and hence the current is independent of the E.M.F. It varies, however, directly as the surface of the cathode, and as the percentage of mercurous nitrate. The author dissolved one gramme $HgNO_3$ in 1,000 cubic cm. of normal nitric acid. The phenomenon described recalls the similar behaviour of gases pointed out by Stark.

[C. CHRISTIANSEN, *Ann. der Physik*, No. 8, 1902.]

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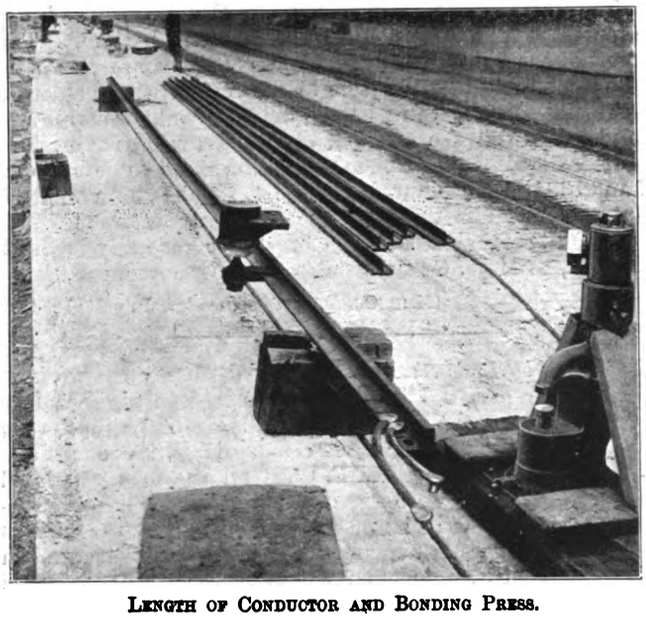
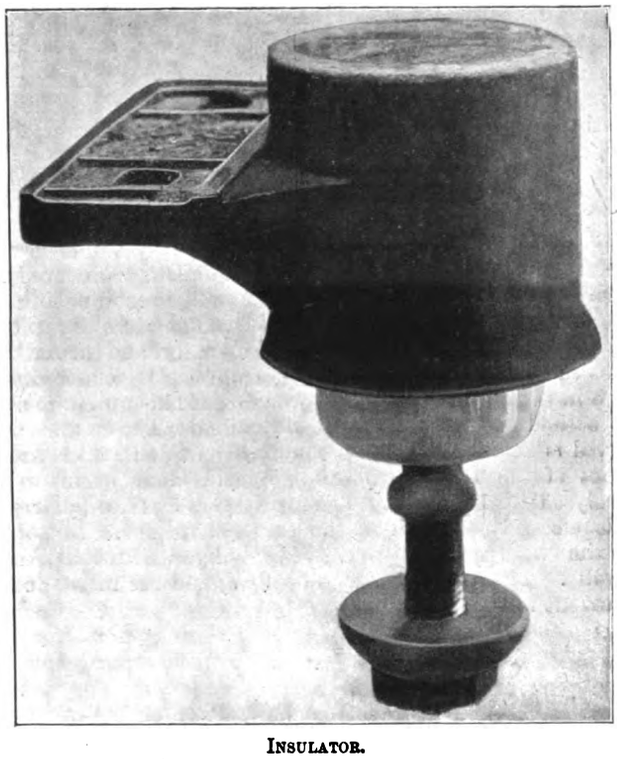
THE LONDON COUNTY COUNCIL ELECTRIC TRAMWAYS.

Some very interesting work is in progress in connection with the track work for the new London County Council electric tramways between Clapham Common and Balham. Departing from the orthodox system of overhead wires, the Council has embarked on a conduit system, which, it is said,



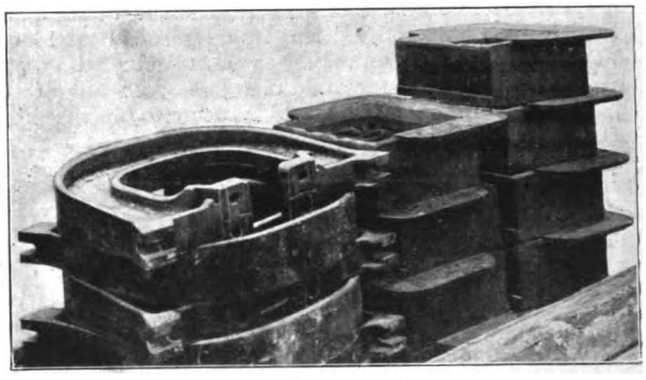
Length of Conductor and Bonding Press.

has been very successfully worked in various places, notably Paris. Both the overhead and the conduit systems possess merits peculiar to each, and the arguments in favour of either are so well known that it is scarcely necessary to touch upon

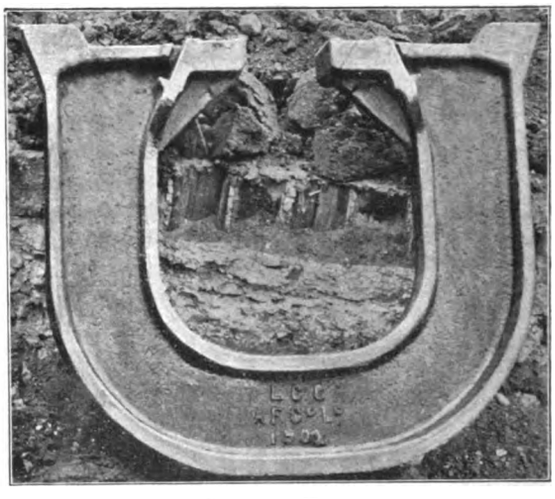


Insulator.

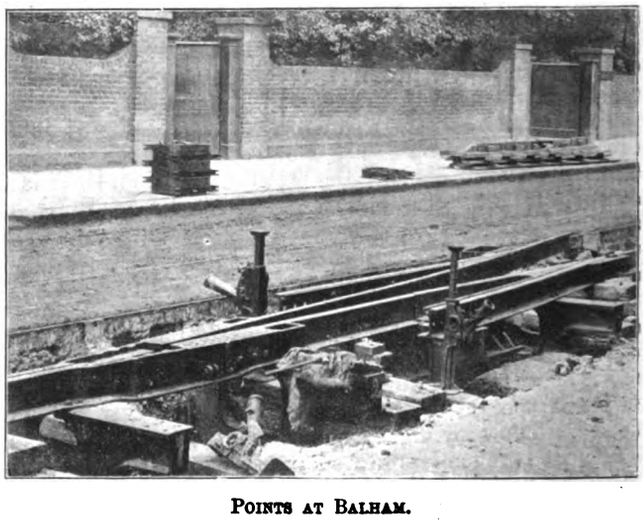
them here. The conduit itself is popularly supposed to be the chief source of difficulty, but, as a matter of fact, such is not the case; although water, dirt and refuse of all sorts will find their way into it, yet difficulties arising from these can be, and are prevented. The point which causes the engineer so many anxious moments is the design of the "plough." When it is remembered that the total width of the aperture through which the plough has to do its work is only $\frac{1}{2}$in., then some of the real difficulties will be appreciated. In this width of $\frac{1}{2}$in. there must be a conductor of sufficient section to carry the current required by the motors; this must be insulated,



Yokes and Insulator Covers.



Cast-iron Yoke.



Points at Balham.

and over all there must be a steel sheath to prevent injury from constant rubbing against the rails forming the entrance to the conduit. After having satisfied all electrical requirements the mechanical design of the apparatus must be carefully considered, and it is only after years of

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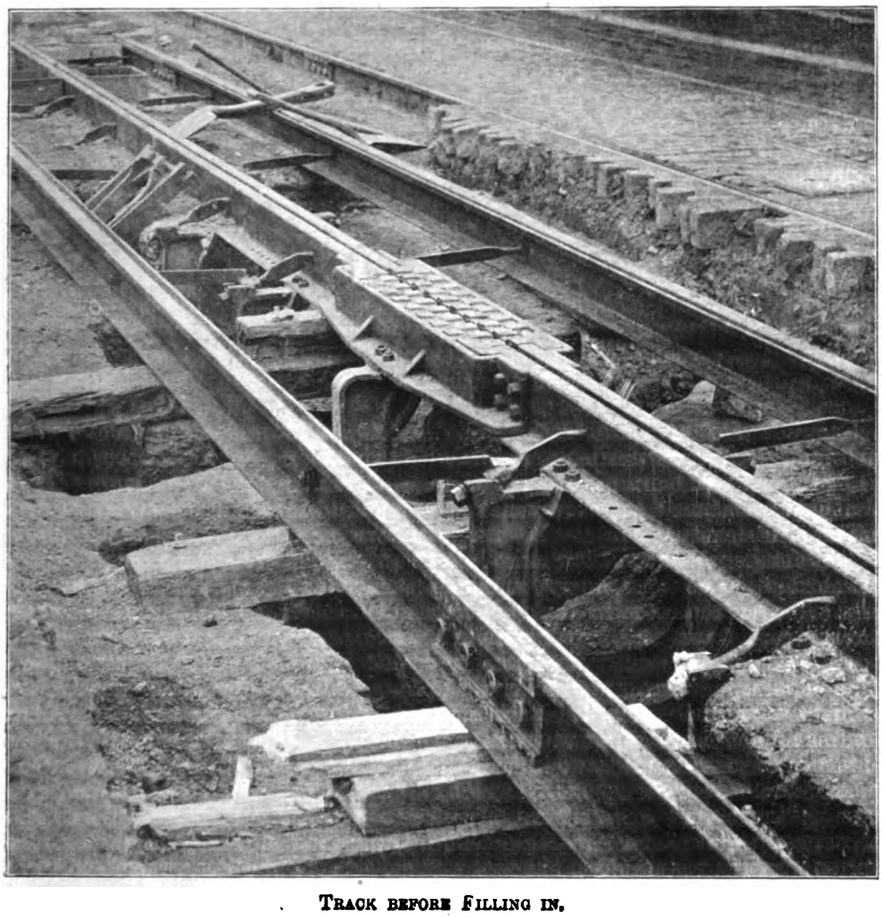
experience and many experiments that a satisfactory plough has been found. There are 2 miles of conduit on the track in question, and most of this is laid immediately over a 30in. water main, and if the insulation is satisfactory under these conditions it may safely be assumed that it will be so under any conditions whatsoever. The work was commenced on April 10th, and will be complete on December 1st next, this including the whole system as far as Westminster Bridge. Progress is being made at the rate of 800ft. of single track per day, and this means pulling up the old track, which, we believe, is one of the best horse tracks ever laid, and putting down the new, complete with conductors in conduits. The method of demolishing the old track is quite a novel one in this country, and is accomplished by means of raising ties, concrete, rails and setts all in one solid mass by the aid of jacks. It is lifted to an angle of about 30deg., and then a gang of men follow and break it up. Much time is said to be saved by this practice, particularly in this instance of the track being so thoroughly well laid. The conduit itself is 24in. deep and 16in. wide, and, as may be seen by the illustration of the track before being filled in, consists of cast iron yokes placed at regular intervals. The cement filling in the spaces between the yokes, and forming the actual conduit, is shown at the bottom right-hand corner of the same picture. The yokes are fastened to the conduit rails and to the tram-rails by means of ties, and in addition are bolted to the bottom flanges of the former. In the picture showing the conduit in course of construction the ties are not yet in position, but have been bolted on. The conductor consists of a T-shaped cast-steel bar of 2·2 sq. in section which is supported by an insulator and bonded to the next length. We are, fortunately, able to give an illustration of a length of conductor exactly as it would appear in the conduit, except that the insulator should be in the centre instead of nearer to the end. Two of these conductors placed thus, ⊣⊢, run throughout the whole length of the track, and are only broken every ½ mile for 1ft. in order to conform to the Board of Trade regulations. The machine shown in the picture is the hydraulic press, by means of which all the bonding is carried out. The bonds have solid heads, which expand under the pressure applied, and make a good electrical connection. The insulators weigh several pounds, and assume the position shown when fixed in the conduit and supporting the conductor. A petticoat porcelain insulator carries the bolt, and is contained by an iron body. Point work constitutes one of the chief difficulties, and it used to be not at all uncommon for the car to run on to one track and for the plough to endeavour to take a different conduit. This has, however, now been overcome, and it is possible for the driver of a car to release the plough instantaneously in the event of anything unexpected happening. Over each pair of insulators there are two insulator covers which serve the double purpose of supporting the insulator, by means of bolts, on the projecting ledge shown

Conduit in Course of Construction.



Track before Filling in.

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in the illustration, and providing convenient means of examining the insulator when occasion arises. Each evening after the cars have finished running, a special car with a sort of broom to fit the bottom of the conduit will run over the track and clear away any objectionable matter. Of course, there must be far less danger to life accompanying the working of a conduit as compared with an overhead system, but, on the other hand, the former costs just double the price of the latter mile for mile. The opening of the work will be looked forward to with great interest, and Messrs. J. G. White & Co., the contractors, can already be congratulated on the way in which they are so expeditiously carrying out their part.

THE NEW SMALL BRANCH EXCHANGES OF THE POST OFFICE TELEPHONE SERVICE.

(*Concluded from page 547.*)

The connections of junctions out-going from these small exchanges and in-coming at a large common battery exchange are shown in Fig. 7. The operator at the out-going exchange asks for a junction line over the call-wire in the usual way. In this case an automatic ringing key (see *The Electrician*, Vol. XLVIII., p. 292), is employed at the in-coming junction board, and the originating operator sees the call through; but, as a matter of fact, she need not speak with the called subscriber as his clearing lamp remains alight until he answers, and its darkening shows that the connection is through. When the wanted subscriber responds to the call, in addition to the automatic ringing key being released, the relay R at the in-coming board is actuated, and the relay R_1 immediately afterwards. This cuts the battery and earth connections off

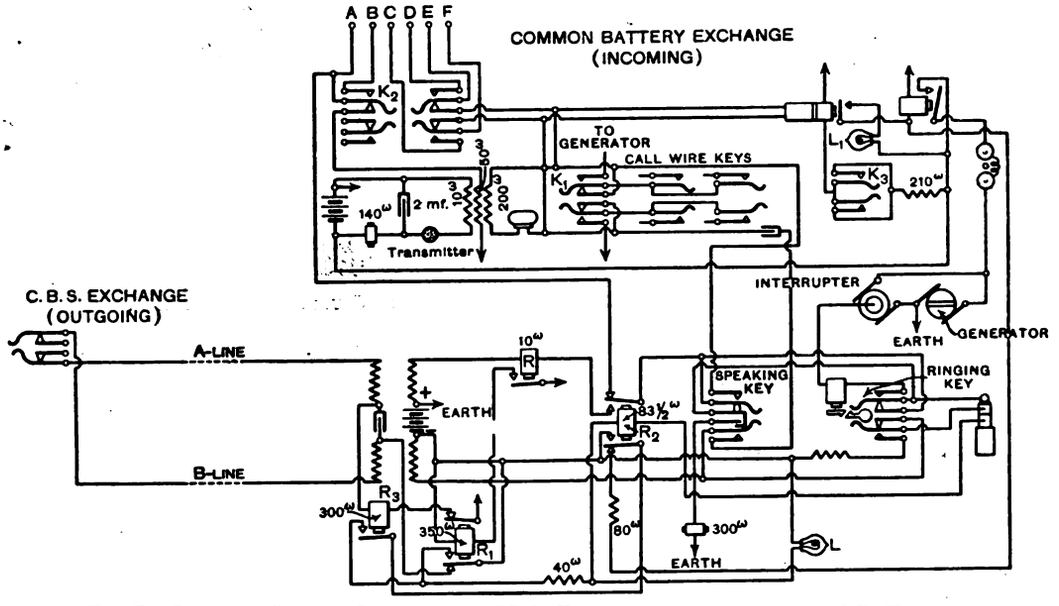

FIG. 7.—JUNCTION CIRCUIT, OUT-GOING AT C.B.S. EXCHANGE AND IN-COMING AT C.B. EXCHANGE.

the junction line at the condenser, the current through the clearing relay on the cord circuit of the originating exchange is interrupted and the lamp is extinguished. As soon as the called subscriber hangs up his receiver, R and R_1 cease to be actuated. As the lower tongue of R_1 is released, the negative end of the battery is connected to the B-line, and at the same time the A-line is earthed through R_3 and the upper tongue of this relay. A current, therefore, flows through the clearing-lamp relay on the calling cord at the originating exchange and through R_3. At this stage, although the clearing lamp at the originating exchange glows, L (the clearing lamp at the in-coming board) does not glow, as it is short-circuited by the 40-ohm coil in the circuit closed by the tongue of R_3, but as soon as the originating operator clears the connection between the A and B line at that end is broken. R_3 is no longer energised, and, the 40-ohm shunt being removed, L glows, and the junction operator clears. Should it happen that the wanted subscriber's line is engaged, or that he does not answer, the junction operator plugs into a "busy-back" or "don't answer" jack, in which case the clearing lamp at the originating exchange flashes in and out, and the originating subscriber hears the tone signal. If the latter subscriber does not appreciate the meaning of this, and does not hang up his receiver, the operator, who will notice the flashing of the clearing lamp associated with the calling plug, and will not have received the clearing signal on the lamp on the answering side, cuts in, gives the subscriber the necessary information, and then clears.

In the case of junction circuits in-coming from the magneto exchanges of the National Telephone Co., each junction line is connected through condensers to the main springs of an eight-point jack, and two 2,000-ohm relays (R_1 and R_2 in Fig. 8) are permanently bridged across the line. R_1 is for the purpose of preventing magneto currents from circulating on the Post Office side of the circuit, and R_2, whose middle point is connected to the negative side of the common battery, is for the purpose of giving the automatic clearing signal. At the magneto exchange there is a 1,000-ohm bridging coil whose centre point is connected by a relay R_3 to earth as soon as a plug is inserted in the jack in which the junction line terminates. There is normally no path for a current through R_2 and the circuit of the clearing lamp L_1 is made through the armature of this relay, but is broken at the outer springs of the eight-point jack. On a plug being inserted in the latter, therefore, the clearing lamp glows; but on the National Company's operator plugging into the other end of the line, a current flows through R_2 and the circuit of the clearing lamp is broken. As seen in the figure, there is a 2,000-ohm relay bridged across the line on the exchange side of the condensers, the middle point and tongue of this relay being connected to the negative side of the common battery. This relay, in operation, causes the lamp L_2 to glow until the wanted subscriber removes his telephone from the switch-hook. Clearing takes place at the magneto (originating exchange) and then at the Post Office exchange. The junction line is asked for by the National Company's operator through the call wire in the usual way.

Out-going junction circuits of the National Telephone Co.'s magneto exchanges are connected to a special strip of eight-point jacks fitted in the lower portion of the central panel of

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the switchboard. Call wires are used in this case also, and the connections of the junction lines are apparent from Fig. 9. The earth connection at the National Company's exchange is made as soon as a plug is inserted into a subscriber's jack on the National board, the relay R_2 being actuated. Connection is made at the Post Office end by means of an ordinary pair of plugs and cords, and in this case the Post Office operator clears as soon as the lamp associated with the answering (Post Office subscriber's) plug glows. The withdrawal of the

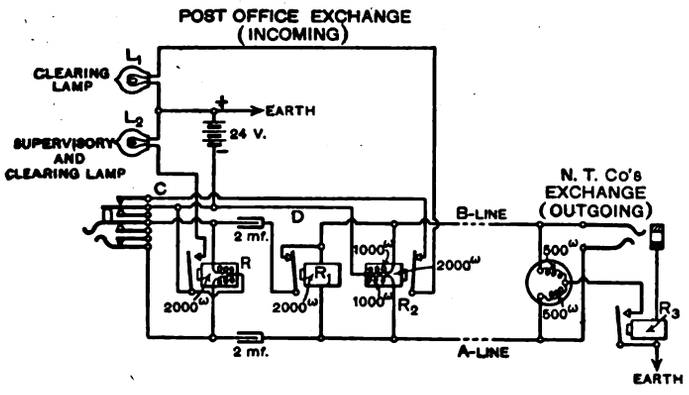

FIG. 8.—JUNCTION CIRCUIT IN-COMING FROM MAGNETO EXCHANGE.

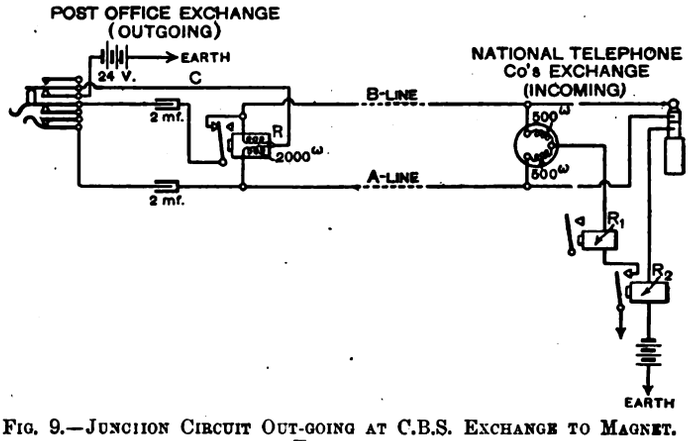

FIG. 9.—JUNCTION CIRCUIT OUT-GOING AT C.B.S. EXCHANGE TO MAGNET. EXCHANGE.

plugs restores the eight-point jack to its normal position, and joins up the battery with the differentially-wound relay R. The current flows through R, along the lines of the junction circuit in parallel, and through the relay R_1 at the National exchange, and the contacts of this latter relay are connected to the clearing indicator there. A relay instead of a bridging coil is used at R in order that no magneto currents may get through to the Post Office exchange when the National subscriber uses his magneto.

sleeve of the plug is connected to the centre of a 2,000-ohm bridging coil which is permanently placed across the line.

The party-line system, which enables two or more subscribers (up to 10) to have the use of one exchange line at reduced rates, will be available in connection with all the smaller exchanges of the Post Office. Up to the present, little use has been made of the system in connection with the Post Office exchanges, and in no case are there more than two subscribers. On the exchange switchboard the line is joined up on the board just as the other subscribers' lines, and the ordinary cords and plugs are employed for making the connections, the only difference being the employment of party-line keys for ringing. The subscribers' instruments are connected in bridge on the line (as seen in Fig. 10), and on each instrument, except the furthest one, the magneto bell is connected to earth through a condenser. The furthest instrument has no condenser in series with its magneto bell, which must, therefore,

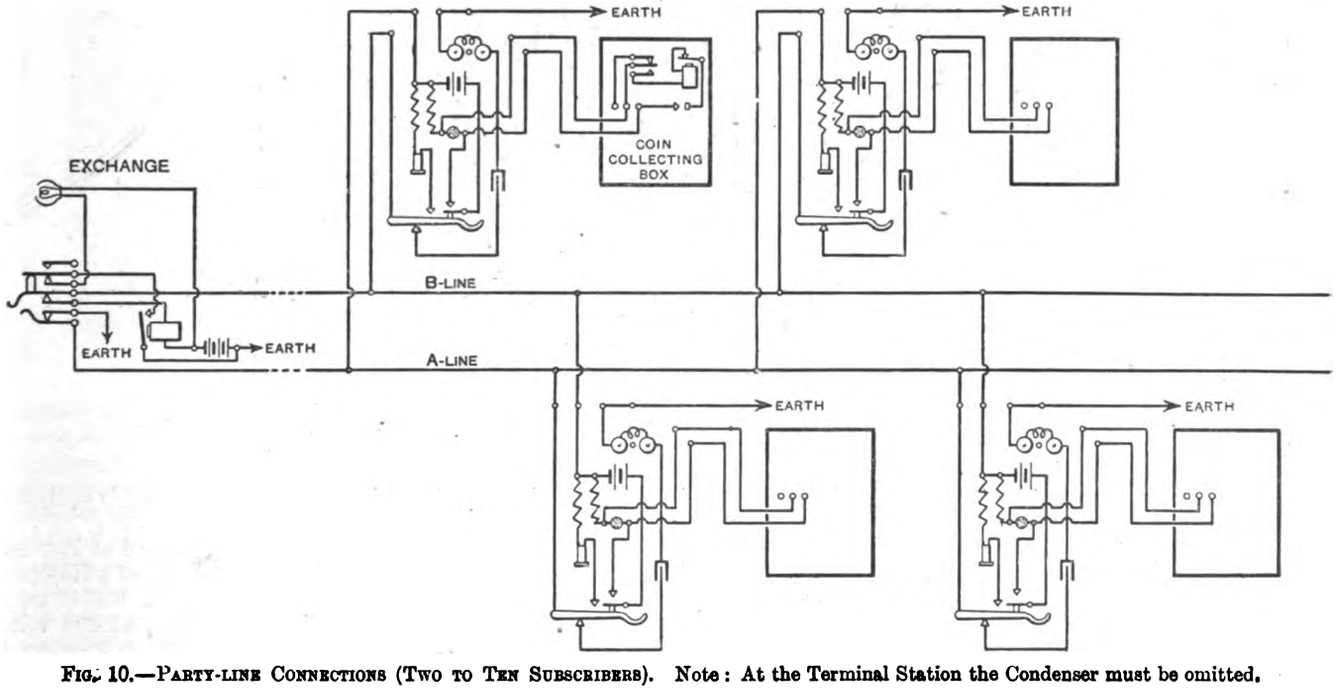

FIG. 10.—PARTY-LINE CONNECTIONS (TWO TO TEN SUBSCRIBERS). Note: At the Terminal Station the Condenser must be omitted.

Demands for trunk connections are put through to a record table at the Post Office central trunk exchange in the usual manner, and when the calls mature they are dealt with at the originating exchange as in-coming junction calls. The connections are made on the same principle as those on the in-coming side of Fig. 5, but the equipment and connections are slightly different. At the trunk exchange these junction lines terminate on a three-way plug on a junction transfer board. The lines are not connected directly to the plug but through two microfarad condensers to its tip and ring. The

be connected between the A-line and earth—otherwise a call would be indicated permanently at the exchange. The other magneto bells are connected alternately on the A and B line, and except in this respect the connections are similar to those of ordinary subscribers with the addition of a coin-collecting box such as is used at call offices. Normally the A-line is earthed at the terminal subscribers' station through a 1,000-ohm bell, while the B-line is insulated so far as continuous currents are concerned. On any party-line subscriber removing his receiver from the switch-hook, the A and B lines are

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connected through his receiver circuit (175 ohms), so that both lines are practically joined in multiple and are earthed through 1,000 ohms. When a plug is inserted in the jack at the exchange currents flow through both coils of the clearing relay (Fig. 4) to earth through the A-line and B-line respectively, and as the relay is differentially wound, the effects of these currents neutralise one another. As soon as the subscriber hangs up his receiver, the earth connection on the B-line is broken, the current flows through one coil only of the relay, and the clearing signal apparatus is actuated.

The party-line subscriber must insert a fee in his coin-collecting box before the operator finally puts him through, after he has originated the call. Inside the box is a buzzer, which, when a coin is dropped in and a handle turned, is joined up in parallel with the subscriber's transmitter and the buzz informs the operator that the coin has been inserted.

For ringing up party-line subscribers, the special party-line keys already referred to are employed. As has been explained, half of the subscribers have their magnetos between the A-line and earth just as ordinary subscribers, and others between the B-line and earth. The former are numbered x 1, x 2, &c., after their line number, the latter y 1, y 2, &c., and the subscribers are called by ringing once, twice, &c., on the A-line or B-line respectively. This is done by means of the party-line keys marked x and y, which must be held down while the ordinary ringing key is depressed the requisite number of times. When an x-key is down, one terminal of the generator is connected to the A-line side of the ringing key, and when the y-key is down this terminal is connected to the B-line side, the other terminal of the generator being earthed in both cases. As, unfortunately, an operator has only two hands, a different method of ringing has to be employed at night time when the machine ringer is not running. Then a junction-line pair of cords is used for the purpose of ringing, one plug of which is inserted into the jack of the wanted subscriber, and the other into a special jack, which takes the place of the ringing key, being connected to the generator through a special strip of party-line keys in the middle of the board, serving then to connect the generator between the A and B lines as required; these keys are depressed the requisite number of times for ringing the subscriber.

A further complication occurs when one party-line subscriber desires communication with another party-line subscriber on the same circuit. Then the originating subscriber must be asked to hang up his receiver for a few seconds while the operator rings the subscriber wanted, otherwise the ringing currents would pass through the calling subscriber's apparatus, and ring the bells on those subscribers who are called up on the opposite wire.

Fig. 11 is a view of the test-board and cross-connection frame at the Putney exchange. It has present capacity for 800 circuits but is extensible to 1,200 circuits, and is equipped with the usual lightning arresters and heat coils.

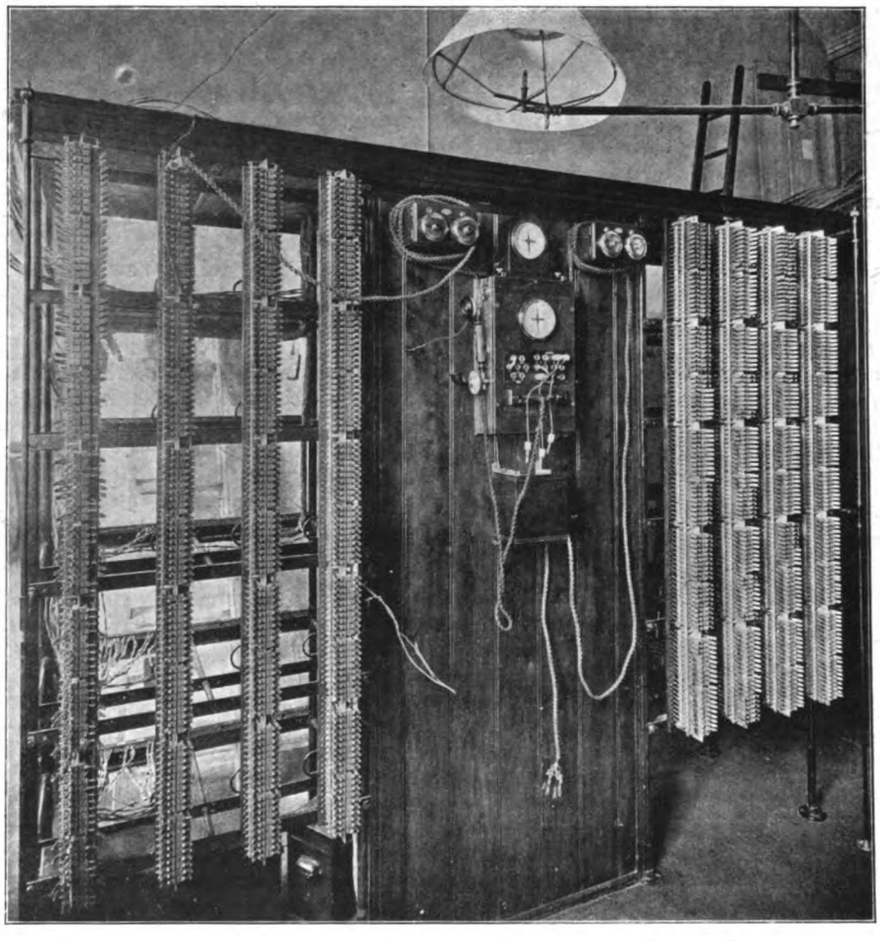

FIG. 11.—TEST-BOARD AND CROSS-CONNECTION FRAME AT THE PUTNEY EXCHANGE.

Fig. 12 shows the power plant and switchboard at Putney. The motor-generator, as seen on the left, consists of a Heyland alternating current motor connected direct to an E.C.C. two-pole generator. The motor takes 17·6 amperes, at 200 volts and 50 ~ from the County of London and Brush Provincial Co.'s mains, and runs at 1,400 revs. per min. The generator supplies a maximum of 60 amperes at 80 volts for charging the cells. To the right of the motor is seen its starting switch. This plant was supplied by Messrs. Witting Bros. In addition to this motor-generator is the generator for machine ringing (not seen in Fig. 12), which is a small scale counterpart of the one at the Post Office central exchange (*The Electrician*, Vol. XLVIII., p. 769). The current from the "busy-back" and "don't answer" commutators is not led directly to the switchboard terminals; a one-to-one transformer is inserted, so that the line is unaffected by the earth connection of the ringing generator. The motor driving this ringing machine

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is actuated from the cells, but a second machine as a spare, with a small Fuller-Wenström alternating current motor for connection to the public mains, is being put in.

The power switchboard is also very similar to that at the central exchange. It is divided into three panels, as seen in Fig. 11, the left-hand panel performing the connections between the motor of the motor-generator and the public mains, the middle panel being the dynamo and cell connections, and the right-hand panel distributing the current to the various circuits. At the top of the left-hand panel is a voltmeter, and below it a multi-way switch to connect the voltmeter to any of the circuits. Below these are two 25-ampere switches, one for connecting the motor of the ringing machine to the cells and the other for connecting the motor of the other ringing machine to the mains. The two largest switches below these are 50-ampere switches for connecting the motors of the motor-generator and of a duplicate motor-generator which may be added later to the mains. At the top of the central panel is a Weston meter, which can be put across a resistance in the charging or discharging circuit of the cells by means of the switch below it on the right. A throw-over switch in line with the latter connects the switch sections to either of the two ringing generators as required, and at the middle of the board is seen the handle of the field rheostat of the dynamo, and below this again the main generator switch to connect either machine to the charging 'bus bars. This switch is so arranged that when one machine is switched into the charging position the second machine is switched into the discharging position, and vice versa. The stop contact of this throw-over switch is for the single cell at the end of each battery which is used for the operator's microphone circuits. A circuit breaker and circuit breaker relay are placed above this main switch, and each of these has a main coil in series with the generator circuit. The coil of the circuit breaker simply makes it cut out when the current exceeds what should be its maximum value, but the relay is polarised so that in the event of the current through it changing direction it is actuated and closes a local circuit, energising a coil which releases the detent holding up the circuit breaker. On the third panel are three pairs of 'bus bars for the speaking circuits (2 volts), lamps and junction signalling (24 volts), and spare. The ammeter at the top of this board is of the Weston type, and a shunt for it is connected in each of these circuits, so that it can be put on to either by turning the switch beneath it. The cells are of the Chloride R type. There are two batteries, each containing 13 nine-plate cells, with a capacity of 240 ampere-hours at a 27 amperes discharge rate, and an emergency discharge rating of 120 amperes. The power plant and battery room are in the basement of the exchange, and there is an electrically-driven Reavell pump also to be erected there for a dessicator which will dry out faulty dry-core cables.

To conclude this article, it may be interesting to give the number and size of the cables leading to the Putney exchange. As already mentioned, the cross-connection and test-board has a present capacity for 800 lines; the single section of the switchboard already in is a 200-line board, and at present there are not quite 100 subscribers connected to the exchange. The total number of pairs led in at Putney are 615.

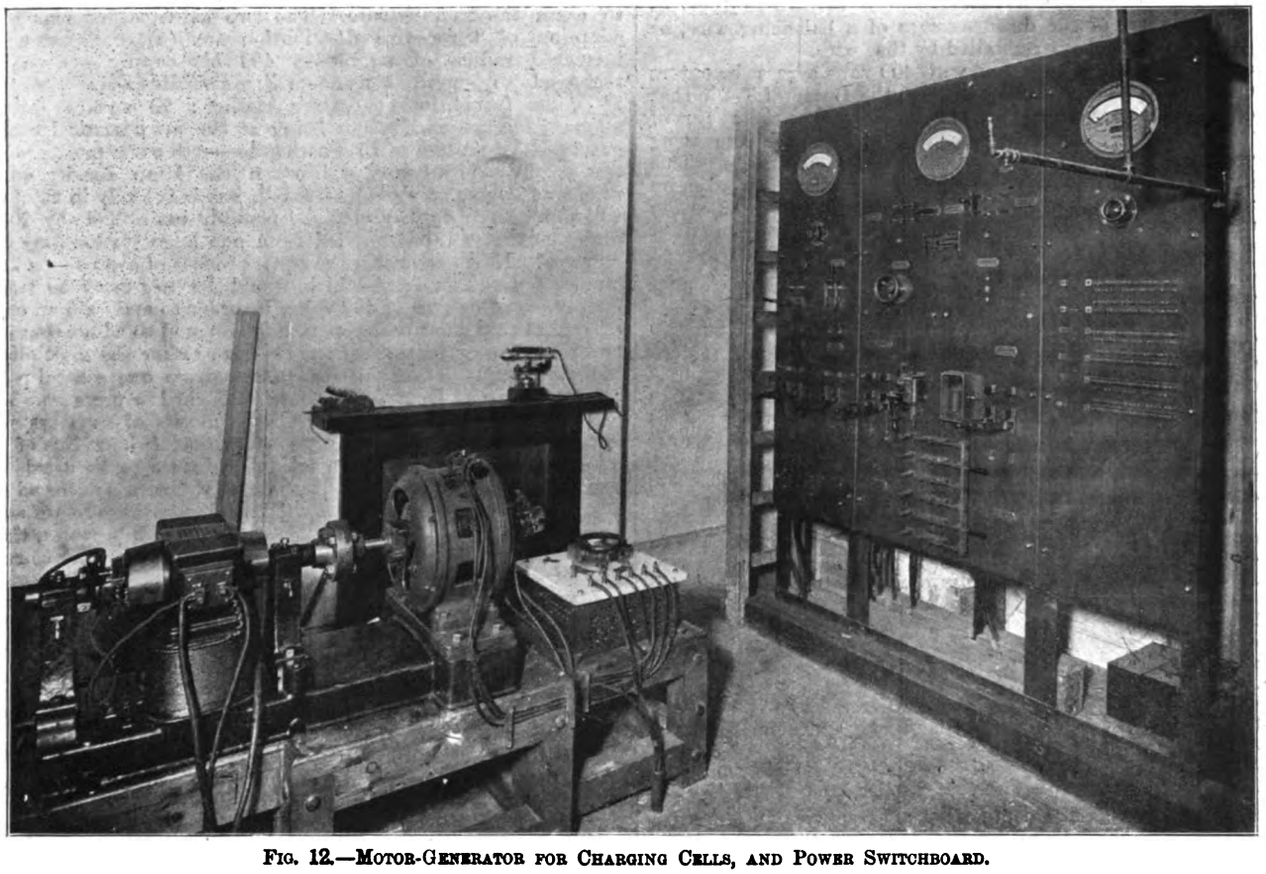

FIG. 12.—MOTOR-GENERATOR FOR CHARGING CELLS, AND POWER SWITCHBOARD.

There are six main cables and 21 small cables, and the routes and sizes of the various cables are given in the schedule below:—

No. of cables.	Route via	Type of cable.	Laid between Putney and	Description of cable.	
				No. of pairs.	Weight of conductors per mile.
1	Wandsworth	Composition paper core	Central Exchange	15	150
				56	40
1	Wandsworth	Ditto	Santos-road, Wandsworth	18	20
				61	20
1	Richmond	Ditto	Richmond ...	15	150
				56	40
1	Wimbledon.....	Paper core...	Kingston.....	75	40
1	Fulham	Ditto ...	Central Exchange	108	40
1	Upper Richmond-road	Composition paper core	White Hart-lane, Barnes	16	20
				48	20
10	Putney-hill.....	Seven-pair paper core	Putney-hill...	70	20
4	Putney Bridge ...	Ditto	Fulham	28	20
5	Ditto ...	Ditto	Putney Brdge	35	20
2	Upper Richmond-road	Ditto	Keswick-rd., West-hill	14	20

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THE RELATIVE ADVANTAGES OF TWO AND THREE-WIRE DISTRIBUTION.*

BY JOHN F. C. SNELL.
(Borough Electrical Engineer, Sunderland.)

Nearly all the electric lighting undertakings in the United Kingdom distribute energy on the three-wire system, whether the supply be by direct current or alternating. In 1886 the late Dr. John Hopkinson suggested the three-wire system as a means of saving copper, the claim being that, for any set of conditions, the three-wire system showed an economy of nearly 40 per cent. in the weight of copper used, when compared with two parallel two-wire systems of the same capacity; and, so far as it affects the copper alone, this is correct. Then 100 volts, or thereabouts, was the pressure adopted at the lamp terminals, and the introduction of the three-wire system enabled the radius of supply to be doubled, and double the amount of the original energy to be conveyed by the addition of only 25 per cent. of copper. Then, about 1895, a great change in the conditions took place when 200-volt lamps became commercially possible, by which a simple two-wire 200-volt distributor could give all the advantages of a three-wire 100-volt system, without any of the disadvantages of a balancing wire, or the 25 per cent. extra copper entailed by that wire.

But a three-wire 200-volt system with 400 volts across the outers became also possible, with the proviso of the Board of Trade that the middle wire should be connected to earth; thus the radius of supply became again doubled, or a sphere of influence amounting to four times the original permissible area became feasible. This proviso, that the middle wire should be earthed, was insisted upon to prevent the potential between any conductor and earth rising above the limit of 250 volts. Such a system has many manifest advantages, which may at once be enumerated:—

1. Economy in copper, and therefore in capital outlay on mains.
2. Increased radius of supply from the station or sub-stations.
3. Reduced percentage variation of pressure across any pair of terminals, and theoretically, therefore, a steadier pressure across the outers.

There is, however, the other side of the question, which shows many disadvantages:—

1. Difficulty of balancing consumers accurately, which increases as time goes on, and as the lamp density rises, and consequent variation of pressure due to variable want of balance.
2. Actual increased section of the middle wire in practice, much above the theoretical section required.
3. Switchboard complications.
4. Less reliability of supply when compared with a two-wire simple system—especially in large networks.
5. The burning out of consumers' lamps connected to either side of the middle wire, if temporary or permanent short-circuit takes place between the middle and the outer conductors.
6. The effect of permanent stress and of electrolysis on negative cables and service leads due to the permanent earthing of the middle wire, and to osmosis.
7. The certain electrolytic decomposition of water, gas and other pipes, due to local currents between outside faults on a big system and the earth connection.
8. Difficulty in localising and rectifying faults on middle conductors themselves, without interference with supply to local consumers.

The author is taking for comparison a three-wire system with 400 volts across the outers, and a two-wire system 200 volts.

A great deal of the economy in copper is largely counterbalanced by the cost of insulation of the middle wire. The author, in discussing Mr. Addenbrooke's Paper in 1896 at the Institution of Electrical Engineers, drew attention to the considerable leakage resulting between the earthed middle wire and the negative cables; and the late Dr. John Hopkinson, the then president, said:—

In Manchester, it is true, from a negative terminal there is a substantial leakage, and that exists, *and always* exists, because the middle wire is bound to be earthed. That, of course, really arises from the fact that bare copper is used to a very considerable extent. . . . . The leakage does not cause any inconvenience at all, but, of course, there is a certain loss of power from that leakage.

The author's note on this is that, while they might not cause much trouble to the electric lighting undertaking, such unmuzzled currents frolicking about would get into mischief and eat up the pipes of other undertakers. What is the use of the Board of Trade making stringent rules for the return currents of tramway undertakings, and overlooking the leakage from an earthed three-wire system, which the author ventures to predict will be a serious item in the course of time.

In 1894, in his Paper before the Institution of Mechanical Engineers, the late Dr. John Hopkinson stated that—

The insulation of the positive conductor is always good, while that of the negative is always bad, and with the Board of Trade insisting upon the middle wire being earthed, this obligation involved a certain loss, because their resulted a leakage going on the whole time from the negative conductor, and they would be glad to be set free from the obligation.

Again, our esteemed late president, Mr. C. H. Wordingham, in his Paper read at Huddersfield, said:—

In his judgment there can be no possible doubt that, at all events with continuous currents the effect upon the insulated material of the negative main is most severe; while it is possible that with alternating currents there may be an effect on the insulation of both conductors. If, however, the middle conductor be deliberately connected with earth, so that the negative outer is kept below earth potential, a current corresponding to the amount of the leakage will be constantly forced through the leak, and the tendency for moisture to flow to the negative conductor will be maintained.

And he went on to say, "what happens with rubber may happen with other material," and in the author's opinion there can be no doubt whatever very grave risk of breakdown of the insulation of negative conductors is introduced by earthing the middle wire. Our last president, Mr. W. A. Chamen, also said:—

Some engineers, no doubt, felt happy so long as the earth recorder showed no current, but how many of them knew whether their middle conductor was tight at all other points or not.

These quotations will suffice to show that the foregoing eminent authorities recognise the grave risk attendant upon this obligation to earth the middle wire. The two principal reasons for the adoption of three-wire distribution are (*a*) economy and (*b*) increased radius of supply—a 400-volt supply system being reckoned to supply consumers economically at a distance of 2½ miles from the generating station: 20 square miles—or allowing for the station not being at the mathematical centre of gravity—say, an area of 15 square miles—will cover most provincial towns. This is all very well when the lamp density and the number of consumers are both small, but is it likely in the future, when the lamp density shall be possibly multiplied by 20, that direct current will be supplied from one huge station for so large an area? If one estimates the square inches of copper—one might almost say square feet—which would be necessary to transmit energy over this area at 400 volts, in order to maintain an equable pressure throughout the system, one is bound to admit that one of two things must infallibly happen—viz, either the multiplication of stations or high-tension transmission from one central point to sub-stations, and from thence distribution at low pressure.

This is not an essay on the relative merits of such systems of transmission, but it is necessary to show that if the radius of transmission from a central station is in the future to be considerably decreased owing to increased lamp density, the reason for adopting a three-wire system, so far as it concerns increased radius of supply, no longer exists. In short, the denser a system becomes, the less necessity hereafter for a three-wire distribution in order to reach a greater distance from the station.

Before dealing with the relative economies, the author is aware that it will be said the variation in pressure due to changes of load—especially with large motors—is a sufficient reason to adopt 400 volts, and, therefore, a three-wire system, instead of 200 volts—with this he does not agree. At Sunderland there are motors of 100 H.P. connected to the supply mains, and other smaller motors, driving punching and shearing machines, and the pressure line is nevertheless surprisingly good throughout the day. With careful attention to the starting devices, this difficulty disappears; and, moreover, as the density increases, the momentary pressure variation due to local change of load, will, of course, be less apparent; and therefore this is not a real practical objection, and, so far as the consumer is concerned, 200 volts is better as regards danger to person, and slightly better in cost.

A two-wire system costs more than a three-wire. With distributors of two (0·2 sq. in.), and (0·1 sq. in., 0·06 sq. in., and 0·1 sq. in.) respectively, the costs per 100 yds. are £78 and £72; or 8 per cent. difference. Also the percentage volt drop and energy loss in the former is twice that of the latter, if the third wire losses are neglected. In a network covering 25 miles of frontage the costs will be (neglecting feeders):—

Two-wire	£34,320
Three-wire	31,680
	£2,640 increase.

Taking the distributed load as being at a maximum for 260 hours a year, and the remainder as equivalent to one-third full load × 2,190 hours a year, the energy losses will be:—

Two-wire	156,816 units.
Three-wire	78,408 „
	78,408 increased loss.

Such a network would be capable of distributing about 5,000kw., which, at 16 per cent. load-factor, will sell 7,000,000 units a year.

In a town of 160,000 inhabitants, the gas consumption is roughly 900,000,000 cubic feet per annum. This is equivalent to, say, 8,000,000 units of electricity. Add for tramways 2,000,000, and the total units supplied is 10,000,000. This will represent a maximum demand of not more than 10,000kw. Such a town will usually

* Paper read before the Incorporated Municipal Electrical Association, July 4th.

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measure not less than 6 miles across each longest axis, and often more than this. Now, a town with no greater output can well afford to centralise its plant, and careful estimates will show that a three-phase 5,000 volt sub-station, with duplicate primaries, is as cheap—when 500kw. or more are transmitted—as is a 500 volt direct-current feeder, when a distance of about 2 miles has to be reached, and, moreover, that the equated energy losses are the same. The only point in favour of the direct-current feeder being greater simplicity and no sub-station wages, but against these are better control of pressure, less additional cost when *further* power has to be transmitted, and greater flexibility of the sub-station system, as well as better control generally. The greater flexibility is especially to be noted, and the greater ease with which large amounts of power can be distributed. And so far as simplicity is conterned, a star-wound generator, driving either a synchronous or inductor motor generator at the sub-station which in turn feeds into a two-wire network, without any balancing transformers or complicated switchboard gear, is only one degree less simple than a simple direct-current system, and, in the author's opinion, not less simple than a three-wire system. That this will have to be adopted by the larger towns, with their ever-increasing boundaries, is the author's belief, up to the above limit, and afterwards it may be found more convenient, and as economical, to add more generating stations. This is essential to the argument, for otherwise a two-wire system would prohibit the radius of supply now reached, or would necessitate the adoption of a second or more stations earlier than would be warranted by the output.

From the sub-station must radiate short small feeders, and to continue the concrete example begun (and which will suffice for argument) let 2,000kw. be distributed direct from the station and let there be three sub-stations, each distributing 1,000kw. There would be, say, 10 home feeders, with an average load of 200kw. each—this number would probably be necessary to preserve uniformity in size of distributor, and to maintain pressure—and five from each sub-station. The home feeders might average 750yds. in length, and the sub-station feeders 500yds. :—

500-volt feeders would cost, say	£19,000	
250-volt feeders would cost, say.....	26,000	
	£7,000	
Deduct four balancing transformers and extra switch gear, &c.	£2,000	
	£5,000	increase.

The energy losses in the two cases would be—

Two-wire	385,580	units.
Three-wire	199,400	,,
	186,180	increase.

Therefore, the two-wire system would cost £7,640, or 14 per cent. more, and the increased interest and redemption fund on this at 6 per cent. would be £458 per annum. The energy loss in the two-wire is 542,396 units, and in the three-wire 277,808 units, being 7¾ per cent. and 4 per cent. respectively. It will be considered that ⅜d. per unit generated is an outside figure to take to cover engineering charges, and the cost of this increased loss will be £660.

The total charges against the two-wire system being £1,118 per annum, on a system having a capital outlay of about £350,000, and with a revenue of not less than £50,000 per annum, consider now the other side of the question. There are not yet sufficient data to give precise figures of the relative lives of negative cables in simple and in earthed systems, but that there is more trouble arising from them and from service leads in the latter is certain, and this entails heavier costs of repairs and greater depreciation, and the author maintains that the increased repairs to an earthed three-wire system of the dimensions taken herein will be absorbed by this 2 per cent. on the outlay, and that over and above this there are the other objections from which the simple two-wire system is free. The losses in the third wire, which at times are greater than is usually thought, have been omitted from the debit side of the three-wire system. One cannot alter a physical law, and osmosis will manifest itself; everyone admits it, so much so that some makers have adopted a special type of negative cable differing from, and more costly, than the positive. Does not reliability of supply represent value? And will not the Board of Trade have something to say later when the negatives do become weak, and the middle wire ammeter will not stand at zero, and if it does what guarantee is there against outside faults and local circuits which may not necessarily be recorded by this ammeter? The author believes that on the ground of reliability and safety, and seeing that the ascertained increased cost cannot exceed a moderate figure, while the other side of the equation is an unknown quantity—it will be found to be a safer investment to be content with a simple two-wire system than to adopt the more fashionable three-wire. This is, of course, most revolutionary—and it will be said, utterly out of date—and the author expects severe criticism. It will at least enliven the discussion. He hopes, nevertheless, this will be seriously considered and believes that in years to come his opinion will be justified.

Not to adopt the best and most permanent system is a most serious matter. The author knows of one large system in London, controlled by an eminent engineer, in which the third wire is being taken out (and, of course, used elsewhere), leaving a simple two-wire system at 200 volts. Mr. Bromley Holmes has been most successful at Liverpool, and apparently the only reason he has gone over to the three-wire system in parts of his city is to temporarily meet the demand at distant points, and to enable all his plant to be serviceable for either the tramway or lighting sides at will. Now, however, judging by the last annual report, he has to go the further step and adopt three-phase transmission to meet the ever-growing demand. A word as to the interchangeability of the steam sets from traction to lighting. It is admittedly a convenience, but looking at it squarely, is it really necessary? Stand-by plant for both must be always held in readiness, and, that being so, the necessity to turn over any set to either system is obviated. For single-phase alternating work little need be said; here, again, sub-stations play their part, and there can be no question whatever that a plain concentric is better in every way than a triple concentric cable.

It may be said by many that this prophesying of evil to earthed systems is laboured and unwise; that the author is sacrificing economy and efficiency to a mere fad—and he admits that, were it not for the infallible troubles which must result from this physical effect of negative leak, he would be among the first to recommend a system which so obviously involves less outlay and less loss in distribution. So much capital, however, is invested in cable systems, and they are so comparatively inaccessible that the greater simplicity of the system, and freedom from vexatious troubles to consumers, entitle the simpler and more reliable, albeit, at first sight, more costly, system to some consideration. That we must aim at giving as reliable a supply as our competitors, and more free from complaints, is a cardinal principle with the author, and looking ahead to the time when our networks will be many times larger than they now are, it will be agreed that the simpler they are the more lasting and better investments will they be. It must not be forgotten that the life of cables on the simpler system must be largely increased, and must prove a more valuable asset at the end of the 25 years—the period now fixed by Government for the redemption of the capital outlay on them.

The author has referred alone to three-phase transmission—there are other methods such as the Hull system adopted by Mr. Barnard, and battery sub-stations, especially now that the Highfield reversible booster method is available; but as this Paper is one on distribution only, and not on systems of generation, he has not attempted to bring additional controversy into this subject.

The author will be glad to hear the views of those who have had a long experience of earthed systems, whether in view of the moderate extra cost entailed by two-wire distribution (which he has endeavoured to state boldly and fairly), and the almost entire elimination of negative cable troubles, balancing transformers, frequent rearrangement of service leads, local overloading of balancing wire, occasional dead shorts between that wire and one of the outers, and more frequent interruption of supply, local leakages, and the probable intervention hereafter of the Board of Trade, constitute a sufficient justification for its adoption in preference to the cheaper three-wire distribution, and hopes that because it has become fashionable to use three wires, the consideration of these points raised by him will not be too lightly thrown aside.

DISCUSSION.

Mr. E. T. RUTHVEN-MURRAY (Willesden), taking the first point in the Paper, that the saving by the use of the three-wire system amounted to nearly 40 per cent., said that, as a matter of fact, taking three conductors of the same section with the same average loss, there was a saving of 62½ per cent., and by taking a three-wire system in which the middle wire was only one-half the sectional area of the two outers, there was a saving of no less than 68½ per cent. for transmitting the same amount of energy with the same percentage loss. This, he thought, was perfectly clear, because, by doubling the pressure in a conductor, the current was halved and the outer conductors need be only one-half the size. But it was possible to go further than that if they were only transmitting over the same distance, because, since the volts lost were the same numerically in both cases, the percentage loss was only half in the second case, and therefore they could use "outer" conductors of one-quarter the section required in the first case when the pressure was doubled. Dealing with the disadvantages of the three-wire system pointed out by the author, he said he could not agree with many of them. The first was that the difficulties of balancing consumers increased as time went on, and as the lamp density rose. From his (the speaker's) own experience he could state distinctly that the difficulty of balancing decreased. The author's second objection to the system was that the actual increased section of the middle wire in practice was much above the theoretical section required. He would like to ask what was the theoretical section? Theoretically, he should say that there need be no middle wire at all, and that the theoretical section depended upon the value assigned to the out-of-balance current. On the question of switchboard complications, he admitted that many three-wire boards were most fearful and wonderful

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things; but there was absolutely no reason why they should be so, and he hoped at Willesden to be able to show them a board as simple as any single-phase, single-pole switchboard. He hardly thought experience proved that there was more or less reliability of supply with a two-wire system for large networks, but perhaps this was because there were so few two-wire systems in operation. With regard to other points, such as the burning out of consumers' lamps, the effect of permanent stress, one certain electrolytic decomposition in pipes, and the difficulty of localising and rectifying faults, he contended that the whole of these objections depended entirely upon the system of mains employed. By using a three-core or a triple-concentric conductor many of the difficulties disappeared immediately. In the first case—the burning out of consumers' lamps—the risk was certainly minimised by using three-core or concentric cables, and he would say the same about the second point. He admitted that the stress would always be there, whatever the system of mains, but it would be only a stress and would not get to be an actual strain causing a breakdown. With regard to the electrolytic decomposition of gas, water and other pipes from outside faults on a big system, his contention was that a system of mains should be put down which would not allow of external faults. By putting down three single conductors faults would occur all over the system, and there would be great difficulty in finding them. If all the cables were under one cover a fault would burn out. At present it was thought wiser in house wiring to bunch the wires of different polarity and put them inside a metal tube. For similar good reasons he felt inclined to say that the difficulty of localising faults should be overcome by using a system in which there would be a burn out. He strongly believed in cutting up a district system by means of section boxes, so that there should not be undue interference with a large number of consumers if a fault did burn out. The extracts from various authorities quoted in the Paper referred to systems with three separate conductors, and would not apply at all if triple-concentric or three-core cables were used. The author mentioned that he was able to supply very large motors off a two-wire system without undue interference with the pressure. He would like to ask what the current-density was in these mains. He had made out that the current-density on one of the feeders at Sunderland was something like 150 or 200 amperes per square inch. Coming to the author's comparison between the distributors of a two-wire system employing two 0·2 sq. in. conductors, and a three-wire system employing conductors of 0·1, 0·06 and 0·1 sq. in. section, and in which the difference in cost was said to be 8 per cent., he said he had gone somewhat carefully into this matter because he was astounded to see the difference so small. He found that with single conductors of the sections proposed by the author there was a saving of 25½ per cent. Taking into account concentric conductors there was a saving of 19 per cent. in favour of the three-wire system. But the author was comparing a two-wire system with a certain loss against a three-wire system with half the percentage loss. If the proper section were taken for comparison there was a saving with triple concentrics of 47½ per cent., and with single conductors there was a saving of 55 per cent. But everything turned upon these numerical examples. If his contention was right—viz., that the author was comparing one system with another working at half the loss—he hardly thought the comparison was a fair one. He would, further, like to ask if the figure in the Paper showing the gas consumption was accurate. 900,000,000 cubic ft. worked out at 50,000 per inhabitant. He entirely agreed with the author in his statements as regards the flexibility of sub-station systems, although he could not agree that there was complication by the use of balancing transformers and switchgear. Personally, he would favour the use of three-core low-pressure mains rather than a system of single conductors and the special type of negative cable mentioned by the author, largely because with the former it was possible to connect on consumers without discontinuing supply as it was with single cables; but if he were using a triple concentric he should put the neutral as the core, put the negative next, and the positive outside, so that the chance of external faults would be minimised. There were one or two undertakings in the country where this was now being done. The strength of the Paper was in the numerical examples, and if he was right in his contentions, he thought it weakened the author's case considerably.

Ald. MORTON (Stafford) asked the author for an amplification of the comparisons between gas and electricity.

The PRESIDENT said that, although Mr. Snell would no doubt be very pleased to give this information, it hardly came within the subject of the Paper.

Mr. F. A. NEWINGTON (Edinburgh), speaking with regard to the advantages of the three-wire system, did not think there was anything in the objection to the difficulty of balancing, nor to the switchboard complications. With regard to the burning out of consumers' lamps, he had had short circuits occasionally, and, somehow or other, his consumers did not seem to get their lamps burned out. He agreed that the author only allowed half the drop in the case of a three-wire, as against a two-wire system, but even with this he was surprised to see a difference of only 8 per cent.

Mr. R. A. CHATTOCK (Bradford) thought the question of electrolysis had been brought rather to the front in this Paper, and too much made of it. In Bradford he had had a system with separate conductors laid on the three-wire system with the neutral earthed, and he had never noticed any electrolytic effect on the gas or water pipes. The waterworks engineer, who had a holy horror of electrolysis, might be safely trusted to call his attention to the matter, had there been any occasion. The cost of the switchboard for the three-wire system was very little in excess of that for a two-wire system. There were certain extra switches required, but the main instruments and switches for controlling the machines were practically the same. With regard to a power supply on a three-wire system, he had a good many motors of 10 H.P. on the 230 volt side, but in some instances these had affected the balance in the network, especially if they were used with an intermittent supply. But it was only in starting and stopping, and not in the actual running, that this effect was noticed. He thought it better to connect all large installations across the outers rather than increase the section of the balancing wire.

Mr. J. N. SHOOLBRED thought the three-wire system, although it entailed in practice a middle wire of larger section than was anticipated, must prevail in most districts, owing to the enormous value of the increased carrying power. On the question of separate conductors and their longer life at the end of 25 years, as mentioned by Mr. Snell, he said we had not yet had experience over so long a period, but some conductors that he knew of had had a very long life, and some at Bradford came within that category. There was a greater immunity from accidents and greater facilities for joining up single conductors than was the case with concentric cables. Although the two-wire system did seem to have so many elements of simplicity, the conditions of the three-wire system ought to prevail.

Mr. J. S. HIGHFIELD did not think the discussion had brought out the extraordinary seriousness of the point put before them by the author. It seemed to him that instead of discussing the small details that the previous speakers had it would be better to discuss whether it was an economical practice to substitute a two-wire system for a three-wire system, admitting that it also involved reducing the voltage by half. It was perfectly certain that the two-wire system was in every way easier to work, it was safer and gave less trouble to the consumer than the three-wire. It seemed to him that with the single-phase alternating-current system, as the author said, the two-wire system of distribution came in perfectly well because the whole thing seemed to turn upon the number of sub-stations. For long distances, however, the system was hopeless. It might be possible to use it in small towns. The whole question turned upon the point as to whether the extra cost of the sub-stations outweighed the advantages obtained by the two wires. He should think that in some cases where the load was exceedingly dense the two-wire system would have enormous advantages. One way in which this system could always be used was for supplying motors for power circuits, although it seemed to him to be an objection that the motors must always be at half the pressure. Mr. Snell was extraordinarily fortunate in being able to work a 100 H.P. motor without upsetting the balance. There was no question that with certain classes of motors, such as rolling presses for lead, and stamping machinery where the load was very heavily intermittent, there was great difficulty in keeping the pressure steady, and he generally fixed such motors on the 500-volt circuits. With regard to the troubles on the negative conductor he said there would always be osmotic troubles. He had carried out a number of experiments on this principle and the extraordinary force of osmosis was surprising. Whether Mr. Snell was right in thinking that as time went on the negative conductor would have to be sacrificed, he would not like to say.

Mr. V. A. H. McCOWEN (Belfast) congratulated Mr. Snell on his Paper. He thought the crux of the whole matter was in the accuracy of the figures, and, perhaps, in his reply, Mr. Snell would give the data he went upon. He had worked out a number of cases of different efficiencies, and had given for the two-wire system a units loss of 7¾ per cent. If the mains were worked out to give the same losses, so that the only important matter to be considered then was the capital outlay, they could practically halve the figures given for the three-wire system. The total capital expenditure for the two-wire was £60,000, and for the three-wire, as assumed by Mr. Snell, £50,000, and if the latter was reduced to the lower section to give the same loss, it would be £34,000, or little more than half the total outlay on the two-wire system.

Mr. H. BOOT (Tunbridge Wells) thought it was something rather new to be told that the three-wire system was going to give trouble. At the present moment there were numerous works which had been running for 10 years or more on this system, where none of the troubles mentioned had been experienced. He would suggest that they should go back to the old pressure of 100 volts rather than reduce the mains by using two wires. With regard to the switchboard, this could be made as simple as the ordinary two-wire. As to the less reliability of supply, he had found it particularly convenient on many occasions to be able to change over a street from one side to the other if there was anything which was wanted to be done to a certain cable. The burning out of consumers' lamps would not happen unless some fault occurred in the cable, but they ought to arrange their cables in such a manner that the cables themselves could not break down, and that damage could only be caused externally. With regard to the starting of Mr. Snell's 100 H.P. motors and the running of them, he remembered when he was running 10 H.P. continuous-current motors he had severe troubles. His experience had rather shown him that the further north one went the less attention the consumers paid to pressure, and he ventured to suggest that to attempt to start a 100 H.P. motor on the 200-volt Brighton mains, for instance, would result in the whole town being up in arms against it. He quite agreed with Mr. Murray that three-core cables were a better solution of the problem. What was necessary was an improvement in cables. A great deal also depended upon the earthing question, and to have a number of small earths on a system was a very serious matter. Perhaps high-pressure engineers appreciated this more than low-pressure engineers. They all knew what happened when there were long feeders going out from the switchboard. When an earth occurred the current returned by other feeders, and the readings on the ammeters were very extraordinary at times. He remembered an accident not long ago. There were some 10 pretty long feeders going out from the works, and something occurred which created a difficulty in running some of the engines in parallel. The whole of the feeders were earthed at the works and connected by the ordinary Ferranti switchgear in the sub-station—*i.e.*, the whole of the outers were practically connected together to the 'bus bar. There was found to be a peculiar "breathing" of the lamps which could not be got rid of until the outer mains were disconnected as well as the inner. With regard to the question of explosions which had been mentioned, he contended that if engineers would not overload their cables and send very heavy currents through them they would not find these extraordinary things happen.

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Mr. W. H. TITTENSOR (Dundee) objected to Mr. Boot's remark as to the docility of consumers further north. Although he considered Mr. Snell's Paper to be a very able one, he thought the results would have been different had he taken the same percentage drop in both cases. As he was at present working on the two-wire, three-wire and five-wire systems, he could agree with the author that the first-named was a good system from the point of view of simplicity at the switchboard. A good many complaints in Dundee had been from consumers who were supplied off the same mains that motors were, and he should like to hear about the 100 H.P. motors referred to by the author. Personally he thought the difficulties were in the early stages. As the number of consumers increased the difficulties seemed to disappear. He was pleased to hear Mr. Murray speak of having a simple three-wire board. There was no need for complexity in this respect, and the great mistake hitherto was the desire to throw everything over from one side to the other. He had been working at Dundee for 10 years, and had never had any necessity for doing so.

Mr. E. E. HOADLEY (Maidstone) said that, supposing they went back to Mr. Snell's two-wire system, it would mean that in a great many towns which were just now only making both ends meet, the capital expenditure would have to be raised in order to make the change. The towns themselves were not sufficiently large to justify the expenditure on high-tension transmission with sub-stations. Among the disadvantages of the three-wire system the difficulty of balancing consumers was put first; but he did not agree that this increased as time went on. In the early days of an undertaking they took some trouble to balance each street by itself, but as the load increased the general load would right itself. As to the 100 H.P. motors on the same mains, he would like to know how Mr. Snell did this.

Mr. A. P. TROTTER said the gist of the problem was a comparison between the conditions under which a two-wire and a three-wire system were most economical. It was a fact that on a very small job the two-wire was the thing. When it grew, then the method was to turn it into a three-wire one. Mr. Snell's proposition meant that some of the large towns with three-wire networks would be better supplied if there were sub-stations feeding small two-wire networks of the size of a town into which it was not worth while putting a three-wire system. The whole question then turned upon as to when it was worth while to put in sub-stations. It appeared to him that in some cases this question of putting sub-stations and three-phase equipments was being just a little bit overdone. Some extraordinary suggestions had been made to him of late in connection with three-phase 6,000 volts transmission, a thing which could be done sometimes much more simply by a homely but not necessarily old-fashioned method.

Mr. F. THURSFIELD (Chester), referring to Mr. Snell's costs of cables, thought at first sight these were rather startling. A comparison had been made between two 0·2 sq. in. cables, and two of 0·1 and one of 0·06 sq. in. The two wire had 50 per cent. more copper than the three wire, and yet they were told that the cost would only be 3 per cent. more. Mr. Snell went on to say that this would give a network of 25 miles a supply of 5,000kw. The cost of the copper would be in a very much greater proportion than the cost of the whole cable, and it would be found that the cost of the two-wire system would be 50 per cent. more than the three wire. The author had admitted that the losses were twice the losses of the three-wire system, and argued that this was permissible. Of course, it was permissible as regards the feeders, provided they increased the complications of the switchboard with regulators to adjust the losses, but it was not permissible with regard to the distributors unless the difference of pressure was going to be very serious between neighbouring consumers. It would be necessary to double the cost of copper in every case in order to supply the load the author referred to.

Mr. H. FARADAY PROCTOR (Bristol), speaking with regard to single-phase alternating currents on the three-wire system, said there was no difficulty in dealing with the author's objections Nos. 1 and 5. These both referred to getting out of balance and variations in pressure due to that want of balance, and by having the transformers diagonally wound this was obviated. By this means the relation between the load on one side and the other did not matter. With respect to the difficulty of localising and rectifying faults, he said he did not find any faults occur.

Mr. A. S. BARNARD (Hull) asked if Mr. Snell could give any concrete instance of the certain electrolytic decomposition of water, gas and other pipes. There were so many three-wire systems throughout the country that it was remarkable that actual cases had not been heard of.

Mr. H. FARADAY PROCTOR asked that this last question should be made to apply to alternating as well as continuous currents.

Mr. A. B. MOUNTAIN (Huddersfield) thought it was not quite right to head the Paper "distribution" only. The whole system must be considered. The figures in the Paper were based on the cost of the distributing system, and had not included the feeders. This, he thought, entirely killed comparison. For small towns he considered the three-wire system right and the two-wire system wrong. At the same time he wished to congratulate Mr. Snell particularly, because he was putting before them something which aimed at simplicity, as he believed this was to be the keynote of their future success.

Mr. J. H. CLOTHIER (Stafford) thought Mr. Snell was very much to be congratulated on reminding the Association that there was such a thing as a two-wire system, and he himself thought the system might have a look in again in connection with high-tension transmission. He did not think that Mr. Snell suggested that any of the three-wire systems, which were commercial undertakings, and were more or less successful, should change over to the two-wire system. The suggestion was for future extensions.

Mr. J. F. C. SNELL (Sunderland), in reply, thanked Mr. Murray for the able way in which he had dissected the Paper, and in this manner helped to elucidate the points which he wished to bring forward. In the first place, with respect to the saving of copper being 40 per cent., and which Mr. Murray said would be 62½ per cent. and 68 per cent., he ventured to say again that his figure would be found to be correct in actual practice. It varied with different localities. With regard to the balancing difficulties, there was no question about it from his own experience that, with a three-wire system, as the consumer density increased, the difficulty of balancing the side streets also increased. From the street books which they all kept, it was found that a certain number of consumers were connected. During the next six months certain new consumers were connected up, and there would be a want of balance in the street. On paper it might be that the balance was accurate, but when the winter load came on, in actual practice the balance was varying from minute to minute. Another point was that while the station ammeter might be practically constantly at zero, it was often found that outside there was a very large want of balance indeed. In fact, in some cases he had known the middle wire to be working at 2,000 amperes per square inch current-density. He did not make much of the switchboard complications. What he did say was that the simpler the system and the less auxiliaries, such as motor generators for balancing and boosters, the happier the lot of the station engineer, and the better the whole system generally. A cardinal point of the discussion had been the question of cost, and, in addition to Mr. Murray's remarks, a later speaker had said he had not taken the cost of feeders into account. This latter was an error, as he had taken the cost of feeders into account on page 631. With regard to the use of concentric cables he was aiming at simplicity and reliability of supply, and it would be admitted that it was wiser to put in a type of cable in which a short circuit would not develop into a breakdown. With an alternating system of distribution they were restricted to a certain class of cable, but the present tendency was towards direct-current distribution; and rightly so, because it was not sufficiently taken into account the advantages which batteries would give in the future. In years to come batteries were going to be a much more important factor than hitherto. This being so, single cables laid in stoneware casings, or some duct or the other, were far freer from short circuits than were concentric cables. Reference had been made to the fact that as so many three-wire systems existed to-day, were they all to be scrapped? No. He had not suggested this in the Paper at all. What he contended was that, with respect to the larger towns which were being supplied on a three-wire system, it would be found that the three-wire system would not meet the whole of their needs. In fact, Mr. Holmes at Liverpool had already found this out. There were a great many towns of the size of his own where he was working on a three-wire system. But he found it difficult to reach economically the boundaries of the borough, which were continually growing, and they were obliged to revert to one of two things—either multiple stations or sub-stations with some other system of transmission. Other towns would find themselves in the same difficulty. If that were the case the necessity for reaching long distances by three-wire systems no longer existed, and it then opened the question as to whether extensions of the future should not be on the simpler and more reliable system. Mr. Chattock had stated that although he had a three-wire system he had had no trouble with electrolysis. He had been asked to give a concrete case in which this had taken place. He knew of two cases where water engineers had recently found differences of from 8 to 10 volts between different sections of their pipes. A great many eminent engineers did actually say that electrolysis took place with direct-current systems where there was any leakage at all, and if there was a switchboard fault on the middle wire at the station which resulted in the development of a series of faults on the negative cables outside, there must be small shunted currents passing through the ground between these points. The bigger the system the worse they would be. With regard to the 100 H.P. motor, of which so much notice had been taken, he said at Sunderland there were two 100 H.P. motors supplied from the 220-volt main. They offered fairly steady driving. They were started up by a very well-known switch, and the putting on and taking off of them made practically no difference to the local pressure. This fact he had ascertained by putting in a recording voltmeter. He would be pleased to send a chart to anyone who questioned this statement. With regard to the criticisms on the sizes of the cables in his comparison of the two systems, he said the whole of the figures were worked out on the basis of the same current density—600 amperes per square inch. He had hoped to have heard a more explicit expression of opinion from Mr. Trotter. He could not follow Mr. Thursfield in arguing that a two-wire system would cost 50 per cent. more than a three-wire. It was a question of the number of feeding points, and therefore his own price still held good—whether it was 5, 50 or 100 miles. Mr. Proctor referred to the diagonal winding of transformers which he thought sounded like differentially-wound machines, and therefore self-controlling. Surely under the circumstances there would be a very large amount of current passing at times through the third wire, and the third-wire network would have to be very much greater than the one he had mentioned. He was convinced that the Board of Trade regulations would not be made less easy. Probably they would be made more stringent. If this be the case, it would probably be found that the 7-volt limit in connection with tramways would be made applicable to lighting systems, and it was from this very point of view that he had asked the Association to take into consideration the question of earthing the middle wire. The whole thing depended upon that, and although it was extremely revolutionary, yet he believed the time would come when some of those who had spoken against him during the discussion would be converted to his view.

A vote of thanks to the author concluded the discussion.

Underground Telephone Wires in America.—$100,000 is being spent in the construction of a tunnel for telephone wires between Minneapolis and St. Paul, Minn. The object of the tunnel is to protect inter-urban service from interruption by storms and to increase the capacity for communication between the two cities.

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CONTINUOUS-CURRENT DISTRIBUTION.

Three subjects were discussed at the recent meeting of the Incorporated Municipal Electrical Association. On the first day methods of transmitting electrical energy from the generating to the supply districts; on the second day the relative merits of various classes of engines; and on the third day continuous-current distribution. It is with the last of these three subjects that we propose to deal in the present article. In this country, at any rate, from 200 to 250 volts is the recognised pressure at which the supply is distributed to the consumer, and, to obtain the maximum economy in conductors, a three-wire system with double this pressure between the outer wires has been almost invariably adopted. The system being thus broadly defined, there remain a large number of details to be considered—details of considerable importance to its efficient working—and these having been worked out in practice in different manners by different engineers, an interesting and useful field for comparison is offered. The first question that arises is the degree of interconnection of the network. Shall the distributing cables be connected up in a closed network fed at certain feeding points, or shall the district be divided up into sections, each with its own distributing network and with its own feeder or feeders? This must depend obviously upon local circumstances. The former method has the advantage of better pressure regulation, the latter the advantage that the effect of a fault is more local, and that the fault itself is easier to detect and locate. Then comes the question of fuses versus links in a closed distribution network. Mr. WORDINGHAM favours good solid connections that will stand the same current as the cable; Prof. KENNEDY, on the other hand, still specifies fuses in the network boxes, we believe. This question, and, more especially the proper position for these fuses, was discussed in a recent Paper by Mr. C. J. A. WARD (see *The Electrician*, Vol. XLVIII.), and was only alluded to casually at the municipals' meeting. Nor did any of the speakers find an opportunity to go deeply into the relative merits of concentric three-core or single cables, or whether the cable should be laid "solid," "drawn in" or "direct in ground," opinions on which are also nearly equally divided.

The middle wire formed the main subject for discussion. Mr. FARADAY PROCTOR wanted to earth it more, others wanted to earth it less or not at all, and Mr. J. F. C. SNELL would have it abolished altogether. We have carefully studied Mr. SNELL'S arguments, and although his contention was most excellently reasoned, we must state, emphatically, that he has made no case. As was remarked by one of the speakers in the discussion, it would be a serious matter indeed if Mr. SNELL were right and we had indeed made a mistake in the almost universal adoption of the three-wire system. His

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reasoning as to the relative costs of the two systems has already been shown to be fallacious, and we need not labour this point. If he will take any large three-wire system, as now existing, and calculate what would have been the cost of a two-wire system supplying the same consumers, and with the same maximum drop of volts, he will find his error practically demonstrated. The small additional trouble due to the necessity of balancing the system is insignificant compared with the enormous saving in cables, as is also the additional panel required on the switchboard. On a well-designed and properly-maintained system of mains on the three-wire system there need be no question of unreliability, and the number of lamps burnt out by undue rises of pressure on one side owing to a short circuit on the other is a negligible quantity.

It is, however, the electrolysis scare to which we would particularly allude. Mr. SNELL gave no statistics as to this, but based his argument purely on academical grounds. We would ask him to tell us of half-a-dozen networks, in which the negative wire leakage, due to osmosis, is serious enough to cause electrolysis. Can he point to one single network originally designed for a 2 × 200-volt three-wire system in which such is the case? Let us assume, for the sake of argument, that there are three or four amperes flowing from the earth at the station to the negative wire. This current will start from the station along the lead of the cables, and a minute fraction of it will branch off at each negative wire leak. These branching points are presumably the points at which Mr. SNELL anticipates electrolysis. A badly-wired house may have an insulation resistance as low as one-tenth of a megohm, let us say. With a pressure of 200 volts on each side of the network, one-fiftieth of an ampere will flow, and this will divide itself over the surface of all the lead cables and pipes in the neighbourhood. But, as a matter of fact, the leakage due to osmosis will chiefly be in junction boxes, and if the leakage is not to the middle or positive main directly (as will most often be the case) it will go over the lead of the cables and the cast iron of the box itself, and this latter will be the anode which is electrolysed. Three-wire systems with their middle wires earthed at the station can be tested for insulation resistance just as well as two-wire systems, and actual defects can be localised and removed equally well, so that electrolysis from faults need not be considered.

Assuming, therefore, a three-wire system and an earthed middle wire the two questions discussed in Mr. FARADAY PROCTOR'S Paper are how the middle wire should be earthed, and whether fuses or links should be employed on it. In this respect we see no good reason for departing from the present practice of earthing at the station only, and avoiding fuses on the middle wire. Here again actual cases must be brought forward if it is to be demonstrated that a departure from the existing English methods would be beneficial. A bare middle wire or a system of distributed earth-plates might necessitate, as Mr. ESSON pointed out, considerably more copper—and its main advantage would be to make matters easier for the house-wiring contractor. We trust that Mr. PROCTOR, when acting on the Institution Wiring Rules committee, did not put forward these remarkable views with regard to house-wiring with one pole insulated as the opinion of the Municipal Electrical Association whose representative he was. The question of fuses on the middle wire is more debatable. Hypothetical cases can doubtless be put forward on either side, but we do not believe that those supply station engineers who have been able to carry out the plan of allowing no fuses on the middle wire—neither on the cable network nor on the house-wiring—have had unfavourable experience.

THE EFFECTS OF SELF-INDUCTION AND CAPACITY IN ELECTRIC TRANSMISSION.

BY G. H. BAILLIE.

(*Concluded from page 519.*)

Capacity.—While self-induction affects the drop of pressure, but not the power wasted in the line, capacity has the opposite effect. Since the capacity current is in quadrature with the pressure, it has practically no effect on the drop in pressure, but with a power-factor less than unity, it diminishes the power lost in the line, provided that it be not so large as to produce a large advance of phase. With a low power-factor the saving due to capacity will in general be greater than any loss due to dielectric hysteresis or charging current, when the load-factor is not very low.

Overhead Lines—Single-phase.—The capacity in microfarads per mile of circuit is $\frac{0{\cdot}0194}{\log d/r}$, where d is the distance between the wires and r is their radius. This gives values varying between 0·009 and 0·011 microfarads per mile for ordinary lines. The effect of capacity is negligible, unless the lines be very long with very high pressures. As an extreme case, where it is far from negligible, may be mentioned the line of the Standard Electric Co., where the capacity charging current is half the full-load current.

Overhead Lines—Three-phase.—Perrine and Baum have given formulæ for the capacity and charging current of three-phase lines in their Paper before the American Institute of Electrical Engineers on aluminium line wire. They reckon the capacity between one conductor and the line, or surface, of zero potential, which, in the case of three wires at the angles of an equilateral triangle is a line through the centre of the triangle. The charging current is then calculated at a pressure $E/\sqrt{3}$ (the pressure between the conductor and the zero potential line) on this capacity, and equals

$$\frac{E}{\sqrt{3}}\frac{K}{10^6}p = 3{\cdot}627\frac{EKn}{10^6}.$$

The effective capacity in microfarads per mile between one wire and the centre line is $\frac{0{\cdot}0388}{\log d/r}$, where d is, as before, the distance between any two wires, or the length of the side of the equilateral triangle.

The charging current per mile is $0{\cdot}1407\,\frac{En10^{-6}}{\log d/r}$ where E is the pressure between the conductors and n is the frequency. This gives a value 15 per cent. higher than that in a single-phase system, with the same wire, the same distance apart and at the same pressure. The charging current, however, is important only in comparison with the effective current, and a comparison between the effects of capacity in single and three-phase systems must take into account the difference in current per wire. For a given percentage loss of power, a,

Single-phase, $2RC^2 = aEC$, or $C = a\frac{E}{R}\frac{1}{2}$.

Three-phase, $3RC^2 = a\sqrt{3}EC$, or $C = a\frac{E}{R}\frac{1}{\sqrt{3}}$.

Therefore, for the same size of conductor, the current in the three-phase system is $2/\sqrt{3}$ times that in the single-phase, or is 15 per cent. more, and consequently the ratio of charging to effective current is the same for the two systems on overhead lines.

Cables—Single-phase Concentric.—The capacity of a concentric cable is $\frac{D.C. \times 0{\cdot}0386}{\log D/d}$ microfarads per mile, where D.C. is the dielectric constant of the insulation, D is the inside diameter of the outer conductor, and d is the diameter of the core.

The dielectric constant for paper cables is, taking a low figure, 2·4, and with this, the formula becomes $\frac{0{\cdot}0926}{\log D/d}$ microfarads per mile. For rubber cables this must be doubled at least.

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The capacity of concentric cables is of the order of 30 times that in overhead lines; a transmission at all approaching that of the Standard Electric Co.'s would be impossible by cables.

The charging current in a line is usually reckoned by assuming the capacity concentrated in the middle of the line, and with a power-factor of unity, the loss of power is then easily found. But where the charging current is an appreciable fraction of the full-load current, this assumption may lead to some error, especially with low power-factors. The exponential formulæ for distributed capacity are such monuments of complexity that their use is out of the question, but the following expression will be found sufficiently accurate for all practical purposes.

The watts lost in the line

$$W = 2R\{C^2 + (C \tan \phi - \tfrac{1}{2}C')^2 + \tfrac{1}{12}C'^2\},$$

where R is the resistance of each wire, C is the effective (in step) current, C' is the charging current, ϕ is the angle of lag at the far end of the line.

Here the question arises as to what should be taken as the charging current, or rather what should be taken as the pressure in calculating it; the mean pressure along the line clearly does not meet the case, and the best value to take is the pressure at the far end plus one-third of the drop.

Without capacity the watts lost are higher, the saving due to capacity being

$$2R\{CC' \tan \phi - \tfrac{1}{3}C'^2\}.$$

The saving depends on the ratio of the charging to the effective current, and may be conveniently expressed as a percentage of the power lost, assuming the line to have no capacity.

Calling this ratio x, the percentage saving is $100 \cos^2 \phi$ $(x \tan \phi - \tfrac{1}{3}x^2)$ or, for $\cos \phi = 0{\cdot}7$, $50x\left(1 - \frac{x}{3}\right)$.

These expressions apply equally to three-phase circuits.

In Fig. 8 are curves showing how the percentage saving varies with the ratio x, for power-factors of 0·7, 0·8 and 0·9. The saving due to capacity reaches a maximum for a certain ratio, depending on the power-factor; for $\cos \phi = 0{\cdot}9$, the maximum is reached when the charging current is three-quarters of the effective. With the charging current only one-fifth of the effective current, the saving is not inconsiderable. With a power-factor of 0·7 it is 9·3 per cent., and with one of 0·9 6·8 per cent. Since in power transmission the size of the cable is determined by the loss of power permissible rather than by the drop in pressure, the saving may be considered as a reduction of the capital cost of the cable. A 9·3 per cent. saving due to capacity means that for a given loss the cable may have a sectional area about 9 per cent. less if the capacity be taken into account. The lowest curve in Fig. 9 gives the capacity in microfarads per mile for paper-insulated concentric cables, with different ratios D/d, and the percentage saving on different lengths of cable for the sizes mentioned, and at 2,000, 5,000, 10,000 and 15,000 volts. A frequency of 50 ~, a drop of pressure of 7½ per cent. and a

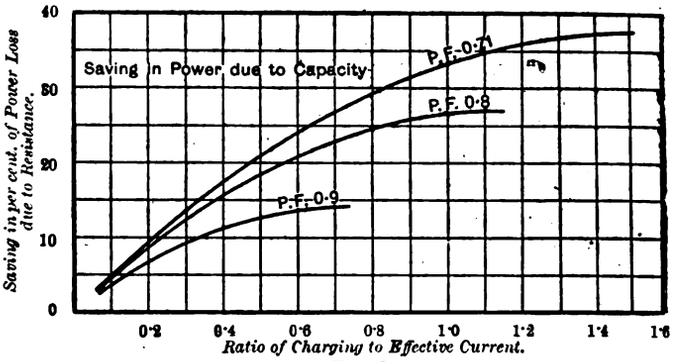
Saving in Power due to Capacity
P.F. 0·71
P.F. 0·8
P.F. 0·9
Saving in per cent. of Power Loss due to Resistance.
Ratio of Charging to Effective Current.

Fig. 8.

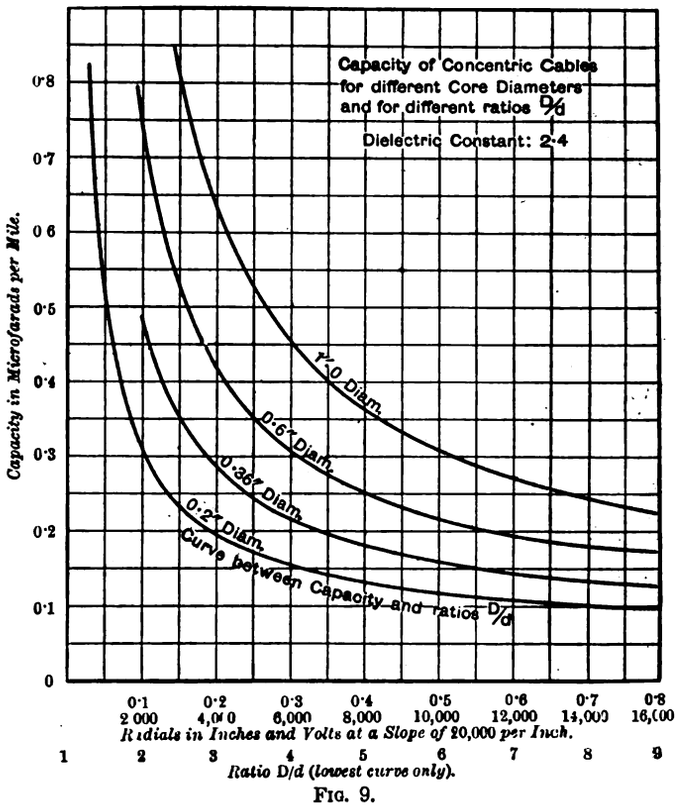
Capacity of Concentric Cables for different Core Diameters and for different ratios D/d
Dielectric Constant: 2·4
1·0 Diam.
0·6" Diam.
0·36" Diam.
0·2" Diam.
Curve between Capacity and ratios D/d
Capacity in Microfarads per Mile.
Radials in Inches and Volts at a Slope of 20,000 per Inch.
Ratio D/d (lowest curve only).

Fig. 9.

power-factor of 0·7 have been assumed. Figures on the curves indicate the number of kilowatts transmitted, and serve to show the practical limits of the curves when these extend into

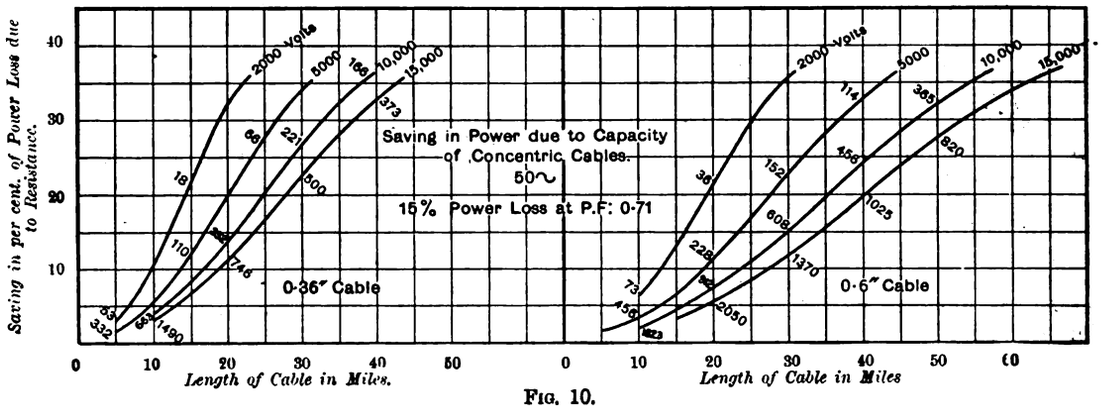

Fig. 10.

shows the capacity for four sizes of cables, with core diameters 0·2in., 0·36in., 0·6in. and 1·0in., the abscissæ representing radial depth of insulation in inches, or volts at a slope of 20,000 per inch, following the Board of Trade rule. From Figs. 8 and 9 the curves in Fig. 10 have been drawn, showing theoretical fields. The curves give minimum values of capacity and saving, as the dielectric constant of 2·4, on which they are based, is a low one for paper insulation.

For a given cable and pressure the effect of capacity increases as the square of the length of the cable, for while

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the charging current increases as the length the effective current diminishes as the length, if the loss of power be kept within practical limits. For long transmissions, such as Mr. O'Gorman contemplated in his Paper, the saving would be very large, and can be large, too, without going to such lengths as 47 miles. A practical example given later will illustrate this.

The charging currents have been calculated on the assumption of true sine curves, which give minimum values; with flatter or more peaky curves the effect of capacity may be considerably more.

A true sine curve also gives a minimum drop of pressure on self-induction, but the variation of drop with the form of curve is negligible.

Cables.—Three-phase.—For three-phase circuits three-core cables are commonly used. Sometimes these have a lead covering over each core, and in this case the capacity can be reckoned in the same way as for overhead lines, the lead covering constituting the surface of zero potential. The charging current per wire is then calculated at a pressure $E/\sqrt{3}$ on the concentric cable constituting each core.

When, as is more usual, the cores have no lead sheath the determination of their charging current is not so easy. Guye, in an article in the *L'Eclairage Electrique* for 1900, works out formulæ giving the effective capacity. He gives this, between one conductor and the neutral—in this case the lead sheath—as $(9K_2 - K_1)/6$, where K_1 is the capacity between the three cores and the lead and K_2 is the capacity between one core and the two others and lead.

K_2 is the capacity measurement usually made on three-core cables, and, according to Guye, is insufficient to determine the effective capacity. However, in the examples given in the article, for two 10,000-volt cables of 0·132 and 0·217 sq. in. sections and a 20,000-volt cable of 0·076 sq. in. section, $K_1 = 1{\cdot}89K_2$, $1{\cdot}99K_2$ and $2{\cdot}15K_2$ respectively, giving a mean value of $K_1 = 2K_2$, and if this ratio could be taken as approximately correct for all cables having similar insulation, the effective capacity could be expressed as $K = 1{\cdot}17K_2$.

This, if true generally, would be useful in giving the effective capacity from the usual capacity measurement between one core and the other two joined to the lead. The usual construction of three-core paper cables is paper-insulated cores, made up with jute worming, and paper-insulated overall, and this is too complex a mixture of dielectrics to admit of the capacity being calculated as it can be for concentric cables. In fact, the capacity can be determined accurately only by a double measurement on Guye's principle, or by measurement of the charging current under three-phase pressure. However, an examination of several three-core cables shows a fairly definite relation between the capacity and dimensions of the cable, taking the minimum insulation thickness between the cores as equivalent to the radial in a concentric cable—that is to say, taking D in the formula for a concentric cable as equal to the core diameter plus twice this thickness. Applying the formula, then, to Guye's two 10,000-volt cables, the capacities come out as 0·221 and 0·262 microfarads per mile, and these values must be increased by 22 and 21 per cent. respectively to give the actual effective capacities. Applying it to a very different cable, the Le Croix 25,000-volt cable of 0·289in. core diameter, the capacity comes out as 0·16 microfarad per mile, while the effective capacity, as measured by the charging current, is 0·202 microfarad, or 26 per cent. higher. These percentages of 22, 21 and 26 are fairly close for so different cables, and it is possible that the formula for concentric cables, increased by, say, 24 per cent., may be applicable in this way to three-core paper cables with sufficient accuracy for practical work. The following two expressions for the effective capacity of three-core paper cables

$$K = 1{\cdot}17K_2$$

and

$$K = \frac{0{\cdot}115}{\log D/d}$$

are put forward tentatively, on incomplete data, as likely to be useful if verified. Assuming the latter formula to be true enables a comparison to be made between the effects of capacity in a single-phase and in a three-phase system transmitting the same power at the same pressure and with the same percentage loss of power. If D and R be the core diameter and radial of the single-phase concentric cable, $d/\sqrt{2}$ or $0{\cdot}71d$ and r will be the core diameter and thickness of insulation between two conductors of the three-core three-phase cable. Considering the three-phase cable as a concentric instead of a three-core cable, D/d, single-phase, is $(d+2r)/d$, and three-phase, $(0{\cdot}71d + 2r)/0{\cdot}71d$ or $(d + 2{\cdot}83r)/d$.

The capacities are respectively proportional to

$$\log \frac{1}{\frac{d+2r}{d}} \quad \text{and} \quad \log \frac{1}{\frac{d+2{\cdot}83r}{d}}.$$

Assuming, as found for the particular cases mentioned, that the effective capacity of a three-phase three-core cable is 24 per cent. more than that of a concentric cable of the same core diameter, the ratio of capacities, three-phase to single-phase, is

$$1{\cdot}24 \times \frac{\log \frac{d+2r}{d}}{\log \frac{d+2{\cdot}83r}{d}}.$$

In practice this is never far from unity. Taking it as unity, the ratio of charging currents is $1/\sqrt{3}$, and the ratio of effective currents is also $1/\sqrt{3}$, so that the ratio of charging to effective currents, and consequently the percentage saving due to capacity, is the same for single and three-phase transmission.

To show what the saving due to capacity may amount to, it may be of interest to quote, by way of example, the St. Croix three-phase power transmission at Wisconsin. This has a line 27½ miles in length, partly overhead line and partly cable, working at 25,000 volts. The line is in duplicate, one being paper and the other rubber-insulated; they are normally worked in parallel.

For purpose of illustration, the cables may be assumed to run the whole distance of 27½ miles. The power transmitted is 3,000kw., giving an effective current per wire of 31·6 amperes. The charging current, from actual measurement on the paper cable, is 29 amperes; that on the rubber cable is rather more than double, say 58 amperes. The ratio of charging to effective current is then 0·837 for the paper cable and 1·674 for the rubber. The saving on the paper cable is, with a power-factor of 0·7, 30·1 per cent., or 100kw.; 0·8, 25·2 per cent.; 0·9, 14·0 per cent.

The rubber cable in each case has capacity sufficient to more than balance the lagging current, and produce a leading current at the generator.

By taking the capacity into account, the section of copper could be reduced by 28·5, 24 and 13·3 per cent. for the three power-factors respectively.

There is a further saving of power, indirectly due to capacity; its presence in the line reduces the lag of current (unless the capacity be very large), so that the power-factor at the near end is higher than that at the far end. The alternator then, working on an improved power-factor, has a higher efficiency, and takes less exciting current.

If ϕ and ϕ' be the lags at the near and far ends of the line respectively, $\tan\phi = \frac{E'}{E}\left(\tan\phi' - \frac{C'}{C}\right)$ is an approximate formula for determining the lag.

Applying this by way of example to the St. Croix transmission, and taking $\cos\phi' = 0{\cdot}7$, $\phi = 8°40'$ and $\cos\phi = 0{\cdot}989$.

The effect of capacity, therefore, is to give the alternator a practically non-inductive load.

As the load diminishes, the ratio of charging to effective current increases, and the percentage saving due to capacity increases to a maximum, then diminishes to zero, and finally turns into a loss when the leading current produces a greater loss than would the lagging current if there were no capacity. However, the actual loss decreases with the square of the current, so that the power saved decreases continuously with the load.

The saving in kilowatt-hours cannot be expressed simply in terms of the load-factor, as it depends on the distribution of the load throughout the day. If the current decrease uniformly from C_1 to C_2 in T hours, the saving in watt-hours is

$$\tfrac{1}{2}RC'(C_1 + C_2 - \tfrac{2}{3}C')T,$$

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where R is the resistance per wire and the power-factor is 0·7. For instance, in the St. Croix transmission, if the load diminished uniformly from full to one-tenth load in the 24 hours, the saving would be 722 units. The saving, however is of no practical importance except at full load.

Mr. Mordey has said that "electrostatic capacity is, on the whole, a serious drawback in alternate-current work, mainly because it is directly and indirectly a cause of waste of power." He then, of course, referred to cables supplying lighting loads with unity power-factor; but as soon as the power-factor falls the opposite is the case, and so great is the saving which can be effected in a supply at low power-factor that, in spite of previous failures, it is not improbable that condensers will eventually come into use in cases where the line capacity is insufficient. An instance where this has already been done is on the Tivoli to Rome 10,000-volt transmission, a condenser made by Prof. Lombardi having been connected across the line.

With a condenser at the far end of the line a greater saving is possible than with distributed capacity, and less capacity is required to give the same saving. At a power-factor of 0·7 the section of copper could be halved by the use of a condenser to produce balance at full load; but then, unless the load-factor were very high, it would have to be cut out below half load. The method of neutralising lagging currents by over-excited synchronous motors is complex in comparison, but is free from the dangers attendant on breaking a circuit having capacity. After all, these may prove so serious as to counterbalance all the virtues of capacity.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Proceedings of the Royal Society." July. No. 463. (London: Harrison & Sons.) 2s. 6d.

"Transactions of the American Electrochemical Society." No. 1. Vol. I. (Philadelphia: The Society.)

"Electric Wiring." By W. C. Clinton. (London: John Murray). 1s. 6d.

ELECTRICITY WORKS ACCOUNTS.

Bristol Municipal Electric Supply Works.

A material improvement in the costs at this station is noticeable in the accounts for the year 1901–2. A general reduction has been effected in the works costs, and they now present very satisfactory figures. From the subsidiary table given below it will be seen that the diminution in the fuel item was possible through the lower price paid for coal, though the price was still high at 13s. 3d. per ton. There was a slight but negligible increase in the consumption of coal per unit sold.

To some extent the economies effected in the works costs were neutralised by the increase in the management charges, and more particularly by special charges amounting to £778 in total, of which expenses of testing, upkeep and insurance of machinery at the Avonbank station were £510, surveyor's fees for new works £100, and some unusual work at the old station £162. The total costs shown are, therefore, very creditable in the circumstances.

We learn from the engineer's report that, though the first instalment of the Avonbank works were opened on February 19th last, these works had not been in regular use during any part of the period covered by our analysis. It is, of course, very necessary in passing judgment on the financial results shown to keep the fact of the existence of these works in mind, otherwise it would appear as if the capital expenditure were high. In relation to the output for the year the mean capital last year was rather high. The total capital expenditure on the new station was £94,964 to March, 1902, and at Temple Back £132,031.

Belfast Municipal Electric Supply Works.

Good cost figures are shown by the Belfast accounts for last year. Especially creditable are the works costs. At 1·26d. per unit they are considerably under what might reasonably have been expected. In consequence of the unusually large item of £320—commission to brokers on stock—the management charges show a rise where they would otherwise have been reduced. The only item not satisfactory is that of repairs at the station. The rise in these expenses is due to repairs involved by storm last winter and by the re-construction of portion of the main boiler flue.

Here again, as at Bristol, the capital is too high in relation to the output, and it is partly to this and partly to the somewhat low total revenue that the financial results are again disappointing. Regarding the capital expenditure, the engineer informs us that he has carried out large extensions of plant and mains, which will not be remunerative for some time to come. Further extensions are in hand for the supply of power to some of the large shipbuilding yards. The motor connection at the end of March was about 900 H.P., and it is expected that this and the output for power will be doubled during the present year. With even the present motor load, it is somewhat surprising that the load-factor remains at so low a value.

REMARKS.

BRISTOL.—*a* Of which 140,882 units (estimated) in 1900-1 and 176,109 units (estimated) in 1901-2 were used by day-load consumers through controlling clocks and unregistered. *b* 225,363 at generating station and 496,758 in external system. *c* There are five 16 c.p., one 25 c.p., and three 75 c.p. glow lamps. *d* £5,000 in "reserve" fund and £200 at credit of suspense account. *e* Lands £19,333. *f* £8,363 on public lamps, meters £9,297. *g* Over-expended. *h* £5 392 for electricity and £1,752 for attendance. *i* Buildings £60, engines, boilers, &c., £737, dynamos, exciters, &c., £98, condensers and other plant £1,011. *j* Of mains £276, apparatus on consumers' premises £32, apparatus at distributing stations £275. *k* Attendance and repairs. *l* Cartons and renewals £606. *m* Engineers' department £1,519, secretary and clerical staff £963, electric inspector £70. *n* Stock management £111, insurance £141. *o* At generating station 210,214, external system 476,439. *p* £4,509 in "reserve" fund, £350 in suspense account. *q* Lands £20,413. *r* Public lamps £8,425, meters £11,123. *s* £5,542 for current. *t* Buildings £117, engines, boilers, &c., £794, dynamos, exciters, &c., £31, condensers and other plant £800. *u* Of mains £268, apparatus on consumers' premises £96, in distributing stations £416. *v* Engineers' department £1,690, secretary and clerical staff £1,088, electric inspector £64. *w* Preliminary expenses at Avonbank £510, stock management £111, law £171, insurance £137.

BELFAST.—*a* Being 382,644 at 6d., 16,635 at 5d., 77 at 4½d. and 352,556 at 2d for lighting; 4,000 at 4d., 53,769 at 3d., 22,518 at 2½d., and 65,627 at 1½d. for motors; also 330 at 6J. for batteries. *b* 29 standards of 2 (16 c.p.) lamps each. *c* 525 H.P. in motors. *d* No land. *e* Assistant engineer £219, engine men £360. *f* Of mains £47, on consumers' premises £43. *g* Engineers' department. *h* Insurance £164, meter inspection £86. *i* Maximum demand system. *j* 433,731 at 6d., 21,646 at 5d., 733 at 4½d., and 456,186 at 2d. for lighting; 105,772 at 3d., 28,463 at 2½d., 41,218 at 1½d. and 106,362 at 1d. for motors. *k* Includes £2,000 depreciation fund. *l* Accumulators £2,874, meters £6,472. *m* Accumulators £2,859, meters £7,468. *n* Assistant engineer £243, engine men £998. *o* Buildings £273, engines and boilers £278, boiler seatings and flue £509, dynamos £37, accumulators £96. *p* Of mains £39, on consumers' premises £125. *q* Commission to brokers on stock £320, insurance £251, stamp duty on stock £50. *r* After deducting £502 income tax received. *s* 900 H.P. in motors.

Year ended	No. of public lamps. Arc.	Glow.	Equiv. 30 watt.	Motors. Agg. H.P.	Equiv. 30-watt lamps.	Total 30-watt lamp conect'ns (equiv.)	No. of con-sum'rs	Plant capa-city. Kw.	Max. load. Kw.	Load factor per cent.	Units sold to private con-sumers.	Units sold for public lighting.	Total costs per total units sold.	Total rev. per unit sold.	Per cent. ratio total costs to rev.	Fuel cost per unit sold.	Fuel con-sumed per unit sold. lb	Price of coal per ton.
Dec., 1893	90	...	1,500	...	...	9,403	120	700	226	8·5	53,829	10,019	9·97d.	6·02d.	166	1·82d.	..	...
,, 1894	97	...	1,616	...	...	16,146	240	930	322	10·4	143,106	150,417	5·04d.	5·41d.	93·1	1·30d.	...	...
,, 1895	99	...	1,650	3·33	83	25,696	439	1,014	515	9·1	251,708	156,593	3·51d.	5·87d.	59·8	0·97d.	18·75	...
,, 1896	105	...	1,750	3·33	83	33,049	593	1,216	766	9·7	483,527	167,231	2·75d.	5·55d.	49·5	0·76d.	16·60	...
March 25, 1897.*	105	...	1,750	3·33	83	40,586	617	...	656	17·8	188,357	47,607	...	...	...	0·64d.	4·55	...
,, 1898	105	3	1,778	19·53	486	51,493	749	1,972	1,010	10·3	743,163	167,725	2·50d.	5·42d.	46·1	0·88d.	16·50	...
,, 1899	304	3	5,094	60·53	1,504	73,630	967	2,589	1,707	9·1	1,033,324	329,462	2·37d.	4·60d.	51·6	0·86d.	14·25	8/6½
,, 1900	308	3	5,161	111·5	2,770	91,117	1,215	3,154	1,676	12·4	1,330,670	481,841	2·38d.	4·20d.	56·6	0·83d.	12·37	12/5
,, 1901	310	9	5,241	377·5	9,389	119,615	1,507	3,102	2,099	11·9	1,716,212	475,347	2·80d.	4·07d.	68·7	1·25d.	12·57	18/7
,, 1902	310	9	5,241	785·0	19,520	149,146	1,790	4,922	2,535	12·4	2,275,848	480,776	2·33d.	3·91d.	59·8	0·91d.	12·88	13/3

* Three months.

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	BRISTOL.		BELFAST.	
Undertaking Worked by	Bristol Corporation.		Belfast Corporation.	
Date of Commencement of Supply	August, 1893.	[distribution.	Jan., 1895 (steam station started July, 1898).	
System of Supply	Alt.-current trans. sub-stations with 3-wire		3-wire continuous-current.	
Chief Engineer	H. Faraday Proctor.		Victor A. H. McCowen.	
YEAR ENDED	MAR. 25, **1901.**	MAR. 25, **1902.**	MAR. 31, **1901.**	MAR. 31, **1902.**
QUANTITIES—				
Units generated	2,913,680	3,443,270	1,091,895	1,426,622
„ **SOLD (TOTAL)**	**2,191,559**	**2,756,624**	**908,067**	**1,206,699**
„ sold to consumers	1,716,212[a]	2,275,848[a]	897,856[a]	1,194,101[j]
„ sold for public lighting, &c.	475,347	480,776	10,211	12,598
„ sold for traction	nil	nil	nil	—
„ used on works	722,121[b]	686,646[c]	51,195	60,393
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**22·4**	**22·0**	**12·7**	**14·0**
Actual maximum supply demanded	2,099 kilowatts	2,535 kilowatts	1,308 kilowatts	1,485 kilowatts
Load factor	11·9%	12·4%	7·93%	9·28%
Number of public lamps	310 arc, 9 incan.[e]	310 arc, 9 incan.[e]	58 glow[b]	30 32 c.p. standards
Number of consumers	1,507	1,790	660	803
Connections to mains in 8-c.p. lamps at end of year	119,615	149,146	80,000[c]	98,000
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	3,102	4,922	2,500	3,000
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£408,165 / £132	£419,761 / £85·2	£190,000 / £76·0	£280,822 / £93·6
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	408,165 / 132	419,761 / 85·2	190,000 / 76·0	280,822 / 93·6
RECEIVED (TOTAL)	283,015 / 91·2	418,757 / 85·1	175,493 / 70·2	218,476[k] / 72·8
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	283,015 / 91·2	418,757 / 85·1	172,360 / 68·9	212,500 / 70·8
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	125,150 / 40·3	1,004 / 0·204	17,640 / 7·06	— / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	125,150 / 40·3	1,004 / 0·204	17,640 / 7·06	68,322 / 22·8
REPAID (TOTAL)	36,922 / 11·9	45,133 / 9·17	4,116 / 1·65	250 / 0·083
RESERVE OR SINKING FUND	5,200[d] / 1·68	4,859[p] / 0·987		7,782 / 2·59
DEPRECIATION FUND	1,390 / 0·448	1,237 / 0·251	— / —	3,132 / 1·04
EXPENDED (TOTAL)	299,260 / 96·4	384,777 / 78·2	173,889 / 69·6	202,357 / 67·4
Lands and buildings	78,122[e] / 25·2	111,295[q] / 22·6	35,713[d] / 14·3	36,610[d] / 12·2
Plant	105,415[f] / 34·0	147,685[r] / 30·0	68,979[l] / 27·6	86,069[m] / 28·7
Mains	105,663 / 34·0	115,450 / 23·5	66,367 / 26·5	76,747 / 25·6
Miscellaneous	10,060 / 3·24	10,347 / 2·10	2,831 / 1·13	2,931 / 0·977
BALANCE OF CAPITAL ACCOUNT	−16,245[g] / −5·23	+33,980 / +6·91	+1,604 / 0·642	+16,119 / +5·38
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£37,217 / 4·075d.	£44,856 / 3·908d.	£14,898 / 3·939d.	£18,023 / 3·584d.
Revenue from supply	28,522 / 3·123d.	35,826 / 3·120d.	14,226 / 3·760d.	17,385 / 3·457d.
„ meters, &c.	1,383 / 0·151d.	1,644 / 0·143d.	640 / 0·170d.	475 / 0·095d.
„ public lighting	7,144[p] / 0·783d.	7,164[s] / 0·624d.	— / —	— / —
„ supply for traction	nil / —	nil / —	nil / —	nil / —
„ miscellaneous sources	168 / 0·018d.	222 / 0·019d.	30 / 0·008d.	163 / 0·032d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£25,535 / 2·796d.	£26,822 / 2·334d.	£7,133 / 1·885d.	£9,290 / 1·850d.
TOTAL WORKS COSTS	19,929 / 2·183d.	19,433 / 1·692d.	5,093 / 1·345d.	6,379 / 1·268d.
Generation of electricity	*16,887* / *1·850d.*	*16,181* / *1·409d.*	*4,736* / *1·251d.*	*5,841* / *1·161d.*
Fuel (including cartage, &c.)	11,437 / 1·253d.	10,476 / 0·912d.	2,857 / 0·756d.	3,055 / 0·608d.
Oil, waste, water, stores	726 / 0·079d.	714 / 0·062d.	267 / 0·071d.	320 / 0·064d.
Wages at station	2,793 / 0·306d.	3,200 / 0·279d.	1,079[e] / 0·285d.	1,241[n] / 0·247d.
Repairs and maintenance at station	1,931[i] / 0·211d.	1,790[t] / 0·156d.	534 / 0·141d.	1,224[o] / 0·243d.
Distribution of electricity	*1,290* / *0·141d.*	*1,630* / *0·142d.*	*331* / *0·087d.*	*499* / *0·099d.*
Wages, &c.	664 / 0·073d.	820[u] / 0·071d.	241 / 0·064d.	345 / 0·069d.
Repairs, renewals of mains, &c.	626[j] / 0·069d.	810 / 0·071d.	90[f] / 0·024d.	154[p] / 0·031d.
Public lighting	*1,752* / *0·192d.*	*1,622* / *0·141d.*	*26* / *0·007d.*	*39* / *0·008d.*
Attendance	1,108[k] / 0·121d.	1,076 / 0·094d.	22 / 0·006d.	22 / 0·004d.
Renewals	645[l] / 0·071d.	500 / 0·044d.	4 / 0·001d.	18 / 0·004d.
MANAGEMENT AND PROPERTY CHARGES	5,606 / 0·614d.	7,389 / 0·643d.	2,039 / 0·539d.	2,911 / 0·579d.
Net rents	*463* / *0·051d.*	*430* / *0·037d.*	*140* / *0·037d.*	*111* / *0·022d.*
Rates and taxes	*1,570* / *0·172d.*	*1,782* / *0·155d.*	*588* / *0·155d.*	*826* / *0·164d.*
Management	*3,573* / *0·391d.*	*5,177* / *0·451d.*	*1,311* / *0·346d.*	*1,974* / *0·392d.*
Salaries	2,542[m] / 0·278d.	2,839[v] / 0·247d.	590[g] / 0·156d.	804[g] / 0·160d.
Stationery, &c.	242 / 0·027d.	466 / 0·041d.	126 / 0·033d.	148 / 0·029d.
Establishment charges	421 / 0·046d.	538 / 0·047d.	266 / 0·070d.	342 / 0·068d.
Law charges &c.	368[n] / 0·040d.	1,334[w] / 0·116d.	329[h] / 0·087d.	680[q] / 0·135d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£11,682 / 4·24%	£18,034 / 5·27%	£7,765 / 4·97%	£8,734 / 4·64%
Sum carried to Depreciation Fund	— / —	— / —	3,132 / 2·01%	— / —
Sum carried to Reserve Fund	6,812 / 2·47%	7,593 / 2·22%	2,232 / 1·43%	3,666 / 1·95%
Net interest on loans (incl. Debenture charges)	7,337 / 2·66%	10,946 / 3·20%	5,057 / 3·24%	5,917 / 3·14%
Net profit for the year	— / —	−505 / −0·148%	−2,655 / −1·70%	— / —
BALANCE FROM LAST ACCOUNT	3,062 / 1·11%	505 / 0·148%	2,655 / 1·70%	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	505 / 0·183%	nil / —	nil / —	— / —
Deficit	— / —	nil / —	— / —	*347*[r] / *0·184%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	68·7%	59·8%	47·9%	51·5%
Expenditure per mean kilowatt capacity	£8. 3s. 2d.	£6. 13s. 9d.	£3. 2s. 2d.	£3. 7s. 6d.
REVENUE PER MEAN KILOWATT CAPACITY	**£11. 18s. 0d.**	**£11. 3s. 7d.**	**£6. 10s. 2d.**	**£6. 11s. 1d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	7s. 1d.	6s. 8d.	4s. 6d.	4s. 1d.
Price charged for lighting, per unit	5d. (max.), 2·33d. (min.)	5d. (max.), 2·33d. (min.)	6d. (1 hr.) to 2d.[i]	6d. (1 hr.) to 2d.
Price charged for power, per unit	1·5d. (max.), 1·2d. (min.)	1·5d. (max.), 1·2d. (min.)	3d. (1 hr.) to 1d.[t]	3d. (1 hr.) to 1d.
Price charged for public lighting	£23 arc, £1. 6s. 5d. 8 c.p.	—	47s. 6d. per standard of 2	47s. 6d. per 32 c.p. stan-
Receipts per unit for private supply	3·99d. [glow	3·78d.	} 3·76d. [(16 c.p.), low	[dard
„ „ public lighting	2·72d.	2·77d.		3·46d.
„ „ traction	—	—	—	—

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SUBURBAN TRAFFIC.*

During the inquiry recently carried out by the Institution of Electrical Engineers, with which we have dealt pretty fully, much importance was attached to the value of electrical tramways as a means of relieving the congestion of cities and towns. London, for example, could not exist as it is now without railways to feed it and carry its population from place to place. It is argued, and argued with a force which we are not slow to admit, that if rapid and cheap means of transit were available people would live in the country and come to their work each morning and leave it in the evening. Metropolitan crowding is largely due now to the necessity for having a domicile somewhere near the place where wages are earned or money is made. But there is another side to the question, about which nothing is said. The provision of cheap and rapid transport tends to promote the very crowding which it is intended to prevent. It is beyond dispute that London, for example, is more crowded now than it ever was before, notwithstanding the enormous number of people who live in the suburbs, and we do not see how it can be otherwise. The railways, tramways and omnibuses all serve the same purpose of concentrating life, at all events during the day-time, while they directly promote the birth of streets which finally assume the importance of towns in themselves. If it so happened that we had reached the absolute limit, that nothing more could be done to get people and goods into London, then it could not increase in size. There would be nothing for it but to start another town, and go on adding to that until the limit was once more reached. Fortunately, or unfortunately, however, we are apparently very far indeed from the limit, and no man can fortell the end. On days when great crowds are likely to assemble in the City, the Central London Railway will not carry passengers to the Bank. The reason is simply that the passengers cannot get out of the station. It is quite conceivable to anyone who watches London Bridge or the approach to Liverpool-street Station in the morning that the time may yet come when the crowding will be so great that the trains cannot deliver their passengers. It is quite true that the possession of facilities for movement may tend to make people live in the country, but, just as it was once said that all roads lead to Rome, so the fact that in the end all the railways and tramways existing or proposed have for their principal object the taking of men, women and children away from the country as well as into it, deserves consideration. Nothing, it is true, can be done; but it is just as well to bear in mind that the promises held forth in committee rooms, and the arguments held by certain members of the London County Council, must be taken with much salt. We hear a great deal about the work that is being done to get thousands of persons into the country, but it is quite forgotten that these thousands have to be carried into London before they can be carried out of it. In one word, the more facilities we provide for transit the larger will our cities become, and the more intense will be the congestion, in particular in the metropolitan district.

The effect of public opinion on the nature of the means of transit used, on which we have recently commented, is clearly shown by the proposals which alone find favour in London. The tramway, whether electrical or not, has its limit of action very rigidly defined. Under no circumstances will the overhead railway, which finds favour with many cities of the United States, be tolerated. For the time being attention is concentrated on tube railways. There are, however, indications that another means of transit may find favour, and that at no distant date. We may yet have a really efficient system of public motor cars taking the place of the ordinary omnibus, and doing far better work at a cheaper rate. Nothing, we think, has retarded the development of speculation in this direction but the insensate action of motor-car owners, who, as a class, have done all that lies in their power to make the motor car unpopular with the general public. It is impossible to read the account which we publish of the Paris-Vienna motor-car race without seeing that it is quite possible now to make motor omnibuses which will not break down or wear out in a hurry. If only the necessity for india-rubber in the tires could be got over, a heavy source of expense would be eliminated. There is, we believe, a great future for the motor vehicle, if only the problem of its construction is handled by competent engineers. It is not necessary to say one syllable as to the advantage possessed by such carriages over the horse-drawn vehicle. Speeds of 10 and 12 miles an hour are allowed now to the electric tramcar. There is no earthly reason why they should not equally be allowed to the motor omnibus; but care must be taken that it is fit to run at that speed.

Another scheme worth consideration is the constructing of public lines of wire along the roads, supplied with current, which may be used with the aid of a suitable trolley pole by anyone who thinks fit to obtain the required licence, and pay the cost of current, &c. No tramway would be needed. We have no doubt that in numerous districts this method of traction could be made a success. But it is clear that it has very short limitations.

Enormous sums will be spent on tube railways with electrical propulsion, but it is just as well to bear in mind that the system is in no sense perfect; indeed, it has serious drawbacks. The electric lifts, for example, are a source of constant expense, and demand a surprisingly large expenditure of power to work them. Ventilation is by no means as good as it was hoped it would be, and there are those who prefer even now the atmosphere of the District Railway to that of "the Twopenny Tube"; but the worst defect of all, and one apparently inseparable from the system, is that a breakdown stops the entire traffic of the line. It is the old story, on which we have often insisted, want of flexibility. However, even these objections may be overcome in time. But, taking all the conditions into consideration, we think it is simply impossible to forecast what, at the end of 10 years, will be the favourite method of carrying suburban traffic.

* From the *Engineer*.

THE RATING OF MOTORS AND GENERATORS.*

BY DR. M. G. RASCH.

A report on the following question: What basis should one adopt in estimating the power of motors and generators, taking into account the different elements which may enter into this calculation, such as output, speed, torque, heating, &c.?

According to the reporter the sense of the question is as follows:—In the case of a contract for the construction or the enlargement of an electric plant, what are the conditions which should be required in the specification for the sound construction of the electric machines and what are the means on the completion of the work which should be used in order to ascertain that these conditions have been really fulfilled? In every electrical undertaking the engineer entrusted with the preparation of the plan, should not overlook the fact that he must endeavour to produce a scheme as perfect as possible from a technical point, and at the same time as economical as possible. The conditions which it is necessary to fulfil, in order to provide for these two factors are, unfortunately, very often contradictory. The concessions which must be made from one of them to satisfy the exigencies of the other, and reciprocally, should be examined carefully; any doubt, the technical perfection which each case demands, must be, above all, provided for. The conditions laid down in the specification may be of two descriptions: (1) Conditions of which the fulfilment can be ascertained by trials—that is, in an objective manner; (2) conditions for which this manner of proceeding is not possible, and which the engineer charged with the acceptance of the work can only judge by relying on his technical sense and on the confidence more or less great with which the manufacturer inspires him; in other words, it is only in a subjective manner that he can convince himself that these last conditions fulfil the requirements of the specifications.

It is evidently important, even in the interest of the manufacturer, that on the reception of the goods the different qualities required on delivery, which can be ascertained by tests, should be tested. In this case it will be necessary to define, in a precise manner, certain of these qualities, and to specify according to circumstances the methods of trial which will be used on reception, the results of trials being liable to vary according to the different methods by which they are obtained. It is taking this into consideration that the German Association of Electrical Engineers has been led to establish regulations for the trials of generators and electric motors,† regulations to which we shall refer several times in the course of this monograph.

Passing to the examination of the different communications received in reply to the question, we will first refer to those qualities which cannot be ascertained by means of trials, or, at least, only imperfectly by them. From this standpoint the replies do not convey anything very new. It is beyond doubt that perfect security of the service, accessibility to the different working parts, and small bulk, form essential conditions for a good traction motor. It is only, however, in specifying more explicitly these requirements, that they become important in a specification. It is evident that plans well studied and carefully examined before the definite order is given, will be of the greatest use; nevertheless, they are not sufficient. Certain of the requirements mentioned above have already been more or less explicitly specified by some companies. Thus, one company, for example, insists on the necessity of the motor case having the quality of being completely proof against the penetration of water and oil from the bearings; while another insists that the armature shall be provided with protection against dust and with a good system of lubrication. The armature must be quickly and easily removable in order to allow of a handy removal of the burnt-out coils; on this account one of the companies is right in recommending the use of Eickemeyer wound up coils, which permit of rapid replacement. Many companies insist on having easy access

* Paper read before the International Tramways Union, at Islington, June 30th.

† *Elektrotechnische Zeitschrift*, 1901, pp. 708, *et seq.*

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to the commutator and brushes and require that these parts shall run without sparking. Although this condition is vital, it will be very difficult in a contested case to decide if the production of sparks can be overlooked or if it is too strong. It will be admitted that all the conditions enumerated above are justifiable, but nevertheless differences of opinion will easily arise concerning the fulfilment of these conditions, as they can only be recognised in an objective manner. On the other hand, generators and motors possess certain properties which can be ascertained by trials, from the moment that these properties have been well defined and the methods of investigating them sufficiently established. It is the investigation into these properties that the German Association of Electrical Engineers has regulated, and the reporter agreeing on this point with the Brussels Tramway Co. warmly counsels the adoption of these regulations to the members of the International Permanent Tramway Union.

We will commence by stating what is to be understood by the *power* of a motor. It is said in many replies, and rightly, that the indication alone of power is not sufficient because it does not allow of the determination of the torque of the motor. Even putting aside this inconvenience, the simple indication of power is insufficient as long as the definition of that property is not given in a more specific manner; a distinction must, in fact, be made between the power received by the motor and that given out by it. I do not share the opinion of some of the companies, which require that the power of a motor should be exclusively expressed in watts, and I would rather see the German terminology adopted, according to which mechanical power should always be given in horse-power and electric power in watts. It follows that a motor of 25 H P. is always a motor which gives out, and not one that receives, 25 H P. Although this terminology prevents mistakes to a certain extent, whether intentional or not, between the power received and the power given out, it is not alone sufficient. Two motors of different sizes may both be of 25 H P., the temperature of one remaining very low during the run, while that of the other rises above the limits admissible. Paragraphs 18 and 19 of the regulations already cited—paragraphs of which we shall speak again in the following pages—define what is to be understood by the admissible limits of heating. We shall content ourselves for the moment by remarking that the German regulations distinguish the three kinds of service as follows:—Intermittent service, momentary service, continuous service. In giving the power of a motor there should always be added to it the indication of the kind of service required from it, and when dealing with a momentary or intermittent service there should also be given the number of hours corresponding to the length of the service. It is, in fact, evident that the same machine may for each of the three categories of service yield quite different powers. This is why the indication of a motor without the explicit designation of the nature of the service to which it will be subjected remains valueless.

The German regulations determine as the normal power of a traction motor that which in the test room can be yielded during one hour without causing the temperature to rise above the admissible limits. In connection with this, we may remark that for these tests, covers, lids, &c., usual in service, must not be removed, opened or modified in any essential manner. Likewise, it is not permissible in the trials of traction motors, to replace artificially the current of air created by the displacement of the car. If it was permitted to make use of this, a trial at full load during the duration of one hour would evidently be too short for traction motors. Nevertheless, the reporter is of the opinion that, even under the conditions of trial given above, a trial of one hour is insufficient. It must not be forgotten, in fact, that a traction motor, even though only loaded on an average below the normal, has to stand a daily run of 14 or 16 hours. One of the companies which replied to the question, appears also to share the opinion of the reporter, for it requires for the traction motors a continuous trial instead of that already mentioned of one hour. It must, nevertheless, be remarked here that, according to § 1 of the regulations, the indications there mentioned are valuable only when they are not modified by special conditions laid down in the contract. It follows, then, that the length of the trial may be determined in another manner. It would be advisable from this point of view to take into consideration the special conditions of the car service for which the motor is destined. It is in this connection that M. Maximilian Müller has examined the question in the *German Electrical Review* for the year 1901, pages 73 *et seq.* This article develops very interesting considerations on the subject of the duration of trials which are to be advised for traction motors. We have attempted to condense the results of this study into the following formula:—

$$x = \frac{tT_1}{t + 28(T - T_1)},$$

a formula in which x stands for the required duration of the trial, T the time during which the car is out of the depôt, T_1 the time during which the motor is working; $T - T_1$ stands, consequently, for the time during which the motor is not subjected to the electric current, t stands for the heating of the motor—that is to say, the excess of its temperature over that of the atmosphere. The foregoing formula admits of a cooling of 28°C. an hour, consequent on the rests of the motor. We shall apply this formula to an example: the motor works during 7·3 hours. Admitting an elevation of the temperature to 70°C. we shall obtain:—

$$x = \frac{70 \times 7{\cdot}3}{70 + 26(14 - 7{\cdot}3)} = 2,$$

or a duration of two hours during which it will be useful to try the motor under its full load. But even while accepting a trial of the duration of an hour, the German regulations preserve the advantage of determining in a precise manner that which should be meant by the normal power of a motor. Without this exact definition of the words *normal power*, no clear signification could be given to the word *overload*, while with this definition overloads of 15, 20, 40 per cent., &c., make themselves understood. Concerning overload trials the German regulations prescribe that the admissible limits of temperature cannot, equally, be passed; it follows, then, that overloads can only be allowed during relatively short periods. Without taking traction motors into special consideration, the German regulations prescribe in a general way an overload of 25 per cent. during half-an-hour for generators, motors, rotary converters and transformers.

Tramway engineers are, in general, of the opinion that an overload of 40 per cent. during three minutes should be regarded as insufficient. It is, nevertheless, sufficient to satisfy the German regulations if care is taken to rate the motor at a sufficiently high normal load. The trial of one hour at the normal load of which we have spoken above, allows of the formation of a more accurate idea of the qualities of the motor when working, the trial load being greater in reality than the working load. The communications made in reply to the question show, as was to be expected, that the different companies possess quite different opinions as to what concerns the proper ratio between the overload permissible and the ordinary load; their opinions are equally at variance in that which concerns the duration of overloads.

These two factors depend, in effect, on local circumstances and are, consequently, liable to differ. One company suggests, for example, an overload of 100 per cent. during some seconds; another one goes as far as even to require this overload for a period of five minutes, but what increases the severity of the conditions laid down by this last company is that it requires that in such a case the limit of the admissible heating shall be diminished by 20°C., a diminution which, in our opinion, is not justified. There can only be one limit admissible of heating which, once passed, would become dangerous. It is of no consequence that this permissible limit of heating be over-reached when working under even loads, or under momentary overloads, the damage resulting from it will be the same in both cases.

Concerning the rise in temperature which may be considered as permissible, the German regulations say:—"As a general rule, and as the temperature of the atmosphere does not exceed 33°C., the admissible limits for the rise in temperature will be as follows:—For cotton insulations, 50°C.; for paper insulations, 60°C; for insulations in mica, amiante or other similar preparations, 80°C.; for stationary coils—as, for example, the magnet coils—the admissible limits of temperature may be allowed an increase of 10°C. The regulations add that for traction motors the foregoing limits may be 20°C. higher if the trial is made in a test room. This greater latitude in favour of traction motors has, without doubt, been made to allow for the better ventilation in ordinary working on a car than in the test room. It seems at first irrational to allow of a greater limit of heating for stationary windings than for rotary windings, the more so as the ventilation of the latter is superior to that of the former. This raising of the limit is nevertheless only apparent, for, according to the German regulations, the elevation of the temperature for stationary windings will be determined by the augmentation of the electrical resistance, while for the movable parts of the machine the elevation of the temperature is registered by the use of the thermometer.

It is a singular thing that in none of the communications which have been received in reply to the question is mention made of that difference in the methods of trial which we have indicated; we may, then, consider that the different companies agree on this point with the German regulations.

A body submitted to the action of a current—as, for example, an induction coil—is not heated in a uniform manner, and, consequently, does not possess a unique temperature; the temperature on the outside is less than that in the interior. The lowest of these temperatures (that, consequently, which is produced on the outside) can be determined by the thermometer; on the contrary, an average temperature can be obtained by calculations made on the principle of the augmentation of the electrical resistance. These two methods of measuring are liable to give results differing as much as 60°C. The limit of heating of 60°C., which would be applicable, according to what has been said, to fixed windings with cotton insulation, for example, has probably been determined according to the investigations made by M. Dettmar, and published in the *Elektrotechnische Zeitschrift* for the year 1900, pp. 727 *et seq.* This author has made experiments on the value of the insulations for conductors, and he has arrived at the following results for conductors covered with cotton:—A temperature of 95°C. may be considered as perfectly admissible for

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stationary windings; on the contrary, for the rotating coils this temperature of 95°C. should be regarded as an extreme one, and is not to be allowed in a well-adjusted machine. Besides, as an atmospheric temperature of 35°C. is in no way extraordinary, it results in the case of a cotton insulation that a limit of 60°C. overheating is permissible.

Amongst the replies which were made to the question of 1900, the opinion is found that motors should be able to support with security temperatures from 75°C. to 80°C.; it would seem unreasonable from this to desire to fix the temperature limit to 50°C. or 55°C. This opinion does not appear to me to be held in contradiction to the opinion generally held. It arises simply from a confusion on the part of the company in question. In reality, when limits of 50°C. to 55°C. are spoken of, there must not be understood by that the temperature of the motor itself, but rather the excess of the temperature of the motor over the temperature of the atmosphere; these limits are, then, the limits of overheating and not limits of temperature.

In the same reply this company seems to suggest that the limits of overheating should be extended as high as possible, so as to cause, by doing so, a reduction of the dimensions of the motor, and, consequently, of its cost. We must contest this opinion. The useful power which a motor will have to develop and the number of turns per minute at which it will have to run are not sufficient in themselves to determine its dimensions; these last can be, at will, large or small. In the first case, a more costly motor would result, but one, the temperature of which would always lie low; in trying, on the contrary, to reduce the dimensions of the motor, a less costly one would be obtained, but the motor, per contra, will overheat itself much more. This greater elevation of the temperature would be occasioned not only in consequence of the greater electric and magnetic strains which the motor will have to develop proportionately, but also because, on account of the same lesser dimensions, the motor will offer a lesser surface for cooling. If the greater elevation of the temperature was the only inconvenience which would result from the smaller dimensions of the motor, allowance would naturally be made for these limits being as high as possible. But a production of heat shows at the same time a loss of energy; it results from this, that the normal power of the motor having to remain the same, the rate of efficiency of these motors will decrease. Admitting, for example, that the weight of the motors of a car represents 20 per cent. of the dead weight of the car, a reduction of 25 per cent. in the weight of the motors would not bring with it any advantage if a reduction of 5 per cent. or more in the efficiency were to be caused by it. It has been replied from many different sources, and we agree with this opinion, that a high efficiency should not be the quality to insist upon in the first place from a good motor, and that this question of efficiency should withdraw before other more important considerations; on the other hand, if a lowering of the rate of efficiency brought no other advantages with it, it would evidently be necessary to weigh the importance of the two factors: efficiency and weight of motor above all, if there was a necessity of paying for electric energy at a high price. It will be seen, then, that it is not always rational to admit the very highest limits of elevation of temperature.

As to the question of the specification of motors, it has already been the object at the Congress of Paris of an important and most remarkable report made by M. Macloskie. In the report of M. Macloskie, as well as in the replies of the different companies to the question already put, and in the investigations which have been quoted by M. Müller, this point is insisted on, and with reason, that the determination in horse-power or in kilowatts of the power of a motor is incomplete, even in the case where the admissible limits of the elevation of the temperature would be specified. In addition to the normal power of the motor, the purchaser has equal interest in being informed of the torque of the motor and its speed. Many companies require that the motor should not only be specified by its torque, but also by its traction power at the periphery of the motor wheel; while as to the speed, they require that the designation of the number of revolutions should be replaced by that of the speed of the car. The aim for which the different characteristic sizes of a motor should be stated ought first to be settled. If it was a special case, for example, as a tender for motor cars, it is natural that it would be sufficient to know the traction force at the periphery of the motor wheels and the speed of the car. But if it was desired to know the general characteristics of different motors without paying attention to particular working or local circumstances, it would be necessary to base one's choice on the particular characteristics of the motor itself and not on the characteristics which, from their nature, depend on the dimensions of the gear and the diameter of the motor wheel. The tractive effort at the periphery of the motor wheel is obtained when the four following particulars are known:—(1) The torque of the motor; (2) the gearing efficiency; (3) the ratio of gearing; (4) the diameter of the motor wheel. Of the four foregoing particulars, it is only the first which is special to the motor. When a change is brought about in one of the three others, the force of traction at the periphery of the motor wheel will accordingly vary even if the torque of the motor remains the same. It will be similar when referring to the speed of the car. This depends not only on the speed of the motor, but also on the gearing and the diameter of the motor wheel. We are of the opinion that it would be convenient to characterise a motor by the two following factors: M = torque in kilogrammes and N = turns per minute of the axle of the motor. Those two factors are related in the following manner to the power, W, of the motor given in watts:

$$W = \frac{2\pi 9{\cdot}81}{60} MN = 1{\cdot}028MN.$$

We must, nevertheless, remark that in this formula the power does not represent the total energy (volt ampere) delivered to the motor, but only the electrical energy received exclusive of electric losses, or then 92 to 97 per cent. of the total electric energy delivered. Admitting, then, an average efficiency of 95 per cent., the above formula could be reduced as follows:

$$W = \frac{w}{0\,95} = 1.08MN.$$

This formula gives, consequently, the energy really received to within 5 per cent., which is sufficiently accurate. In adding, for example, 28/550 in determining a motor, it would be necessary to understand by that, a motor which under a normal load produces a torque of 20 kilogrammeters and attains a speed of 550 revs. per min. The energy received by the motor would be then: $1{\cdot}08 \times 20 \times 550 = 11\,900$ watts, which at a pressure of 600 volts, will represent a current of 20 amperes. It is further to be remarked that in the preceding formula the torque represents not the *useful torque*, but rather a torque somewhat higher than that. The torque indicated above would be sufficient, nevertheless, to rate the motor, and if guarantees can be asked from the contractor, nothing prevents these referring to efficiency. M. Macloskie was right in saying in the report which he presented to the Paris Congress in 1900, that motors cannot be rated by the two factors, tractive effort and strength of current; nevertheless, we doubt if it useful to recommend the general use of the two constants, A and B. The manufacturer must, indeed, begin by calculating these two factors by test trials of the motor; afterwards the buyer must calculate anew that what he wants to know by means of the factors A and B. The procedure would in such a case be the same as in one of a communication made by some one to another person in a strange language, which should be translated on the fresh by the second person into his mother tongue.

We prefer to make the following suggestion: the determination of the expression *normal power* shall remain fixed by the rules of the German Association of Electrical Engineers. These comprehend without ambiguity what it is necessary to understand by half load, and by overload of 50 per cent. The manufacturer would have to fill in the following table:—

—	Half load.	Normal load.	Overload of 50%.
Power of the current in amp.			
Torque in kilogrammetres ...			
Number of revs. per min. ...			
Efficiency			

Concerning efficiency, it will be necessary to specify in every case if the efficiency of the motor alone is required or that of the whole car. This latter information will naturally be asked for when the motors and car trucks are ordered from the same factory. It hardly appears necessary to us to specify the special basis to adopt for the rating of generators. We strongly recommend adhesion to the principles laid down by the German Association for Electrical Engineers.

THE ELECTROLYSIS OF GAS MAINS.*

BY JAMES SWINBURNE, M INST. C.E.

About ten years ago there was a good deal of friendly friction between the National Telephone Co. and the electrical traction industry. Electrical traction was just beginning to develop in this country at that date, and electrical engineers were promoting electric tramway bills in Parliament. The telephone people complained that the leakage, or stray currents, from the tramways disturbed their telephone systems, and they asked for protective clauses. In some cases such clauses were inserted, and in others the telephone people failed. In one case the Committee, in their anxiety to be quite fair, ruled not only that the tramway must not disturb the telephones, but the telephones should not disturb the tramways. The whole question became very acute when the National Telephone Co. sued Graff Baker and the Leeds Tramway Co. for disturbing their circuits in Leeds. This action was heard by Mr. Justice Kekewich, who decided that the Telephone Company could get no damages because the tramway people worked under an Act of

* Lecture before the Incorporated Gas Institute.

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Parliament, and were not negligent, but were doing the best they could in reason. A Joint Committee of both Houses of Parliament was soon appointed to go into the whole question. This Committee discussed the telephone question very fully, and finally decided broadly that, as the telephone circuits could be easily protected by doubling, instead of using earth returns, and that, as they were adopting this metallic return anyhow, because it gives a better service, they should not have the protection they sought. The gas and water companies, however, also appeared in this inquiry, and this was practically the opening of a question which has awaited satisfactory settlement for the last decade. This Committee—generally known for short as Lord Cross's Committee—decided that uninsulated returns are permissible, and that preventing their use would throttle the industry. But they also decided that the tramway people should take all reasonable precautions in building and working their undertaking, so as not injuriously to affect by fusion or electrolytic action any gas or water pipes.

Since this recommendation there has been little done by the gas and water companies until recently. Electrical tramways are now being put down on such a large scale that the owners of underground pipes are naturally beginning to regard the whole question as being very serious. When we consider the capital value of the buried pipes in this country alone, which must run into very many millions of money, it is clear that the question whether they will be eaten into holes and destroyed by tramways, without either means of prevention or redress, is of enormous importance.

The first question was whether tramways should be allowed to have leakage currents at all. Parliament practically decided that, as it was a very great convenience to tramways to have what is called an earth-return, and as the corresponding harm to other people was small, they should be allowed to have earth-returns—that is to say, the gas, water and telephone companies are not to have immunity. The Telephone Company is not on all-fours with gas and water companies, as the National Telephone Co. was not incorporated by Act of Parliament.

During last session the controversy between the tramways and the gas and water companies was substantially that the tramway people said they caused no damage to the pipes, or none that would ever be perceptible, and Parliament had already decided that they should be allowed to use earth-returns. The pipe owners said: "We do not want to stop your use of the earth-return. You say it does us no harm. We do not know whether it does or not; but we fear it may. We, therefore, ask you to be liable for damages if you eat our pipes. If you do not eat them, such a protection, while satisfying our fears, does you no harm; and if you do destroy our property, it is only fair that you should indemnify us." The tramways said: "We will not hurt your pipes; and it is unfair that if your pipes are naturally corroded or corroded by some other tramway people, we should have to pay. For, however, carefully we guard against leaks we may at any time be made liable by the mistake of an arbitrator for a fabulous sum, without having done any harm to you at all." The tramway companies also argued that they worked under the Board of Trade regulations, and that the Board of Trade regulations were designed to prevent corrosion of pipes, and were amply strict enough for the purpose. The pipe-owners urged that there was always electrolysis; and the Board of Trade merely reduced it as far as was consistent with the satisfactory working of the tramways without by any means rendering the tramways innocuous. This we may discuss more fully later. Last session, the gas and water companies on the whole failed to get even the smaller protection they asked for; and this session they have done but little towards getting the insertion of clauses in their favour. Such is very shortly the history of the question.

When I was asked to give a lecture on this subject, I was very undecided as to what sort of Paper I had better give. I might give an elementary treatise on electricity, with special reference to electrolysis, or I might give give a lecture full of experiments. Or I might have drawn awe-inspiring pictures of the future of your distribution systems, when all the iron of your pipes had been eaten away, and the gas merely ran along the tunnels left in the ground. Or I might have urged the tramway point of view, that the electrolysis is very minute, and what there is is rather good for the pipes, being a pleasant stimulant. An experimental lecture appeals to those present, and is, no doubt, more interesting in a way; but I felt that I had been honoured by being asked to deal with a subject which is of enormous importance to your industry, and, therefore, concerned many people who would be outside this lecture-room.* I therefore concluded that you would probably prefer me to deal with the subject broadly, and try and give you as fair and full an idea as I can of the whole subject. It is difficult, of course, to be impartial on such a matter, and you will no doubt regard me as being specially electrical. I am, however, also an old gas man, as I was for some time at the South Shields Gas Co.'s works, under Mr. Warner whom you all know. In the various contentions I have appeared in the law courts and in the committee rooms, sometimes on the electrical side and sometimes for the gas and water people. My views have thus been moderate, and I think fairly impartial; and I will do my best to be impartial in this Paper. But by far the greatest difficulty is to give any real information as to the true effect of the earth-currents from tramways. The question from the technical or scientific side is very obscure. If pipes are being corroded—even if the corrosion goes on to a very serious extent—it may not show for a long time. In fact, corrosion would only show when considerable damage had been done, unless a pipe company happened to examine a pipe which was specially strongly affected. The only thing is for me to give as much information as I can.

Electrolysis, or electric separation, applies to electric separation of chemical compounds. The most familiar example is the electrolysis of water. If an electric current is caused in, say, acidulated water, the piece of metal which leads the electricity down is called the anode, or way down. The piece which leads the electricity up again is called the cathode, or way up. The two pieces of metal are called electrodes, or electric ways. The liquid is called the electrolyte, or thing that can be separated electrically. Water and solutions of salt are all electrolytes—that is to say, they are decomposed when there is an electric current, and a current cannot exist between metallic electrodes in an electrolyte without decomposition. The decomposition is strictly proportional to the current and the time. Thus, when acidulated water is decomposed, the quantity of oxygen and hydrogen liberated depends on the current, and the time it is on. The unit of current is an ampere, and an ampere decomposes 0·3357 gramme of water per hour, yielding 0·0374 gramme of hydrogen and 0·2983 gramme of oxygen. If, instead of water, other substances are decomposed, the amounts liberated are proportional to the combining weights. If the electrodes are platinum there is no corrosion, as the platinum does not easily form salts. Suppose, for instance, the solution, instead of being acidulated water, is water containing common salt and other salts, and suppose iron electrodes are used, then the anode will be converted into ferrous chloride. Hydrogen will come off at the cathode, unless there is some metal that will deposit instead of it. Thus, if we have copper electrodes in copper sulphate, copper will be eaten off the anode, forming copper sulphate, and copper will be deposited on the cathode, forming a fresh-coloured coating. This process is carried on on a huge scale in copper refining.

What we are concerned with is the corrosion of iron when used as an anode in the ground. In the ground in a town we may take it that the pipes are buried in earth or sand which is damp with salt, and other compounds of sodium, potassium and ammonium. Iron has a very curious property. It is not attacked when it is used as anode in an alkaline solution. In caustic soda, for instance, it is not touched. But this property is scarcely likely to help it in the ground; for even if the ground was slightly alkaline, an effect of the electrolysis is to render the region round the anode acid. The iron is thus attacked. If there is plenty of salt present we get chloride of iron; but the chances are that the iron is converted into basic salts or oxides. It does not matter much to the pipe what it is converted into. No harm is done to the pipe where it forms a cathode, as the only thing that could happen would be that metal might be deposited. Iron could not be deposited under the circumstances, so that we need only consider the corrosion of the anode. As the combining weight of iron is 28, the consumption of iron per ampere is 0·00029035 grammes a second, or 20lb. a year. It will be clear, then, that a gaspipe can only be corroded where it is acting as an anode—that is to say, where the electric current is leaving it, to pass into damp ground. There is no corrosien where the electricity enters the pipe, because it is a cathode there, and there is no corrosion where the electricity leaves, unless it passes into an electrolyte such as damp earth. If the electricity is taken off by a metallic conductor, such as a wire, which is not an electrolyte, there is no corrosion.

We may now consider the electrical connections on a tramway system. In its simplest form, a tramway system consists of an electrical generator driven by power at the station. This is connected with an overhead wire, which is thus kept at an electrical pressure of 500 volts. Each car has a sort of fishing-rod with a little trolley wheel, which makes contact with the overhead wire, and connects to the motors. From the motors, the circuit is led to the wheels and thence to the rail. It is carried back to the station by the rails. The current that goes back to the generator is necessarily equal to the current that goes out. Electricity is not like gas; there is the return circuit which must carry the whole current. Any current that leaks away from the rails must either find its way back into the rails, or otherwise get back to the generator. Whether the current will all go back by the rails, or will partly go by the earth depends upon the resistance of the paths. Iron as a substance has very little resistance compared with damp earth; but, on the other hand, the damp earth forms a very broad path—in other words, the cross section is very large. Again, the rails are not continuous; and the joints have more resistance than the rails. The result is

* The lecture actually given was experimental and explanatory. As the same lecture does not both sound and read well I practically prepared two.

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that there is considerable straying from the rails. This is shown iagrammatically in Fig. 1.

Here A is the generator; B is the overhead system at 500 volts; C is a car, and D is the return circuit. Some electricity leaves the rails, and returns towards the generator by the earth, and when it gets near the station it enters the rails again. The earth acts as a by-pass. Electricians talk of leakage, but the analogy is the by-pass. In Fig. 2 is another elementary system, with gas pipes shown close to the rails The gas pipes are generally good conductors. Sometimes the joints do not make good electrical contact, and the resistance of the joints is high.

In Fig. 2 the gas pipe is shown as E. There is a current into the pipes at F, and out again at G. As has already been explained, the earth acts as a sort of by-pass to D, and takes a share of the return current. The gas pipe acts as a sort of second by-pass—that is to say, a by-pass to a by-pass; and there is thus a small current in the pipe.

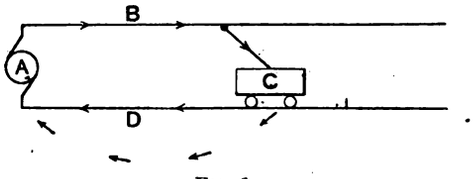

FIG. 1.

If the system is examined it is seen that the rails have a fairly large current leaving them. The rails must be proportionately corroded at these regions. Then a portion of the leakage goes into the gas pipe at F. This does no harm, as the pipes are cathode there—that is to say, the current into the metallic conductor does not corrode it. At G, however, the current leaves the pipe, so there is corrosion there. The electricity that leaves the pipe at G crosses through the earth to the rail, and thus to the generator. If, therefore, the pipe is connected by means of a wire to the return or negative end of the generator circuit, the electricity leaves the pipe by a metallic conductor, so that there is no corrosion. As will be seen presently, making metallic connection to the pipes in the neighbourhood of the station is one of the methods of minimising the electrolytic corrosion.

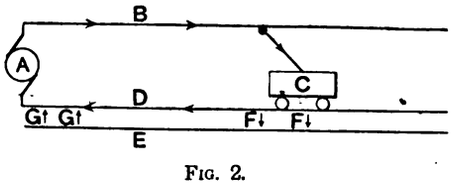

FIG. 2.

We have mentioned electrical current, and electrical pressure, and referred to resistance and conductors. It would be no use to try and give a clear explanation of what controls electric currents here, for time is too short. Many, probably most, of my readers also understand the matter already. But it may be advisable to give those who have not studied electricity at least some idea of the relations of the electrical quantities we have to deal with most. The electrical current (amperes) is analogous to a current of water, a conductor corresponding roughly to a pipe. The resistance of the conductor (ohms) then corresponds with the friction of the pipe, due to its smallness of bore or internal roughness, and the electrical pressure (volts) to the pressure or head of water. But there is this difference; the relation between the flow of water and

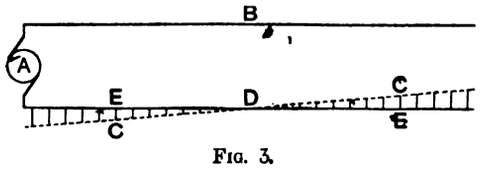

FIG. 3.

the pressure causing the flow in a pipe is complicated; but in electricity it is very simple. The current (in amperes) is proportional to the pressure (in volts) divided by the resistance (in ohms). In the case of electrolysis, there is often a back-pressure; for instance, when water is electrolysed into oxygen and hydrogen. But in the sort of electrolysis which we are discussing, there is generally no appreciable back-pressure. This is mentioned because it is sometimes said that electrolysis cannot take place unless there is over a volt of pressure available.

If we consider a track where the rails form the only return, if the current to be returned is large and the distance long, so that the resistance is considerable, we might have considerable pressure between the far end of the rails and the station. In America, especially in the early days, they had very high pressures on the rails—sometimes 30 volts and upwards. Taking the earth itself generally as being at zero pressure, or, to use the water analogy, at zero level or head, we may consider that one end of the rails would in the extreme case mentioned be 15 volts above the zero, and the other 15 volts below. With such a pressure as this, there would be considerable leakage, or by-passage of current through the earth. Any pipes lying along the route would then pick up a portion of the stray current, and suffer corrosion where the electricity left it.

The variation of potential along the earthed return, supposing it to be uniform, is shown in Fig. 3. Here EE is the return, and its potential with regard to the earth is given by the vertical distance between EE and the inclined line CC. At the far end the rails are positive (this being shown by C being above E), and no corrosion of pipes will take place. But at the near end they are negative. Between these two areas there is a spot, D, where the rails are at earth potential, and there is no tendency for electricity to pass to or from the pipes.

(To be concluded.)

CORRESPONDENCE.

ELECTRIC TRAMWAYS AND OMNIBUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From the editorial note in your current issue, it would appear that you do not follow the sense in which the term "overtaking power" has been used by Col. Crompton and myself, or else you do not agree with the value we put on it.

It is on account of superior overtaking powers and of the limited number of tramcars that could pass along a road in a given time that I believe motor bicycle traffic would be a more speedy performance than that by electric tramways. You have assumed that the motor cycles would all "go at the same pace" and "none must turn aside." This makes one suppose, for the moment, that, after all, you sufficiently follow the term "overtaking power" to assume that the motor bicycle has none—any more than a tramcar; yet the facts are otherwise, for though the speed of the first "tram" would govern the rest—and if one stopped all those behind it would require to stop—a number of motor cycles on a roadway would be absolutely independent of one another.

With regard to the last paragraph of your note, I would remark that the question I was discussing was the road carrying capacity by motor cycles as against tramways. I was not, however, advocating the motor bicycle for general traffic as against improved motor 'buses, but only pointing to it—for illustration purposes—as the ideal machine on account of combined high speed and superior overtaking powers, the latter being enhanced by the small space occupied.

I spoke of "a given speed" because I did not think it necessary to touch on the maximum attainable speed of each, and was content to deal with the superior point-to-point speed of a motor by reason of its overtaking powers.

The speed of an electric tramcar is to a great extent wasted owing to being largely under the control of market carts and such like; and for this reason the tramcar, on a comparatively narrow road, is often beaten from point to point by the horse-drawn omnibus entirely independent of rails.—Yours, &c.,

Westminster, Aug. 2. CHARLES BRIGHT.

LEGAL INTELLIGENCE.

Attorney-General v. Bournemouth Corporation.

This case was mentioned in the Court of Appeal on Tuesday before Lords Justices Vaughan Williams, Romer and Mathew.

Mr. ASQUITH, K.C., said the matter had been recently before their lordships, and the question raised was whether the Corporation had substantially commenced certain tramways within the period mentioned in the Act of Parliament. The Court decided that they had not, and granted an injunction restraining them from continuing to work the tramways or to construct those not yet completed. The Corporation had been advised to appeal from that decision and were about to appeal, and the only question before the Court was as to the terms on which matters should go on in the interim. One of the tramways had been actually completed and was at work, and obviously it would be a great public inconvenience if its operation was to be suspended until the result of the appeal to the House of Lords was made known. He did not think much difficulty would be

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raised in arranging terms by which the operation of the injunction could be suspended pending the appeal. The Corporation would undertake to prosecute the appeal with all reasonable despatch.

Mr. WARMINGTON, K.C., for the Poole Electric Construction Co., said the time within which his clients had to construct their tramway commenced on Aug. 2 this year, but obviously it was not to the advantage of anybody that the same tramway should be twice constructed, and he suggested that, as a condition of suspending the operation of the injunction, the Corporation should undertake, if the injunction stood over, to sell to the company that tramway at the cost of the construction of the permanent way and overhead equipment That could not do the Corporation any harm, because if the decision of the Court of Appeal was upheld they would have to take up the line, and it must be to the advantage of the ratepayers that, instead of taking it up, they were repaid the cost of construction.

Lord Justice WILLIAMS considered this a reasonable offer.

Mr. WARMINGTON: We do not want to take their stations.

Lord Justice ROMER considered it would be an advantageous arrangement if the appeal failed.

Mr. ASQUITH said he did not think it an unreasonable offer, and he would like to say that the Corporation, as regarded the other tramways—for there were a number of other lines involved in this case—contemplated applying to Parliament to extend the time during which they could make them, so as to put right the defects which were made, and they did not wish their assent to any such undertaking as was now asked for to prejudice them in their application to Parliament.

Lord Justice ROMER: It ought to be without prejudice to any Act of Parliament passed for that purpose.

Mr. WARMINGTON said he rather objected to the idea that the Court recognised that their decision could be upset by Parliament. He did not think it would be regular, and indeed it would really be depriving the plaintiffs of the benefit of the decision, for it might be represented to Parliament that their lordships had really suspended their judgment.

Lord Justice ROMER: Why cannot you suspend the injunction until the hearing of the appeal to the House of Lords, leaving you to arrange terms?

Mr. WARMINGTON: The danger to us is that our time is running, and we can do nothing. We have only got a year to construct, and if your lordships' decision stands we are at liberty now at once to construct this tramway.

The Court made the following order:—"The operation of the injunction to be stayed, pending the appeal to the House of Lords, upon the appellants undertaking to give notice at once, and prosecute with due diligence their appeal, the defendants also undertaking that, in the event of the House of Lords affirming the decision of the Court of Appeal, they will transfer to the plaintiffs the tramway upon the terms of the plaintiffs paying to the defendants the reasonable cost of the construction of the permanent way and overhead equipment. In case of difference, such cost to be settled by arbitration. This order to be without prejudice to any application in the meantime to Parliament by the defendants." The appellants to pay the costs of this application.

Postmaster-General v. Westminster City Council.

The SOLICITOR-GENERAL moved yesterday for an interim injunction to restrain the defendant Council, until the trial of the action or further order, from removing or disturbing materials, tubes, apparatus, &c., placed on the streets by the Postmaster-General or his contractors for the purpose of executing works authorised by the Telegraph Acts, and from retaining the apparatus that had already been removed. The Postmaster-General, it was stated, was having certain works executed in Westminster for the purpose of making a connection with the National Telephone Co. under a scheme formulated by the Post Office for the purpose of establishing a new telephone exchange. The surveyor to the Council still had the apparatus and declined to give it up.

Mr. HAMILTON, K.C., said the Council were willing to give up the articles if the Court was of opinion that they should do so. The question whether the Postmaster-General had power to so use the streets as he had done in this case would have to be determined at some time or another, and he (counsel) suggested that the pleadings should be delivered at once and the action speedily tried. If, however, the contractors continued to use the streets of Westminster as a storage depôt the Corporation would interfere again.

Mr. Justice JOYCE said in that case the motion could be brought before him again. At present it would stand over until the trial.

Sir E. CARSON said that if the Council did it again he should indict them for highway robbery.

Read v. Friendly Society of Operative Stonemasons and Others.

In the Court of Appeal (composed of the Master of the Rolls and Lords Justices Stirling and Cozens Hardy) on Tuesday, the defendants (other than R. E. Saunders) appealed from a judgment of a Divisional Court (fully reported in our issue of May 23) ordering a new trial of the action tried before Judge Eardley Wilmot at Ipswich, and in which he gave judgment for defendants. There was also a cross appeal by the plaintiff asking that judgment might be entered for him. The action was brought for damages for wrongfully and maliciously inducing Messrs. Wigg and Wright to break their contract of apprenticeship with plaintiff. Certain rules had been agreed between masters and men, and these rules Messrs. Wigg and Wright had agreed to and signed. At a meeting of defendant society in August, 1900, it was resolved that if plaintiff started work for Messrs. Wigg and Wright as a mason, one of their employés was to report the fact. Owing to the action of the society Messrs. Wigg and Wright did not employ plaintiff as a stonemason or teach him the trade; but he continued to do labourer's work. On the latter date defendants' secretary wrote to Messrs. Wigg and Wright that the members of the society considered their action a direct infringement of the understanding, and that, accordingly, they had empowered their members working for the firm to take prompt action. In their answer to interrogatories defendants admitted that "prompt action" meant that the masons in Messrs. Wigg and Wright's employ should give two hours' notice and leave their employ if they thought fit. The County Court judge held that the facts fell short of any ground of action against defendants, who seemed to have acted bonâ fide in the best interests of the society, and not from any improper motive, and that though the defendants' interpretation of the rule might not be correct, they had not acted improperly in their method of enforcing it. The Divisional Court, on plaintiffs' appeal, held that the contract alleged by defendants was one which, if proved, might, by reason of its being in restraint of trade or otherwise illegal, be incapable of being enforced, and, in that case, to seek to hold Messrs. Wigg and Wright to it could not be held a sufficient justification. Whether there was a contract between Messrs. Wigg and Wright and the defendants did not sufficiently appear. There must, therefore, be a new trial,

Mr. COHEN, K.C., contended that defendants were perfectly justified in giving the notice to Messrs. Wigg and Wright, and were not liable for an action for malicious conspiracy. It appeared to him that the action ought to have been brought against Messrs. Wigg and Wright, by whom the agreement was broken. Messrs. Wigg and Wright, having subscribed to the rules, had violated them, and they called upon Messrs. Wigg and Wright not to employ plaintiff as a mason apprentice. There had been no agreement on the part of defendants to do an unlawful act. The resolution of the society to give warning to Messrs. Wigg and Wright was a legal act. To support an action for conspiracy it must be shown that there had been an agreement or combination to do an unlawful act.

Mr. LOW, for plaintiff, said it had been suggested that the proper course for plaintiff to pursue was to sue his employers, but that would dispose altogether of actions for procuring breaches of contract. He submitted that it was a violation of a legal right to interfere with contractual relations. In that case it was absolutely clear that a violation of a legal right had been committed, and that the contractual relations between plaintiff and Messrs. Wigg and Wright had been interfered with. Had the contract been carried out the plaintiff would now be in the position of a fully qualified mason, but the society interfered, and there was nothing to show that the plaintiff had any knowledge of the existence of the rules of the society.

The MASTER OF THE ROLLS said that the Court would take time to consider its judgment, which was accordingly reserved.

Standing on Tramcars.

The Leeds Corporation were sued at West Riding Assizes on Saturday by a man named Hughes, for damages for personal injuries caused through negligence of defendants' servant. It appeared that whilst plaintiff was standing on the top of a car, owing to the seats being wet, the speed was suddenly increased, and the jerk threw him over on to the roadway.

Defendants pleaded that plaintiff was guilty of contributory negligence, inasmuch as he committed a breach of bye-laws by leaning on the rail.

Mr. Justice BRUCE said he had noticed several passengers standing on cars and sitting on the rails with the car conductor's knowledge.

Plaintiff succeeded in obtaining a verdict from the jury for £250 damages.

In re the Birmingham and Midland Tramways Co.

On Saturday, Mr. Justice Joyce sanctioned the alteration of the Memorandum of Association of this company by allowing it to generate and supply electricity for all purposes, and to act as electricians, electrical engineers, &c.

His LORDSHIP, in sanctioning the alteration, said he thought that this form was being adopted by most of the big electrical undertakings in the kingdom.

Re Electric Lamp Regenerating Co. (Ltd.).

This matter again came before Mr. Justice Buckley on Tuesday, when Mr. Astbury, K.C., stated it was a creditors' petition for the compulsory winding-up of the company, and no evidence was filed in opposition. Last week a Mr. Milne had given his personal undertaking to pay debts and costs, and also the costs of the provisional liquidation; but that undertaking has not been carried out. Since the petition was presented another petition was on the point of being filed, and the creditors agreed to release Mr. Milne from his undertaking.

His lordship made a compulsory order.

Electric Moving Sidewalk.—A scheme is being brought forward, states the *Electrical World and Engineer* of New York, to provide an electric moving sidewalk for Brooklyn Bridge, similar in many respects to that installed by the Westinghouse Company at the Paris Exhibition of 1900. It is intended to provide a main platform 8½ft. wide to run on the tracks now used by the cars, and, being built in 12ft. sections, could go round fairly sharp curves. To get on and off the scheme provides for three narrower moving belts, moving at 2½, 5 and 7½ miles per hour respectively. The rate of the main platform is to be 10 miles per hour.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Oldham Corporation Electricity committee require an assistant engineer. Applications to town clerk (Mr. A. Nicholson) by Aug. 11. See advertisement.

An assistant engineer is required for the Colchester electric light and power department. Applications to the borough electrical engineer (Mr. Alfred R. Sillar) by Aug. 12. See also advertisement.

There is a vacancy for an improver at Barnsley electricity works. Applications to borough electrical engineer (Mr. S. E. Bastow). See advertisement.

An assistant engineer is required for the Dewar-place electricity station, Edinburgh. Applications to resident engineer (Mr. F. A. Newington) by Aug. 22. See advertisement.

A meter inspector is required by Bradford Corporation. Applications to the city electrical engineer (Mr. R. A. Chattock, M.I.E.E.), Town Hall, Bradford. See advertisement.

An electrical draughtsman is required by large shipbuilding and engineering works, to be experienced in design of electricity generating stations. See advertisement.

There is a vacancy for an instructor in physics and electrotechnics at the Polytechnic School of Engineering, Cairo. Salary about £430 per annum, rising to £553. Applications before 25th inst. to Mr. R. Holt, c/o Sir B. Baker, Queen Anne's Gate Mansions, London, S.W.

A lecturer and demonstrator in physics is required at the University College, Bristol. Applications by Aug. 30.

A head master is required for Newry Technical School. Applications to hon. sec., Town Hall, Newry, by Aug. 16.

Mr. H. R. Paterson, of Edinburgh, has been appointed station superintendent at the Hammersmith (London) Borough Council electricity works.

Mr. Albert Pickersgill, chief assistant engineer at Dewsbury, has been appointed resident electrical engineer (out of 104 applicants) at Cleckheaton at a salary of £200 a year.

Mr. George Ernest Heath, assistant electrical engineer at York, has been appointed clerk of works and resident electrical engineer at Erith.

Mr. Wood has been appointed station superintendent at Bolton at £140 per annum.

Mr. J. L. Hill, an ex-sergeant of the Royal Engineers, and a former telegraphist at Bristol, who went to the front with the first batch of the telegraph battalion, has been appointed inspector of telegraphs at Pretoria.

Mr. J. Steward, of Ayr, has been appointed charge engineer at Paisley.

Mr. W. R. Bowker has been appointed lecturer on electrical engineering and physics at the Municipal Technical School, Halifax.

Aberdeen.—The accounts of the tramways department for the year ended May 31 show revenue of £37,931. 17s. 9d., compared with £35,452. 10s. 9d. in 1901; working expenses were £26,577. 1s. 7d., against £26,683. 7s. 9d. Under the horse haulage system the earnings were 10½d. a mile, and the working expenses amounted to 9d. Since electric traction had been introduced the earning capacity was 13d. to 15d. per mile, and the working expenses were a little over 6d. After meeting all indebtedness the capital stands at less than £246,000. The report states that Aberdeen is paying 150 per cent. more than Glasgow Corporation for its electric current.

Amalgamations.—The well-known electrical engineering firms of Dick, Kerr & Co. (Ltd.), of London and Kilmarnock, and the English Electric Mfg. Co. (Ltd.), of Preston, have been amalgamated. The two companies, together with the Electric Railway and Tramway Carriage Works (Ltd.), of Preston, have previously been closely associated in their business relations, Messrs. Dick, Kerr & Co. being the principal shareholders in the other two companies. It has, however, been considered advisable to consolidate interests by amalgamation with the English Electric Mfg. Co., and it is most probable that a similar combination of interests will be effected with the Electric Tramway and Railway Carriage Works Co. at an early date. At the present time Messrs. Dick, Kerr & Co. have several very large contracts in hand for electrical plant and machinery, including large orders for electric tramcars. The big Sydney (N.S.W.) contract recently let has been secured by this firm after the very keenest competition. Their profits for the last four years have averaged over £60,000 per annum, and for the current year is estimated at considerably over £100,000. The English Electric Mfg. Co. last year paid 4½ per cent. interest on £125,000 debentures, 6 per cent. dividend on £185,000 preference shares, and put £27,000 to reserve.

The business of Guest, Keen & Co. has been amalgamated with that of Nettlefolds Limited, the name of the new company being Guest, Keen and Nettlefolds (Ltd.).

Aston.—Application has been made for a loan of £11,352 for the overhead equipment of tramways.

Asylum Lighting.—Radnorshire County Council have resolved to adopt electric lighting at the county asylum.

Barrow.—The British Electric Traction Co. have undertaken to commence at once the construction of electric tramways to the Docks, Roose and Furness Abbey. The Corporation have the right of purchase after 7, 14 and 21 years.

Belfast.—At the last meeting of the Gas and Electricity committee the question of the supply of electrical energy to Messrs. Harland and Wolff's and other works was discussed. A report was submitted by the city electrical engineer (Mr. Victor A. H. M'Cowen) as to the most economical system of giving a comparatively large supply of power in the Alexandra Dock district on the County Down side of the river. The committee resolved that, in the event of more than 500 H.P. being demanded on the Queen's-road mains, that the high-tension method of transmission should be adopted. For the half-year ended June 30, the total units sold amounted to 679,474, against 487,779 for the corresponding period of the previous year, an increase of 40 per cent., the income being £9,239. 3s. 2d., against £7,354. 4s. 5d., an increase of 25 per cent. The average price per unit for the half-year was 3·263d., against 3·618d. for 1901. The increase in units sold for lighting was 22 per cent., and for power 103 per cent. The units sold for power formed 30 per cent. of the total units sold. After discussion the minutes were approved.

Belper.—The Derbyshire and Nottinghamshire Electric Power Co. offer to supply electricity in bulk in this district.

Bermondsey (London).—The Electric Lighting committee have decided to expend £4,185 in extending the arc lighting system.

Birkdale.—The electricity works were formally opened on Friday last.

Birmingham.—The Dudley-road tramway route has been converted to the overhead trolley system.

Bolton.—The borough electrical engineer (Mr. A. A Day) is preparing an estimate of the cost of extending the electric tramway system.

Bournemouth.—A numerously-attended ratepayers' meeting has passed resolutions urging the Corporation to appeal to the House of Lords against the judgment of the Court of Appeal in the action Attorney-General *v.* Bournemouth Corporation, and also protesting against the attitude of the company. As will be seen from our "Legal Intelligence," the Corporation have decided upon an appeal, and Mr. Asquith, K.C., M.P., has been retained.

Brighton.—The accounts of the tramways department were presented on Friday.

Ald. SENDALL moved their adoption, and in dealing with the adverse balance of £3,051, pointed out that £2,600 of the £4,905 required for interest had been incurred before the lines were opened for traffic, and, in addition, there were Parliamentary expenses amounting to £470. He pointed out that £3,507 due from the Telephone committee, together with £2,400 which they expected to recover in the way of penalties, and the valuable asset the Council held as a set-off to the purchase of the old brewery property, would make a considerable reduction in their capital account. For the 13 weeks ended June 30 the accounts showed a profit of £105. 17s. 6d. a week, or £1,373 for the quarter, and for the four weeks ended July 28 they would show a profit of another £700, making a total of £2,073. By the end of the next financial year they would be able, he considered, to show a favourable balance of £3,400 or £3,500, out of which he strongly urge the setting apart of, say, £2,000 for depreciation.

Ald. Sir John BLAKER seconded, but considered that to try and build up a reserve fund out of money deliberately taken out of the rates would not be just to the ratepayers.

The accounts were approved.

On the motion of Councillor CARDEN the Tramways committee were authorised to at once give notice to the water works engineer to alter the water mains in London-road, York-place and the Old Steine, in order to enable the tramways in those roads to be laid at an early date.

Bursiem.—The Council having decided to establish municipal electricity supply, the application of the Potteries Electric Traction Co. and another syndicate for provisional orders will be opposed.

Cheltenham.—Owing to the opposition of Prestbury Council, the Corporation have abandoned their scheme for extending the electric light cables to Cleeve Hill.

Scholarships.—As a result of recent scholarship examinations, the Board of Control of the Electrical Standardizing, Testing and Training Institution have made the following awards:—To Mr. Herbert Stanley Phillips, of Oakham School, Oakham, an exhibition value £31. 10s., tenable for two years; and to Mr. John Nelson Nayler, of Kingswood School, Bath, a prize of £21.

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Colchester.—The Board of Trade have granted the Council an extension of 12 months to comply with the terms of their provisional tramway orders.

Cults (Aberdeen).—The electric lighting of the streets has been renewed. Messrs. Lowdon Bros. & Co., who acquired the plant at the old station from the liquidator of P. C. Middleton & Co., have put down additional generating plant, overhauled the mains, &c, and current was again available on 30th ult.

Darwen.—The gross profit on the electric lighting department for the year ended March was £2,374. 9s. 4d., and the net profit £126. 17s. 8d. On the tramways the gross profit was £2,335. 4s. 6½d., and the net deficit £963. 16s. 7½d.

Dockyard Lighting.—The Admiralty are considering a scheme for erecting electricity generating plant for lighting and power at Chatham Dockyard. It is proposed to replace all smaller machinery, including cranes, haulabouts, and engines at the slips, docks, and workshops by electric motors. The naval ordnance works at the Gun Wharf and the new magazines at Upnor and Chattendel will also be illuminated electrically. The scheme has been drawn up by Messrs. Preece and Cardew.

Doncaster.—The Hyde Park tramway route was opened on Friday.

Dumfries.—A report by the Council's consulting engineer (Prof. D. S. Capper) on the proposal to erect electricity works and to construct electric tramways estimates that the cost of steam-driven plant for the generating station would be £38,000, and of gas-driven plant £39,150, while an electric tramway from Dumfries railway station to Glencaple would cost £19,000.

Dundee.—The accounts of the tramway department have been issued, and show total receipts £35,874. 0s. 9d., working expenses £23,494. 19s. 8d., maintenance of lines £547. 7s. 10d., interest £5,076. 7s. 4d., sinking fund £3,415, fund for renewal of rails £300, depreciation on plant £903. 13s. 3d., amount paid to the tramway company £2,100, leaving surplus carried to suspense account £36 12s. 3d. The total liabilities on capital account are £218,819. 18s. 7d. The debt prior to the municipalisation of the system was £46,279. 13s. 9d. In constructing lines there has been expended £117,026. 2s. 5d., car sheds and workshops cost £12,210. 1s. 3d., cars and equipment £26,213. 1s. 3d., and Parliamentary powers £4,854. 1s. 1d.

Eastbourne.—A considerable extension of arc lighting was decided upon at Wednesday's meeting of the Council. A reduction in charge for electric current for private consumption has also been decided upon.

Eccles.—Owing to complaints as to the unsatisfactory character of the incandescent electric lighting, it has been decided to adopt arc lamps in some of the leading thoroughfares.

Electric Power Pump for High-level Working at Montreal.—We referred, in a recent issue, to the tenders invited by the Montreal municipal authorities for a new power pump for the high-level pumping-station at the Montreal water works. The specification was for an electrically-driven 5,000,000 imperial gallons pumping engine with pumps and motor complete; the pumps were to be double-acting plunger force pumps of the 24 hours' capacity above mentioned, representing 3,472 imperial gallons per minute, safely and continuously pumped against a total pressure of 126lb. per square inch, including the friction of the force mains, the plunger speed of the pumps to be so regulated as to ensure smooth and effective working of the pump valves, this speed in no case to exceed 150ft. per min. No suction lift exists at the station. It was required that each pump should be provided with pressure rate relief valves of sufficient capacity to by-pass the total discharge of the pumps. The power transmission between the electric motor and pumps was to be made by efficient and well-proportioned single-reduction gear connection, the large gears to be mortised and noiseless in working. All pump castings were to be of sufficient strength to stand a pressure of 175lb. per square inch. The pumps were to be driven by an electric motor of such capacity that the rise of temperature under continuous running at the pump's full load would not exceed 40°C. above surrounding air. The motor to be adapted to work with direct connection to the jack-shaft of the pumps. The test of the machinery, when delivered and erected, was to be a capacity test of 24 hours' continuous duration, and a further pressure test of 12 hours against a pressure of 300ft., the contractor to operate the machinery for 30 days following the test at his own cost, except for labour. The work to be completed ready for testing by Dec. 1, 1902, under a penalty of $100 for every 24 hours' default.

The City Council received two tenders for this work—one from Messrs. Northey & Co., of Toronto, for $45,500, and the second from the John McDougall Caledonian Ironworks Co., of Montreal, for $40,425, and the latter tender has been accepted. The McDougall Company's tender to supply an 18in. × 24in. Worthington triplex horizontal power pump, inside plunger pattern, capable of pumping 5,000,000 imperial gallons per 24 hours when running at 27 revs. of the crank shaft per minute, against a pressure of 126lb. per square inch. This will be driven by pinion on the electric motor shaft, making about 150 revs. per min. The pinion is to be of hard charcoal iron of 25½in. pitch diameter, having 16 teeth of 5in. pitch, with 20in. face. This pinion will drive the large wheel on the crank shaft of the pump, the wheel having a mortised gearing 143in. of 3in. pitch diameter, having 90 teeth of 5in. pitch, with 20in. face. The electric motor is of the induction type, of 400 H.P. normal rated capacity, and will be built by the Bullock Co., of Ohio.

The water works authority have received two tenders for electric current to run the pumping engine, and these are still under consideration. The Montreal Light, Heat and Power Co. offer for 12 hours' running every day of the year an annual flat rate per horse-power of $26 for day running, or $21.50 for night running. The Lachine Rapids Hydraulic and Land Co.'s offer is for the same supply, at $25 and $20 respectively. The pump engine is destined to work only 12 hours per day, or 2,500,000 gallons, this quantity being sufficient for the present water consumption of the Montreal high-level district, and no storage is provided for. Current is to be supplied at 2,200 volts at 60 or 66 cycles.

Exeter.—The Council have adopted an electric tramway scheme estimated to cost £74,772.

Foot's Cray.—A ratepayers' meeting has approved a resolution that an agreement be entered into by the District Council with either the Sidcup or the Woolwich local authorities for the supply of electricity in bulk.

Gillingham.—An inquiry was held here last week into the Council's application to borrow £52,000 for the purchase of that portion of the undertaking of the Chatham, Rochester and District Electric Lighting Co. which lies within the Council's area, and for extensions.

Gravesend.—Electric current was supplied for lighting and traction on 29th ulto. For street lighting there are 27 arcs and at present the tramway service consists of 20 cars.

Greenock.—The electric light is now used throughout the M'Lean Museum and Lecture Hall. In the museum 10 16 c.p. incandescents, 13 1-ampere Nernsts and five 5-ampere arcs are installed, and in the lecture hall 10 Nernst lamps. The installation has been carried out under the supervision of the burgh electrical engineer (Mr. W. M. Nelson).

Guatemala.—From a review of the trade of Guatemala for 1901 we learn that during the year six new telegraph offices and 19 new telephone stations were opened. Telegraph lines were constructed to the extent of 191½ miles, and a considerable length of line was reconstructed with iron in substitution for wooden posts. The total extent of the telegraph lines throughout the Republic at Dec. 31, 1900, was 3,490 miles, and at the same date there were 283 miles of telephone lines. The Government telegraph and telephone services are described as a credit to the country, and the telephone system is in very general use.

Hastings.—The borough electrical engineer (Mr. L. Andrews) has placed his resignation in the hands of the Lighting committee, who, however, desire to retain his services as consulting engineer.

Hebden Bridge.—The Electricity committee have submitted an electric lighting scheme estimated to cost £18,000.

Honley.—The Council has received sanction from the Board of Trade to use overhead wires for electricity supply for five years.

Horsham.—At a meeting of the Council on 31st ult., protests were made against employés at the electricity works being allowed to do private work to the detriment of the local electrical trade. The matter was referred to the committee which had sanctioned private practice.

Huddersfield.—The Board of Trade inspector (Major Druitt) has issued his report on the tramcar accident which took place on June 28, when three persons were killed and several injured.

The report states that the evidence at the inquest showed that the method of training the men for drivers was not satisfactory. There appeared to be no satisfactory instruction given to the men what to do in case of defect in brakes or equipment. The evidence showed that Hewitt, the driver, had not been taught the way to use the brakes when descending inclines. He therefore did not use his brake efficiently, as he apparently did not use it after starting his car until he had quite lost control. As to the condition of the brakes, the inspector states that, on examining the car the day following the accident, he found it could be worked quite well from the damaged end, which was in use at the time of the accident; that the electric brake was in good order, and that one of the blocks of the hand-brake did not press against the wheel when applied. If Hewitt's evidence was correct, he (Major Druitt) could not account for the failure of the electric brake to act unless some temporary insulation of contacts had occurred; but the accident would not have occurred had the slipper-brake been used, as it should have been, all down the incline.

The report further states that it cannot be sufficiently borne in mind by managers of tramways that to drive a car safely down steep hills requires

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steady men of good nerve, intelligence and a high standard of training, as any carelessness or loss of head will certainly result in a bad accident. Besides receiving more training, drivers should be given definite instructions what to do in case of failure of any part of the equipment, and where to find someone in authority to give them instruction at any time; also that, before a car is taken out of the shed to commence running, the driver should be given a quarter of an hour paid time in which to test his car and its equipment before he commences to carry passengers. At any time after running up and down steep gradients the driver should take his car back to the shed if he is in doubt as to the reliability of his brakes. Major Druitt further recommends that the evidence regarding the working of the electric brake be referred to the Board's electrical inspector (Mr. A. P. Trotter) for his opinion.

The Corporation have to some extent anticipated the inspector's recommendations, and have appointed motorman A. Walton as driver instructor, to test all present motormen as to their efficiency, and to inspect applicants for similar positions before they take charge of cars. It has also been decided to fix a telephone box at Market-place to accelerate communication with head office in the event of defect in electric cars; that every driver and conductor sign for his book of rules; that the manager prepare and pass a time-table showing the time of leaving St. George's-square and the passing places, and issue instructions to the men that the journeys must be run punctually to time-table; that the tramways manager arrange with the medical officer of health for the examination of all drivers as to their physical fitness for such positions, and also for periodical examinations of the men.

Irvine.—Messrs. Kirkland and Capper have been appointed consulting engineers to prepare an electric lighting scheme for the burgh.

Kendal.—The municipal electricity works were formally opened last week.

Kingston-on Thames.—The Corporation recently applied to the president of the Institution of Electrical Engineers to nominate three gentlemen from whom the Council might select one to advise them on various questions relating to electricity supply. The Corporation have been informed that it is contrary to the by-laws of the Institution for the president to submit names. The councillors have been asked to submit names at the next meeting.

Light Railways.—An inquiry was held at Gloucester last week into three applications for orders to construct light railways between Cheltenham, Gloucester and Stroud. The applicants were Messrs. T. Nevins & Son, for a light railway from Cheltenham to Stroud, with a branch from Brockworth to the boundary of Gloucester at Wotton, and some short lines radiating from Stroud; Gloucester Corporation for light railways within the City, and an extension into the county at Brockworth; and the Gloucestershire County Council for a light railway between Gloucester and the Cross Hands at Brockworth. The scheme of Messrs. T. Nevins & Son was opposed by the Great Western Railway Co., and the Commissioners decided not to proceed with it, as the proposed lines would compete with the existing railways. The Commissioners declined to authorise the Corporation to enter the county area against the wish of the County Council. The decisions regarding the remaining applications were deferred.

The Board of Trade have, after modification, confirmed the following light railway orders:—Darlington, Colne and Trawden (capital and further powers, amendment), Barnsley and District (extensions).

Longton.—The Council, before consenting to extend the electric light mains to manufactories outside the compulsory area, require an annual guarantee of £300 for three years. The cost of extension is estimated at £1,000, and the promised consumption would yield £100 a year.

Limerick.—Satisfactory progress has been made with the electricity supply scheme. The charge for current for private lighting has been fixed at 5d. per unit and for power at 2d.

London Electrical Contractors' Association.—We are informed by circular that, at the general meeting on 29th ult., the suggested alterations and additions to the rules were passed. Mr. A. Rashleigh Phipps was elected president, and Messrs. W. W. Gillard, H. Marryat and E. T. Tomlinson were elected vice-presidents. Mr. Rawlings was re-appointed hon. treasurer, as were the hon. secretary (Mr. E. J. Hogan), the hon. solicitors and the hon. auditors. Messrs. T. O. Belshaw, E. L. Berry, W. Duncan, H. Foote, F. A. Glover, A. J. Noble, F. Tricket, C. L. Troup and Harrington Wyman were appointed to act upon the council. The retiring president (Mr. Woodward) touched upon various items which had occupied the attention of the Association during its first year's existence. He also referred to the endeavours of the Institution of Electrical Engineers to establish a uniform standard specification, and to negotiations which the Association had in progress with the Institution and the Royal Institute of Architects as to obtaining goods for clients at preferential trade rates to the detriment of the electrical contractor carrying out installation work. No further progress had been made with the National Manufacturers' Association, as they in turn were occupied with the endeavour to bring in the allied manufacturers' associations—viz., plant and cable—and within a short time it was hoped that the Manufacturers' Association would reply to the recommendations placed before them by the Contractors' Association. Workmen's certificates and municipal trading were also dealt with. On account of pressure brought to bear, Glasgow Corporation had deleted the clauses in their bill for powers to undertake installation work and other forms of electrical trading. Evidence was being collected concerning other municipalities, and it was hoped to bring pressure upon those municipalities also. The new president (Mr. Rashleigh Phipps) briefly outlined the points which should command the attention of the Association during the year, drawing attention to the probable serious results of trading by municipalities in competition with ratepayers. He also referred to a proposal of establishing a permanent committee to deal with all questions which might arise with manufacturers and consultants.

Municipal Telephony.—The first annual report of the Glasgow telephone department has been issued. The original scheme, which was for 5,250 completed lines, with duct accommodation and switch-room space for 5,250 further, has been very greatly extended. Pipes have been provided with a capacity of 27,000 lines and cables actually laid, containing 14,572 pairs of wires, of which only 5,479 had been used up to May 31. The capital expenditure amounts to £192,693, out of which £16,058 was expended in connection with the telephone inquiry of 1897, in promoting and opposing bills in Parliament, in other matters foreign to the construction of the system, and in providing working expenses from the opening of the exchange in March, 1901, till revenue began to be earned on Sept. 1 last. It is intended to write off this amount in from five to seven years, thus reducing the capital expenditure to £176,635. The 8,787 partially-completed lines are computed to have cost £8 each, or £70,296, which, deducted from £176,635, leaves £106,339. This sum, divided by 5,479, the number of completed lines actually working on May 31, gives an average cost per completed line of £19. 8s. 2d., against £19. 1s., the original estimate, the difference being accounted for by the adoption of underground distribution to subscribers' premises and by the substitution of underground for overhead work on the junction routes, neither item having been originally estimated for. The revenue statement is for nine months, from Sept. 1, 1901. The total receipts (£28,171. 13s. 5d.), divided by 5,479, the number of working lines, gives an average of £5. 2s. 10d. per line, against an estimated average annual receipt of £5. 5s., but when the estimate was framed there was no obligation under the Post Office licence to provide a toll tariff. Subsequently that obligation was imposed, and the Corporation met it by making a tariff of £3. 10s. per annum and 1d. per outward call. The working expenses for the nine months (including interest, sinking fund and terminal fees) were £15,356 4s. 1d. The working expenses for the year are arrived at by transferring a debit item of £5,601. 3s. 8d. for general expenses (engineering commission, proportion of salaries to May 31, 1902, expenditure previous to Sept. 1, 1901, &c.), which, added to £15,356. 4s. 1d., gives a total of £20,957. 7s. 9d., an average working cost per line of £3. 16s. 6d. per annum, or £1. 6s. 4d. less than the average receipts for nine months. No depreciation has been allowed for, as the system is not yet completed, and what work has been done is not yet one year old. It is stated that the announcements which have appeared in certain papers as to the Corporation intending to "scrap" the central switchboard are without foundation. The following statistics are appended to the report:—

Number of switchrooms in operation		9
Number of lines in operation—		
Direct lines to the exchange, tariff No. 1	4,532	
Do. do. do. No. 2	186	
Public telephones	27	
Service telephones	42	
Extensions outside	198	
Extensions inside	412	
Private lines	80	
Sundry lines	2	
Junction lines	306	—5,785
Mileage of metallic circuits in use inside switchrooms and subscribers' offices—		
In switchrooms		306½
In subscribers' offices		221½
Mileage of metallic circuits in use outside switchrooms and subscribers' offices—		
In underground cable		11,061¼
In aerial cables		26
In leading-in cables		317½
Overhead open wires		370½
Number of pairs of wires in underground cables		14,572
Particulars of outside construction—		
Number of underground pipes from exchanges		126
Do. underground cables from exchanges		60
Do. distributing points		982
Do. manholes built		98
Do. poles erected in ground		691
Do. standards erected on roofs		223
Do. fixtures to buildings		6,342
Mileage of trench opened		94 miles 130yds.
Do. pipes laid		104 miles 616yds.
Do. armoured cable laid		53 miles 477yds.
Do. cable drawn into pipes		60 miles 720yds.

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Number of employés—

Salaried officials	11
General office	22
Stores office	8
Operators	121
Canvassers	5
Engineers and draughtsmen	19
Clerks in engineers' offices	12
Cleaners	9
Fitters, inspectors and boys in inside superintendent's department	106
Inspectors, foremen, wiremen, labourers and boys in outside superintendent's department	315—628

Grantham Telephone committee have entered into preliminary negotiations as to the equipment of a municipal telephone exchange, and in the meantime the Council have suspended further operations for the exploitation of the proposed scheme for the present.

Hastings Telephone committee, having considered the report of their consulting telephone engineer (Mr. A. R. Bennett), report adversely on the municipal telephone scheme.

Manchester.—At the meeting of the City Council on Wednesday, the Electricity committee reported that the total number of consumers on March 31 was 4,030, an increase over 1901 of 260. The total number of equivalent 8 c.p. lamps connected was: Incandescent 307,067, arc 2,453, compared with 279,860 and 2,316 respectively. In addition, 774 motors were in use, representing 2,806 H.P., an increase of 102 motors and 32 H.P. The maximum demand on the works at any one time during the year was, for lighting and power, 7,930,000 watts, for traction 1,210,000; total 9,140,000. The total output of electricity during the twelve months was 12,697,590 units, and the quantity accounted for was 11,518,940 units. The total mileage of mains laid on March 31 was 209 miles 1,299 yds., an increase of 50 miles 814 yds. The revenue from sale of current (which worked out at 3·07d. per unit) amounted to £134,462. 13s. 5d., and the expenditure to £74,054. 18s. 3d, leaving a gross profit of £60,407. 15s. 2d. £52,773. 2s. 5d. is set apart for interest and sinking fund, leaving a net profit of £7,634. 12s. 9d. to be carried to reserve. The total borrowing powers to date amount to £2,171,121.

The CHAIRMAN (Dr. Bishop) moved the adoption of the report, and said there had been a steady increase of customers, a large increase in the output and in new mains and a large increase in revenue. He was sorry he could not announce any reduction in the price of electric current, but that question would engage the committee's attention later.

Mr. HEENAN appealed to the committee to let consumers know as soon as possible when they would be ready to meet demands for electricity for power and the price that would be charged, so that employers of labour might make arrangements. He had himself been waiting patiently for four years.

Okehampton.—The Council have resolved to adopt electric lighting for the leading thoroughfares.

Parliamentary.—In the House of Commons, on Thursday last week, the Pacific Cable Bill was read a third time, and in the House of Lords yesterday the same bill was read a third time and passed.

The Great Northern and Strand Railway Bill, the Nottingham Corporation Bill and the Swansea Corporation Bill were read a third time in the House of Commons on Friday last.

On Tuesday last, the London United Tramways Bill was read a third time in the House of Lords, and passed. On the same day, in the House of Commons, the Birmingham and the Midland Tramways and the Great Northern and City Railway Bills were read a third time.

Peterborough.—A further loan of £2,000 for additional generating plant has been applied for.

Precautions against Lead Poisoning.—The members of the Industrial Health Hygienic Section of the British Medical Association visited the works of the Chloride Electrical Storage Co. and Pilkington's Tile and Pottery Co., Clifton Junction, near Manchester, on 30th ult., to inspect (*inter alia*) the provisions and preventatives employed for dealing with lead poisoning and the systems of periodical examination which are voluntarily adopted by both firms. The visitors included Dr. Whitelegge, H.M. chief inspector of factories; Mr. Richmond, superintendent inspector; Dr. Oliver, Government expert; Dr. Gilbert, chief medical inspector of factories of the Belgium Government; and Major E. M. Roe, inspector of factories. The works were inspected throughout under the guidance of Mr. G. A. Grindle on behalf of the Chloride Company and Messrs. Burton for the Pottery Company.

Presentation.—At Wigan last week the chief assistant engineer (Mr. J. W. Hame) was presented with an oak timepiece on the occasion of his marriage. Mr. H. Collings Bishop made the presentation.

Redruth.—Public electric lighting commenced on Aug. 1. Current is supplied by the Urban Electric Supply Co.

Reigate.—The Council are prepared to receive and consider schemes for the construction of electric tramways.

Ross.—The local electric light and power company have submitted a tender for public lighting, and offer to carry out the contract at a figure not exceeding the present charge for gas.

Royal Assent.—The following acts (having electrical clauses) have received Royal assent:—

Aberdeen Suburban Tramways Order Confirmation.
Bristol Corporation.
Cavehill and Whitewell Tramways.
Croydon and District Electric Tramways.
Colwyn Bay and Colwyn Urban District Council.
Electric Lighting Orders Confirmation (Nos. 5 and 6).
Finchley District Council.
Hastings Tramways (extension of time).
Leicester Corporation.
London, Tilbury and Southend Railway.
Metropolitan Railway.
North and South Shields Electric Railway.
Norwich Corporation.
Rhondda Urban District Council.
Salford Corporation.
Southport and Lytham Tramroad.
Whitechapel and Bow Railway.
Wrexham District Tramways (extensions).

Rugby.—An inquiry was held here on Tuesday into the application of the Council to borrow £9,000 for electric lighting. The clerk (Mr. T. M. Wratislaw) and the consulting engineer (Mr. W. H. Trentham) supported the application, which was opposed by a few ratepayers.

Salford.—Some weeks ago Judge Parry, of the Salford County Court, held an inquiry into certain allegations regarding the electricity undertaking of the Corporation. The matters investigated were:—

(1) As to the building, &c., of the Walness works; (2) as to whether the aforesaid works could have been enlarged (so as to use the machinery at present contained therein) sufficiently to supply electric current for the necessary lighting and to run the tramways at the present time and for the next five years; (3) as to the total power provided in the Walness works and the new works, and if found to be in excess of the requirements to go thoroughly into the matter and report to the Council as to who is responsible; (4) as to all matters appertaining to any specifications, tenders or contracts in connection with the erection of Strawberry-road station; and (5) as to any other matters that should be inquired into.

With regard to question (1), his Honour finds that the Electricity committee could not have done more or other than they did. On question (2) Judge Parry has come to the conclusion that the Corporation exercised a wise forethought in moving the works to the new site, and that they would have incurred a large expenditure in trying to make the Walness-road site suitable without any probability of ultimate success. By doing certain things a building probably sufficient for the next few years might have been erected, but it would have been a costly and difficult matter, and not one that any responsible adviser of the Corporation seems to have proposed. On question (3) his Honour states that there was at one time a kind of suggestion made that some parties had advocated large and excessive works in order that they might get large contracts in connection therewith. Such a suspicion was absolutely groundless, and he could state, without the least doubt or hesitation, that if the total power provided was excessive, that excess had in no way been brought about by any fraudulent or wicked means, but had come about by a bona fide though maybe mistaken notion of the needs of the borough. In this connection he states that he can see nothing blameworthy in the action of Mr. C. L. Turner, the late borough electrical engineer for Salford. The result of the committee's actions had been to give Salford an electricity supply in excess of immediate needs, but if he was asked whether it would be in excess of future needs he should refuse to prophesy. That the works were a credit to the borough, and the result of an honest effort on the part of the committee and their servants to produce what was supposed to be requisite, he has no doubt. At present there is an excess of power, but if they applied the historical analogies of gas, water, railroad, and similar undertakings it would be within probability that Mr. S. V. Clirehugh (their consulting engineer) was right when he spoke of the works as an intelligent anticipation of public demands. As to question (No. 4) Judge Parry cannot see that anything wrong was done by Sir Richard Mottram in regard to it. The boiler matter was even more remote from evil, and he is satisfied that the decision of both committee and Council was honestly arrived at, and that no one sought to influence them in their decision by unworthy or improper means. With regard to the allegations that the cable contract was not carried out according to specification, his Honour complains of the refusal of Mr. Wheatcroft and Mr. Turner to give any particulars of their complaints. He is of opinion that no wrong has been done to ratepayers by deviations made, and that Mr. Clirehugh had dealt honestly with the Corporation in all these matters.

On the question of the principle laid down by Mr. Hunt during the inquiry that a councillor must not trade with another person doing business with the Corporation, Judge Parry considers that that view is certainly not the law, and is not a sensible proposition to put

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forward, and concludes that, if that principle were sound, either trade would be paralysed or a municipal council must consist solely of those undesirables who had neither trade, occupation, business, nor profession. The report concludes on this point as follows :—

A councillor is not fettered in carrying on his ordinary business in his ordinary way, or in trading with persons who trade with the Corporation. He may sell where he pleases, and that the person to whom he sells is a trader with his Corporation is of no importance. Even if the things he sells come, by ultimate re-sale, into the hands of his Corporation it does not disqualify him from his post. But he must not enter into a contract with his Corporation, nor must he take a portion of another man's contract with his Corporation, nor have any interest in such a contract. He seems to me to be in a position of trust, and is put on reasonable inquiry to discover whether he is trading with his Corporation through some other firm, for that is clearly forbidden. I need hardly add, perhaps, that anyone who seeks to evade the law by invoicing goods in another's name, or by any underhand means seeks to trade with his Corporation, is far more likely to prove his disqualification than to escape the penalties of the section. An honest trader may, by carelessness or mistake, find himself trading with his own Corporation, but there need be no reason, with ordinary care, why such a thing should take place. No amount of ingenuity, however, in the form and manner of sales can assist a dishonest man who tries to evade the law. If he passes his goods through half a dozen hands and his intention is to trade with his Corporation, the complication of the transaction will not assist him.

The report was received and adopted by the Corporation on Wednesday.

South Africa.—The *British and South Africa Export Gazette* states that the *Durban* Municipal Council have decided to make considerable extensions to their electricity works, including two additional 500kw. generators, at an estimated cost of £23,000.

Durban County Electric Tramway Syndicate, which recently acquired sanction for the construction of an electric tramway from the city boundary to New Brighton, is making preliminary arrangements for the construction of the line. The syndicate will supply current for light and power to private consumers in the districts traversed.

Johannesburg City and Suburban Tramway Co. have been officially informed that His Majesty's Government recognises the concession granted by the late Republican Government, but the Transvaal Administration requires them to resume an efficient service at the earliest opportunity, in accordance with the terms of the concession. The company has offered to construct electric tramways, but the offer has been declined, as the Council has decided to run its own service, and a committee has been appointed to consider details.

The Works committee of the *Johannesburg* Town Council, in a recent report, call attention to the fact that, owing to the extraordinary climatic conditions which prevail in the Transvaal in the summer, all the various type of transformers for overhead high-tension mains offered in recent tenders failed, under the tests, save those manufactured in Switzerland and Berlin, and point out that transformers of English pattern are designed entirely for running on underground mains, and for working in a climate where severe lightning is unknown.

Johannesburg Municipal Council have extended the contract with the Rand Central Electric Works for the supply of electric current from Dec. 31, 1903, to Dec. 31, 1904, on the same terms as hitherto.

Indwe Colliery Co. (Cape Colony) are putting down generating plant for supplying electric current for lighting and power in their mine, and also for the supply of current in Indwe. The capacity of the initial plant is 400 H.P., and current will be employed for coal-cutting, hauling, &c.

The *Pietermaritzburg* Town Council are about to construct electric tramways. The scheme, which has been prepared by the borough engineer and the borough electrical engineer, is estimated to cost £75,000.

In *Natal* the employment of electricity is one of the features of the labour-saving movement, and it is announced that one firm has laid down electric power plant at Umhlati, current being generated by the waters of the river Umvoti. Electrically-driven pumps have been installed in a factory at Esperanza. On many of the sugar estates the use of tramlines is increasing, and it is urged that electric locomotives would be very suitable for use on these lines.

Teddington.—The borough electric engineer at Kingston (Mr. J. E. Edgcome) has been appointed consulting engineer to the Council.

Tipton.—The dispute between the Council and the Midland Electrical Corporation for Power Distribution as to the charge for electric current has been referred to arbitration.

Twickenham.—Electricity supply is now available in this district. The Twickenham and Teddington Electric Supply Co. are owners of the works.

Wallasey.—The Gas and Electricity committee have instructed the electrical engineer (Mr. W. Travers) to prepare a scheme for the further extension of the electricity supply works to provide for the probable requirements of the next seven years.

Worcester.—The Council have entered into an agreement with the British Electric Traction Co. to convert the tramways to electric traction.

Worthing.—Owing to the increasing demand for current, extensions of the generating plant are necessary, the equivalent of 8,410 8 c.p. lamps being now connected to the mains.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Poplar (London) Electricity committee invite tenders for the supply of arc lamp carbons. Specifications, &c, from the borough electrical engineer (Mr. Alfred Blackman), electricity works, Glaucus-street, Bromley-by-Bow. Tenders to the town clerk (Mr. Leonard Potts), Council offices, High-street, Poplar, E, by Aug. 25. Further particulars are given in an advertisement.

Aberdeen City District Lunacy Board invite tenders for an electric light installation at Kingseat Asylum, Newmachar. Plans with the architect (Mr. E. Marshall Mackenzie), 343, Union-terrace, Aberdeen, and tenders to the clerk (Mr. C. B. Williams), 20, Union-terrace, Aberdeen, by 10 a.m. 25th inst. See also advertisement.

Plymouth Corporation invite tenders for overhead-line construction, &c. Specifications, &c., from the borough electrical engineer (Mr. E. G. Okell), Prince Rock, to whom tenders by Aug. 23. An advertisement contains further particulars.

Accrington Watch committee invite tenders for supply and erection of nine arc lamps and pillars. Specifications from the borough electrical engineer (Mr. H. Gray), and tenders (addressed to chairman) to the Town Hall, Accrington, by noon Aug 19. See advertisement.

Tenders are wanted for two single-phase, alternating-current motors of 4 H.P. and 6 H.P. Particulars from Mr. E. L. Newman, Phœnix Brewery, Notting Hill, London, W. See advertisement.

The directors of the *North-Eastern Railway Co.* invite tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. (See the last issue of *The Electrician* for particulars.) Tenders to secretary (Mr. C. N. Wilkinson), York, by noon Oct. 7.

Malvern Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work), engines, alternators, exciters and switchboard, high and low-tension concentric cables and transformers. Tenders to chairman of Gas, Water and Electricity committee by Aug. 23.

Rugby Urban District Council invite tenders for one 150kw. and one 60kw. high-speed steam alternators (three-phase), switchboard, underground mains, arc lamps, public incandescent lamps, &c., and meters. Tenders to clerk by 3 p.m. Aug. 20.

Pemberton Urban District Council invite tenders for feeder cables, and overhead electrical equipment, engines, dynamos, &c., boiler, &c., rail bonds, rails, fishplates, &c., and switchboard. Tenders to clerk by noon Aug. 20.

Leicester Tramways committee invite tenders for steel girder tramway rails and fishplates; points, crossings and special track work; feeder cables; telephone and test wires; overhead electrical equipment and copper bonds; steam-raising plant, engines, generators, batteries, boosters, switchboard, overhead travelling crane, electric tramcars, &c., &c. Tenders by noon Sept. 3.

Cork District Lunatic Asylum committee require tenders for electric lighting plant for the Youghal Asylum. Tenders to medical superintendent, Eglinton Asylum, Cork, by Aug. 12.

Glasgow Corporation require tenders for wooden troughing for cables, with bends and brackets. Tenders to town clerk by 14th inst.

Ilford District Council invite tenders for a combined track-watering and sweeping car on maximum traction truck with complete electrical equipment. Tenders to chairman of Council by noon Aug. 19.

Hackney (London) Electric Lighting committee invite tenders for the erection of coal stores, including steel work. Tenders by Sept. 11.

London County Council invite tenders for seven tubular fuel economisers and seven motors, and also for dampers and frames for flues and chimney openings. Tenders to clerk by Aug. 15.

Wolverhampton Guardians invite tenders for electric lighting plant, and for wiring new workhouse. Tenders to clerk by Aug. 13.

The *French* Post and Telegraph authorities invite tenders until 20th inst. for 300 tons of copper wire in six lots. Tenders to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle 103, Paris.

The *Madrid Gazette* of Aug. 3 contains the conditions under which 30,000 porcelain insulators (No. 1) have to be purchased by public tender by the Telegraph Department of the Ministry of the Interior of Spain. Tenders have to be sent to the Chief of the Department

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of Telegraphs 20 days from Aug. 4. The *Gaceta* of Aug. 3 can be seen by appointment at *The Electrician* offices, Salisbury-court, Fleet-street, London.

The *Norwegian State Railway* authorities invite tenders until Sept. 13 for the supply of 22,000kg. of telegraph wire, No. 8, galvanised iron wire, 4·1mm. to 4·3mm. dia.; 5,400kg. of telegraph wire, No. 11, galvanised iron wire, 3·1mm. to 3·3mm. dia.; 3,600kg. of copper wire, 2·4mm. to 2·6mm. dia.; 5,900 porcelain insulators; 5,900 insulator holders. Particulars from Inspector of Telegraphs, Stoners Gade, Christiana.

TENDERS RECEIVED AND ACCEPTED.

The contract for the motor equipment of the Tokyo Imperial Dockyards has been secured by Messrs. D. Bruce Peebles & Co.

The contract for a storage battery for tramway work at £3,423. 12s., and £186 per annum for maintenance after the period of maintenance provided for in the specification, has been placed with the Electrical Power Storage Co. (Ltd.) by Brighton Corporation. The tender of D. Bruce Peebles & Co. for booster and switchboard at £975 has also been accepted.

Blackpool Corporation have accepted the tender of Messrs. Crompton & Co. for the supply of arc lamp carbons.

Tunbridge Wells Town Council have accepted the tender of the Alphons Custodis Chimney Construction Co. for the erection of a 180ft. chimney shaft at the electricity station for £2,330.

Rochdale Tramways committee has ordered three additional tramcars from Messrs. Dick, Kerr & Co.

Messrs. Askham Bros. and Wilson (Ltd.), of Sheffield, have received a substantial order from the Sheffield Corporation for toughened crucible cast steel points and crossings.

Newcastle-on-Tyne Town Council have accepted the tender of Messrs. M. A. Potts & Co. for the supply of rails for the Walker electric tramway extension.

Monmouth Town Council have accepted the tender of Messrs. Davey, Paxman & Co. for the supply of a boiler at £398. 13s. 6d.

Bath City Council have accepted the tender of Messrs. Kendall & Sons for wiring the baths, at £272. 7s. 6d.

Rotherham Town Council have accepted the tender of Messrs. W. Thornton & Son for the extension of the electricity station building at £3,139 and that of Messrs. Newton, Chambers & Co. for constructional ironwork at £338.

BANKRUPTCIES AND LIQUIDATIONS.

C. V. T. de Falbe, 1, Penywern-road, Earl's Court (lately trading as the Electrical and General Contracting Co. at 17, Shaftesbury-avenue), London, has been adjudicated bankrupt. Mr. E. H. Hawkins, 3, Barbican, London, E.C., is trustee.

A meeting of the Electrites Co. (Ltd) will be held at 40, New Broad-street, London, E.C., on Sept. 2, to receive an account of the winding-up.

Works Sites.—Particulars are given in an advertisement of land, with railway siding, which Messrs. H. Arnold & Son, Doncaster, have for sale.

Plant for Sale.—Maidstone Corporation invite offers for a 14 H.P. Crossley gas engine and dynamo. Tenders to town clerk (Mr. Herbert Monckton) by Aug. 22. See advertisement.

Patent for Sale.—A patent relating to generation and regulation of electricity supply is advertised for sale on another page.

Fire.—A fire broke out at the London County Council tramway works, Penrose-street, Walworth-road, S.E., on Tuesday. The boiler-house was damaged.

Catalogues.—A new list of "B. B." wood split pulleys is now ready, and can be obtained from Messrs. Bagshawe & Co., 3, Tower Royal, London, E.C. It is claimed that these pulleys are 70 per cent. lighter than cast iron and 40 per cent. lighter than wrought iron or steel, that they present the best belt surface, the best shaft fastening, and are stronger than any other pulley on the market.

A price list of "Stellite" electric fans, manufactured by the Electric and Ordnance Accessories Co., Cheston-road, Aston, Birmingham, is now ready, and will be sent by the company post free on receipt of trade card. The list is fully illustrated.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from July 30 to Aug. 6, with the ports of destination:—

Africa—Alexandria, £147; Cape Town, £154; Durban, £983 (including £780 telegraph material); East London, £59. *Australasia*—Auckland, £720; Brisbane, £2,263; Fremantle, £2,990 (including £2,215 telegraph material); Perth, £42; Sydney, £1,115. *Belgium*—Antwerp, £205. *Brazil*—Rio Grande, £18. *Canada*—Halifax, £934 (telegraph material). *Ceylon*—Colombo, 60 tons (telegraph wire). *Channel Islands*, £18. *China*—Chefoo, £44 (telegraph apparatus); Shanghai, £265. *Denmark*—Copenhagen, £192 (telegraph material). *Germany*—Hamburg, £20 (telegraph material). *Holland*—Amsterdam, £90. *Hong Kong*, £160. *India*—Bombay, £56; Calcutta, £1,188 (including £462 telegraph material); Madras, £16. *Russia*—St. Petersburg, £44 (telegraph material). *Straits Settlements*—Singapore, £40. *Sweden*—Gothenburg, £410; Stockholm, £20. *U.S.A.*—New York, £129. Total, £12,322, against £29,526 for eight days last year (July 31 to Aug. 7).

COMPANIES' MEETINGS AND REPORTS.

British Electric Transformer Mfg. Co. (Ltd.).

The fourth ordinary general meeting was held on Friday last, Mr. R. STEWART BAIN presiding.

The SECRETARY (Mr. J. C. Wrist) having read the notice convening the meeting and the auditors' certificate,

The CHAIRMAN said: Gentlemen, the old proverb that "good wine needs no bush" may, I think, be appropriately applied to these accounts and to this Company. For three years in succession it has been my pleasure to recommend a dividend of 10 per cent., after putting aside provision for reserve, depreciation, &c., amounts equal to another 10 per cent. In the face of the keen competition which exists in these days, and the talk of the British manufacturer being ousted by the foreigner, here, at least, we have an electrical machine which is successfully holding its own against these attacks. The best proof that can be given of this is our ability, year by year, to pay these substantial dividends, and not only to strengthen our position financially, by adding substantial amounts to our reserve fund, which is now equal to about 30 per cent. of the amount paid for our patents, but to strengthen it from a technical point of view by the aid of our adviser, the original inventor of our apparatus, who is not only able to keep abreast of the times, but with his keen intuition and inventive ability anticipates the requirements of the industry, and by his new discoveries and adaptations keeps adding to our existing patents, increasing their value and lengthening their duration. Many of our shareholders, I am glad to say, are scientific men, and, being connected with the electrical industry, are better able to judge of the merits of the transformer than I am; but when I was at the works yesterday I had an opportunity of inspecting some transformers built in accordance with our new patents, and it was obvious, even to a layman, that the 1897 designs had been greatly improved upon. The new transformers were more compact in form, and the mathematical lines in which they appeared to be constructed appealed to me, as I feel they must do to all of you who are engaged in this industry. I am of opinion that our new designs are as far in advance of our 1897 designs as those were in advance of the designs in existence then. I need only further point out that this means that we have added another four years to the life of our patents. In addressing you last year I mentioned that our new works at Hayes were nearing completion and that we hoped to commence manufacturing in October. The actual commencement took place in November. The new works have, you will be glad to learn, much better facilities for handling work than had the old. The profit and loss account shows that although we had this removal to contend with, our sales have increased by 12 per cent. as compared with last year's, and our profit has increased from £6,658 to £7,194, which, with the amount carried forward, £1,960. 14s. 11d., gives us an amount of £9,155 7s. 10d. to deal with, which enables us to recommend the usual dividend, to set aside the usual amount to reserve fund and to increase the amount carried forward. The balance-sheet, which I think may be considered very satisfactory, shows that we have expended £452. 18s. 11d. in additional patents. This amount includes the cost of our applications for single and polyphase patents in nearly every country in Europe as well as the United States of America, Canada and South Africa. It also includes a new three-phase patent which we have acquired during the year. The total expenditure on the new works, including freehold land, is £5,348. 14s., or £651. 6s. less than the estimate. This, as well as the economy and efficiency exercised in the removal of the works, we may attribute to special attention and ability exercised by our manager, Mr. Hetherington. I will not trouble you further with the accounts, but will now refer to our position generally. The subscribed capital of the company was £20,000. We have carried on our works upon this comparatively small capital for 3½ years. For three successive years we have paid a dividend of 10 per cent. and put aside £7,500 to a reserve fund, and we are carrying forward £2,600. In addition to this, we have purchased freehold land upon which we have built our new works without increasing this capital, and, further, you will see from the balance-sheet we have to carry forward debts due to us amounting to over £12,000. All this has been done on £20,000, out of which £5,000 was paid to the vendor. But we cannot accomplish impossibilities, and we have now reached a period when, if the Company is to increase its output, and, I trust, its profits, it will be necessary to raise more capital. We have not yet been in our new works quite nine months and already the necessity for extensions is exercising our minds. Large power schemes in several parts of the country are now advanced so far as to be in the market for plant, and the transformers for these will be on a large scale, both as to numbers and output, and we shall do our best to secure a good share of them at prices leaving a fair margin of profit. Then, again, station engineers with continuous-current plant are now finding it advisable to lay down alternating plant alongside the continuous

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plant, to enable them to reach the outlying parts of their areas or to supply districts outside, and some considerable work of this kind will be coming out shortly. Then there is the question of our foreign patents. We believe that these foreign patents form a very valuable asset, and it may be more to the advantage of the shareholders that subsidiary companies should be formed in the various countries to work them rather than to grant licences. I need hardly point out that this is very largely a matter of capital. As you are aware, the authorised capital of the Company is £50,000, of which £40,000 has been issued, leaving only £10,000 to be issued on the present capital. With the hopeful prospects in view, I think it is unnecessary to point out that the ultimate capital of the Company must be considerably in excess of £50,000, but whether we decide to rest content for the present with issuing the £10,000 still remaining unissued, or to ask you to increase the nominal capital to a greater extent largely depends on circumstances. I may state that the work in hand shows a very large increase as compared with the corresponding month of last year—in fact, more than twice as much. I now move the adoption of the report and accounts.

The motion was carried unanimously. The retiring director (Mr. T. Petersen) and the auditors were re elected, and a vote of thanks to the Chairman terminated the proceedings.

Anglo-American Telegraph Co. (Ltd.).

The half-yearly meeting was held on Friday last under the presidency of Mr. FRANCIS A. BEVAN.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting,

The CHAIRMAN said that, in consequence of the decrease in the receipts for the first quarter, the directors were not able to pay the dividend for that period which they had distributed for some time past of 15s. per cent. on the ordinary stock and 30s. per cent. on the preferred stock. There was only sufficient in hand to pay 12s. 6d. and 25s. per cent. respectively on these stocks. In the second quarter of the year, however, the traffic increased, and they were enabled to pay the 15s. and 30s. for this period. The receipts for the six months had been £13,167 less, consequent, possibly on the volume of business being less, and he believed that that had been the experience of submarine cable companies generally in this period. Apparently, however, there was going to be an improvement, and for July their own receipts had been slightly more than those for the corresponding month last year. Their repairing ship "Minia" earned in the past half-year £5,605 less, owing to the good order of the cables of all the associated companies. On the other hand, more had been received from interest and transfer fees; and in the expenses there had been a decrease in various items amounting altogether to £6,048. Thus, the net decrease in the past six months' receipts had been reduced to £12,510. All their cables were in good working order, excepting a small one on the other side of the Atlantic, which would be repaired very quickly. The half-year had been singularly devoid of any striking event. Of course, the proprietors had seen in the newspapers from time to time reference to a matter which the board watched with the greatest carefulness—the development of wireless telegraphy, which was not now associated with the name of Mr. Marconi only, but with other systems. What would eventually develop from this they were not able to say. They had been told from time to time that they would see the system established in a month or so, or in six months, but they were now in August, and nothing had occurred, so far as he knew, to make them alter their previously-expressed opinion—that, although the system would produce a certain class of telegrams, such as between ship and shore or between ship and ship, there was no reason why it would compete with the class of telegrams which they and other submarine cable companies transmitted, for they could not see that this system would be able to compete with theirs in accuracy or speed. He might give them an illustration of the former point. In one day this week they were able to send from their Stock Exchange office no fewer than 1,063 messages in the space of two hours. It might be said that these messages were short, but so long as they were able to send them with that speed, and with perfect accuracy, the directors did not think the shareholders need be greatly alarmed about the development of wireless telegraphy. He might state that, like his friend the chairman of the Direct United States Cable Co., he had met Lord Kelvin the other day and had a conversation with him on the subject, and Lord Kelvin said:—"I have given careful consideration to the subject, and I do not believe the shareholders in your company need be alarmed at the prospect of wireless telegraphy." Of course, they could not say what might happen—science developed in such a wonderful manner that it was impossible to prophesy—but considering the speed and accuracy with which they could send telegrams, he thought it would be a long time before wireless telegraphy did them very much harm. He regretted that the French lawsuit had not yet come to an end, but they were now waiting for the fixing of a day by the Court of Cassation for the hearing of what it was hoped might be the final suit. He moved the adoption of the report and accounts.

Mr. CHARLES BURT seconded the motion.

Mr. W. A. THOMPSON said he saw that the board added £24,000 a year to the renewal or reserve fund, and he wished to know whether that addition would stop when this fund reached £1,000,000. As to the French lawsuit he understood the chairman at a former meeting to state that a verdict had been given in the company's favour for £250,000.

Mr. BAGGALLAY inquired whether the reduction in the traffic receipts was owing to a lowering of the rates or to a smaller number of messages having been sent. If the latter, was it due to foreign competition?

Mr. JOHN CHESTER considered that the deferred shareholders had been treated harshly in the matter of the renewal fund additions. In years gone by, when the traffics were very different and their difficulties were very much greater, the directors were no doubt justified in going on building up the renewal fund; but it now amounted to £923,000, and he thought the time had arrived when the deferred shareholders should be treated differently.

The CHAIRMAN, in reply, said at the present meeting the discussion of the renewal fund did not properly arise. He was perfectly aware that his predecessor, Lord Monck, used to say that when the fund reached £1,000,000 the directors should carefully consider whether there should not be given to the shareholders the £24,000 now annually put to it out of the traffic receipts, or the interest earned by the fund itself, or both. When the fund reached £1,000,000 the matter would be taken into the board's serious consideration. They did not think that the renewal fund was at all excessive. They had 10,000 miles of cables, and though it might be said that they were all in good working order, yet if a bad accident occurred it would be more difficult to lift them for repairs with every year that they were down. In their past history—he believed it was in 1894—out of seven cables owned at the time by the pool, as many as four were interrupted at one time. It was perfectly true that he stated at a former meeting that a judgment had been given in their favour in the French lawsuit for £250,000, plus 5 per cent. interest, but that did not mean they would get that money. He could not say that he was sanguine of getting a large amount. The reduction in the traffic receipts was due to the reduction in the volume of business.

The motion was then carried unanimously.

A vote of thanks to the chairman and directors closed the proceedings.

Central London Railway Co.

At the meeting, on Tuesday, the CHAIRMAN (Sir Henry Oakley) said their past half-year showed most encouraging features, so far as working and the results of working were concerned. They had received on debenture account £107,000, and had spent £21,137. They had expended money on the purchase of land at Shepherds Bush for enlarging the station there, and for providing additional lifts. At Marble Arch, also, they had completed the purchase made some time ago, anticipating the necessity of enlarging that station, which would be necessary shortly. The further expenditure was for providing new motor cars, which the board had determined to adopt with the view of avoiding complaints on the subject of vibration. He hoped they would begin delivery in Ooctber. They had endeavoured and they would endeavour, by the working and arrangement of their stock, to prevent any possibility of complaint on the ground of vibration. They had increased the number of passengers carried by nearly 2 500,000 in the half-year, bringing the number for the half-year up to 23,000,000. The average fare practically remained about the same. It was now 1·88d.; previously it was 1·90d. Their gross receipts were £185,118, or £20,000 more than in the corresponding period last year, and practically represented an increase of 12½ per cent. in receipts. The average earning per train-mile was 5s. 8d.; last year it was 5s. 2d. They had run 15,000 more miles in the half-year to earn their additional £20,000; but the most satisfactory feature about it was that additional revenue had been earned without any real addition to their working expenses. Rates and taxes were £5,153 more than they were last year. Their assessment had been increased. There was no real variation in any of the items forming expenditure, and, with the balance from last year, they had £93,465 to divide. After providing for debenture interest, £82 600 remained. They recommended the appropriation of £47,000 in payment of dividend at the rate of 4 per cent. per annum on the original stock and on the preferred, and also to provide £9,994 further for dividend on the deferred stock, which was not payable until the end of the year. That left £25,600 to carry forward. They put aside £10,000 last year towards a reserve fund, and proposed at the end of the year to make a further addition to it. To add to the comfort of their passengers they pumped out the tunnel air every night. They could not effectively do it in the daytime, owing to the number of openings and shafts, because pumping out the air, unless the doors were closed, would be simply clearing the space between any two stations, and not the rest, but they did really clear the tunnel out every night, and their atmosphere was infinitely purer than that of any other underground railway. After referring to the throwing out of their bill by the Parliamentary Committee, he proposed the adoption of the report and accounts.

The motion was adopted.

Great Northern and City Railway Co.

At the meeting on Friday the CHAIRMAN (Sir Charles Scotter) said that the contractors were of opinion that the line between Drayton Park and Finsbury-pavement could be opened for traffic in four or five months. It would, perhaps, be nearer the mark if he said that that section would probably be completed and ready for opening by the end of the year. At Poole-street they had erected a spacious and handsome generating station, one of the largest in London. The engine house was practically finished. Its dimensions were: 52ft. by 122ft. by about 60ft. high, excluding basement. The plant consisted of four 1,600 I.H.P. engines, with a capacity for sudden overloads up to 2,500 I.H.P. These engines were provided with steam from 10 Davey-Paxman boilers of the cylindrical marine type, and there was up-to-date coal-handling plant. The engine house was provided with a 30-ton electric crane. There were auxiliary engines to ensure that the tunnels should always be lighted. Their tunnels were larger than those of any tube railway in London, being 16ft. against 10ft. and 11ft. of the other companies; so that, assuming there was a breakdown, passengers would be able to get out and walk along the railway. The tunnels would always be lighted whenever there was a train running, and people would, if necessary, be able to walk along with the greatest safety. These auxiliary engines were of the "Peache" type, and

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were supplied by Messrs. Davey, Paxman & Co., Colchester. The boiler house was 60ft. wide, 80ft. long, and 50ft. high. The steel work of the coal storage bin was incorporated with the framework of the buildings over the boilers. It had a capacity of about 1,000 tons of coal, sufficient for about a month's supply. The dynamos, motors and electrical equipment were supplied by the British Thomson-Houston Co., and economisers and mechanical stokers were provided. The rails were all delivered and in process of being raised. They were 85lb. per yard. Special rolled steel chairs support the rails, and were fixed every 2ft. 6in. The rolling stock, which was being constructed by the Electric Railway and Tramway Carriage Works, Preston, and by the Brush Company, of London and Loughborough, was most luxurious and roomy. The carriages were wider than any existing suburban carriages, being 9ft. 4in. wide overall, by 50ft. in length. Seven carriages went to form a complete train, three of them being motor carriages, and equipped with six 125 H.P. motors. They were to be controlled on the multiple unit plan, and were of the same type as those about to be adopted by the Metropolitan and Metropolitan District Railways. The seating capacity of the trains would be about 450 passengers. The lifts were being constructed, and would be ready when required. All the equipment had been supplied by British firms. The directors were considering the question whether to open the section between Drayton Park and Finsbury-pavement, or whether they should wait until the short bit of line at the Finsbury Park end was completed and the station made under the existing Finsbury Park station of the Great Northern Railway. In their bill to Parliament they asked for an extension of time, for powers to construct a station at Highbury, to purchase the land on which the generating station was erected, and to extend the line from Finsbury-pavement to Lothbury. Their bill passed through without serious difficulty, but a clause as to vibration was inserted.

BARCELONA TRAMWAYS CO. (LTD.)—An extraordinary meeting was held on Wednesday to confirm an agreement between the company and Luis Pujol and Juan Llopart, of Barcelona, conferring an option to purchase the company's undertaking for £590,000 plus value of unissued stores, cash in hand, &c., on Oct. 31. The purchasers, if they decided to carry out the purchase, had to pay £196,000 on Oct. 31 in addition to £4,000 already received, and to give a guarantee of a first-class London bank for payment of balance of £200,000 on Nov. 30, and £190,000 on Dec. 31. They might postpone the payment of each of the last two instalments for two months, but the final payment must be made not later than Feb. 28. The purchasers would take over the undertaking on Nov. 1. Debenture and preference holders would get a fixed sum. The board estimates the return to the ordinary shareholder at about £11. 10s. to £12. The sale was unanimously approved.

METROPOLITAN RAILWAY CO.—At the meeting on Friday the chairman (Mr. J. J. Mellor) said that they had not lost a day or an hour in pushing forward their scheme of the electrical conversion of the line. The work had occupied the constant time and attention of the board and officials, and already substantial progress had been made. The contracts were let early in the year with the British Westinghouse Co. for the complete installation of the power house at Neasden. They had been blamed for the delay in effecting the transformation. As a matter of fact, however, there had been no electric railway in the metropolis up to the present time which could be called a complete success, looked at from the purely electrical side. Certain serious defects and drawbacks had revealed themselves in the working of those railways, and those, of course, they could and should avoid. The contract for the installation at Neasden had been given that morning to the British Westinghouse Co. The contract for the conducting rails—a heavy item—had been let. The design for the rolling stock had been approved, and the contract for that portion of the equipment was in hand. The best form of carriage—the one best adapted to secure the comfort, convenience and safety of the public, had received their consideration. They had also had to consider the important question whether they should have one, two or three classes of carriages. The conclusion they had come to was that there was a demand for two classes by the public travelling on their system. A considerable percentage of their patrons would willingly pay a little more for extra accommodation, and they believed that if that price was not too high they would be considerable gainers by having a first as well as a third class. As to the Neasden generating station, it was unquestionably their best policy to put down their own plant on their own land. There was ample space for the generating plant and for any subsequent enlargement of the station. With their power house at Neasden they could carry the cables entirely over their own system without paying for way leaves or coming under any obligation to outside authorities. The two new directors went into that question thoroughly, and after full examination expressed themselves perfectly satisfied they had taken the right course. There was also an ample water supply on the spot. Their consumption of electric current was estimated at 70,000,000 units per annum, and if they purchased their water from a company the cost would not exceed $\frac{1}{10}$th of a penny per unit. If they brought it from their land at Rickmansworth the cost would be only $\frac{1}{3}\frac{1}{0}$th of a penny per unit. At Neasden, at a depth of 400ft., they had found a supply of pure clear water capable of yielding sufficient for all their requirements. Referring to the struggle between the promoters of the two groups of tube railways, he said they had two American magnates fighting for supremacy on English ground. In their anxiety to secure Parliamentary sanction for their rival schemes they were making reckless promises as to price at which they were prepared to carry passengers—in some instances that price was as low as 1d. for 8 miles. If so, they would not all be Central Londons, which possessed a route presenting exceptional advantages. They still had confidence in their own property. They believed they had touched the bed-rock of their traffic decrease, and that the tide had turned, increases having already set in, and when the locomotive was banished from their underground system it was only reasonable to expect the present traffic increases would receive a great impetus.

METROPOLITAN DISTRICT RAILWAY CO.—In the report for the June half-year it is stated that the company has again suffered seriously from the competition of the Central London Railway, although the recent large reductions of fares at Ealing, Hammersmith, and other West End stations may assist the company to regain its traffic. 986,355 more passengers were carried during the half-year, but the money earned has been £864 less. Ealing and Harrow line is being prepared for electric traction, and, it is hoped, will be opened before the end of the present year. The Metropolitan District Electric Traction Co., who contracted to erect the power house at Chelsea and electrically equip the District Railway, had become absorbed in a larger company, with a subscribed capital of £5,000,000, known as the Underground Electric Railways of London (Ltd.) That company was rapidly pushing on with the erection of the generating station and the other works. The contracts for the construction of the Brompton and Piccadilly Circus Railway had been let, and the works are in active progress. Mr. Alfred Powell, for a long time general manager of the company, has, through failing health, resigned his office, and in view of the conversion of the railway to electric traction at an early date, the directors do not propose at present to fill up the appointment.

At the meeting yesterday, the chairman (Mr. R. W. Perks, M.P.) moved the adoption of the report, and said that the company had suffered, and was still suffering, seriously from the competition of the Central London Railway and the London United Tramways. They had recently made drastic reductions in the rates charged on the District Railway. He explained the measures taken for working the line by electric traction under the arrangement made with the Underground Electric Railways of London, which had absorbed the Metropolitan District Electric Traction Co., the original capital of £1,000,000 having been increased to £5,000,000. The electric company had acquired the whole of the land at Lot's road, Chelsea, for the power house, and statutory powers had been taken to extend the house, with the result that they would be able to generate electricity up to 60,000kw., the station being the largest for traction purposes in the United Kingdom. The contracts had been let for laying cables between Lot's-road and Earl's Court.

WATERLOO AND CITY RAILWAY CO.—At the meeting yesterday the chairman (Col. the Hon. H. W. Campbell) proposed the adoption of the directors' report, and said that on the present occasion the accounts showed an improvement on last year, because, after providing for 3 per cent., there was a surplus of £504, and as, by arrangement with the London and South-Western Company, the accumulated deficiency in net revenue of past half-years had been disposed of, the surplus over 3 per cent. came in for division between the two companies. Their company took two-thirds. That did not enable the directors to pay more than 3 per cent. per annum for the past half-year, but after paying that dividend on the ordinary and debenture stock they carried forward a balance of £458. To pay a dividend of ¼ per cent. would require £675. The ordinary stock remained unchanged at £540,000, but the debenture stock was more by £6,500, making the total on June 30 £65,500. The total amount received on capital account was £605,500, and the total expended £605,317. The London and South-Western Company had paid over £8,191 on an adjustment of accounts, and had at the same time relieved this company from being called upon at any time to pay the accumulated deficiency to June 30, 1902. The arrangement did not, however, extend to any deficiency which might arise in the future. If further capital were required it was provided for by the available powers, amounting to over £106,000. Passenger fares, less Government duty, amounted to £16,957, an increase of £855 compared with the corresponding period of 1901. Working expenses were £7,714, or £1,200 less than a year ago, while compared with the gross receipts the rate was 44·84 per cent. against 54·78 in June, 1901. A dividend of 3 per cent. per annum absorbed £8,100 out of £8,558 available, and they carried forward £458. Nearly 2,250,000 passengers were carried during the half-year, exclusive of season-ticket holders. The working company had introduced an altered system of signalling, and were thus enabled to run the trains more frequently.

NEW COMPANIES, STATUTORY RETURNS, &c.

BARNABY & CO. (LTD.)—Reg. July 28, capital £3,000 in £1 shares, to act as an electricity supply company, to generate, accumulate, transmit and distribute electricity, and to carry on the business of electrical and mechanical engineers, manufacturers of, agents for and dealers in electric, magnetic, telegraphic, telephonic and other apparatus, &c. The first directors are W. Collins and W. F. Barnaby. Reg. office, 13, College-street, Rotherham.

DUBLIN AND SLANE TRAMWAY CO. (LTD.)—Reg. Aug. 1, capital £1,000 in £1 shares, to carry on the business of a tramway company, electricians, electrical and mechanical engineers, &c. Reg. office: Lower O'Connell-street, Dublin.

ELECTRICAL AUTOMATIC LOOM SYNDICATE (LTD.)—Reg. Aug. 1, capital £60,200 in 60,000 preference shares of £1 each and 4,000 deferred share of 1s. each, to acquire and turn to account patents, inventions, &c., relating to the automatic changing of shuttles or to the automatic indication of breakage in weft or warp, or to other devices for the better working of looms, or otherwise, to adopt an agreement made between the Electrical Machinery Developments Co. (Ltd.) and others, manufacturers of and dealers in looms and other machinery, &c. The subscribers include the Electrical Machinery Developments Co. (Ltd.) who hold 3,900 preference shares. Reg. office: 151, Cannon-street, London, E.C.

FARMAN AUTOMOBILE CO. (LTD.)—Reg. July 29, capital £60,000 in £1 shares, to carry on the business of motor, motor car, motor yacht, launch,

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airship, cycle and carriage manufacturers, vendors, dealers in and makers of vehicles propelled by electricity or other motive power, mechanical, electrical and general engineers, &c. Reg. office, 100, Long-acre, W.C.

JESSOP & CO. (LTD.)—Reg. July 29, capital £270,000 in £10 shares, to acquire business of Jessop & Co. (Ltd.), Calcutta, and to carry on the business of electricians, mechanical engineers, tool makers, brassfounders, &c.

NEW GUTTA-PERCHA CO. (LTD.)—Reg. July 30, capital £200,000 in £1 shares, to manufacture, refine, prepare, grow, import, export, and deal in indiarubber, gutta-percha, balata, &c. Reg. office: Dashwood House, New Broad-street, E.C.

NEWTON-PEARCE MOTOR CAR CO. (LTD.)—Reg. Aug. 1, capital £10,000 in £1 shares, to adopt agreements with G. E. Heyl-Dia, C. H. Stocks and H. Pearce and with G. E. Heyl-Dia, to acquire a licence to use a certain patent process for variable throttle, cut-off or expansion cam gear, and to carry on the business of motor car and vehicle manufacturers. The first directors are G. E. Heyl-Dia (chairman), C. H. Stocks and H. Pearce. Reg. office: 55, Market-street, Manchester.

NORTH BRITISH ELECTRICAL CO. (LTD.)—Reg. July 31, capital £10,000 in £1 shares, to adopt an agreement with the Electrical Maintenance and Accessories Syndicate (Ltd.) and Gilchrist & Co., and to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in electric, telegraphic, telephonic and other appliances and apparatus, &c. Reg. office: 265-7, Deansgate, Manchester.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver $24\frac{3}{16}$d. per oz. (Aug. 7). Consols ($2\frac{3}{4}$ per cent.) $95\frac{1}{16}$—$95\frac{3}{16}$ for money, $95\frac{5}{16}$—$95\frac{7}{16}$ for account; $2\frac{1}{2}$ per cent. $95\frac{1}{4}$—$95\frac{3}{4}$ (Aug. 7). Consols Pay day, Sept. 1; Stocks and Shares Continuation Days, Aug. 12 and 26; Ticket Days, Aug. 13 and 27; Pay Days, Aug. 14 and 28; Mining Share Carry-over Days, Aug. 11 and 25.

ARMSTRONG-OHRLING WIRELESS TELEPHONE CO.—It is stated that this company, which has been formed to purchase the patent rights of the wireless telephone apparatus invented by Messrs. Armstrong and Ohrling, is to be registered at an early date with a capital of £175,000. It is also announced (in the financial papers) that the capital has been obtained privately and has been largely over-subscribed.

BAKER STREET AND WATERLOO RAILWAY CO.—The report for the June half-year states that capital expenditure during that period was £66,011, and the estimate for the current half-year is £175,000. The construction contracts have been transferred by the Metropolitan District Electric Traction Co. to the Underground Electric Railways Co. of London (Ltd.). Satisfactory progress is being made with the construction of the works.

BRISTOL TRAMWAYS AND CARRIAGE CO. (LTD.)—The directors have declared an interim dividend, to June 30, at the rate of 8½ per cent. per annum.

BRITISH ELECRIC TRACTION CO. (LTD.)—It having been announced that the British Electric Traction Co. had secured the contract for the construction of a new rapid transit tunnel between New York and Brooklyn, the secretary of the company (Mr. Dade) stated on Tuesday that the rumours regarding Mr. Pierpont Morgan's holding in the company were correct, and that Mr. Morgan had availed himself of his option over £400,000 of the company's capital, but Mr. Dade points out that the company's capital amounted to over £2,000,000.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)—The directors after providing for debenture and other interest and dividend on preference shares, have declared an interim dividend at the rate of 8 per cent. per annum for the half-year ended June 30, carrying forward £19,734.

GREAT NORTHERN RAILWAY CO.—In the report of the directors for the past half-year it is stated that in the ordinary passenger receipts there was a falling-off of £5,986, traceable to the competition due to the development of electric tramways, especially in Yorkshire.

LANCASHIRE AND YORKSHIRE RAILWAY CO.—On Wednesday the chairman (Sir George Armytage) attributed the decrease in the number of passengers carried to the effect of electric tramway competition in the urban districts.

NORTH METROPOLITAN TRAMWAYS CO.—The accounts for the June half-year show gross receipts £374,794, expenditure £377,552, leaving a debit balance of £2,758, which, with the £2,615 provided for debenture interest, after deducting the amount forward and the amount received from War Office for registration of horses, showed a loss for the half-year of £4,482. The directors state that the loss is fully accounted for by the high cost of forage, rates and taxes and unseasonable weather. The bill for "electrification" had passed through Parliament, and it is now proposed to apply to the Board of Trade for consent to a sale of the company's lines to the Metropolitan Electric Tramways Co.

PERSONAL.—Mr. Arthur E. Hadley has resigned his seat on the Board of Ferranti (Ltd.) and has taken the position of manager to the Allgemeine Electric Co., London.

RIVER PLATE TELEPHONE CO. (LTD.)—Mr. George Keith, of the Cuba Submarine Telegraph Co., and chairman of the Chili Telephone Co., has joined the board of this company.

ROTHESAY TRAMWAYS CO.—The directors' report for the year ended May 31 states that contracts have been entered into for the electrical re-construction and equipment of the line, and work was commenced on the permanent way on March 3, and finished, fit for resumption of car traffic, on May 17, since which date it had been worked by horses. Concurrently with the road construction, the erection of a power station, car sheds, and overhead equipment had been in progress. Unforeseen difficulties had arisen causing delay on the power house and car shed site, but they were now overcome, and the work was approaching completion. It was hoped that by the end of July the line would be entirely worked by electric power.

SCHATTNER ELECTRICITY METER CO. (LTD.)—The directors' report for the year to June 30 states that the amount to credit of profit and loss for sales, &c., is £10,033. 18s. 2d. Manufacturing costs were £5,789. 5s. 3d., leaving gross profit £4,244. 12s. 11d. From this has to be deducted expenses of administration and amounts written off for depreciation (in all £2,983. 3s.), leaving £1,261. 9s. 11d., which, with amount brought forward (£347. 2s. 8d.), makes £1,608. 12s. 7d. A dividend at the rate of 6 per cent. per annum is recommended, requiring £675, £100 written off works account, £500 put to reserve, and £333. 12s. 7d. carried forward. The business continues to show a steady rate of progress.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to allow the further issue of 30,000 £5 fully-paid ordinary shares, and 20,000 £5 fully-paid 6 per cent. cumulative preference shares of the *British Insulated Wire Co. (Ltd.)*, and the further issue of 10,000 £5 fully-paid shares of the *Calcutta Electric Supply Corporation (Ltd.)* to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	July 26	1,113	+ 13	8	9,016	+ 166
Ayr Corporation	Aug. 2	444	...	1	444	...
*Birmingham Tramways.	„ 2	4,680	- 33	4	19,962	+ 603
*Blackburn Corporation..	„ 1	843	+ 206	19	15,588	+ 3,012
Blackpool Corporation...	July 31	1,512	- 93	18	15,690	- 933
Blackpool and Fleetwood	Aug. 2	1,183	- 127	5	4,742	- 799
Bolton Corporation ...	July 27	1,563	+ 81	17	27,694	+ 1,722
	Aug. 3	1,609	+ 24	18	29,303	+ 1,746
Bradford Corporation ...	„ 3	3,390	+2,195	18	60,307	+41,397
Brighton Corporation ...	„ 3	998	...	36	24,430	...
Brisbane Tramways.....	June 18	2,243	+ 310	25	57,045	+ 4,950
*Bristol Trams & Carriage	Aug. 1	4,847	+1,043	4	19,932	+ 1,347
*Buenos Ayres & Belgrano	July 6	2,935	+ 352	1	2,936	+ 352
Burnley Corporation ...	Aug. 2	683	+ 237	‡18	12,753	+ 4,571
Calcutta Tramways Co...	„ 3	₹23 195	+ 2,243	5	₹120,510	+₹19,707
Cardiff Corporation	„ 2	1,535	...	18	22,931	...
Carlisle Tramways Co....	„ 2	209	- 6	†31	5,274	+ 359
Central London Railway	„ 3	5,981	+ 302	5	32,572	+ 2,495
City & South London Ry.	„ 3	2,697	+ 979	5	13,588	+ 4,320
Cork Elec. Tramways Co.	July 31	788	+ 202	§30	16,570	+ 1,605
Devonport & Dist. Trams	„ 25	474	+ 40	29½	12,296	+ 403
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	Aug. 2	276	- 23	18	4,118	- 116
Dublin & Lucan Railway	„ 3	123	- 15	5	623	- 98
Dublin Southern Dist....	„ 1	1,053	- 184	†5	5,089	- 636
Dublin United	„ 1	4,011	- 105	†5	13,452	
Dudley—Stourbridge ...	July 25	829	+ 118	29½	21,100	+ 2,987
*Dundee Corporation ...	„ 30	903	+ 170	...	...	...
East Ham Council	Aug. 2	491	+ 40	6	3,152	+ 440
Gateshead & Dist. Trams	July 25	831	+ 200	29½	20,789	+ 3,059
Glasgow Corporation ...	Aug. 2	11,167	-1,177	...	...	...
Greenock & Port Glasgow	July 25	843	+ 623	29½	14,067	+ 8,319
Hartlepool Tramways ..	„ 25	319	+ 39	29½	7,080	+ 780
Hull Corporation	Aug. 2	1,681	- 174	18	31,113	+ 776
Isle of Thanet Co.	„ 2	1,497	- 117	5	5,970	- 404
Kidderminster & Dist....	July 25	145	- 6	29½	3,411	+ 28
Leeds Corporation	Aug. 2	6,314	+1,750	19	97,110	+16,249
*Liverpool Corporation...	July 26	10,243	+ 621	30	235,484	+23,787
Liverpool Overhead Rly.	Aug. 3	1,694	- 55	‡5	8,067	- 588
Manchester Corporation	...	...	...	...	...	...
Merthyr.....	July 25	197	- 68	29½	5,919	- 820
Middleton	„ 25	291	...	17½	5,432	...
Newcastle-on-Tyne Corp	Aug. 2	2,925	...	...	...	...
Oldham, Ashton & Hyde.	July 25	552	+ 50	29½	15,139	+ 557
Perth (W.A.) Elec. Trams	Aug. 1	945	+ 79	¶30	32,505	+ 5,181
Poole & Dist.....	July 25	289	- 1	29½	6,946	- 100
*Portsmouth Corporation	Aug. 2	1,950	+ 793	...	...	...
Potteries	July 25	1,494	- 10	29½	42,498	+ 1,544
Salford Corporation ...	Aug. 4	2,972	+ 986	18	46,786	...
*Sheffield Corporation ...	„ 3	4,181	+ 272	5	21,182	+ 2,354
Southampton Corp. ...	July 24	995	+ 27	...	...	...
	„ 31	1,061	+ 108	...	...	...
Southend Corporation...	„ 30	380	+ 162	17	4,639	...
Southport Tramways ...	„ 25	342	+ 155	29½	6,820	+ 2,375
*S. Staffordshire Trams...	„ 25	769	- 40	29½	22,707	+ 644
Sunderland Corporation.	...	...	..	...	...	...
Swansea Trams.....	„ 25	486	- 26	29½	13,501	+ 1,397
Taunton Trams.....	„ 25	68	...	29½	1,780	...
Tynemouth & Dist.	„ 25	442	+ 51	29½	7,681	+ 664
Weston-super-Mare	„ 23	260	...	11½	2,196	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 25	333	+ 257	29½	4,616	+ 3,049

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 30.		Price Wednesday, Aug. 6.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 6	
										Highest	Lowest
			ELECTRICITY SUPPLY.					£ s. d.			
£100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½	¾	½	¾				
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103	106	103	106	4 6 0	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	5 12 0	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101	104	101	104	4 6 7	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9½	9¾	9½	9¾	4 2 1	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9½	9¾	9½	9¾	3 11 10	March and September	...	...
3 ,000	5	3/6	Calcutta Elec. Supply Ordinary	8	9	8	9	3 6 8	...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	107	105	107	3 15 2	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	10	9	10	5 0 0	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	5¾	5½	5¾	3 18 3	,, ,,	...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	106½	105½
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½	5¾	5½	5¾	2 12 2	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	110	...
70,595	10	10/0	City of London Electric Lighting Ord.	8½	9½	8½	9½	5 5 3	February and August	9 1/16	...
2 ,000	10	6/0	Do. 5 per Cent. Cumulative Pref.	11½	12½	11½	12½	4 13 0	January and July	12½	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	101	104	101	104	4 6 7	...	102⅞	...
2 ,000	10	4/0	County of London and Brush Prov. Ordinary	8	9	8½	9½	4 4 3	...	9⅛	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12½	12	12½	4 16 0	March and September	12 1/16	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	109	112	109	112	4 1 1	...	...	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5¾	6¼	5¾	6¼	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	,,	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary xd	10	11	10	11	4 10 11	...	10¾	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6¼	6¾	6¼	6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) xd	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knghtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105	108	105	108	3 15 0	...	106½	...
£111,000	3	...	London Electric Supply Ordinary	1½	1¾	1½	1¾	...	...	...	...
10,000	5	3/0	Do. 6 per Cent. Preference	4	4½	4½	4¾	6 6 4	...	4⅜	...
£350,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	94	99	94	99	4 0 10	Mar., June, Sept., Dec.	93	95½
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15½	16½	15½	16½	3 18 9	April and October	16	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	108	112	108	112	4 0 5	June and December	110½	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	98	101	98	101	3 10 0	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary	13½	14¼	13½	14¼	4 2 9	March	...	...
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	97	100	97	100	4 0 0	...	98	...
300,000	1	...	Rand Electric	⅜	⅝	⅜	⅝	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 7 0	April and October	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary xd	14½	15½	14½	15½	4 13 7	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference xd	8¾	9¾	8¾	9¾	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97	100	97	100	3 10 0	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1½	2½	1½	2½	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures xd	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2½	3	2½	3	...	...	...	...
110,000	5	5 6	Westminster Electric Supply Ordinary xd	10½	11½	10½	11½	4 15 8	March and September	11⅛	...
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5¾	6¼	5¾	6¼	4 0 0	...	6	5¼
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
166,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4¼	4⅜	4¼	4⅜	4 11 5	April and October	4 15/16	4 7/16
£280,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9	11	9	11	2 14 7	...	9½	...
10,000	10	5/0	Do. 5% Cumulative Preference	8½	9½	8½	9½	5 5 3	...	8½	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.) xd	93	98	93	98	4 11 9	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½	14½	13½	14¼	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3¾	4¼	3¾	4¼	...	...	...	...
75,000	5	2/6	Do. 5% Cum. Pref.	4¾	5	4¾	5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	102	105	102	105	4 5 9	...	4 1/16	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	21	22	21	22	3 13 4	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	105	107	106	108	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7½	7	7½	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9½	10	9½	10	5 0 0	May and November	9¾	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	103⅞	105⅞	103⅝	105⅞	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12½	13⅛	12⅝	13⅛	6 13 4	...	...	...
100,000	10	6/0	Do. 6% Cum. Pref.	12½	12⅝	12⅝	13⅛	4 8 11	February and August	13⅛	12⅝
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	12 1/16	12 1/16
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅛	1⅜	1⅛	1⅜	...	...	126	125⅛
40,000	5	3/0	Do. 8% "A" Cum. Pref.	4½	5½	4½	5½	5 14 3	...	...	...
27,500	5	10/0	Do. "B"	5	5⅛	5	5⅛	5 9 1	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	102	105	103	106	4 14 9	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	95	98	96	98	5 2 0	...	105	...
70,000	10	6/0	Calcutta Tramways	7	7⅛	7	7⅛	4 0 0	...	...	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	109	107	109	4 3 1	...	...	...
£80,000	1	1/2½	Cape Electric Tramways Shares	2¼	2⅜	2¼	2⅜	6 4 6	...	108½	107⅜
£1,870,014	Stock	4%	Central London Ordinary Stock	105	108	105	108	3 14 0	June and December	2⅛	...
£494,093	Stock	4%	Do. 4% Preferred Stock	106	109	106	109	3 13 4	...	107	106
£494,993	Stock	4%	Do. Deferred Stock	103	106	103	106	3 15 6	...	...	...
£898,201	100	4%	Do. 4% Deb.	115	118	115	118	3 7 8	...	104½	104½
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	4¾	5¼	5	5¼	4 10 9	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	3%	City and South London Railway Con. Ordinary xd	71	73	71	73	3 11 11	...	101⅜	...
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	...	...	...	...	...	February and August	73	71
10,000	10	0/11½	Do. (60,001 to 70,000)	...	...	...	...	...	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891) xd	128	131	128	133	3 16 4	...	...	...
£200,000	Stock	5%	Do. (1896) xd	127	130	127	130	3 16 1	,, ,,	129½	...
£150,000	Stock	...	Do. (1901) xd	121	125	121	125	4 0 0	...	...	...
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	123½	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary xd	11½	12½	11½	12½	4 8 0	...	117	...
52,987	10	6/0	Do. 6 per Cent. Preference xd	14½	15½	14½	15½	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4¼	4¾	4¼	4¾	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	102	99	101	4 18 0	...	...	...
78,000	10	3/0	Great Northern and City Railwy Pref. Ord. (2%)	8	9	8	9	3 6 8	...	8 1/16	8 1/16
30,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	13¾	13½	13¾	4 7 3½	...	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	108	110	108	110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½	5	4½	5	5 0 0	...	...	...
57,600	10	1%	Liverpool Overhead Railway Ordinary	4⅞	4¾	4⅞	4¾	3 3 2	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10	10½	10	10½	4 15 3	...	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture xd	99	101	99	101	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	10½	11	10⅝	11⅛	4 8 11	...	11	10 15/16
50,999	10	2/3	Do. (£7. 10s. paid)	8	8½	8	8⅛	4 8 6	...	...	...
£655,341	Stock	3%	Do. 4% 1st Mortgage Debenture Stock	107	109	107	109	3 13 3	...	108½	108½
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	81	83	81	83	...	...	81⅞	...
$6,501,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112	117	112	117	4 5 7	...	...	...
£50,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	106	108	106	108	4 14 5	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922) xd	107	109	105	107	4 4 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½	4½	3½	4½	6 13 4	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93	98	93	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100	103	100	103	4 17 5	...	...	...
44,334	10	5/0	Potteries Electric Traction Ordinary	8½	9½	8½	9½	4 4 3	...	...	...
39,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10½	9½	10½	4 15 2	February and August	10⅜	...
4220 000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108	111	108	111	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...	...	...	...	...	...
62,750	1	...	Do. 6% Preference (£4/6 paid)	...	...	...	...	...	October	...	...
[illegible]	1	...	[illegible]	...	...	...	...	...	...	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, July 30.	Price Wednesday, Aug. 6.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 6. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£32,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98 102	98 102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3½ 4½	3⅜ 4⅜		June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70 80	70 80		,, ,,	89⅜	...
£788,840	Stock	15/0	Anglo-American xd	45 48	45 48	6 1 7	Feb., May, Aug., Nov.	45⅛	...
£3,105,580	Stock	30/0	Do. Preferred xd	89 91	89 91	6 6 4	,, ,,	90⅜	89½
£3,105,580	Stock	2/0	Do. Deferred	6½ 7	6½ 7	1 8 7	,, ,,	6⅞	...
$13,333,300	$100	$12½	Commercial Cable Capital Stock	165 170	165 165	4 17 0	Jan., Apr., July, Oct.	159½	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	95 97	95 97	4 2 6	,, ,,	96⅜	95½
16,000	10	4/0	Cuba Submarine Ordinary	4½ 5½	5 6	6 13 4	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½ 13½	12½ 13½	7 8 2	,, ,,	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅝ 3⅛	2⅝ 3⅛	5 14 4	April and October	...	
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7⅞ 8⅛	7⅞ 8⅛	5 17 8	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞ 103⅞	99⅞ 103⅞	4 7 8	January and July	...	...
60,710	20	4/0	Direct United States Cable xd & bonus	10 11	10 11	5 18 2	Jan., Apr., July, Oct.	10 1/16	...
£96,300	100	4½%	Direct West India Cable 4½% Red. Db. (within Nos. 1	99 102	99 102	4 8 3	June and December	...	
£4,000,000	Stock	65/0	Eastern Ordinary xd & bonus [to 1,200) (red.)	1 7 127	117 127	5 10 3	Jan., Apr., July, Oct.	119	1'8
£1,955,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	87 90	87 90	3 17 8	,, ,,	88¼	88
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108 112	108 112	3 12 2	May and November	108½	
300,000	10	2/6	Eastern Extension	12 13	11⅞ 12½	5 12 0	Jan., Apr., July, Oct.	12	11 3/8
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	107 112	107 112	3 11 4	February and August	109	108⅛
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909 xd	100 103	98 101	3 19 3	February and August		
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100% 103%	100% 103%	3 18 3	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen	25 27	25 27	5 11 1	January and July		
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos.	99 102	99 102	4 8 1	June and December		
17,000	25	37/6	Indo-European [1 to 1,200) (red.	37 41	38 42	5 19 1	May and November	...	
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	101 105	101 105	5 17 1	March and September	3⅜	38½
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99 102	99 102	3 18 5	June and December	...	
15,609	10	..	*West African Telegraph Shares	3½ 4½	3⅜ 4⅜		,, ,,	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	100 103	100 103	4 18 5	March and September	...	...
30,008	2½		West Coast of America	⅛ ⅜	⅛ ⅜		,, ,,		
£150,000	100	4%	* Do. 4 per Cent. Debentures	97 100	97 100	4 0 0	January and July	...	...
88,321	10	..	West India and Panama	¼ ½	¼ ½		May and November	...	
34,563	10	£/0	Do. 6 per Cent. 1st Pref.	4⅜ 5⅜	4⅜ 5⅜	11 8 6	,, ,,	5	4 13/16
4,669	10	..	Do. 6 per Cent. 2nd Preference	3 4	3 4		,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99 102	99 102	4 18 0	January and July	...	...
207,930	10	3/0	Western Telegraph (late Br zil'n Submarine)	11½ 12†	11⅛ 12⅛	5 16 4	Mar., June, Oct., Dec.	11⅛	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series. 1908)	101 104	101 104	4 16 2	June and December		
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	97 100	97 100	4 0 2	,, ,,	...	...
			TELEPHONES.						
44,000	£5	5/0	Chili Telephone (fully paid) xd	3⅜ 4	3⅜ 4⅛	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/6 2/6	2/0 2/3	13 5 0	April and October		
72,630	1	2½%	Monte Video Telephone Ordinary	⅛ ¼	⅛ ¼	5 0 0	November		
86,492		1/0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	,,		
£983,333	Stock	6%	National Co. Preferred Stock	95 99	95 99	6 1 3	...	97⅛	95
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	4⅝ 4⅞	4⅝ 4⅞	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	56 60	59 63	7 10 0		59	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12 14	12 14	4 5 9	February and August	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11 13	11 13	4 12 4	,, ,,		...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞ 5⅛	4⅞ 5⅛	4 17 6	,, ,,		...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	95 98	95 98	3 11 5	June and December	95⅝	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102 106	102 106	3 15 6	...	104⅛	102⅛
171,504	1	0/8½	Oriental	1 1/16 1 1/16	1 1/16 1 1/16	5 12 11	April and October	...	...
58,000	5	4/6	United River Plate	4¼ 5¼	4⅛ 5⅛	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅛ 5	4⅛ 5	4 16 3	June and December	4⅞	...
£172,947	Stock	5	* Do. 5 per Cent. Debenture Stock (red.)	101 104	101 104	4 16 2	June and December	...	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛ ¼	⅛ ¼	6 13 4		...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛ ¼	⅛ ¼	...		...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅛ ¼	⅛ ¼	12 0 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7½ 7¾	7½ 7¾	6 9 0	July and February	...	...
80,000	5	3/0	Do. 6 per Cent. Preference	5⅛ 5⅜	5⅛ 5⅜	5 4 4	January and July	...	
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	101 104	101 104	4 6 1		...	...
200,000	5	3/0	British Westinghouse 6% Preference	5⅞ 6⅛	5⅞ 6⅛	4 18 0	...	6 1/16	...
105,781	2	..	Brush Electrical Engineering	1⅜ 1⅝	1⅜ 1⅝		March	...	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅜ 2	1⅜ 2	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	102 106	102 105	4 7 5	March and September	1.5	1'4
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	94 99	93 98	4 11 6	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15½ 16½	15½ 16½	4 10 11	,, ,,	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛ 6	5⅛ 6	5 0 0	,, ,,	5 1/16	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109 113	109 113	3 19 8	November and May	...	...
450,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1 1½	1 1½	4 16 0		...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.) xd	94 99	94 99	4 11 0		...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	⅜ 1	⅜ 1	9 2 0	March		
85,000	3	1/9½	Crompton and Co. (Nos. 1 to 54,000)	2⅜ 3⅛	2⅜ 3⅛	6 19 0	January and July	2 1/16	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	101⅞ 106⅞	101⅝ 106⅝	4 14 4	,, ,,	...	
99,261	5	..	Edison & Swan United ("A" Shares) (£3 paid)	⅜ ⅝	⅜ ⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1⅜ 2⅛	1⅜ 2⅛		,, ,,	...	...
£344,022	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	74 78	74 78	5 3 0	June and December	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	78 83	78 83	6 2 10	...	...	...
150,000	5	4/0	Edmundson's Electricity Corporation Ord.	6 6½	6½ 6⅝	5 3 3	Half-yearly	6⅛	...
130,000	5	3/0	Do. 6% Cumulative Preference	6 6⅛	6 6⅛	4 12 4	...	...	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	105 108	106 109	4 2 8	...	...	...
112,100	2	1/2½	Electric Construction Co.	1½ 2	1⅛ 2	6 0 0	January and July	...	...
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅜ 3	2⅜ 3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97 100	97 100	4 0 0	January and July	100	...
122,985	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...		...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾ 1⅛	¾ 1⅛			...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	9⅜ 10⅛	9⅜ 10⅛	4 17 7		10	9⅛
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	99 102	99 102	3 19 5		...	...
35,000	5	5/0	Henley's Telegraph Works Ordinary	16 17	16 17	4 8 3	February and August	16½	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛ 5⅜	5⅛ 5⅜	3 18 3	,, ,,	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 115	111 115	3 18 3	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	4 13 0	,, ,,	20½	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 18 5	March and September	101	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½ 15½	14½ 15½	6 9 0	July	...	...
87,350	12	12/0	Telegraph Construction and Maintnce.	36 39	36 39	6 3 1	March and July	38⅜	38½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	... ...	... ...	5 14 3	...	...	...
20,000	5	2/6	Do. 6 per Cent. Cumulative Preference	... ...	... ...	4 8 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	... ...	... ...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	... ...	... ...	...	,, ,,	...	...
			FINANCIAL, INVESTMENT, &c.						
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5½ 5⅝	5½ 5⅝	5 9 1	...	...	...
180,227	10	2/6	Globe Telegraph and Trust	8⅜ 9⅛	9 10	5 5 0	Jan., Apr., July, Oct.	9⅜	9⅛
180,042	10	3/0	Do. 6 per Cent. Preference	12½ 13⅜	12½ 13⅜	4 8 11	,, ,,	13⅛	13 1/16
11,839	8	4/0	Reuter's	6⅜ 7½	6⅜ 7⅜	5 6 8	April and October	...	...
8,303	£100 Cert	6%	Submarine Cables Trust	110 120	110 120	5 0 0	,,	118½	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

WITH feelings of loyalty and thankfulness we take pleasure in recording in these pages the coronation, on Saturday, the 9th inst., of THEIR MOST EXCELLENT MAJESTIES KING EDWARD VII. and QUEEN ALEXANDRA. A nation and a world-wide empire rejoices that, after the dangerous operation and painful illness through which HIS MAJESTY has just passed, he has been restored to full health and strength and to a degree of vigour hitherto unsuspected, even by HIS MAJESTY'S immediate *entourage*—"long to reign over us. God save the KING!"

AN article on "British Railway Capital" in the *Standard* on Monday presents some of the financial aspects of the electrical equipments of main steam railways in a light which should make investors and shareholders pause and consider:—

In the near future it is certain that a large amount of money will have to be spent in improving the equipment of our railways, with a view to promoting economy in haulage, and also to meeting the competition of electric lines. More powerful locomotives and improved waggon stock are imperatively demanded, with many consequent structural alterations. A revolution in railway signalling is imminent, power plants of various types having already been installed experimentally on several leading lines. There is also a growing conviction that electrification will be necessary to save a number of local lines from extinction as profit-earners. But if all, or the greater part, of this impending expenditure be charged to capital account, necessitating new issues of stock on perhaps onerous terms, surely the remedy will be worse than the disease!

THE writer of the article believes that the only alternative involves the shareholders in the "self-denying ordinance" of devoting profits to the good work of electrification. It is out of the question to expect debenture-holders to make any such sacrifice; so, if the work is to be done at the expense of the preference and ordinary stockholders, it is not likely to be accomplished very speedily on the railways where these holders now get next to nothing. Up to the present, railway companies embarking on electrification schemes have had to obtain fresh capital for the purpose, and it is difficult to see which, if any, of our home railways are so favourably placed as to be able to dispense with this preliminary. The bold step must, therefore, be made, even if it becomes necessary to secure for the new capital a first charge on the benefits accruing from electrification. True, the original stockholders may not relish such a proceeding; but, as Mr. STAATS FORBES told the stockholders of the Metropolitan District Railway, in a precisely similar case, it will be their only chance to save their property. On the whole, therefore, the outlook for British railway capital is by no means rosy, though it is brighter than it would be if electrification were not to be adopted.

APROPOS of this impending revolution in British railroading, we may direct attention to the attitude of Sir ERNEST PAGET, chairman of the Midland Railway Co. Without doubt, if this important railway company were to adopt electric traction on any extensive scale it would not be long before every railway that is worthy of notice would follow suit. But Sir ERNEST PAGET is cautious, and he evidently does not mean to commit his board at present. The scrapping of 2,700 steam locomotives is no light matter to contemplate, even though it might not be intended to abolish all the engines until after a considerable time had elapsed. Even the initiation of an electrification policy is a serious step for a large railway company to take. So Sir ERNEST PAGET proposes that the lines of the Cheshire Lines Committee in the neighbourhood of Liverpool and Manchester shall be made the *corpus vile* for a crucial experiment. This Committee comprises, in addition to the Midland Railway Co., the Great Northern and Great Central Companies, and we understand that an official of the Great Central Railway Co. has denied that there is at present any formal intention on the part of the Committee to adopt this experiment. Nevertheless, he characterised Sir ERNEST PAGET'S proposal as "a happy thought," so there is good prospect that it will ripen into fruition.

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The unpleasant dispute at Salford has been finally closed by the publication of Judge Parry's report to the Salford Corporation last week, and the result may be considered as satisfactory. Allegations which had been made as to misconduct and undue influence in awarding and carrying out the works for the Salford extensions were shown to be unwarranted, and we trust that this is the last that will be heard of the matter. While acquitting everybody concerned of any questionable motives, however, Judge Parry is bound to admit to those who had suggested an inquiry that the plant installed at the new works represents a power in excess of immediate requirements owing to a *bonâ fide* but mistaken notion of the needs of the borough. It was stated in the evidence, and we believe that this was not contradicted, that 12 boilers and six engines were lying idle. Although new tramway routes were rapidly being opened at Salford, and it may be supposed that the demand for electric light, as well as for power, is rapidly increasing, no one can regard it as good economical policy to increase the capacity of the station to this extent beyond the actual demand upon it—especially in the case of works so overburdened with capital charges as are those at Salford. In December, 1897, the capital expenditure was £128 per kilowatt capacity. By December, 1898, this figure had risen to £174. In March, 1900, it was £167, and in March, 1901, £279.

It has long been known that wrought iron or very mild steel can be converted into high-grade steel without the necessity of first melting the metal. This is effected, in fact, by the direct absorption of carbon in contact with the metal when at about red heat. The ordinary cementation process, by which much of the steel used in the manufacture of cutlery and tool steel is made, is an example of this process. It is reported that Lieut. Davis, of the United States Navy, has adopted an electrical method of causing carbon to be absorbed by the steel for the purpose of case-hardening armour plates. The process consists in acting upon the plates while hot by high-tension electric currents with large carbon anodes, the current displacing the particles of carbon and incorporating them in the substance of the metal. The surface, so it is reported, is thus, in five hours, rendered harder than by any other method, with a consequent saving of from 20 to 50 per cent. in weight of metal, as well as a great saving in the time required for the cementation.

University College (London).—The session 1902-3 commences on Tuesday, September 30th. Prospectuses may be obtained of the secretary. An advertisement gives some further particulars.

Owens College (Manchester).—The engineering drawing-room and Whitworth engineering laboratory will open on October 7th. Lectures commence on October 8th. Particulars of the course of instruction may be obtained from the registrar. See advertisement.

Electrically-equipped Locomotive Shops.—The Great Northern Railway Co. has recently made provision at the locomotive works at Doncaster for a new locomotive erecting shop 580ft. long, and equipped throughout with electrically-driven machinery. The overhead electric cranes are capable of lifting a weight of 35 tons. For riveting and similar operations pneumatic tools are used.

Electric Railway in Mexico.—Preparations are being made to operate a portion of the Mexican Railway between Esperanza and Vera Cruz by electricity. The electrification of this section of about 120 miles is of considerable interest, containing, as it does, the heaviest grades in Mexico. Power will be derived from the waters of the Metlac river.

London United Tramways Extension.—It is now possible to travel from the Bank to Twickenham in electrically-propelled vehicles. The section of tramway from Isleworth to Twickenham was completed on Tuesday, thus connecting it to the existing line from Hounslow to the Shepherd's Bush terminus of the Central London Railway. The new service is one of five minutes during the day and 10 minutes at night, and there can be no doubt that it will prove of great convenience to residents in the district served, as well as to Londoners visiting those of up-river districts.

Düsseldorf Meeting of the Iron and Steel Institute.—The detailed programme of the Düsseldorf meeting of the Iron and Steel Institute is now published. The meeting is fixed for September 3rd to 6th, and a number of excellent Papers and interesting visits to works have been arranged for. Two of the nine Papers down for reading are on electrical subjects: "On the Application of Electricity in the Manufacture of Iron," by D. Selby-Bigge, and "On Electrical Plant in Steel Works," by F. Kylberg. The excursions include visits to the Krupp works at Essen, several other large iron and steel works in the neighbourhood of Düsseldorf, the Duisburger Maschinenbau Aktiengesellschaft, and the Elberfeld-Barmen Suspended Railway.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Bolama	April 19, 1902 ...	July 26, 1902.
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Santa Cruz—Teneriffe	July 7, 1902 ...	—
Puerto Plata—Martinique	July 10, 1902 ...	—
Anjer—Kalianda	Aug. 2, 1902 ...	—
Nagasaki—Fusan	Aug. 5, 1902 ...	—
Guantanamo—Mole St. Nicholas	Aug. 5, 1902 ...	—
Cayenne—Pinheiros	Aug. 13, 1902 ...	—

Electric Railway to Vesuvius.—The Faculty of Science in the University of Naples has forwarded to the Italian Government an urgent protest against Messrs. Cook's project for an electric railway to run direct to Mount Vesuvius from the Naval Arsenal in the city of Naples, thus affording increased facilities to the 30,000 to 50,000 tourists who visit the crater annually, and who have hitherto done so by means of the well-known funicular railway, situated at the foot of the volcano. The objections are based on the fact that an electric railway in such close proximity to the University observatory would seriously interfere with seismic observations and records, and that the magnetic and electrical instruments already installed or about to be installed would be injuriously affected.

Improvement in Electric Transmission by Wires.—Mr. Chas. E. Fritts has patented in America a system of suppressing inductive resistances usually encountered in telegraph and telephone lines, and has described this in the *Electrical World and Engineer* of New York. The method consists essentially of splitting up the cable or line into sections, the length of which is determinable by the conditions of the case. Between the sections are placed condensers shunted by induction coils. The shunt coils are only necessary for use with a telegraph line in order to allow the condensers to discharge instead of sending back a "kick" along the line. The retardation of the whole line worked on this plan is only equal to that of one section, and when it is remembered that the retarding effect increases as the square of the distance, its advantage will be appreciated.

Electric Signalling.—The electro-pneumatic signalling system, erected for the North-Eastern Railway Co. at Tyne Dock by Messrs. McKenzie and Holland, of Worcester, has now been formally brought into use. The plant consists of two electro-pneumatic frames, one of 71 levers and the other of 35 levers. The work of pulling over or throwing back the

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switches is done by a small air motor fixed close to the signal or switch operated, whilst the valves controlling the supply of air to these motors are opened by an electromagnet. Hence the levers in the cabin are really electric switches, and the signalman is thus relieved of the heavy manual labour involved in pulling over the signals. The principal duty of the signalman is merely to set the power in operation. He pulls from a frame 4ft. high by 5ft. wide a small slide for a distance of about 5in. This movement lets into a pipe, connected with the machinery, a current of air out of a reservoir, and thus operates the signal.

Motor Car Tests in America.—Recent American brake tests have had the desired effect of inducing municipal authorities to raise the speed limits for motor traffic in cities, where motor users have hitherto been cramped by restrictive regulations, and since the holding of the brake tests an endurance run has been organised by the Automobile Club of America in order to test motors for general trustworthiness and fuel consumption. The most astonishing results have been obtained with regard to the smaller type of steam carriage. Three 8½ H.P. steamers average 13 gallons of petrol per 100 miles, and over 100 gallons of water each. Steamers fitted with condensers and indicating nearly twice the horse power, averaged 7 gallons of water for the same distance, but the petrol cars show, at this power, a consumption of petrol 40 to 50 per cent. less, and their use of water is practically nil, unless accidental leakage occurs.

Power House Flooded Out.—The *Electrical World and Engineer* of New York, states that the power house of the Union Gas and Electric Co., of Waterville, Me., equipped with three large generators, was recently submerged for 24 hours. The water reached almost to the top of the first floor windows, and it subsided so slowly that several days elapsed before access could be had to the floor of the dynamo room. After the machines had been dried out, careful tests were made to ascertain whether the insulation had broken down, but no short circuit or other defect was found, and the machines were started up. To the great satisfaction of the company's officials, the generators were found to be uninjured, and they have been running ever since with their original normal efficiency. This is by no means an isolated instance, owing to the exceedingly heavy rains which have been experienced in many parts of the States during the last two or three months.

Acceleration of Electric as Compared with Steam Locomotives.—An interesting Paper dealing with the above subject was read by Messrs. Arnold and Potter before the American Institution of Electrical Engineers, and published in the *Railway and Engineering Review* of Chicago. The steam locomotive used on the tests was one specially built for rapid-acceleration work in suburban service, and the two electric cars each weighed 85 tons, and were each equipped with four 55 H.P. motors. All axles being equipped with motors the two cars together gave approximately the same weight upon the drivers as the steam locomotive. The same trail cars were used in each case, and therefore the following figures need no comment:—

Miles per Hour attained in 10 Seconds.

Number of trailers	1	2	3	4	5	6
Motor cars Nos. 4 and 5	22·5	20·7	17·3	14·4	12·6	11·0
Locomotive No. 1,407	14·0	13·0	12·5	12·0	10·0	9·7

Miles per Hour attained in 20 Seconds.

Number of trailers	1	2	3	4	5	6
Motor cars Nos. 4 and 5	34·0	32·3	29·4	27·4	24·5	21·2
Locomotive No. 1,407	25·0	21·2	21·5	19·5	18·0	16·3

Miles per Hour attained in 30 Seconds.

Number of trailers	1	2	3	4	5	6
Motor cars Nos. 4 and 5	38·2	36·4	34·2	32·0	30·3	28·1
Locomotive No. 1,407	31·7	26·2	27·0	24·7	23·2	20·8

Demand for Electrical Plant in Peru.—According to the *Chamber of Commerce Journal*, Mr. Consul-General St. John says that the use of electricity for purposes of illuminating is increasing rapidly in Peru. The town of Lima is now entirely lighted by electricity. This illuminant is also extensively used in private houses in Lima, and supplied by three companies. The town of Arequipa is also lighted to a considerable extent by electricity, and companies are being formed for lighting Callao, Trujillo and Chiclayo in the same manner. The electrical plant chiefly comes from the United States. Notwithstanding the initial advantages possessed by the United States in the matter of electrical plant, it would seem that this is a branch of industry which fully deserves close attention on the part of British manufacturers, as the demand for electrical plant throughout South America, where there is so much water-power, must eventually become enormous. British machinery of this class is barely mentioned in Peru. German dynamos and motors have been tried, but although well finished, they are looked upon as being too complicated. It is also highly probable that a demand for power transmission lines for various purposes must arise sooner or later, as the natural configuration of the ground can be turned to account for the development of immense power, at comparatively little cost.

Electrolytic Conductors.—A patent was granted in America on June 10th to C. P. Steinmetz, which describes details of a glower of the Nernst lamp type. It is stated that as customarily made, such glowers have terminals consisting of fine platinum leading-in wires, and that after the lamp has been running awhile, the contact between these wires and the glower becomes greatly impaired, the end of the glower becoming smaller where the wires are wrapped around it, thereby loosening the latter. The inventor has found that by enclosing the wire-wound ends of the glower in magnetite and then fusing the latter, the wasting away of the glower end is prevented, and the ends run much cooler than those of the ordinary lamp of this type. In practice, the magnetite in powdered form is sprinkled upon the platinum wires where they are wound around the ends of the glower; these ends are then heated for a moment, preferably in a small electric arc between carbon points, to melt the magnetite about the wire. This material has the advantage of being conductive at all temperatures—slightly so when cold, but increasing rapidly with the rising temperature. Moreover, it can be fused to make a firm compact mass at the joint between the wire and the glower, and will successfully withstand the heat at which the glower becomes incandescent.

A Novel Application of Electricity.—At a colliery in the Dortmund district of Prussia it was required to dismount a horizontal arm of the pump rods; but this was found impossible, owing to the rusting of the bolts and cotters, while the part in question could not be cut through by hammer and chisel on account of the small space at disposal. It was, therefore, determined to effect the separation by means of the electric arc. The energy employed was obtained from a continuous-current dynamo generating 320 amperes at 110 volts, which served for lighting, the negative pole being put in connection with the pump rod and the positive with a carbon of 20mm. diameter, held in a well-insulated gas pipe. The latter was fitted with a rest, so that the carbon might be guided by hand, and, for preventing danger from fire, a bucket filled with sand was placed under the spot where the melting was to be effected, while a small hand-pump was also held in readiness. For protecting the men's eyes from the bright light red and green glasses were provided, to be held in the hand. The work was carried through with a current of 320 amperes at 60 to 70 volts, the carbon point being held from 40mm. to 50mm. away from the point to be melted in such a manner that a vertical slot of 20mm. to 30mm. was formed, and then gradually deepened. The guiding of the carbon, which became more difficult as the depth increased, had to be effected in the upward direction, so that the molten iron might fall in drops. The work was performed by six men, who relieved one another every hour or half-hour, in about 12 hours altogether, including a few interruptions. No inconvenience was experienced by the men during the operation; but afterwards all of them felt more or less severe pains in the face and hands, while those who did not always use the glasses also suffered in their eyes. The pains, however, lasted only a short time.

Russian Rules for Help in Case of Electric Shock.—At the recent biennial convention of the electrical engineers of all the Russias at Moscow, one of the subjects of discussion was the regulations to be observed in connection with rendering help in case of accidents caused by contact with heavily-loaded

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electric wires. The regulations were prepared by a specially-appointed commission, and contain, among others, the following recommendations, which were adopted by the convention and recommended to be made law by the Government:—Each power station shall in future have a special room, which shall serve exclusively as a "life-saving station," and shall contain devices and instruments necessary for rendering help in case of accidents. As the separation of a person who meets with an accident from contact with live wires is of the greatest danger for the rescuing person, special care shall be taken in the selection and proper care of devices of protection. Rubber gloves and overshoes shall be kept at the stations in proper quantity and quality. But, as careful experiments in laboratories have shown that from 14 different brands of rubber gloves and shoes only three proved to be adequate for the purpose required, the regulations provide that the rubber gloves and shoes kept at the stations shall be submitted every six months to a new test, exposing them to a current of three times the strength ordinarily generated at the station. The life-saving departments shall be kept accessible to every person connected with the station and liable to be called for help. Those rules shall be placarded in the stations in connection with instructions and diagrams, showing at a glance how to proceed in different cases of accident and how at the same time the rescuing person should protect himself. Every workman of the station shall be made familiar with these regulations, as well as with the instructions for rendering help. In cases where the accident occurred at a place remote from the station, and no other means for the insulation of the wires are accessible, it was recommended to throw dry cordage or clothing, over the wires, which procedure is said to have been proven, by experiments, in ordinary cases to be sufficient. Very dry pieces of wood, properly used, can also be used advantageously for insulation.

A Canadian Water Power Utilisation Plant.—The Shawinigan Falls power plant has been for some time in partial operation, and is now nearly completed and at work. At these falls there is said to be available a flow of water sufficient for producing 200,000 H.P. The water is obtained from a canal 1,000ft. long, 20ft. deep and 100ft. wide, and is carried to a forebay formed by a solid concrete wall or bulkhead, from which the water is conducted through pipes to the power houses 130ft. below. The concrete wall is 30ft. thick at the bottom and 40ft. high, and each pipe supplies water sufficient to generate 5,000 H.P. at the turbine and generator below. It is intended to transmit power to Montreal and Quebec, 84 and 90 miles distant respectively, and the conductors have already been laid out. The town of Three Rivers and various towns and villages along the Great Northern Railway will also be supplied with electrical energy. The St. Maurice river possesses enormous power, and flows south until within about 1,000yds. of the falls, when its course is diverted by an island to the west first and then to the north. The stream on the north side approaches the falls very swiftly in a channel 600ft. wide, 20ft. deep, and nearly a quarter of a mile long. The steel pipe from the forebay to the power house increases in diameter from 9ft. to 11ft. near the turbines, in order to reduce the velocity before it reaches the wheels, and at about 50ft. from the power house the thickness of the shell also increases from $\frac{5}{16}$in. to about $\frac{9}{16}$in., and each penstock is held against movement from expansion and contraction at the place it passes the power house wall. The turbines were built by the I. P. Morris Company, of Philadelphia, and each has a capacity of 6,000 H.P. under a working head of 125ft. The tail water has a mean low level 25ft. below the centre of the wheel shaft. The turbine is controlled by gates in the draught chamber, and is 30ft. long. Butterfly valves are used at the gates, closing towards the centre between the shafts. Revolving field generators of the Westinghouse type are direct-coupled to the turbines, and each generates 3,750kw. at 180 revs. per min. They are 2,000 volts, two-phase, 30~ machines. The pipe lines now constructed at this power house have a capacity of 15,000 H.P., and the turbines and generators 10,000 H.P., but it is expected that soon the entire 80,000 H.P. will be ready, and at no distant date 60,000 H.P.; the entire capacity of the canal will be used by establishments in the vicinity.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Zeeman Effect in Absorption Bands.—A. Schmauss has made some further measurements of the magnetic rotation of the plane of polarisation within an absorption band, mainly in order to clear up some theoretical points raised by Voigt. He used fields varying from 8,000 to 10,000 units, and operated upon solutions of litmus and of aniline blue and upon didymium glass. He succeeded in verifying two of Voigt's theoretical conclusions, the first being that the maximum rotation in a field of absorption is nearly independent of the strength of field, and the other that the negative rotation in the interior of an absorption band diminishes with an increasing field. This diminution is convincing in the case of litmus and aniline blue, but not so marked as it is in didymium glass.

[A. Schmauss, *Ann. der Physik.*, No. 8, 1902.]

Electric Production of Sleep.—S. Leduc describes a method of producing sleep and local anæsthesia by means of electric currents. The currents are continuous, with a small resistance in the circuit, and are best furnished by an accumulator. An interrupter free from inductance, and giving 150 to 200 breaks per second is inserted in the circuit. A moist electrode is placed on the animal's shaven head and another on the back near the tail. The E.M.F. is rapidly increased till the animal shows generalised contractions and respiration is stopped. The curent is then reduced to about 5 milliamperes, with 12 to 30 volts. Respiration then sets in again and the animal sleeps a profound and tranquil sleep. It lasts as long as the current is continued. As soon as it stops the animal wakes up and jumps about with every sign of delight, and no evil consequences appear to result. If the current is not first brought to the point at which respiration stops, some agitation is displayed, such as seen in the administration of chloroform. A similar current applied to the root of a human nerve, such as the median of the wrist, gives rise to complete anæsthesia of the region innervated, accompanied by a prickling sensation which is not painful.

[S. Leduc, *Comptes Rendus*, July 21, 1902.]

Influence of Electrode Metal upon Discharge.—The discharge potential of a spark-gap is a function of the distance between the electrodes, of the pressure of the gas, of the kind of gas, of the shape of the electrodes, and of the temperature. All this is known and acknowledged, but J. Stark points out that under certain conditions the material of the electrodes may also have a distinct influence. If the electrode at which discharge first sets in is an anode, the positive ions, as chief ionising agents, shoot out from the anode, and the ionisation they produce by their impact upon gaseous molecules is independent of the material of the anode. At the cathode, on the other hand, they produce ionisation by impinging upon gaseous molecules attached to the cathode. Now, the proximity of a metal has the effect of reducing the "ionising potential" of a molecule to an extent varying from one metal to another. Hence, in this case the material of the electrode is of importance. But it is masked if the cathode is in the least oxidised. Iron, nickel, silver and aluminium show a great variation of the negative discharge potential with their state of oxidation. Gold and platinum maintain a steady value.

[J. Stark, *Physikal. Zeitschr.*, August 1, 1902.]

Electro-chemical Effect in Tourmaline.—As was first shown by Lord Kelvin in 1877, from thermo-dynamical considerations, there corresponds to the pyro-electric phenomenon—*i.e.*, the electrification produced by a uniform rise of temperature—a reverse effect—namely, a temperature change due to a variation of the electric state. If a pyro-electric crystal be brought into an electric field so that the lines of force run from the analogous to the antilogous pole, it will be heated; if the orientation of the crystal in the field is reversed, a cooling will take place. R. Straubel has carried out some experiments on the effect so predicted, using a Brazilian tourmaline. Four plates, each 0·2cm. thick, were cut from the tourmaline crystal in a direction normal to its axis. The

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plates were then arranged in two pairs, in one of which the analogous poles, and in the other the antilogous poles, were uppermost. Between the plates of each pair was introduced one set of junctions of a thermopile of 10 elements, made of fine wires of constantan and iron. The measurements showed the change of temperature sought for, and in the required direction. It amounted to $0{\cdot}74 \times 10^{-3}$ °C., a number which, so far as the order of magnitude is concerned, is in sufficiently good agreement with the value demanded by theory.

[R. Straubel, *Phil. Mag.*, August, 1902.]

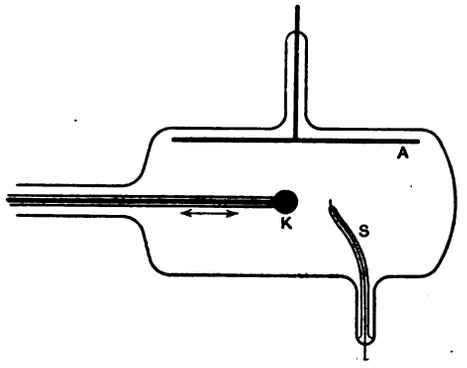
Electron Theory.—J. J. Thomson writes "On Some of the Consequences of the Emission of Negatively Electrified Corpuscles by Hot Bodies," and develops some interesting and important points. According to Richardson's measurements, the negative electrons stream so fast from carbon at a white heat as to be equivalent to a current of about 1 ampere for each square centimetre of carbon surface, corresponding to the discharge of about 5×10^{18} electrons per second. The question naturally suggests itself whether this great crowd of electrons does not produce other effects besides the ordinary electrical ones, and the author indicates some of these in the present Paper. In the first place, since the electrons or "corpuscles," as the author somewhat ambiguously calls them, carry a charge of negative electricity, they will move when acted upon by an electric force such as is at play in the electromagnetic vibrations of light. They will be set in motion by light, will absorb energy and give it out again, probably as scattered light. The author shows that the co-efficient of absorption will be $\frac{4\pi}{3} \frac{Ne^4}{m^2}$, where N is the number of electrons per centimetre. Thus the region round incandescent metals or carbon will scatter light, and the scattered light will be polarised in the same way as if the light had been reflected from small particles. Now, since metallic vapours and carbon are present in the sun, there should be a similar scattering of light in its neighbourhood, and many phenomena of the corona are probably due to that. Interplanetary space probably contains a considerable number of free electrons. No part of it should, therefore, be absolutely dark, nor would it be perfectly transparent. If the sun gives out long Hertzian waves, these would communicate to electrons disengaged from a comet velocities comparable with the velocity of light, and they would appear behind the comet as a luminous tail. Such streams of electrons exist not only in rarefied gases but in metals. When they impinge upon molecules, they produce Röntgen rays as usual, but of a "softer" kind. A succession of sufficiently broad pulses would produce a continuous spectrum, such as we obtain from a glowing solid. In an insulating body such as quartz, the glow is probably produced by the revolution of electrons about fixed centres. The author calculates the rate at which they emit energy, and finds it to be proportional to the fourth power of the absolute temperature, as actually found in the case of an ideal black body. The Paper is full of valuable theoretical advances which extend the scope of the electron theory. A further step might suitably consist in the investigation of the full kinetic theory of electrons, taking into account the repulsive force between individual electrons, which complicates the ordinary reasoning of the kinetic theory.

[J. J. Thomson, *Phil. Mag.*, August, 1902.]

Is Rotatory Polarisation influenced by the Earth's Motion?—The question whether the rotation of the plane of polarisation of light propagated along the axis of a quartz crystal is affected by the direction of this axis relatively to the earth's orbital motion, is of considerable theoretical importance. According to an investigation of Lorentz, an effect of the first order might be looked for. Such an effect would be rendered apparent by comparing the rotations when the direction of propagation of the light is parallel to that of the earth's motion and in the reverse direction, and it might amount to $\frac{1}{10000}$th of the whole rotation, this fraction representing approximately the ratio of the velocity of the earth in its orbit to the velocity of light. According to Larmor's theory, on the other hand, there should be no effect of the first order. At the latter's request, Lord Rayleigh tested the negative result of Mascart, and carried the test as far as can readily be done. He found that the rotation is certainly not altered by the $\frac{1}{100000}$th part, nor probably by half of this, when the direction of propagation of the light is altered from that of the earth's motion to the opposite direction. The difference never amounts to $\frac{1}{30}$th of a degree, which would be $\frac{1}{100000}$th of the rotation. This result supports the idea that the ether moves bodily with the earth, at least up to a certain height.

[Lord Rayleigh, *Phil. Mag.*, August, 1902.]

Dark Cathode Space.—A. Wehnelt gives some results of measurements of free electric charges in the dark cathode space, which, according to Stark's theory, marks the mean free path of the positive ions, and is characterised by the formation of negative ions at the cathode and of positive ions in the negative glow light. The author used a large vacuum tube with a globular movable cathode, K,



a large plate anode, A, and a fixed probe, S. The anode was made large so that the displacement of the cathode should not alter the strength or path of the current. The author found that Schuster's formula for the distribution of the potential does not hold good. The greatest amount of free positive electricity is found immediately at the cathode and at the outward limit of the dark cathode space. In between is a space having a surplus of negative ions. The cathode is concentrically surrounded by electric charges of different signs, but the algebraic sum of the whole free charges is always positive. This surplus of positive ions varies as the pressure of the gas and as the current strength. Corresponding to the positive surplus in the gas is a negative charge on the cathode itself, whose discharge is facilitated by the ultra-violet light given out by the negative glow.

[A. Wehnelt, *Physikal. Zeitschr.*, August 1, 1902.]

Invisible Solids.—R. W. Wood is apparently at work at the fascinating problem of rendering objects invisible. A transparent body, no matter what its shape, disappears when immersed in a medium of the same refractive index and dispersion. Could a transparent solid substance be found whose refractive index and dispersion were the same as those of air, it would be absolutely invisible. The difficulty lies in the fact that the solids which have such refraction and dispersion are not transparent, and vice versa. The author points out that a solution of chloral hydrate in glycerine can be obtained which has all the optical properties of glass, so that a glass rod disappears entirely in it. The solution is better than Canada balsam. Transparent objects are only visible owing to non-uniform illumination. A transparent object becomes nearly invisible in a dense fog. But the author secures uniform illumination by enclosing the object—say, a glass stopper—in a hollow sphere painted on the inside with Balmain's luminous paint. On viewing it through a small hole the stopper is quite invisible, though the whole sphere is illuminated with a blue light. It may be mentioned that the problem of electric vision at a distance involves the "invisibility" of the intervening objects, and that if the state of luminous vibration in any plane could be exactly reproduced at another plane, all intervening objects would be invisible and transparent.

[R. W. Wood, *Phys. Review*, August, 1902.]

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THE "ARC" WORKS, CHELMSFORD.

On July 28th, at the invitation of Messrs. Crompton & Co. (Ltd.), an interesting visit to the above works was paid by about 30 gentlemen connected with electrical engineering. Although Messrs. Crompton's works are at all times of interest, yet on this occasion the interest was considerably increased owing to the fact that there were on the test bed two 800kw. multipolar generators, built by this firm. We give illustrations of the general appearance of one of the machines with its efficiency curve and drawings. These machines were built for the Calcutta Electric Supply Corporation, for whom Messrs. Crompton & Co. are contractors for the whole plant and machinery, and it may be of interest to note, in passing, that the Calcutta Company started in 1897, the first instalment of plant providing for a total output of 880kw. The demand for lighting and power has, however, been so rapid that the stations have been extended to 3,500kw. capacity, which will include the two machines referred to, and further extensions are still under consideration.

These two 800kw. machines run at 230 revs. per min., and are fitted with slotted drum-wound armatures 7ft. in diameter; the magnets are compound wound, the outside diameter of the yokes being approximately 12ft. The commutators are fitted with carbon brushes, and all bearings are self-oiling. The net weight of the armatures is 18 tons each, and the total weight 80 tons for each machine. Although the generators were primarily designed for lighting purposes, they embody all the essential qualities of dynamos for traction purposes, and could be used equally well in that capacity, if necessary, at a future date. Being designed for use in India, the greatest care has been taken to ensure cool running, and even on continuous work at their normal load the temperature rise of the machines is below the average. Their efficiency is very high, reaching 94 per cent. at full load, and they run sparklessly without brush shifting from full load to no load. At the time of our visit they were being tested by the Hopkinson method, and we had an opportunity of seeing them shut down and started up again. The complete absence of noise and vibration demonstrated the excellence of the design, and the brushes required very little alteration even during these operations. Three slightly larger generators have been supplied by Messrs. Crompton & Co. to the Glasgow Corporation.

On leaving the Calcutta machines, a brief inspection of the various shops was made under the able guidance of Lieut.-Col. Crompton. The works are quite close to the Great Eastern Railway, and cover an area of about 10 acres. The main shop—or that in which the heavy machinery is manufactured—is a building 240ft. long by 260ft. wide, with a total floor space of 63,000 sq. ft. It is divided into eight large bays of 30ft. to 40ft. span, the roofing being of the "saw-tooth" or "weaving-shed" pattern, with large frames, so that the short side, which is entirely of glass and faces the north, is very high, and thus a very regular light is obtained all over the building. As the roof principals have a 30ft. span it will be seen that the high glazing for the north light is exceptional. The north wall of the building is easily removable so as to allow of lengthening the shop at any time.

Three of the larger bays are 30ft. high from the floor to under the roof girders, and 24ft. up to the travelling crane gantry; two have a span of 40ft. and a third a span of 30ft. The remaining bays are 30ft. span, 20ft. to the underside of the roof girder and 16ft. to the travelling crane gantry. Special pains were taken to construct the building in the most fireproof manner. With the exception of the flooring blocks which, from their position, can never take fire, the whole of the building is constructed of non-combustible materials. The walls are of brick, the stanchions, travelling crane girders and roof girders are principally of steel, the glazed slopes of the roofs are fitted with Helliwell's patent glazing bars, and the long slopes are covered with corrugated sheathing in two thicknesses, spaced apart. There are no internal walls or partitions, so that an uninterrupted view of the whole floor can be obtained from the shop manager's offices, both of which are situated on a long gallery at the east end of the building. The bays run north and south, and are parallel to the Great Eastern Railway line. Five of them are provided with electrically-driven travelling cranes, varying from 15 tons down to 3 tons capacity, and the remainder with hand-power travelling cranes, but with provision for the addition of electrically-driven cranes in all the bays. Several of the cranes bear the well-known name of Broadbent & Sons, while others are by Marshall, Sons & Co. To facilitate further the rapid and easy shifting of goods, a 27in. gauge railway runs down the centre of each bay, these lines being connected at the north and south ends by cross rails with turntables to each bay.

Artificial light is provided when necessary by about 60 arc lamps, the shops are heated by means of special stoves, and the special system of glazing allows of ample ventilation.

Electric motor driving has been adopted for many years by Messrs. Crompton & Co., and its advantages have been found so great that the works under notice are equipped throughout in this manner. In the erecting bay there is a particularly useful combination of tools, consisting of a large floor plate on which a number of portable tools can be placed, thus bringing the tools to the work in cases where it is inconvenient to bring the work to the tools. The stores are fenced off by pierced ironwork, so that the view of the shop is uninterrupted, and yet the contents are inaccessible to workmen. Ovens, heated by gas from a "Dowson" plant, are situated in various parts of the shop and are used for drying field coils, armatures, &c. There is also a large steam-heated drying oven, arranged in conjunction with an air pump and condensing apparatus, so that articles placed therein are dried in vacuo. Attached to this oven there is also a set of impregnating tanks, by means of which armatures, coils, &c., can be perfectly impregnated with varnish. The coils, &c., are first placed into a tank which is then put into communication with the air pump and thoroughly exhausted. Communication with the air pump having been shut off, a valve connected with a varnish tank is opened and the whole is filled up with varnish, which penetrates into the most minute interstices of the coils, thus making them thoroughly waterproof.

The task of levelling the ground for the new instrument shops, which involved the removal of some 12,000yds. of earth, was begun in May, 1901, and regular work was commenced in the shops at the end of February, 1902. The floor space is 270ft. wide by 160ft. long, but the length can be extended almost indefinitely. The shop is floored throughout with American maple boards, laid on an under floor of deal with concrete below. Motor driving is universally adopted and the shop is heated by steam.

In the instrument department, which is occupied chiefly in the manufacture of measuring instruments, amperemeters, voltmeters, potentiometers, and other high grade instruments, the firm is also engaged in originating gauges and cutting tools for the system of small screw threads recommended by the British Association committee in the Bradford report of 1900. These gauges and tools are made on a system now being worked out in the shops under notice, and except that the parts are roughed out when soft, all the operations are on the hardened steel with emery wheels in a peculiar form of lathe. Irregularities due to deformation by hardening are avoided, no polishing of the surface is required, and a high perfection of geometrical form should be obtained in practice. An electrical contact gauge measures easily within 0·001mm.

The power for the whole works is supplied by three direct-coupled generators—two slow-speed sets and one high-speed combination. The two slow-speed sets consist in each case of a 150kw. continuous-current Crompton generator coupled to a 240 H.P. horizontal engine by Messrs. Marshall, Sons & Co., the engines being fitted with the well-known Proell-Marshall valve gear. The generators each have a 6ft. diameter armature built up on the engine crank shaft, and the 8-pole field magnets are entirely of steel. The high-speed set is a 200 H.P.

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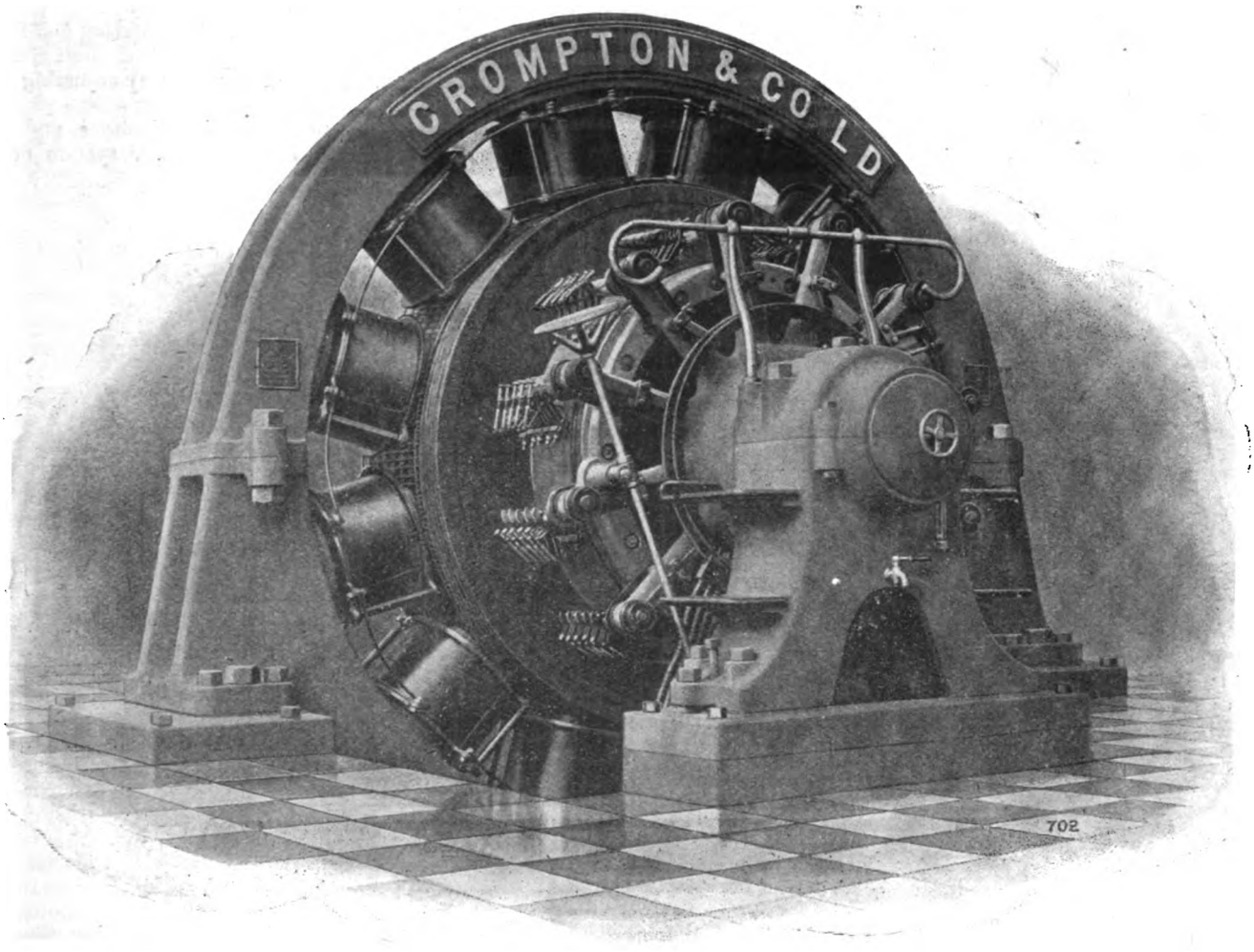
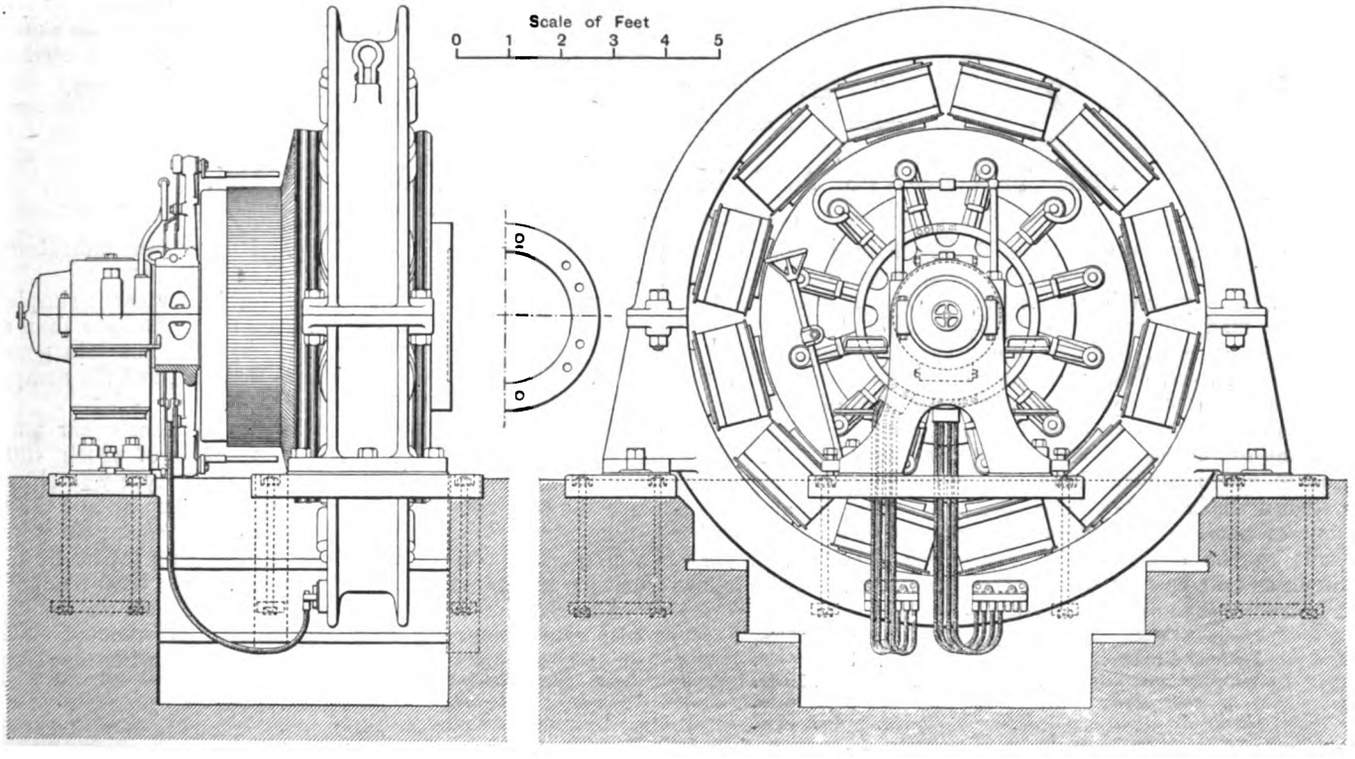


800KW. GENERATOR FOR CALCUTTA.



FRONT AND END ELEVATION OF 800KW. MULTIPOLAR GENERATOR.

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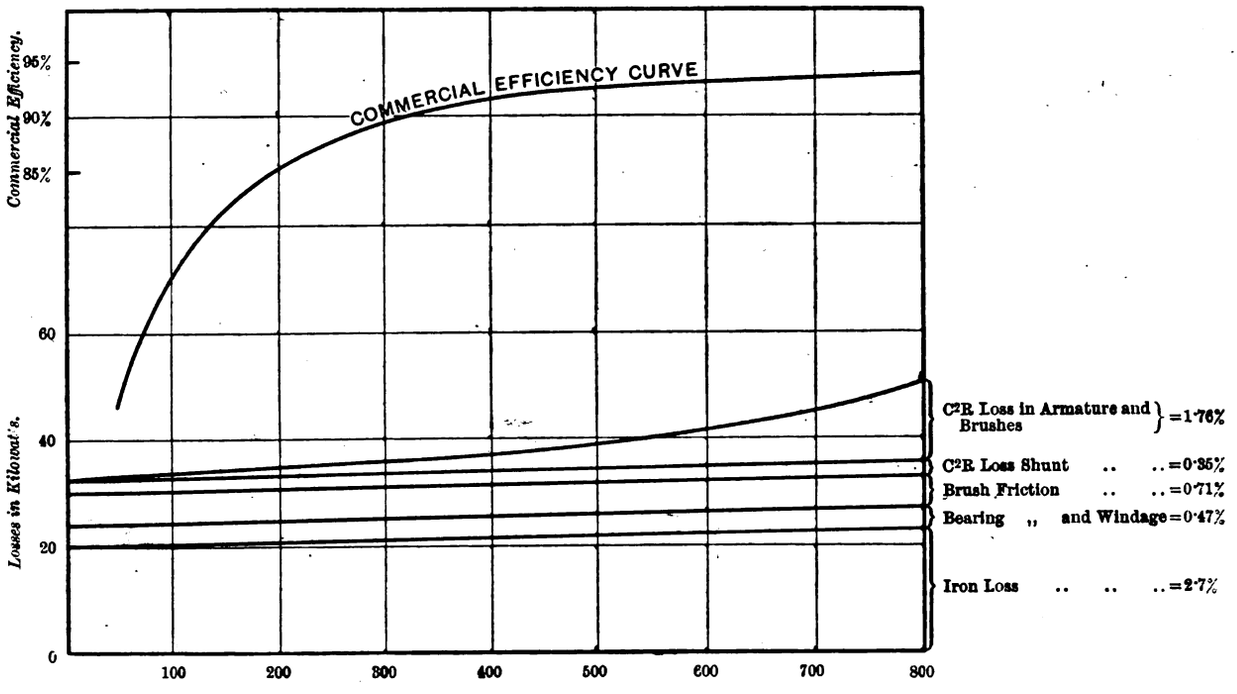
combination, the dynamo being a bipolar machine and the engine a Willans. Shafting is used to a comparatively small extent, and the trunk mains from the generating plant to the respective motors and lighting branches are of bare copper carried overhead and hung on the Crompton patent system, as used for underground street mains in many towns.

Steam is provided by three Babcock and Wilcox boilers, and there is also fitted a Green's economiser and a condenser of the power plant, is a large testing bed of ample size to allow of the carrying out of full electrical tests by the Hopkinson method on machines up to 2,000kw. This testing bed is provided with two large pits, a very heavy central shaft running in self-oiling bearings, and all the necessary adjusting rails and blocks.

All departments are interconnected by telephone, and these in turn can be connected to the telephone system of the



EFFICIENCY CURVE OF 800KW. GENERATOR. 230 REVS. PER MIN. 450 TO 550 VOLTS.
Temperature Rise after 6 hours' run at Full Load: Armature, 50°F.; Shunt, 37°F.

of the evaporative surface type, made by Ledward. The switchboard is a specimen of Messrs. Crompton's latest design in switches and other gear for low-tension distribution, and is an exceptionally heavy and substantial type.

No special building has been provided for the testing department, but the south-east corner of the main shop has been railed off for the purpose. The load is taken up on resistance frames of the usual kind, and tests are carried out by means of the Crompton potentiometer sets.

In the same bay as the test room, but on the opposite side country. Socially, the employés have everything they can desire, and it is very evident that Messrs. Crompton make every effort to secure their goodwill, welfare and co-operation in furthering the progress of the work. Messrs. Crompton & Co. are to be congratulated on their enterprise in extending their works to meet the demand, instead of turning away work because the necessary tools and appliances are not actually on the spot, this being a failing of many British manufacturers, who thus drive the trade away to either America or the Continent.

THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

(*Continued from page 585.*)

All the exhibits on stand No. 86 were manufactured by the Brush Electrical Engineering Co. at their Loughborough Works. Two types of cars were shown, the first being a double-deck car mounted on Brush single truck, of which the total length over fenders was 27ft. 6in. It was equipped with two motors of 25 H.P. each, and carried 32 passengers inside and 34 outside. Ordinary hand brakes with 12in. ratchet handles and controller with five breaking stops were provided. The lighting of the car was accomplished by means of 12 lamps, and in addition there were two earth leakage lamps fixed between the trolley base and the rail. We give an illustration of another car exhibited, being one of a large number built to the order of the Manchester Corporation. It is mounted on a pair of Brush maximum trucks, and the following are its principal dimensions:—

Length of body	21ft. 10½in.
Extreme length	33ft. 4½in.
Width of roof	6ft. 10 in.
,, over pillars	6ft. 6 in.
Gauge	4ft. 8½in.

Number of passengers inside, 28; outside, 28.

The inside finish is in maple and teak. The staircase is of the ordinary type. Lighting is by means of handsome bulkhead fittings in the ceiling. Destination indicators of the Brush revolving type.

The single truck shown under the shorter car is simple in design, light in weight, and claimed to be stronger than any other make of truck. This pattern has come into general favour on most of the tramways in England, and the company have a large number of orders in hand.

The type B trucks shown under the Manchester car are the company's standard for maximum traction, of which 400 to 500 are on order. Another truck of the B type was shown; this has been constructed for the Wolverhampton and district tramways, and differs from the standard in having an adjustable traction device which permits of varying the load on the driving wheels from 60 to 80 per cent. of the total load.

The type D maximum traction truck shown is fitted with one motor. Each truck, however, is intended for two motors, and is of the type used on cars with four motor equipments.

Various standard tramway motors of the company's manufacture, rated at 17, 25 and 50 B.H.P., were shown with different types of controllers, canopy switches, fuse boxes, rheostats, &c.

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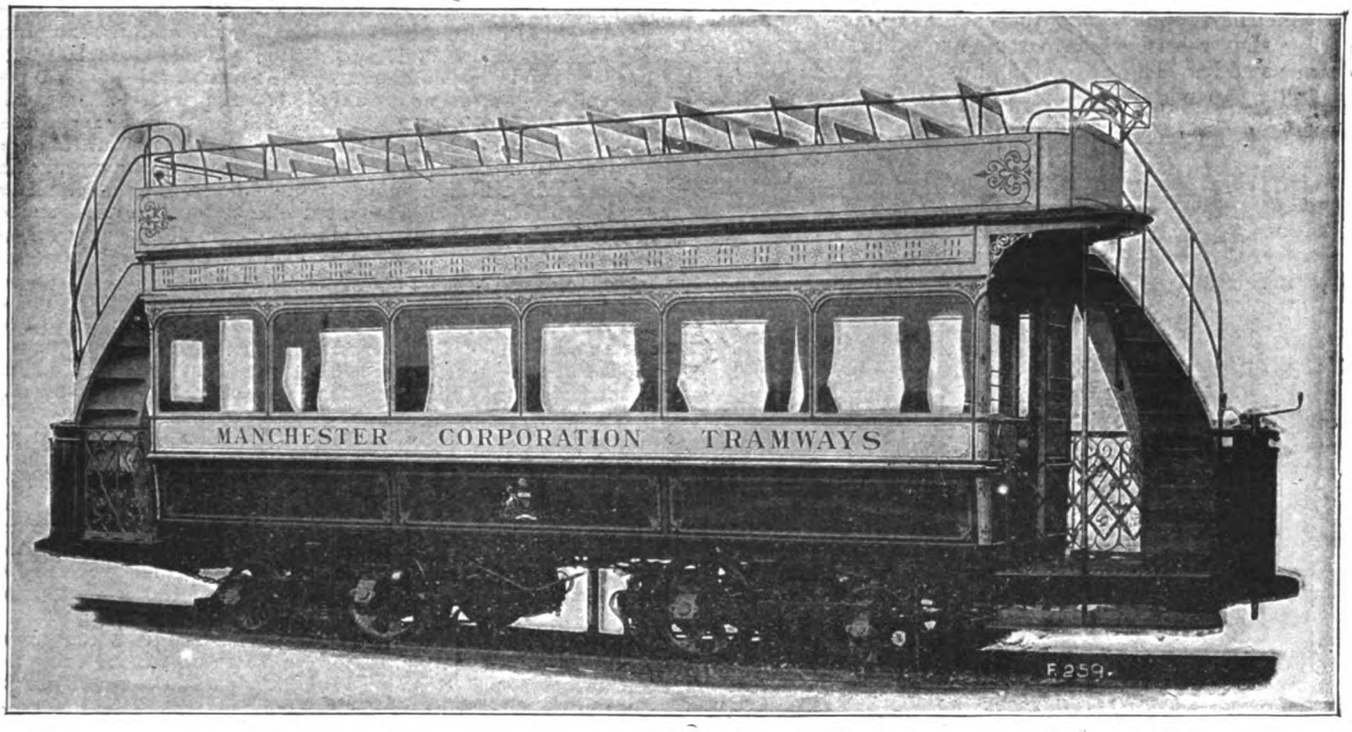
A 10 B.H.P. Brush light petrol motor carriage, of which we give an illustration, was shown, geared up to 30 miles per hour. The weight complete equipped for road is 15cwt.

A line of protected type motors for direct-current circuits was exhibited, together with a negative booster for tramway work made up of machines of the same patterns. Different sizes of high and low tension switch fuses suitable for section boxes and sub-stations, &c., were also shown.

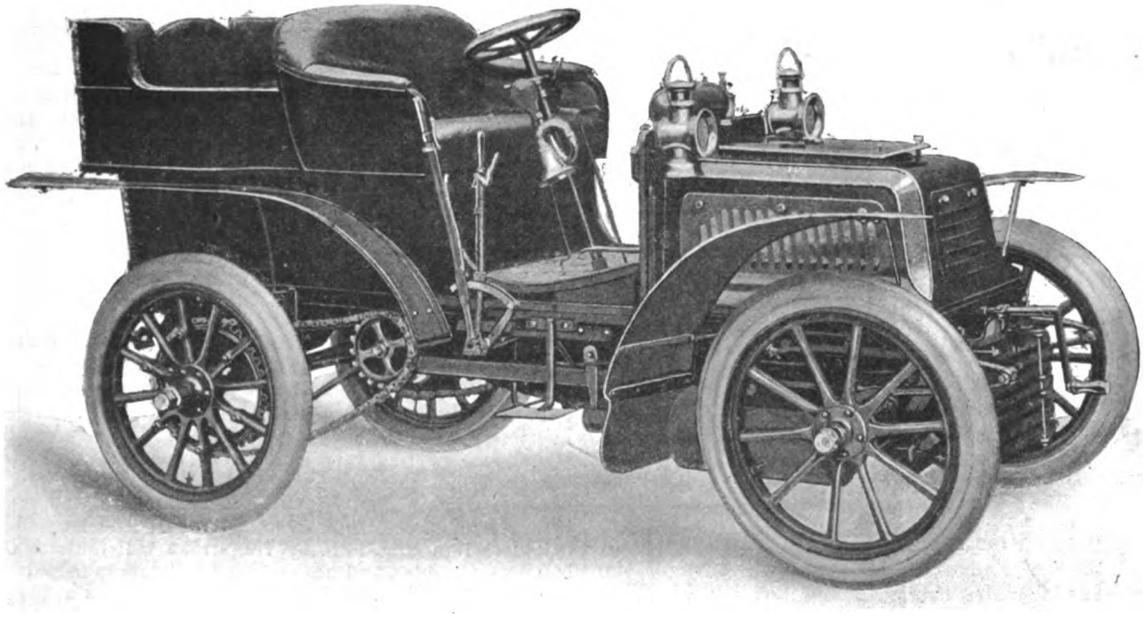
The exhibits of the Imperial Electric Supplies (Ltd.) at stand No. 44 consisted of Macallen overhead and fuse material, arc lamps, motors and dry cells. The overhead material has been largely used in the United States, and its appearance is consistent with long service and excellence of design. The section insulators are arranged for fixing without solder, but are provided with mechanical clamps for connecting the trolley wire. The ends are provided with a shear, so that, should the car approach with the trolley off, it is immediately thrown to one side.

The Toerring arc lamps are enclosed lamps of a simple, cheap and effective kind. They are specially recommended on account of the slight amount of attention they require. One pair of carbons have been known to last for 240 hours without renewal. They are made either for series or parallel working, and either for direct or alternating current.

We give an illustration of the new "Imperial" enclosed hot-wire arc lamp exhibited by this firm, which contains only one spring merely holding the brake collar against the top carbon. The feeding of the carbon is effected automatically and steadily by the simple expansion of a strip of flat steel wire through which the current flows to the carbon.



"BRUSH" CAR FOR MANCHESTER CORPORATION.



"BRUSH" MOTOR CAR.

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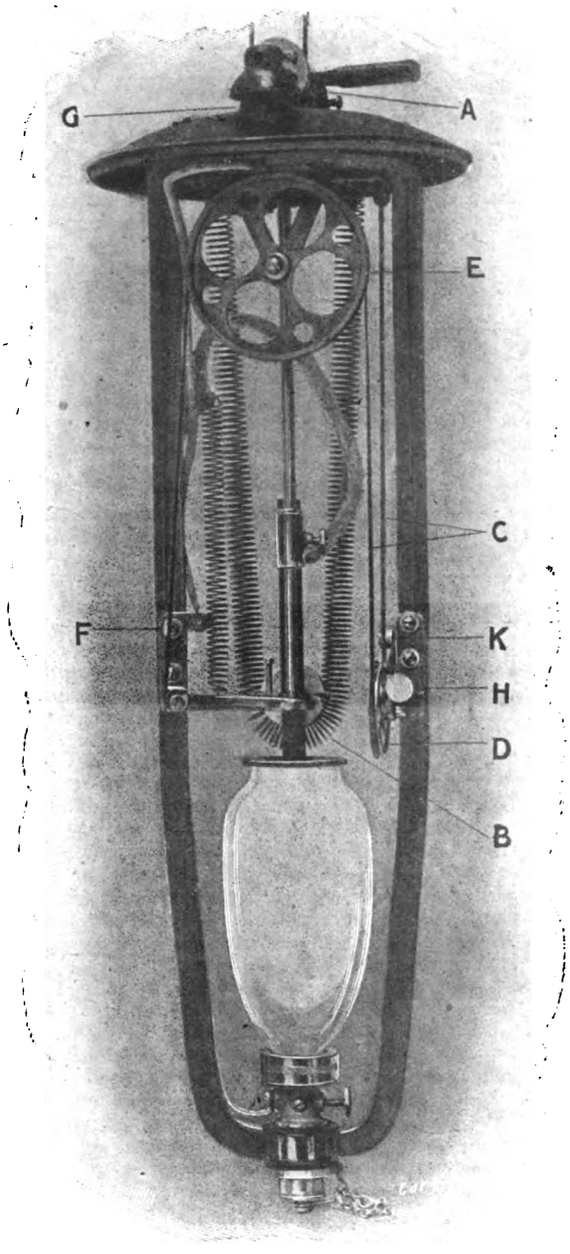
1. On starting, the current takes the path from terminal A through the only resistance coil B along steel wire or ribbon C (which is carried over the wheels D and E) to the terminal plate F, and then to the carbons through the terminal G.

As the carbons consume, the steel wire is gradually contracted, due to the decrease of current, which slight contraction is sufficient to pull down the "brake collar" against the spring, thus releasing the carbon and allowing same to feed down steadily. The arc being thus restored the steel wire instantly expands, slightly releasing the pull on the "brake-collar," causing the latter to again grip the carbon firmly. Adjustment of the arc is instantly effected by a turn of the milled screw head H, which carries a small roller K bearing against the steel ribbon.



"Imperial" Enclosed Hot-wire Arc Lamp.

The "Imperial" motors are direct-current semi-enclosed motors of British manufacture; they are very liberally designed, and are, therefore, capable of running night and day continuously for very long periods.

The I.E.S. dry cell is a new cell of British manufacture, specially recommended for telephone work, or for ignition purposes where it is desired to obtain steady currents continuously for comparatively long periods.

(*To be concluded.*)

THE WOLVERHAMPTON EXHIBITION.—V.

The finest electrical exhibit at the Wolverhampton Exhibition is undoubtedly that of the Electric Construction Corporation, and we give two illustrations of this below. A 500kw. and a 250kw. generator of this firm's manufacture, both driven by Belliss engines—as seen in Fig. 15—furnish current for light and power purposes in the exhibition. The larger engine is of Messrs. Belliss and Morcom's 800 B.H.P. standard, and is capable of exerting this power at a speed of 330 revs. per min. with a steam pressure of 170lb. per square inch. The smaller engine is their 400 B.H.P. standard, and capable of exerting this power at a speed of 400 revs. per min. at the same pressure of steam. They are both of the double-acting, triple-expansion type, having three cylinders, high, intermediate and low, working on cranks set at 120deg. The cylinders are fitted with piston slide valves and are designed to be self-draining. Oil is supplied to all bearings by means of the simple form of forced lubrication on the principle originated by the firm in 1890. Messrs. Belliss and Morcom inform us that they have a large number of these triple-expansion engines on hand, and that those on hand or at work include 20 sets of 1,600 to 1,200 B.H.P. and others of 1,500 and 2,250 B.H.P. Altogether, upwards of 250,000 horse power of these self-lubricating engines have been built by the firm since 1890 for electric lighting, power and traction purposes.

The dynamos are also of standard design, being of the usual pattern adopted by the Electric Construction Co. for their multipolar machines. The larger larger one is capable of an output of 1,000 amperes at 500 volts, running at a speed of 250 revs. per min. This particular machine is a duplicate of many sets supplied to corporations for municipal lighting and tramways, and is a good example of a typical British multipolar generator. The smaller generating set has an output of 500 amperes at 500 volts when running at 380 revs. per min.

Between these sets and the company's stand is a continuous-current transformer, connected as a balancer, for the exhibition three-wire system. It is capable of dealing up to a capacity of 200 amperes on one side with nothing on the other, and the pressure or voltage per side is 230 to 250.

On the Electric Construction Corporation's stand one of the most interesting exhibits is a small dynamo which has stood the test of 22 years' continuous working. This machine was the first one built by the early predecessors of the Electric Construction Co., and from the day it was completed until May 24th inst., when it was removed to be placed on exhibit, it was in constant use at the E.C.C. works driving a line of shafting. We are informed that this machine has cost nothing in repairs beyond the necessary commutator renewal. Amongst the other exhibits there is a 5 B.H.P. iron-clad Bushbury motor coupled to a treble plunger pump made by Messrs. Hayward, Tyler & Co. This pump is fitted with 2½in. diameter plungers by 3in. stroke, and can deliver 18,600lb. of feed water per hour against a constant pressure of 160lb. per square inch. The company also show several continuous-current and three-phase motors, with and without gear, and their enclosed motors are particularly noticeable for their appearance of excellent general finish. A Highfield booster is also shown, as well as the E.C.C. continuous-current transformer with auxiliary pole-pieces, for regulation of pressure, and a 25 ∿ rotary converter which is a duplicate of the sets recently supplied to Halifax for the Corporation tramways. There is also a transformer for experimental and testing purposes, stepping up the pressure to 40,000 volts. The secondary is in eight sections, and the whole transformer is immersed in oil. Finally, the fine stator casting of a 1,600kw. two-phase alternator as supplied to Leeds, forms a striking feature on the Electric Construction Co.'s stand.

In addition to the generating sets already enumerated, the Mirrlees Watson Co. show two of their small, quick revolution compound, single-acting, splash lubricating engines. One of the engines exhibited indicates 30 H.P., and is coupled directly to a Mavor and Coulson dynamo running at 700 revs. per min., the engine having cylinders 6¾in. and 10in. by 5in. stroke. The larger engine with cylinders 10in. and 14in. by 7in. stroke will indicate 60 I.H.P. at 550 revs. per min., and has extended bedplate to take dynamo.

Messrs. D. Selby-Bigge & Co.'s exhibit includes a 200 E.H.P. combined set, a switchboard and motor-driven shipyard winch fitted with warp ends instead of a barrel. The motor is enclosed, and drives the winch through worm gearing. The New Brotherton Tube Co.'s stand has a fine collection of tubes, bends, &c., for internal wiring in iron pipes. The firm make a neat pattern of split inspection bends, tee-pieces, &c. A four-way piece of this type is shown in Fig. 17.

The National Telephone Co. (Ltd.) have fitted up at the Wolverhampton Exhibition a telephone exchange in the Industrial Hall provided with a switchboard of modern design, in which small lamps take the place of the indicators both for calling and clearing. It is interesting to note that the batteries used for the glow lamps and

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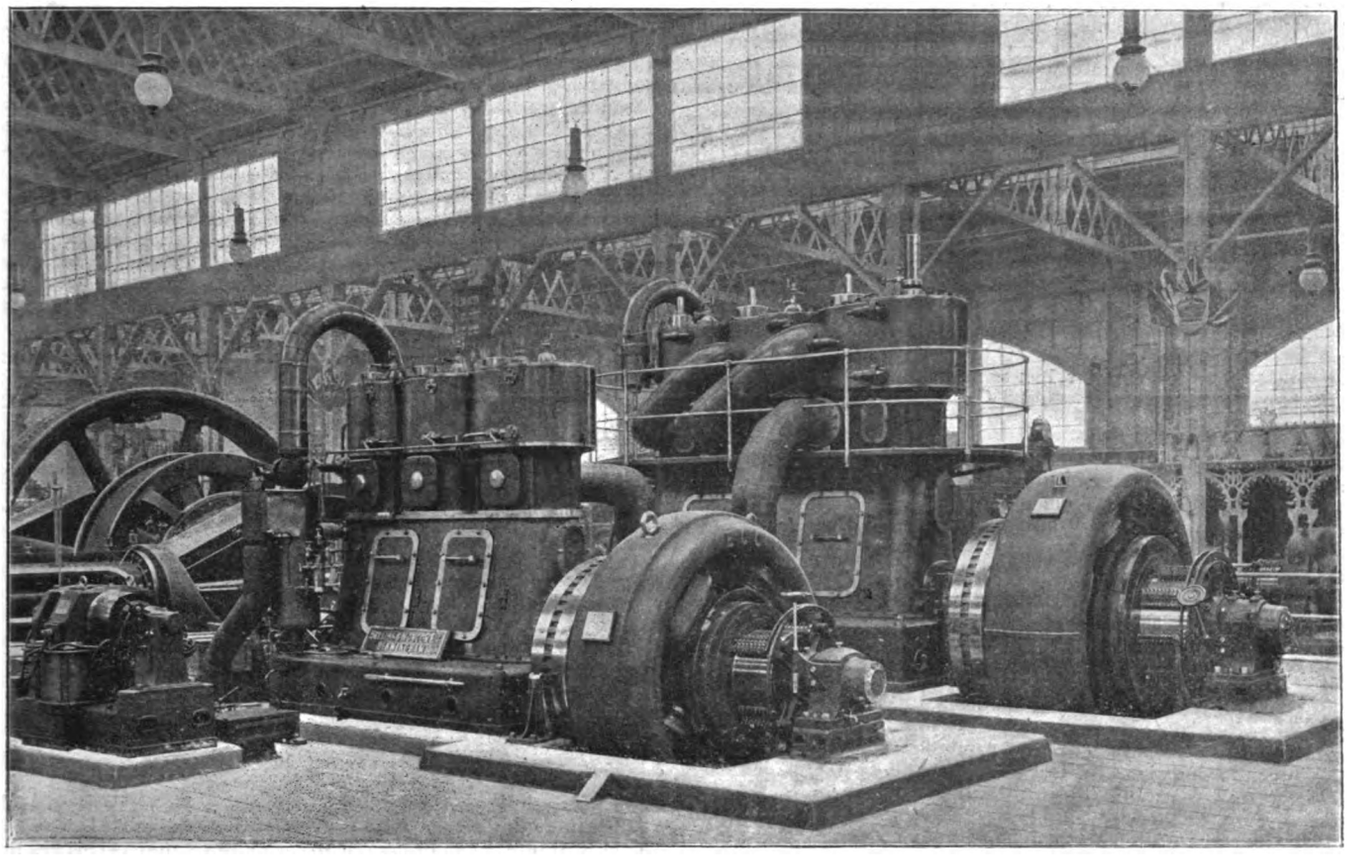

FIG. 15.—BELLISS–E.C.C. GENERATING PLANT.

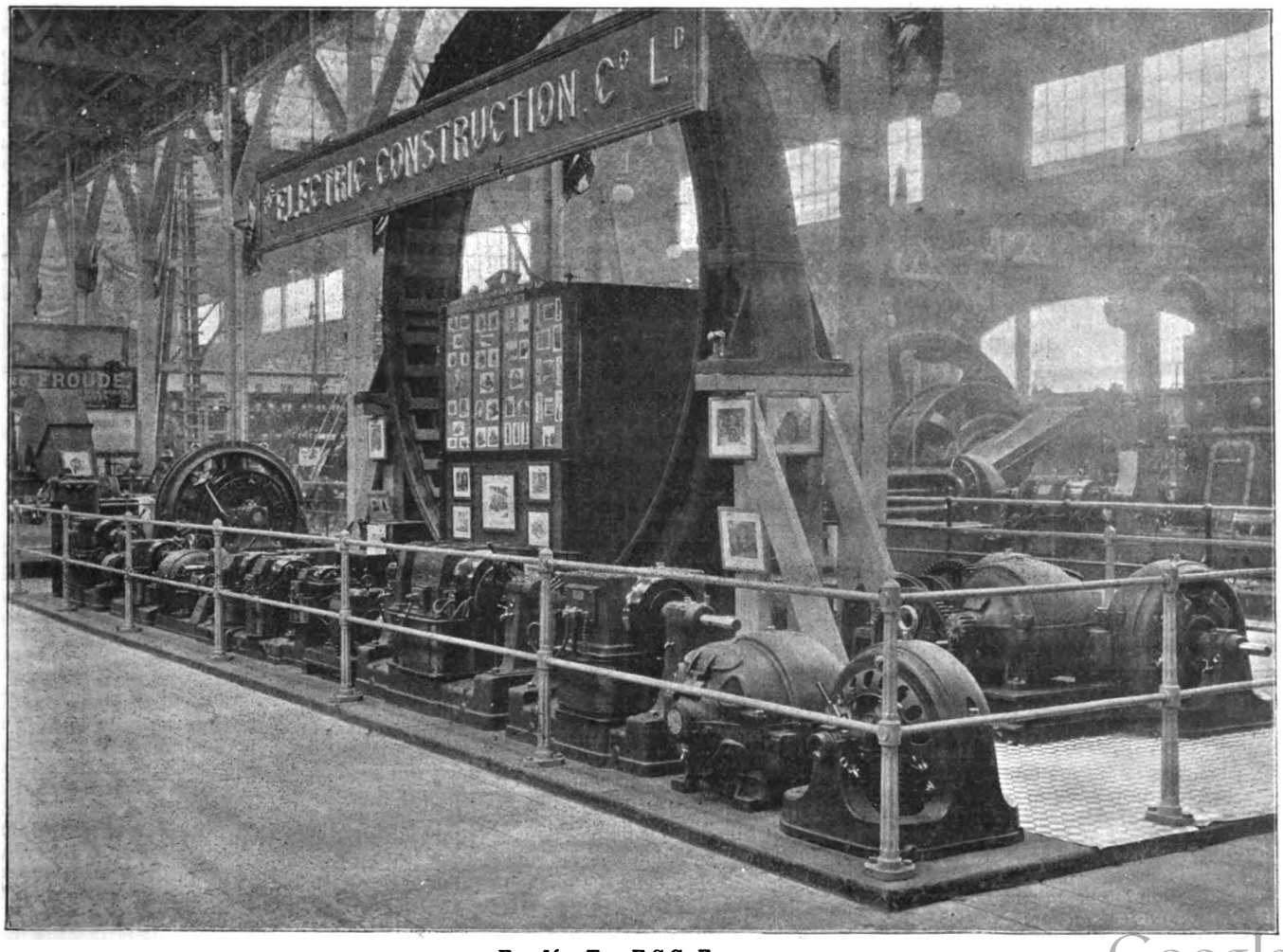

FIG. 16.—THE E.C.C. EXHIBIT.

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relays consist of Leclanché cells (666 type), which have been found to be most reliable and efficient. The exhibition exchange is in connection with the Wolverhampton exchange by means of several junction wires, and communication can be established thereby with any subscriber on the Wolverhampton or Bilston exchanges, and by means of the trunk wires to any subscriber on the company's system throughout

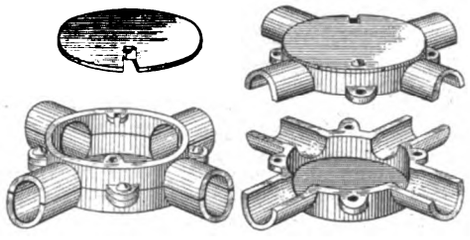


FIG. 17.—SPLIT FOUR-WAY BOX MADE BY THE NEW BROTHERTON TUBE CO.

the country. There is also a public call office in the adjoining room to the exchange fitted with silence telephone cabinets, and from here any subscriber or member of the public can speak on payment of the usual charges. In the call office is also fitted an interesting collection of the various types of instruments, switchboards, fire alarm apparatus, &c., as supplied by the company. The exchange and call office are open for use from 10 a.m. to 10 p.m.

MODERN MACHINE METHODS.*

BY H. F. L. ORCUTT.

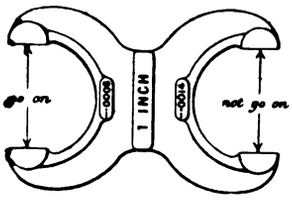
There is a rapidly increasing tendency to minimise hand labour and to reduce manufacturing to purely machine operations by the aid of accurate tools and fixtures combined with properly adapted machines. Admitting this, it follows that the lines on which manufacturers will work in the future will mainly be in the direction of perfecting methods of machining. It is with respect to machine operations, where accuracy combined with cheapness of product is secured, that this Paper deals, contrasting modern developments with those methods where accuracy is secured only by laboriously expensive hand work, or where machine work is performed on tools of comparatively simple design, unaided by highly developed tools, fixtures and gauges. It is not, however, assumed that automatic machine operations are invariably more economical than hand work, as doubtless many a sadder and wiser manufacturer who has invested in complicated expensive machines can testify. It is, however, beyond dispute that the producing power of the individual, aided by the labour-saving automatic machine, is practically unlimited, whilst we have long since reached the limit of production of the skilled worker, making use of only simple machine and hand tools. A high degree of accuracy is possible by either the old or the new method; but accuracy combined with cheapness is only possible under new conditions, whilst interchangeability is commercially impossible, except in those establishments fitted with the best machines, tools and gauges.

Strictly speaking, there are few, if any, mechanical operations that may be called new since the time when the planer and milling machines superseded the chisel and the power lathe and the drilling machine replaced the bow stick. Turning, milling, planing, grinding and boring are as "old as the hills." It is the latter-day developments of these operations in which the progressive manufacturer is interested, developments which have practically taken place within the last 20 years, some of them within the last five years. It is proposed to touch briefly upon the different methods in respect to the latest practice only, and to finally deal with the workshop reforms which in some cases follow, and in others must precede, the introduction of new methods before such methods can be successfully adopted. The range of subjects is so large that in most cases ambiguity has been risked for the sake of brevity. Descriptions of methods of working have not been possible, and an attempt only has been made to mention the most important points to which modern manufacturers must give attention. Technical details as to constructive features of machines have been avoided. The chief aim has been to make the Paper suggestive to those who are considering economical methods of manufacture.

Gauges.—It is altogether too commonly supposed that the extensive use of accurate gauges is only economical where either highly accurate work is called for or parts are to be made in large quantities. Neither supposition is correct. In nine cases out of 10 where even only one piece is concerned, that piece can be produced more cheaply and better with the aid of proper gauges than by the old-fashioned method of "fitting," or by measuring with micrometers or callipers. There will be the additional advantage of pieces being practically interchangeable. Again, where comparatively coarse work, as, for instance, in some parts of a loom, is permissible, the use of suitable gauges is desirable for the reason that, no matter how loose the fits may be, they are necessary to save work in erecting, to secure interchangeability and to keep sizes within certain limits. All this can be accomplished by means of the "limit" gauge, whether used for large or small dimensions, for inside or outside work, or for running or driving fits. Although the "limit" gauge in certain forms has been in use for years, particularly amongst gun and small-arms makers, it is surprising how little its advantages and use are known and understood by manufacturers for every-day work of all sorts. It is impossible to enumerate or describe the various forms of limit gauges which can be adopted in nearly all engineering works, but manufacturers will find the subject well worth investigation.

When the advantages of working with limit gauges are better understood, the system is sure to be extensively adopted for general engineering purposes, and limit gauges will supersede, except in a few cases, the ordinary standard plug and ring gauges. Even where

FIG. 1.—INTERNAL.



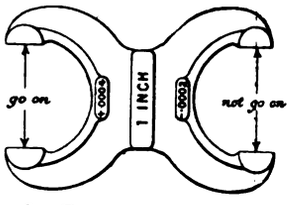
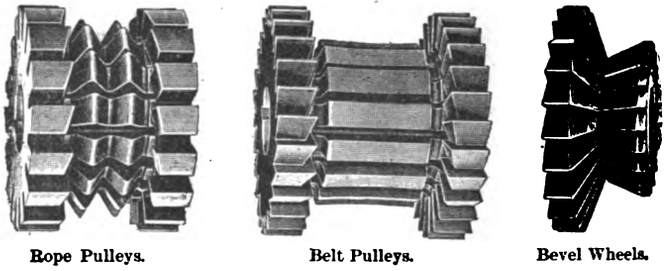


FIG. 2.—EXTERNAL. RUNNING FIT. FIG. 3.—EXTERNAL. KEYING FIT. LIMIT GAUGES. Examples from Table I.

the best gauges, of the ordinary sort, are used, work is in reality finished within certain "limits." When only standard gauges are used, however, these limits are never known; dimensions are made in accordance with the skill, judgment, or experience of the workman. With the limit gauge system, it is only necessary to determine what the allowable limits are to be and to then make use of a maximum and minimum gauge, by which sizes are kept within the prescribed limits. For inside cylindrical work the form of gauge used is shown in Fig. 1, for outside work those shown in Figs. 2 and 3. With these gauges, comparatively unskilled labour will (aided by the proper outfit) quickly learn to produce work accurate within limits of 0·0006in. when using the external limit gauge and within limits of 0·0006in. when using the internal limit gauge. These limits are none too close for a large percentage of ordinary engineering work and close enough for interchangeability, even in fine machine work.



Rope Pulleys. Belt Pulleys. Bevel Wheels.

FIG. 4.—BUILT-UP FORMED CUTTERS FOR CIRCULAR MILLING.

The adoption of limit gauges is in itself desirable, but, of course, the most economical results cannot be secured without also giving consideration to the outfit of machines and tools. It does not follow that grinding is necessary either for inside or outside work. The above limits can be kept to either in lathe or screw-machine work, and holes can be finished in steel, brass, or cast-iron with reamers.

It is an erroneous idea to suppose that because comparatively rough work is in question, comparatively rough gauges are "good enough." This may be true, as in the case of working gauges for unfinished material, but it will be rarely found profitable to follow this principle where machined surfaces are to be dealt with. Carefully finished hardened gauges, accurate to within 0·001in., are none too good where working surfaces are in question. A finer degree of accuracy than this is not demanded, except in comparatively small work, as, for instance, in tools connected with the manufacture of watches. It is proved that 0·0001in. is a limit to which hardened gauges can be made without too great an expense. It is desirable not to go below this degree of accuracy for working gauges (never in the case of standards), as errors multiply rapidly, and four or five times this limit means that in many cases work must be rejected

* Paper read before the Institution of Mechanical Engineers. Slightly abridged.

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The following Table I. of limits given is one which is adapted to a large range of work :—

Table I.—*Internal and External Limit Gauges.*

Limits of tolerance expressed decimally in inches.

INTERNAL LIMIT GAUGES. (See Fig. 1.)

Diameter of holes (nominal).	Go in.	Not go in.	Total limit of variation.
½in. to 1½in.	−0·0004	+0·0004	0·0008
1⅝in. to 1⅞in.	−0·0006	+0·0004	0·0010
2in. to 1 5/8in.	−0·0006	+0·0006	0·0012
1 11/16in. to 1 15/16in.	−0·0008	+0·0006	0·0014
1 13/16in. to 2 1/8in.	−0·0008	+0·0008	0·0016
3in. to 4 9/16in.	−0·0010	+0·0008	0·0018

EXTERNAL LIMIT GAUGES FOR RUNNING FITS. (See Fig. 2.)

Diameter of shafts (nominal).	Go on.	Not go on.	Total limit of variation.
½in. to 1½in.	−0·0004	−0·0010	0·0006
1⅝in. to 1⅞in.	−0·0006	−0·0012	0·0006
2in. to 1 5/8in.	−0·0008	−0·0014	0·0006
1 11/16in. to 1 15/16in.	−0·0010	−0·0018	0·0008
1 13/16in. to 2 1/8in.	−0·0012	−0·0020	0·0008
3in. to 4 9/16in.	−0·0014	−0·0024	0·0010

EXTERNAL LIMIT GAUGES FOR KEYING FITS. (See Fig. 3.)

Diameter of shafts (nominal).	Go on.	Not go on.	Total limit of variation.
½in. to 1½in.	+0·0004	−0·0002	0·0006
1⅝in. to 1⅞in.	+0·0004	−0·0002	0·0006
2in. to 1 5/8in.	+0·0004	−0·0002	0·0006
1 11/16in. to 1 15/16in.	+0·0004	−0·0004	0·0008
1 13/16in. to 2 1/8in.	+0·0004	−0·0004	0·0008
3in. to 4 9/16in.	+0·0004	−0·0004	0·0008

Light Milling.—The field of operation for the milling machine has materially widened within a comparatively short time. Improvements in design and increased skill in the manipulation and care of tools are the two factors mainly responsible for its success. It has largely displaced the planer and shaper ; it produce shighly-finished and accurate surfaces, and makes substantial savings in hand labour ; it is designed with a view to adaptability in making short runs. In many cases it is found profitable to set up a machine for a run on 10 or 12 parts. Stability and quickness of manipulation are the chief characteristics of the modern milling machine as compared with those of older design. Wherever it can be adopted it usually scores over the planer or shaper as a labour-saver, for the reason that in nearly all cases it can be served by unskilled attendants who can keep from two to four, and even six, machines in operation ; whilst with the planer or shaper it is not very often the case that one operator can advantageously attend more than two machines.

There are three essentials to economical results in milling :—

1. Up-to-date machines.
2. A not too niggardly supply of good milling cutters and tools.
3. Good tool makers who know how to keep machines and tools in the best of condition.

The following may be mentioned as a few of the most interesting milling operations which are not as widely adopted as they will be when their advantages are better understood. The vertical milling machine or, what amounts to the same, the horizontal machine, performing operations with the end mill, produces in many cases very satisfactory results both in speed and accuracy. There is a good variety of excellent machines, both of the vertical and horizontal type, now on the market for this class of work. A most valuable machine, comparatively little used, is a combined vertical and horizontal machine with long table. For taking roughing cuts with fast feeds inserted tooth cutters with Mushet blades give good results.

Circular Milling.—The circular mill, either on simple or complicated forms, effects great savings, and one attendant can keep six machines in operation. It can also be run in connection with other milling machines, reducing costs in many cases 50 and 75 per cent., and competing with the best turning machines in accuracy as well as in costs of operation. On castings with a chemical composition suitable for change gears, pulleys, hand wheels and similar parts, circular milling is accomplished with the cutter running at a surface speed of over 50ft. per minute and work feeding 4in. per minute on the periphery. One of the simplest and most effective methods is neglected to an astonishing degree, even by those who have large milling equipments ; that is, taking a roughing and then a finishing cut, not hurrying the machine too much on a finishing cut. The milling machine is too often regarded as a means for merely removing metal instead of as an instrument for producing accurately finished surfaces where little or no hand work is necessary. In many case five minutes more on the machine would make a saving of ten minutes fitters' work, files would be saved and greater uniformity secured. It should not be forgotten that the wrongly designed, badly made, rarely sharpened milling cutter largely assists in keeping the milling machine in disrepute, when otherwise it might rise to the rank of a valued ally.

The adoption and profitable use of the milling machine is often impossible on account of the lack of exact knowledge as to the composition of cast iron, and for want of proper treatment of castings for the removal of sand and scale. A large percentage of castings which are used could be soft if cupola mixtures were properly regulated. This would allow fast speeds and feeds for the milling cutters, without breakages or too much wear, instead of the comparatively slow planer cuts where castings are hard. There is little comprehension of how much the want of laboratory work stands in the way of the adoption of the milling machine. The pickling of castings alone makes it possible to increase the product of milling and planing machines, saves cutting tools, and consequently makes good work easier. Milling in many cases easily reduces costs 100 per cent. when compared with planing.

Heavy Milling.—The anticipated annihilation of the planing machine is not yet a reality, as some milling machine enthusiasts have from time to time predicted, and for heavy work the honours are now fairly well divided between the miller and the planer. Where rough but comparatively true surfaces only are required, what is known as the rotary planer turns out remarkably cheap work. It has the advantages of requiring little attendance and of turning out work two or three times faster than the planer ; the cutters used are mostly of the inserted teeth pattern with self-hardening steel. Another profitable use to which the heavy mill has been put is in "roughing out" work, particularly on castings which are to be accurately finished afterwards on the planing machine. The author has known cases where this operation effected a saving of 75 per cent. in time. The rate of feed which can be commonly made use of varies from 2in. to 6in. per minute. One particular case which he has in mind as an illustration of profitable milling is that of roughing out lathe beds. The cutter is perhaps 23in. wide, and removes from ¼in. to ½in. of metal with a feed of about 3½in. per minute, the peripheral speed of cutter being about 45in. per minute. Lathe beds are roughed out in this manner at about a fourth or a third of the labour cost when done on the planer. In this case the beds are afterwards allowed to stand about two weeks to "season," then a light finishing cut is taken by the planer, and then they are ready for being scraped. The regularity of cut varies of course with the material, whether it is hard or soft, accurate to size or not, or whether sand has been thoroughly removed from castings. Pickling and compositions of castings of course largely affect the possibilities of heavy as well as of light milling. Splendid results of heavy milling are attained by taking roughing and finishing cuts, surfaces of complicated shape up to 20in. to 24in. in width are finished outright on the heavy mill and are then ready for being scraped. Good gains are made over the planer, in some cases even when on short runs. Cutters are sometimes expensive, even costing £25 and £30, often more, but they are good investments as labour-saving tools. The variety of heavy milling machines now on the market is large, so that good selections can be made for all classes of work. The adoption of the milling machine is not as extensive as it should be, for the reason that often an apparently formidable investment in cutters is necessary. The milling cutter, however, should be looked upon as any other labour-saving tool. It is not so much a question of how much does it cost as how much does it save, or how much does the article cost which it turns out.

Planing.—The planer is a much neglected, long-suffering machine, too often found in such dismal, unfavourable quarters that any attempts to improve either the accuracy or quantity of its product would be of little avail. Daylight and good foundations are commonly wanting in the planer department. Most of the improvements connected with the latter-day practice in planer work are seemingly of little importance, but when added together give a substantial total. They can be briefly enumerated.

A quick return stroke is a feature of all up-to-date planers. This is now rarely less than three to one on machines up to 36in. capacity, and on smaller sizes four to one is common. Where castings are of good quality and the machine is well designed, cutting speeds are maintained of from 25ft. to 30ft. per minute and even up to 40ft. Where castings are hard, either through design or ignorance, cutting speeds are necessarily lower. There is an immense amount of planing being done at cutting speeds of from 12ft. to 18ft. per minute which could be done at the rate of from 20ft. to 25ft. All planers of 24in. capacity and upwards should have two heads, and larger sizes three and four. One of the most highly productive planers the author has seen is a 24in. machine with four heads and a 24ft. bed ; it runs a close race with fast milling machines. It it claimed by a well-known machine-tool manufacturer that good savings are effected by the use of variable speed countershafts, with which all their planers are fitted, as they can vary the speed of planers at will in accordance with the quality of material, length of stroke, and depth

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of cut. The author has seen in but one shop a simple device which saved considerable time; it was a brake in the form of a wooden shoe which pressed on the fast running countershaft pulleys when the belt was thrown off. All the best types of planers are quickly manipulated by an easy working lever by which the machine can be started, stopped, or reversed. Few planer hands realise the time saved by good holding devices, clamps, dogs, wedges, and quickly adjustable blocking pieces. Where any quantity of parts are to be planed, properly arranged jigs

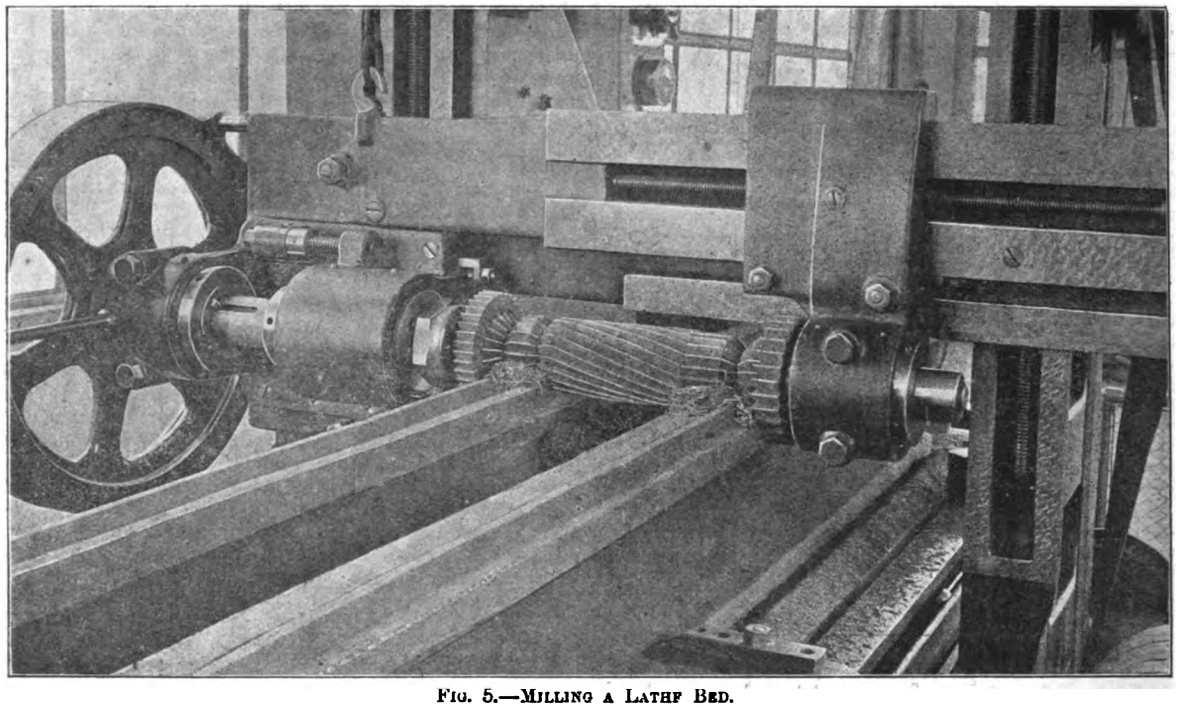

FIG. 5.—MILLING A LATHE BED.

are of as much importance as for the milling machine. Block templates which clamp to planer bed are extremely useful devices for complicated shapes. An illustration of this gauge as used for lathe-beds is shown in Fig. 6.

Electric chucks for thin parts are the latest and most useful innovations. An exceedingly simple and useful little tool is the block gauge. It is cheap, lessens the chances of mistakes being made

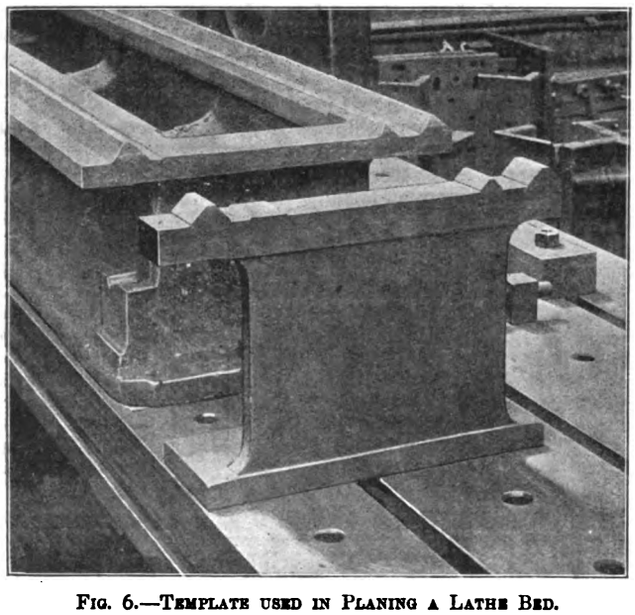

FIG. 6.—TEMPLATE USED IN PLANING A LATHE BED.

in measuring, and saves time in setting tools. The practice of periodically levelling the planer beds is astonishingly neglected, yet it is absolutely essential for good work.

The magnetic clutch-driving mechanism (Fig. 7) promises to be a most important improvement in planer construction. This consists essentially of two magnetic clutch discs, A, which are revolved in opposite directions and at speeds corresponding with the forward and return stroke of the planer table. The current is automatically switched by dogs on the table to either one clutch disc or the other. They alternately attract and grip discs B, shown in section, which are connected by a sleeve, and which slide endwise on the driving shaft of the planer to which they are keyed. Reference to drawing will show that these discs are so made that flywheel effect is reduced to a minimum. This arrangement makes it possible to reverse a planer table with a motive power very little in excess of that required to drive it. With the ordinary belt-drive the amount of power consumed at the moment of reversal is from 75 to 100 per cent. in excess of that necessary to move the table when under cut, whereas with the Riddell electric clutch drive on a 1in. planer the increase in power is only about 15 per cent. The mechanism is practically noiseless and reverses more accurately to a line than with a belt drive.

Grinding.—Grinding is probably the most ancient of all mechanical operations. As an operation by which accurate surfaces are cheaply produced, it is, however, a development of the last few years. The plain and universal grinding machine in its latest form is now a manufacturing machine as much as the lathe or milling machine; its use is no longer restricted to the "tool room" or for finishing hardened parts. It is conceded by those who use the grinder extensively and are expert in manipulating it, that it is the cheapest as well as the best machine for producing mechanically correct cylindrical surfaces where good work and interchangeability are desirable. This is true respecting soft as well as of hard steel, cast iron or bronze. The turner and the file cannot compete with the grinding machine

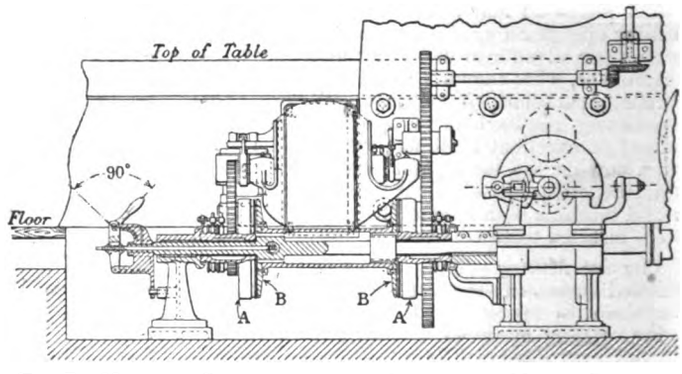

FIG. 7.—MAGNETIC CLUTCH APPLIED TO DRIVING AN 84-INCH PLANER. (Riddell.)

and the limit gauge. The author believes it is safe to state that (excepting in heavy work) the grinding machine and the turret lathe will in the near future absorb 50 per cent. of the lathe work now performed by skilled turners. Parts can be roughed out on lathes by unskilled attendants, each running from two to three lathes, allowing from 0·006 to 0·008 on parts up to 4in. diameter for finishing, and then accurately finished almost to the nicety of a gauge on grinding machines, one operator keeping two of these machines

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at work. For good cylindrical grinding, machines of extreme stability are necessary to resist vibrations; they must be of the very best workmanship and capable of handling a large stream of water by which the work is kept at an even temperature. Accurate limit gauges are of great assistance as measuring instruments in the grinding department, for they can be more readily used in many instances than micrometers or vernier calipers.

Surface grinders, where accuracy is necessary, are not much used except where comparatively small areas are in question. Where accuracy is not of much importance, they will be found effective for a great deal of work and more economical than hand polishing, One man can keep from four to five machines in operation. They are best when arranged with exhaust pipes for removing dust, as the present machines are not constructed to be used with a stream of water. As for planers, electric chucks are again "the latest" and most useful accessories to surface grinders.

Where accuracy is required on flat surfaces, except those of small dimensions, nothing in the way of a machine operation has been devised to take the place of hand scraping, or, where hardened surfaces are in question, hand lapping.

The most striking example of advance practice in cylindrical grinding is that of work recently done on a machine capable of finishing parts up to 8in. in diameter and up to 8ft. long, carrying a grinding wheel 24in. in diameter with a 2in. face. It is recorded that a 4in. shaft 3ft. long can be finished on this machine in 6min. The shaft to be previously rough turned with a 12 per inch feed, and left 0·01 above size at the bottom of the tool marks. Parts up to 7in. diameter are rapidly finished, the limit of variation being 0·001in. Knowing that results like the above have been accomplished, few manufacturers can neglect to seriously consider grinding as an important method by which costs may be reduced and quality of work improved.

Chucking.—Chucking is an American term used to designate that class of work which is held in a face-plate chuck in either a vertical or horizontal turret machine, and is operated upon by a series of tools which finish a cylindrical hole. Comparatively true cylindrical surface, cheapness of operation, and interchangeability are virtues sufficient to recommend a proper system of chucking to enterprising manufacturers. Its adoption in accordance with the best practice need not be restricted to those who only make in large quantities or turn out very close work. Whether there is one piece or 500 to be "chucked," whether the "fit" has $\frac{1}{64}$th in. or $\frac{2}{1000}$th in. play, the system is profitable. In the same manner that milling is specialised to secure accurate flat surfaces at a low cost, so is "chucking" specialised for the purpose of securing accurate cylindrical holes with comparatively unskilled machine attendants. "Chucking" machines, with proper outfits of boring tools, are as much a part of a modern engineering equipment as are milling machines with their outfit of cutters and arbors. One prominent English manufacturer told the author that the introduction into his works of a chucking department revealed the fact that he had never before made holes that could be called round. The best system calls for a series of tools, usually varying in number from four to six for each diameter, the final operations in most cases being performed by an adjustable reamer which takes out about 0·004in., all holes being tested by the inside limit gauge, Fig. 1.

For cast iron, when parts are not too light weight, the vertical machine is best adapted, Fig. 8. One operator can in most cases attend two machines. Other operations, such as facing and turning, are often to advantage combined with chucking work. For steel work where oil is used and light parts or parts with a long hole, the horizontal machine is better adapted, Fig. 9. As in many other operations which are specialised, comparatively unskilled labour can be employed, but the highest skill is required to supervise and keep machines and tools in proper working condition. The tools ordinarily used consist of under-size twist drills, boring tools, three-lipped chucking drills, four-lipped boring tools, roughing reamers, finishing reamers (adjustable) and facing tools; a part or all of these may be used, in accordance with the work and available machines. The best shop organisation demands a department equipped with chucking machine, tools and gauges, to which every part within the scope of the department should be sent. The results are a reduction in the costs of boring, a higher degree of accuracy, and the attainment of interchangeability. With a proper outfit, holes up to 3in. diameter can be easily finished by comparatively unskilled workmen to within from 0·0005in. to 0·0010in. of standard size.

Turning.—The lathe has been and will continue to be one of the most important machines in the equipment of an engineering establishment. The principal improvements in design to be noted in the modern lathe are quickness, ease of manipulation, and rigidity. There is also a growing appreciation of the value of a lathe possessing the best quality of workmanship, even when used for comparatively rough work. Referring particularly to light lathe work, recent developments in other machine tools have taken away from the lathe a large amount of work for which it was formerly thought that this machine was indispensable. Except in special cases, the boring of holes is now largely relegated to the chucking department. The accurate finishing of plain parts, and, in many cases, of parts of considerable complication, is done in the grinding department. Where repetition, even of small quantities, is possible, parts up to 2ft. long and 2in. diameter, are sent to the turret machine department. It is now recognised that it is poor economy to make a polishing bench of a fine screw-cutting engine lathe. It seems pretty well assured that in the future the lathe will be largely used as a roughing-out machine. Following this line, a great deal of work can be done by unskilled labour, one man keeping two or three lathes in operation. Stiff lathes, fitted with double tool post and with pump and pans, so

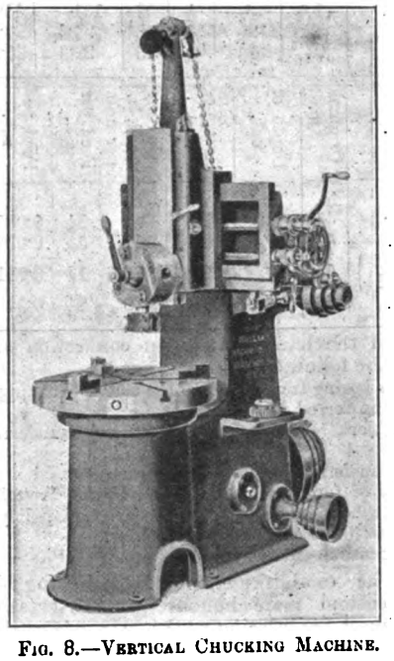

Fig. 8.—Vertical Chucking Machine.

that the work can be flooded with soapy water, are found to be, as a means of reducing parts, much cheaper than smith work. For instance, soft machinery steel spindles can be reduced 3½in. in diameter at one operation by means of two cutting tools, which would have a feed of about 0·007in. per revolution. Table II. is interesting as showing possibilities in this direction.

It is in many cases one man working three pieces in the lathe department *versus* three men working on one piece in the forge shop. All the modern innovations which are either supplanting or improving lathe work, such as chucking, grinding, screw-machine work, polishing

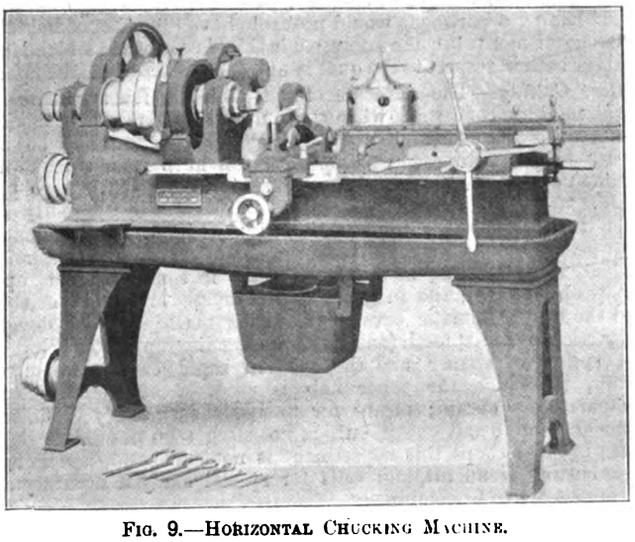

Fig. 9.—Horizontal Chucking Machine.

and roughing, are accompanied by a reduction in costs of manufacturing, the employment of less skilful machine attendants, an increase in the number of machines that one man can attend and better work. It should be mentioned that the various processes of treating turning tools may revolutionise lathe construction. Speeds, feeds, and strains must all be recalculated. Cutting speeds from 80ft. to 120ft. per minute are now quite common. Where the lathe is used for roughing out, from 0·006 to 0·008 is sufficient to leave for finish grinding. Roughing limit gauges are useful for this work.

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Table II.—*Tool Speeds for Cutting Soft Steel.**

No.	Material.	Diam. before turning.	Diam. after turning.	Depth of cut.	Revs. per min.	Cutting speed, ft. per min.		Feed per min.	Feed per rev.
						At outer circumference.	At bottom of cut.		
		in.	in.	in.		ft.	ft.		
1	Soft machinery steel	5¼	1¾	1¾	27	37·1	12·25	3/16	0·007
2	Do. do.	1 9/16	9/16	1/2	297	121	43·5	1¾	0·006
3	Tool steel	3¾	2 3/16	1/2	30	29·4	21·5	5/16	0·010
4	Do. do.	2½	1 5/8	7/16	45	29·4	20·25	7/16	0·010

No.	Material.	Original diam.	Depth of cut.	Revs. per min.	Cutting speed, ft. per min.	Feed per min.	Feed per rev.	—
		in.	in.		ft.			
5	Cast iron	4¼	1/8	37	41	3⅛	0·085	Roughing cut.
6	Do. do.	4¼	1/32	100	111	3½	0·035	Finishing cut.
7	Soft machinery steel	4¾	3/32	23	28·5	1⅞	0·081	Roughing cut.
8	Do. do.	5¾	1/32	63	78	2½	0·04	Finishing cut.

A summary of the latest practice in connection with lathe work would include the following :—

1. Chucking or boring transferred to the turret chucking machine.
2. Finishing transferred to the grinder.
3. Repetition work (even for a dozen pieces) transferred to the screw machine.
4. Polishing transferred to a separate department.
5. A great deal of forge work transferred to the "roughing out" lathe.
6. Castings like hand-wheels, flanger or grooved pulleys, bevel wheels, &c., transferred to the circular milling machine.
7. A great increase in cutting speeds.

Polishing.—The establishment of a polishing department is apparently a custom more honoured in the breach than in the observance by most engineering works, even where this work could be specialised to good advantage. A well-arranged polishing department is one of the best examples of simple organisation that could be selected, for the reasons that its equipment is cheap, costs of operations are reduced, and quality is improved. This work only needs to be classified. Let any manager walk about his shops and observe polishing operations going on here and there. It is most probable that they are being done by skilled turners or fitters on expensive machines, when the work could be done by a comparatively unskilled hand with an inexpensive apparatus. A gain would also be realised in time of operation and quality of finish if all polishing was done by men trained by constant practice. The downfall of many an accurate engine lathe could probably be traced to surplus charges of emery administered by the combined turner and polisher. A comparatively cheap and simple apparatus for removing dust from the polishing department would probable have the effect of inducing better grade men to become interested in this class of work, which is important both in respect to the quality and appearance of finished parts.

Gear Cutting.—The advocate of cast gears has few arguments, as far as costs are concerned, when confronted by the results of modern automatic gear cutters. Every form of gear cutting can now be done on automatic machines. One operator can keep from three to five automatic spur machines, and from three to 10 automatic bevel-gear cutters at work. The latest practice in gear cutting is really confined to the following latest designed machines: fully automatic spur-gear cutters, with rapid return stroke to cutter spindle carriage and accurate dividing mechanism, which in some cases cut up to five teeth at once; the fully automatic bevel-gear planing machine and the fully automatic bevel-gear milling machine which develop theoretically correct teeth (one operator attending up to 10 machines); the spur-gear shaper and the modern rapid cutting worm-gear cutter, in which the taper hob is used. Accurate cutters are comparatively cheap; means for testing the accuracy of finished gears are simple and cheap, but are not often seen in modern shops. Even in large shops this department is not sufficiently specialised. Gear cutting is an art, and calls for special study if accuracy and cheapness are to be combined.

(To be continued.)

* *American Machinist*, Sept. 29, 1900.

ELECTRICITY WORKS ACCOUNTS.

Central London Railway.

As a result of the large influx of visitors for the proposed Coronation in June, the passenger traffic on this line during the past half-year shows a welcome increase. There were 2,493,595 more passengers carried than in the corresponding period in 1901, and during the week in which the Coronation was to have taken place 1,256,000 passengers were carried. It is interesting to point out that the mean weekly traffic in the first half of 1901 was 785,000, and in the corresponding period this year 881,000. The receipts per passenger being constant, there was a material improvement in the total revenue and in the revenue per train-mile run.

What may be termed the works costs show a commendable reduction, but the advantage thus gained was more than lost by the great increase in rates, taxes and Government duty. The rates and taxes were more than double what they were in 1902, being £9,750, as against £4,597. The net result in the total working expenditure is indicated by the slight increase of 0·23d. per train-mile.

Nothing has yet been set aside for depreciation, and including £5,874 brought forward from 1901 there was an available surplus of £82,603. Out of this dividends at 4 per cent. were declared, £25,603 being carried forward. The relative largeness of the amount carried over is in view, it is stated, of the expenses in connection with the vibration inquiry, with the promotion of the company's rather ill-fated bill and of the provision for reserve.

It is anticipated that by the end of this year the present locomotive system will be largely replaced by a motor-car or multiple-unit system, in pursuance of the recommendations of the committee of inquiry on vibration caused by the line.

Liverpool Overhead Railway.

It will be seen from our table that the competition of the Liverpool Corporation tramways is continuing to tell seriously on the fortunes of this line. In order to render it more attractive the company decided to accelerate the service, thus reducing the time required to make the journey from end to end from 32 to 20 minutes. As a study of the costs of working, the revenue account loses interest through the fact that included in the costs of the railway working are those of the tramways owned by the company. The car-mileage run has increased and the train-mileage on the railway has diminished. Thus, in the first half of 1901, the train-miles run were 398,802 and the car-miles 107,372. Last half-year the respective figures were 383,464 and 113,870. This has the effect of showing a diminution in the expenses and receipts "per train and car-mile." In the 1901 half-year the passengers carried per combined train and car-mile were 10·6, in last half-year the number was 10·1. Unfortunately, the ratio of costs to revenue shows a rise from 70·5 to 73·5 per cent., and the working profit has drooped from 1·53 to 1·24 per cent. of the mean capital employed.

The following is a list of electric railway and tramway works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Birmingham Trams. (Co.) ..	May 30, 1902	Dublin United (Co.)	Feb. 28, 1902
Blackpool Corp. Trams. (Mun.)	Oct. 4, 1901	Dublin and Lucan (Co.)	Feb. 21, 1902
Blackpool & Fleetwood (Co.)	Feb. 21, 1902	Glasgow Corporation (Mun.)	Aug. 11, 1899
Brighton & Rottingdean Seashore (Co.)	May 25, 1900	Isle of Man (Co.)	May 27, 1898
Bristol Tram. & Carriage (Co.)	Mar. 21, 1902	Leeds City (Mun.).....	June 2, 1899
Br'mpt'n & Picc'dilly Cir. (Co.)	July 8, 1898	Liverpool Overhead (Co.) ..	Feb 14, 1902
Central London (Co.)	Feb. 14, 1902	Liverpool Trams. (Mun.) ..	May 30, 1902
City & South London (Co.)..	Jan. 31, 1902	New General Traction (Co.)	May 27, 1898
Douglas Southern (Co.)	May 27, 1898	Oldham, Ashton & Hyde (Co.)	July 5, 1901
		Waterloo & City (Co.)	Mar. 1, 1901

REMARKS.

CENTRAL LONDON RAILWAY.—*a* Inclusive of 2,190,084 workmen. *b* £14,151 premiums. *c* Repairs of signals £483, of stations and buildings £364. *d* Being wages of working, generating and loco. engines. *e* Water and gas £1,001. *f* Car cleaning £1,677, printing tickets, &c., £939, clothing £610. *g* Office expenses £1,120, stores £5 3, insurance £131. *h* Government duty £156. *i* Law £740, compensation £583. *j* Including £26,348 premiums. *k* Over expended. *l* Reserve fund. *m* Of signals and works £601, stations and buildings £367. *n* Water and gas £613. *o* Cleaning cars £1,648, clothing £648, printing and stationery £726. *p* Office expenses £919, stores £378, advertising £270, insurance £440. *q* Government duty £501. *r* Law £460, compensation £517.

LIVERPOOL OVERHEAD RAILWAY.—*a* Includes 107,872 tram-miles on tramways. *b* Inclusive of 2 miles 40 chains of tramway. *c* 8 trailers, 46 motor cars. *d* Including £16,927 on Waterloo with-Seaforth and Great Crosby tramways. *e* Office expenses £323, insurance £210, contingent fund £100. *f* Includes 113,370 tramcar miles on tramways. *g* Includes £17,933 on Waterloo-with-Seaforth and Great Crosby tramways. *h* Includes £136,055 on general equipment. *i* over-expended. *j* Includes £2,084 in respect of Dingle station accident. *k* Clothing £224, printing and stationery £610. *l* Office expenses £350, insurance £231, contingent fund £100. *m* Law £60, compensation £100. *n* Includes £300 from contingent fund re Dingle accident; over-estimated and repaid.

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	CENTRAL LONDON RAILWAY.				LIVERPOOL OVERHEAD RAILWAY.			
Worked by	Central London Railway Co.				Liverpool Overhead Railway Co.			
Date of Commencement of Working	July 30, 1900.				March 6, 1893.			
System	Third-rail with transformer sub-stations.				Third-rail surface conductor at 500 volts.			
Chief Engineer	Sir Benjamin Baker.				S. B. Cottrell.			
HALF-YEAR ENDED	JUNE 30, **1901.**		JUNE 30, **1902.**		JUNE 30, **1901.**		JUNE 30, **1902.**	
QUANTITIES.								
Train mileage	*629,213*		*644,545*		*506,174*[a]		*496,834*[f]	
Passengers Carried	**20,385,739**		**22,879,334**		**5,382,224**		**5,026,422**	
Length of railway authorised	6 miles, 34·7 chains		6 miles, 34·7 chains		9 miles, 45 chains[b]		9 miles, 45 chains[b]	
Length of railway constructed	6 miles, 34·7 chains		6 miles, 34·7 chains		9 miles, 17 chains[b]		9 miles, 17 chains[b]	
Length of Railway Worked	**5 miles, 66 chains**		**5 miles, 66 chains**		**9 miles, 17 chains**[b]		**9 miles, 17 chains**[b]	
Length of railway under construction	nil		nil		nil		nil	
Rolling stock, number of cars	168		168		8[c]		8[c]	
,, number of locomotives	28 electric, 2 steam		28 electric, 2 steam		46[c]		46[c]	
CAPITAL.								
Authorised (Total)	**£3,726,000**		**£3,926,000**		**£906,500**		**£906,500**	
Authorised (share)	2,850,000		3,000,000		680,000		680,000	
Authorised (loan)	876,000		926,000		226,500		226,500	
Received (Total)	**3,562,352**[b]		**3,669,451**[j]		**790,000**		**790,000**	
Received (share)	2,850,000		2,850,000		620,000		620,000	
Received (loan)	698,201		793,103		170,000		170,000	
	Total.	Per mile of working railway.	Total.	Per mile of working railway.	Total.	Per mile of working railway and tramway.	Total.	Per mile of working railway and tramway.
Expended (Total)	**£3,534,589**	**£607,000**	**£3,702,850**	**£63,600**	**£803,848**	**£87,250**	**£812,706**	**£88,200**
On line open for traffic	—	—	—	—	653,053[d]	70,850	654,084[g]	71,000
On line in course of construction	—	—	—	—	—	—	—	—
On working stock, with power station	—	—	—	—	150,795	16,360	158,622[h]	17,220
Balance of Capital Account	**27,763**	**4,767**	**−33,399**[k]	**−5,735**	**−13,848**[i]	**−1,502**	**−22,706**[i]	**−2,466**
Renewal fund	—	—	—	—	19,200	2,083	22,200	2,410
Contingent fund	—	—	10,000[l]	1,717	1,200	130	3,484[j]	379
REVENUE.	Total.	Per train mile.	Total.	Per train mile.	Total	Per train and car mile.	Total.	Per train and car mile.
Total	**£164,823**	**62·90d.**	**£185,118**	**68·96d.**	**£41,361**	**19·61d.**	**£37,853**	**18·29d.**
Passenger traffic	160,654	61·30d.	179,288	66·82d.	40,674	19·28d.	37,207	17·98d.
Parcels, rents, transfer fees, &c.	4,170	1·591d.	5,830	2·171d.	687	0·326d.	646	0·312d.
EXPENDITURE.								
Total	**£90,267**	**34·43d.**	**£93,100**	**34·66d.**	**£29,158**	**13·83d.**	**£27,788**	**13·43d.**
Maintenance of way, works and stations	*3,859*	*1·472d.*	*4,097*	*1·526d.*	*3,873*	*1·836d.*	*3,054*	*1·476d.*
Maintenance of way { Wages	1,961	0·748d.	2,233	0·832d.	633	0·300d.	600	0·290d.
Maintenance of way { Materials	733	0·280d.	441	0·164d.	292	0·138d.	496	0·240d.
Repairs of structure, stations, &c.	847[c]	0·323d.	968[m]	0·361d.	1,948	0·924d.	1,958	0·945d.
Salaries, office expenses and general superintendence	318	0·121d.	455	0·170d.	—	—	—	—
Locomotive and generating power	*34,205*	*13·06d.*	*31,538*	*11·75d.*	*8,818*	*4·180d.*	*7,707*	*3·723d.*
Coal and coke	14,158	5·403d.	12,729	4·741d.	2,908	1·379d.	1,844	0·891d.
Wages	9,016[d]	3·440d.	9,889[d]	3·684d.	3,132	1·485d.	3,041	1·470d.
Oil, water, gas and stores	2,655[e]	1·014d.	1,401[n]	0·522d.	789	0·374d.	898	0·434d.
Repairs and renewals { Wages	3,815	1·455d.	3,842	1·431d.	674	0·320d.	765	0·370d.
Repairs and renewals { Materials	2,868	1·094d.	2,347	0·875d.	1,315	0 624d.	1,158	0·559d.
Salaries, office expenses and general superintendence	1,693	0·646d.	1,330	0·495d.	—	—	—	—
Repairs and renewals of cars	*4,118*	*1·572d.*	*5,165*	*1·924d.*	*389*	*0·184d.*	*299*	*0·144d.*
Cars { Wages	1,186	0·452d.	1,747	0 651d.	222	0·105d.	181	0·087d.
Cars { Materials	1,013	0·386d.	1,090	0 406d.	166	0·079d.	118	0·057d.
Lifts { Wages	1,455	0·555d.	1,596	0·595d.	—	—	—	—
Lifts { Materials	364	0·139d.	451	0·168d.	—	—	—	—
Salaries, office expenses and general superintendence	100	0·038d.	281	0·105d.	—	—	—	—
Traffic expenses	*35,233*	*13·44d.*	*34,340*	*12·79d.*	*11,363*	*5·390d.*	*10,979*	*5·306d.*
Salaries and wages—stations and service	18,426	7·032d.	19,340	7·203d.	8,021	3·804d.	7,795	3·770d.
Fuel, lighting, water and general stores	8,025	3·063d.	5,850	2·179d.	2,432	1·154d.	2,350	1·136d.
Electric lifts—wages and materials	5,228	1·994d.	5,514	2·053d.	—	—	—	—
Miscellaneous expenses	3,554[f]	1·356d.	3,635[o]	1·354d.	910	0·432d.	834[k]	0·403d.
General charges	*6,475*	*2·471d.*	*6,729*	*2·506d.*	*2,264*	*1·074d.*	*2,399*	*1·159d.*
Directors	1,250	0·477d.	1,375	0·512d.	350	0·166d.	350	0·169d.
Salaries of secretary, general manager and clerks	2,591	0·989d.	2,643	0·985d.	1,176	0·558d.	1,202	0·581d.
Other charges	2,634[g]	1·006d.	2,711[p]	1·010d.	738[e]	0·350d.	847[l]	0·409d.
Rents, rates and taxes	*5,054*[h]	*1·929d.*	*10,254*[q]	*3·818d.*	*3,002*	*1·423d.*	*3,185*	*1·538d.*
Miscellaneous items	*1,323*[i]	*0·505d.*	*977*[r]	*0·364d.*	*448*	*0 212d.*	*166*[m]	*0·080d.*
FINANCIAL RESULTS.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.
Working Profit for Half-year	**£74,557**	**2·16%**	**£92,019**	**2·49%**	**£12,203**	**1·526%**	**£10,066**	**1·244%**
Sum carried to depreciation fund	nil	—	nil	—	1,500	0·188%	1,500	0·185%
Net interest on loans	12,551	0·356%	15,290	0·414%	3,060	0·383%	3,265	0·403%
Net Profit for Half-year	**62,006**	**1·80%**	**76,729**	**2·08%**	**7,643**	**0·955%**	**5,301**	**0 655%**
Balance from last half-year's account	3,527	0·100%	5,874	0·159%	4,080	0·511%	3,693	0 456%
Balance Available for Dividend	**65,533**	**1·86%**	**82,603**	**2·24%**	**11,723**	**1·465%**	**9,293**[n]	**1·147%**
Ordinary Dividend paid at per cent. per annum	4%	—	4%	—	2%	—	1%	—
Percentage of total expenditure to revenue	54·8%	—	50·3%	—	70·5%	—	73·5%	—
Revenue per mile of Working Railway	**£28,300**	—	**£31,770**	—	**£4,490**	—	**£4,110**	—
Expenditure per mile of working railway	£15,500	—	£15,930	—	£3,163	—	£3,020	—
Revenue per Passenger (Total)	**1·94d.**	—	**1·94d.**	—	**1·84d.**	—	**1·81d.**	—
Revenue per Passenger (from Fares)	**1·89d.**	—	**1·88d.**	—	**1·81d.**	—	**1·78d.**	—

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LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS. By F. C. RAPHAEL. *New Edition in preparation.*

RECENT DEVELOPMENTS IN TELEPHONY.

The effect of the Telegraph Act of 1899 upon the development of telephony in this country is gradually becoming more definite. Results of the first period of working of the two pioneer municipal telephone systems at Glasgow and Tunbridge Wells have been published; the City exchange of the Post Office has been at work for some time, and the smaller metropolitan and suburban exchanges of this department are now being opened; and last, but not least, improvements in the National Telephone Co.'s system, accelerated by the competition which the 1899 Act encouraged, are now evident throughout the country. In the meantime, a large number of local authorities, in addition to Glasgow and Tunbridge Wells, have obtained telephone licences, and the realisation of the municipal telephone systems in some of these places is being rapidly pushed forward.

The municipal telephone undertaking in Glasgow is one which was started under most favourable conditions. At Glasgow the telephone service of the National Telephone Co. was allowed, even by the company itself, to be wanting in efficiency, and the company did not enjoy any great degree of popularity. Competition with this service was rendered still more easy by the fact that the Glasgow Corporation could profit by its control of the streets and lay underground cables, while the company was obliged to rely on overhead wires and had to obtain its wayleaves as best it could; and another important factor was the public spirit of the Glasgow citizens which impelled them to take pride in and support to the utmost any trading undertaking ventured upon by their representatives. With all these advantages, to which must be added the natural desire of the engineers, managers and contractors connected with the scheme to ensure success to the first large municipal telephone undertaking, municipal telephony should be successful at Glasgow if it has any chance of success anywhere, and all who are interested in this new branch of municipal electrical engineering will do well to study the published accounts most carefully. Unfortunately, the figures apply only to nine months instead of a whole year's working, and although the exchange is apparently now working at its present full capacity, it is evident, from the proportion of prepaid rentals entered as applicable to the year 1902-3, that during the period in question the average number of subscribers connected to the exchange represented about half the present capacity of the switchboard. In these circumstances it is not surprising to find that the undertaking has practically been working at a loss—in fact, little else could be expected of the first nine months' working of any municipal undertaking of the same magnitude. Although apparently there is a surplus of about £400, this is only left by omitting to make any allowance for depreciation (the total capital expenditure, it will be observed, has amounted to £126,300) and setting aside nothing to reserve fund. This is the more noticeable as only £1,960 is

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put to the sinking fund, although the Corporation's licence expires in 1913—*i.e.*, in 10½ years after the year under review. We referred to this question of sinking fund and depreciation last February, in connection with a statement issued by the Tunbridge Wells telephone department, and it is evident that Glasgow has made precisely the same mistake as Tunbridge Wells in this matter. So far as is at present known, the telephone business of the Glasgow Corporation may be closed on December 31, 1913, on which date the POSTMASTER-GENERAL may acquire it at a price representing the actual value of the plant and material at that date, exclusive of any allowance for goodwill. By rights, therefore, the Local Government Board should only have permitted the loan for telephone purposes on the understanding that this should be repaid at the date the licence expires. But since the repayment period is longer (30 years), it is evident that large sums should be written off for depreciation, so that the book value of the undertaking in 1913 is its probable saleable value. Had these allowances been made it is evident that there would be a large deficit in the Glasgow telephone accounts, and from the figures before us (an abstract of which was given in our last issue) it is by no means conclusive that the Glasgow telephone department will pay its way in the future. We would again remind our "municipal" readers that Glasgow is situated more favourably than any other town can be with regard to municipal telephony, and urge them to study carefully the Glasgow and also the Tunbridge Wells accounts before risking their ratepayers' money on the experiment of competitive telephony.

We now come to the engineering side of the question. While there is evidence of most excellent work in the construction of the exchange switchboard at Glasgow, we cannot but think that it was a mistake to adopt a system which had already been tried and found wanting in Glasgow itself. Both in Glasgow and Manchester the call-wire system had been employed by the National Telephone Co., and in both these places it was the imperfection of this system which was the main cause of dissatisfaction with the company's service, and the company has replaced it with a better system. The only reason we can see for its adoption by the Glasgow Corporation is that telephone subscribers were already accustomed to the call-wire method of communicating with the exchange, but the force of this argument is discounted by the fact that, out of the 4,697 subscribers to the Corporation exchange, 2,059 had never been telephone subscribers before. What is also significant with regard to the fact that the National Telephone Co. has abandoned the call-wire system at Glasgow is, that their manager there was formerly manager at Manchester, which was the only other large town with a call-wire system.

We are watching with interest the introduction of the common battery system in telephone exchanges, which has been going on apace since its first advent from the United States. Its praises have been sung far and wide, and there is no doubt that for quick, efficient and economical operating it is second to none. Its first cost must not be forgotten, however, and, while it may be an excellent thing for large exchanges, it is surprising that the Post Office should have adopted it in the small exchanges which we recently described in our columns. The initial cost of the battery of accumulators and the power plant, to say nothing of the relays and the more expensive wiring of the switchboard itself, is very great when it is only for a 200-subscriber board in an exchange whose possible ultimate capacity of 1,000 subscribers is hardly likely to be approached for several years. Moreover, while we would not like to suggest that the recent deplorable fire at the London Wall exchange might have been due to such a cause, there is, undoubtedly, a greater fire risk in the case of the common battery system. This should be a consideration in determining whether this system is the most suitable for smaller exchanges, at which the engineers-in-charge are naturally less experienced, and are, possibly, little accustomed to dynamos, batteries, fuses, and short circuits. A luminous-signal switchboard appears to be regarded as almost indispensable for large exchanges both in this country and the United States, but the employment of the combined indicator and jack to some extent on the Continent claims attention, and its adoption might especially be considered in the case of those exchanges which are not of the very largest size. In many small exchanges there seems no good reason for departing from the well-tried "Standard" switchboard which has for long actually been the standard pattern in most countries. These are only some of the engineering questions which have recently come to the fore in telephony. The increase in the number of owners of telephone exchanges, although it has disadvantages from the political and economical standpoint over single control by a Government department, should be beneficial to the technical development of telephony, and a combined simplification and improvement in the design of large telephone switchboards offers an excellent field for those whose interests are in the lighter branches of electrical engineering.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

Electrical Installations of Electric Light, Power, Traction and Industrial Electrical Machinery. By RANKIN KENNEDY. Vol. I.—The Electrical Circuit, Measurement, Elements of Motors, Dynamos, Electrolysis. (London: The Caxton Publishing Co., 1902.) 9s. net.

It is a matter for thankfulness that but seldom are we called upon to express such complete dissatisfaction as we have to do with the author's part of this book. It is not so much that the work bears evidence of lack of knowledge and experience of the subject; what we complain of is its carelessness of expression and incoherence of treatment. Generally, we can agree with the aims set forth in an author's preface, however much they may fail of fulfilment; but with Mr. Kennedy's first paragraph we are quite at issue. He says: ". . . . it is not necessary for a practical man engaged in engineering to work out curves of permeability for iron; it is sufficient for him to have a table of exciting power required per inch length of iron to be magnetised to any degree within which he works. It is more important for the practical man to know how to apply the facts and figures obtained by the pure scientist than to know how they were obtained. Hence this first volume refers to the methods for using ascertained figures or values without any pretence at explaining how such values have been arrived at."

It is difficult, even after a perusal of the book, to conceive a class of reader to whom it might be of service. In the above quotation from the preface the "practical man" is referred to; later on the author addresses himself to the "intelligent plumber, workman or student"; and still later on, to representatives of these vocations without the explicit qualification. Is it in order to appeal to the plumber that such an expression is used as "but they will be for all practical purposes near enough the correct thing"? Then, in what state of mind would the following, which are culled from various parts of the book, leave a student? "We have to deliver so many watts of electrical energy through a wire to a distant point, *not current nor pressure alone*—we want something with horse-power in it." "Any wire should be worked at a certain density of current, 1,000 amperes per square inch for short lengths and less for longer ones"; "Adding lamps or motors in series multiplies the resistance in a current. Adding lamps or motors in parallel divides the resistance by the number added." On p. 57 we find: "For motor work and

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arc lamp circuits dead-beat instruments are necessary. In cheap instruments this is furnished by using an oil dash-pot to steady the needle. To this same class belongs also the fine accurate Kelvin balances, the Siemens dynamometer, the moving coil instruments of the D'Arsonval types, the ballistic and reflecting galvanometers."

In the second chapter some instructions are given for making simple measuring instruments for gaining a practical knowledge of Ohm's law. In detailing experiments with these and a battery, the author ignores the internal resistance of the battery even in the calculations given as showing what results are to be expected. It is true that in the opening part of the chapter, where batteries are referred to, the fact that they have internal resistance is stated, and also that "in practice that resistance should be so low that it is almost negligible." But in any attempt to teach students Ohm's law experimentally it is misleading to suppress that part of the total circuit resistance which is afforded by the battery. Rather should the battery be so chosen as to make clearly manifest to the student that it is the *total* resistance of the *circuit* which should be taken into account, and not merely the conductors and translating devices.

In the discussion on the use of globes on arc lamps the following is delightful:—"For lighting streets and large interiors the large arc lamp is quite correct, the only fault being the use of obscure globes—another case of unreasoning habit. At great expense a powerful light is produced, and then straightway an extinguisher is put upon it extinguishing 60 per cent. of the expensive light. This procedure wants a lot of explanation to justify it. It is fashionable; that is all that can be said for it. . . . . This practice is ridiculous, and should not be perpetuated. The competition of incandescent gas for street lighting is serious, ... and the gas people don't place their lights under a bushel nor up in the sky, but in clear lanterns. . . . . The electrical engineers do not sufficiently study these details."

The matter dealing with the principles and the types of meters would very likely prove useful, but why are arc lamps sandwiched right in the middle of this discussion, and then, again, between arc lamps such lamps as the Nernst and the Cooper-Hewitt?

Instruments et Methodes de Mesures Electriques Industrielles. By H. ARMAGNAT, Chef du Bureau des Mesures Électriques des Ateliers Carpentier. 2nd Edition, 1902. (Paris: G. Naud.)

This work of 599 pages forms a complete description of the principal instruments used both in the laboratory and in commercial electrical measurements, with an exposition of their principles and the methods of using them. The book is divided into three sections; the first of these deals with measuring instruments and standards. The first chapter goes very thoroughly into the elementary principles of oscillating systems, such as those used in galvanometers, and treats also of the different methods of suspension, such as pivots, cocoon and quartz fibres, metallic wires or strips and springs. It gives practical directions for the attachment of fibres, &c., as well as going into the theory. The second chapter deals with the means for measuring the deflections, and goes thoroughly into the question of scales and their illumination mirrors, and telescopes.

The remaining chapters in Section I. deal with galvanometers for direct and for alternate currents, electrometers, standard and other resistances, current standard balances, standards of E.M.F. and condensers. The last chapter deals with the setting up of the measuring instruments and with means for overcoming vibration, a most important point when the observer has to use a room at the top of a building, or even a room in the basement near considerable traffic; it also treats of accessories, such as keys and commutators, sources of current, &c. The second section is confined to the description and theory of the instruments used in commercial measurements, and deals with ammeters and voltmeters for direct and alternate currents, wattmeters, electrostatic voltmeters, recording instruments, and ampere-hour and energy meters. It would need a very large volume to describe all the different varieties of these that have been brought out, so the author contents himself by describing a certain number of the most typical forms and those most in use. The third section deals with methods of measurement involving the use of the apparatus described in the first two sections. The first chapter of this section deals with the theory of errors, and general methods, such as deflection or null methods of measurement, and with the calculation and classification of results. Succeeding chapters, with all the different electrical measurements, both in theory and practice, from resistances to power in alternating current circuits. The last chapter deals with oscillographs, phase-meters and frequency-meters. This work, covering practically the whole ground of electrical measurements, ought to form a most valuable addition to the library of all electrical engineers. That it has been appreciated in France is shown by the fact that it has gone into its second edition within a year of its publication. It is illustrated with 228 figures of instruments described and skeleton diagrams of connections.

E. C. R.

Notes on the Construction and Working of Pumps. By EDWARD C. R. MARKS. (Manchester: The Technical Publishing Co., Ltd.) 3s. 6d. net.

As the author remarks, this book is intended for users rather than makers and students of pumping machinery. It contains a number of plates and diagrams of most of the well-known pumps in use at the present day, and describes in detail the action of ram, piston-pattern, boiler-feed, hydraulic-pressure, electric and centrifugal pumps. It also deals with hydraulic rams and manual and animal power pumps. Everything is put clearly and concisely, and all formulæ are illustrated with numerical examples, although the knowledge of mathematics required does not extend further than simple equations. We can recommend this book to those whose duties bring them in contact with pumps as being of great practical use.

Gas and Petroleum Engines. Translated and adapted from the French of Henry de Graffigny, and edited by A. G. Elliott, B.Sc (London: Whittaker & Co., 1898.)

This book constitutes Vol. II. of Whittaker's electro-mechanical series, and, in the space of 138 small pages, attempts to cover the wide field comprising not only the history and principles of gas and petroleum engines, but also descriptions of the several makes and types.

When, further, gas generating plants are found to be dealt with in the above limits, it will be at once apparent that the discussion must, necessarily, be very superficial. Having said that of this unpretentious little work we have stated its most apparent shortcoming, for it deals with its subject with a clearness and accuracy not usual in this class of book.

A Graduated Collection of Problems in Electricity, Comprising all Branches of Electrical Science. By ROBERT WEBER. Translated from the third French edition by Edward A. O'Keeffe. (London: E. and F. N. Spon (Ltd.), 125, Strand. 1902) 7s. 6d. net.

The number of problems contained in this book is 746, and they cover practically the whole ground of the course on electricity and magnetism given at most technical colleges. The author states in his preface that the figures employed are generally the result of measurements actually made and not imaginary ones. This, of course, adds to the value of the questions for educational purposes. Lecturers and demonstrators, as a rule, prefer to set their own questions, but it is certainly useful to have a book of questions on which to draw if necessary, and as such this book may prove useful. It should also be of aid to students wishing to work additional problems for themselves in the subjects they are given at lecture, particularly as a short working out of each answer is given after the question. We think, however, that it would have made the book more useful in its latter capacity if the answers had all been put together at the end of the book, as it certainly requires a considerable effort of mind to avoid looking at the answer when reading the question as now placed. E. C. R.

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THE CAPABILITIES OF THE MILAMMETER AND THE GALVANOMETER IN GENERAL AND SUBMARINE CABLE TESTING.

BY C. W. SCHAEFER.

The manifold capabilities of the direct-reading milammeter are of such far-reaching importance to electricians, not only on account of the simplicity attending its use, but also because in practical work its adoption is destined to supersede many of the more laborious systems of testing and calculation which, in spite of their greater refinement of method, are, for the purposes intended, often less accurate in result. These methods, admittedly not new in theory, have not, so far as I know, been described in a manner befitting their practical value as regards their application to milammeter work.

More especially, perhaps, are the advantages of a milammeter apparent to electricians engaged in submarine cable work, where it is essential for purposes of fault or break localisation work that the extremely small currents dealt with should be known almost in absolute measure, a proceeding which experience has shown to be quite unattainable by mere calculation based upon the preliminary tests of the batteries used. A primary battery, for instance, may be tested separately for E.M.F. and internal resistance by the most accurate methods in vogue, but the polarisation and variation of its resistance under its working conditions generally combine to modify those determinations in a most unexpected manner; the rate of change being of so complicated nature, involving amongst other variables *time* as one of its functions, that even were it possible to determine the law, its application in practical work would be quite impossible, leading only to intricacy and confusion.

The importance of using a battery free from rapid fluctuations is very evident in cable work, where the capacity effect accentuates the evil, in many cases the onus of its delinquencies being attributed to the behaviour of the break or fault under test. Here, again, the milammeter comes to the fore, enabling a preliminary and continuous test to be made under similar conditions of discharge rate as are to be expected during localisation, and revealing during the latter process a clear insight into the behaviour of a variable fault, which, with its superior exactness, a bridge test alone can never follow up with sufficient rapidity.

First and foremost it is a matter of importance that the calibration of the instrument should be known and checked from time to time in order that the correction for any particular point on the scale may be arrived at by referring to a curve sheet, or more conveniently, perhaps, by a "table of errors."

The *absolute* calibration is not so necessary for break tests, which depend mainly upon the *relative* values of the currents applied, but where versimultaneous methods are adopted from both ends of a single cable, the absolute values of current should be known as accurately as possible.* This *absolute* calibration is, after all, an easy matter, and wherever a potentiometer, Thomson and Varley's slides, or a Sullivan universal shunt are obtainable, can best be effected by measuring the potentials (by null method) at the terminals of a known resistance placed in circuit with the milammeter, and taking simultaneous readings of potential and index value of the current in the region of at least every tenth division of deflection, care being taken to avoid heating the resistance by a too long application of the current. With this data the true currents can be calculated. Wherever slides are not available, another method of calibration will be described presently, the utility of which in cable work will, it is hoped, satisfy a long felt want in enabling currents to be appreciated with adequate precision in the order of a few micro-amperes and upwards.

Before proceeding to describe its adaptability to measurements of batteries, resistances, &c., it should be pointed out how certain formulæ of formidable appearance are rendered absurdly simple with the assistance of the milammeter, which lends itself admirably to a more simple and practical mathematical solution of numerous problems.

Take, for instance, the instrument-zero "Reversals" method of measuring the C.R. of a cable described in "Kempe," and explained in a practical manner by Fisher and Darby, where the formula is expressed as follows:

$$x = \frac{a}{b}\left\{\frac{2(z+k)(c+k)}{(z+k)+(c+k)} - k\right\}, \quad \ldots \quad (1)$$

where,

$$k = \left\{\rho\left(1+\frac{b}{a}\right)+b\right\} \ldots \quad (2)$$

These equations hold good so long as the battery is constant as regards E.M.F. and internal resistance, and therefore does not polarise. If, however, we measure the currents to line simultaneously with the apparent resistances of the circuit, these results will be in excess or defect of the normal line resistance L, by quantities which are directly proportional to the E.C. potential, and inversely as the current, or

$$L \pm \frac{e}{c} = A, \quad \ldots \quad (3)$$

where e represents the E.C. potential (millivolts) and c the current through L in milliamperes.

Also, when the current is reversed, and nc its value

$$L \mp \frac{e}{nc} = B. \quad \ldots \quad (4)$$

Also, let the difference between the readings $A \sim B = d$. (5)

From these three equations we get

$$L = A \mp d\left(\frac{n}{n+1}\right) \ldots \quad (6)$$

or, in other words, the true value of the measured resistance L will lie between A and B in inverse ratio to the current strength, from which follows the simple rule:—

"The resistance to take effect on the *reading with the lower current* will be $\left(\frac{n}{n+1}\right)$th part of the difference between the two readings."

The *sign* of this quantity is easily seen when it is borne in mind that the true C.R. must lie between the limits A and B, whatever their values may be.

Example.—With a positive current to line and $nc = \frac{20{\cdot}1}{2} = 10{\cdot}05$ milliamperes, the reading B was 1,477 ohms; and when reversed $C = \frac{19{\cdot}7}{2} = 9{\cdot}85$ milliamperes, and the reading $A = 1{,}510\omega$.

Then $n = \frac{10{\cdot}05}{9{\cdot}85} = 1{\cdot}02$, and $d = 33$,

$$\therefore \quad L = 1{,}510 - 33\left(\frac{1{\cdot}02}{1{\cdot}02+1}\right) = 1{,}510 - 16{\cdot}7 = 1{,}493{\cdot}3\omega.$$

Let us now consider the Mance test for eliminating a steady E.C. in the same way, for after all, as Dr. Kennelly has shown,* the changing of the ratio coils does nothing more complicated than alter the current to line. The applied currents are in the same direction however, so that with the increased value of current we have

$$L \pm \frac{e}{nc} = B, \quad \ldots \quad (7)$$

A being greater than B according as the signs are taken positive or vice versa. This equation, together with (3) yields

$$L = A \mp d\left(\frac{n}{n-1}\right), \ldots \quad (8)$$

d, as before, being the difference between the bridge readings. The second term in the equation takes effect on the reading with the lower current, and the sign is positive or negative if the E.C. is acting with or against. Practically this is known by observing the direction of the E.C.—namely, if for bridge balance deflection towards *left* means *less* resistance required in the R side to balance L, then, if before the application of the battery the E.C. deflection is to the *left*, the positive value is taken and vice versa.

Clearly, therefore, it is an advantage to keep the ratio coils constant and vary the currents in any other way, such as by altering the number of cells or the resistance in circuit with them.

* *The Electrician*, Vol. XXXIX., p. 17.

* *The Electrician*, October 14, 1887, p. 481.

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Example:

With Z to line $\frac{19\cdot8}{2} = 9\cdot9$ milliamps. Observed resist. $= 1{,}510\omega$,

With Z to line $\frac{9\cdot8}{2} = 4\cdot9$ milliamps. Observed resist. $= 1{,}527\omega$,

$$\therefore \quad n = \frac{9\cdot9}{4\cdot9} = 2\,02.$$

The E.C. was acting *against* the testing current.

$$\therefore \quad L = 1{,}527 - \frac{2\cdot02\,(1{,}527 - 1{,}510)}{2\cdot02 - 1} = 1{,}493\,3\omega.$$

The measured value to E.C. zero in both the examples given above was about $1{,}494\omega$.

In the same manner a simple rendering of the Kennelly two-current break test is obtainable as follows:

$$x + f = A, \quad \ldots\ldots\ldots \quad (9)$$

the reading to E.C. zero with the smaller current c.

$$x + \frac{f}{\sqrt{n}} = B, \quad \ldots\ldots\ldots \quad (10)$$

the reading to E.C. zero with the higher current nc.

From these two equations we get

$$x = A - (A - B)\left(\frac{\sqrt{n}}{\sqrt{n}-1}\right) = A - d\left(\frac{\sqrt{n}}{\sqrt{n}-1}\right). \quad (11)$$

The break test I described* can be expressed in a similar manner and is derived from the following equations:

$$x + f = A_1 \quad \ldots\ldots\ldots \quad (12)$$

where A is the observed scale zero reading with current c, corrected for E.C. in terms of e/c,

$$x + \frac{f}{1\cdot3\sqrt{n}} = B, \quad \ldots\ldots\ldots \quad (13)$$

where B is the observed scale zero reading with current nc, corrected for E.C. in terms of e/nc,

$$\therefore \quad x = A - (A - B)\left(\frac{1\cdot3\sqrt{n}}{1\cdot3\sqrt{n}-1}\right) = A - d\left(\frac{1\cdot3\sqrt{n}}{1\cdot3\sqrt{n}-1}\right), \quad (14)$$

It will be observed that equations (6), (8), (11) and (14) are all of similar formation, the general equation being $x = A \pm dP$.

They differ only in the coefficient P, which depends upon the ratio of the currents n, and in the above form are more easily remembered than the usual formulæ for the several tests.

For convenience of reference, the values of P corresponding to those of n should be worked out and tabulated in the region of the best values for the particular test, and advancing in steps of 0·1. These best values are: for Reversals $n = 1$ Mance $n = 2$, Schaefer $n = 2\cdot5$ and Kennelly $n = 4$.

In break methods, too, the milammeter is most useful in watching the sealing of a fault under the positive current, a proceeding that should never be neglected, for an exposure within the gutta-percha, or an end buried in mud or sand would appear to be beyond its true position and of larger area than it really is. Besides that, bare figures alone can, of course, never be trusted to entirely in localisation work.

Since in practical telegraph work the currents are most conveniently expressed in milliamperes, in describing the ensuing methods this convention will be adhered to throughout, unless specified otherwise, whilst potentials will be expressed in millivolts.

To Find the Internal Resistance of a Battery, the E.M.F. being known and assumed Constant.—In circuit with the cell or battery to be tested insert an adjustable resistance R and the milammeter m, and get a convenient reading c. Then E being the E.M.F. in millivolts, and b its resistance

$$b = \frac{E}{c} - (R + m). \quad \ldots\ldots\ldots \quad (15)$$

Example.—The E.M.F. of a 30-cell chloride of silver battery was found to be 32·9 volts, and when joined up through $(R + m) = 501\cdot3 + 0\cdot3 = 501\cdot6\omega$ the current observed was 50·8 milliamperes.

$$\therefore \quad b = \frac{32{,}900}{50\cdot8} - 501\cdot6 = 146\omega.$$

* *The Electrician*, October 15, 1897.

Care should be taken that the milammeter is not subjected to unreasonable currents which might injure the pivots, bend the pointer, and thus alter the calibration of the instrument and the balance of the moving coil system.

A mental calculation should always be made by dividing the E.M.F. of the cell or battery by the average current it is expected to give; for instance, if 100 milliamperes is to be the working rate of a 10 cell battery, the E.M.F. per cell being approximately 1,500 millivolts, commence by inserting at least $\frac{1{,}500 \times 10}{100} = 150\omega = R$.

The above test affords a ready means of testing the individual cells of a battery, the standard for comparison being the current obtained from a good cell, the condition of which has been ascertained in the manner hereafter described. It is especially useful in ascertaining the condition of trays, Fuller's, or dry cells, which are being so universally used nowadays. This method is not reliable when the battery polarises appreciably.

To Find the Resistance of a Cell or Battery and also its Effective E.M.F.—Obtain a readable deflection C with a resistance R in circuit, and calling $(m + R) = R_1$, where m is the resistance of the milammeter

then $$E = C(b + R_1). \quad \ldots\ldots\ldots \quad (16)$$

Next, increase R by N ohms, so as to approximately reduce the current to half its former value, say c_1.

Therefore, $$E = c_1(b + R_1 + N), \quad \ldots\ldots \quad (17)$$

whence, $$b = N\left(\frac{c_1}{C - c_1}\right) - R_1. \quad \ldots\ldots \quad (18)$$

When $c_1 = \frac{C}{2}$, formula (18) simplifies to $b = N - R$, but in practice it is a quicker process to make c_1 *approximately* one-half of C, and work out the result as follows:—

Example.—Preliminary tests were taken of a 50-cell Leclanché-Barbier battery, the E.M.F. by null method with slides being 72·45 volts, whilst its resistance by Muirhead's method was 144 ohms.

By milammeter the following results were obtained:—

$R_1 = 702\cdot6\omega$, and $C = 83$ milliamperes,
$R_1 + N = 1{,}505\,8\omega$, and $c_1 = 43$ milliamperes.

$\therefore \quad N = 803\cdot2\omega$, $\quad (C - c_1) = 40$ milliamperes.

$$\therefore \quad b = \left(803\cdot2 \times \frac{43}{40}\right) - 702\cdot6 = 160\cdot8\omega,$$

$R_1 = 301\cdot2\omega$, and $C = 156\cdot5$ milliamperes,
$R_1 + N = 752\cdot8\omega$, and $c_1 = 77\cdot0$ milliamperes.

$\therefore \quad N = 451\cdot6\omega$, $\quad (C - c_1) = 79\cdot5$ milliamperes.

$$\text{and } b = \left(451\cdot6 \times \frac{77}{79\cdot5}\right) - 301\cdot2 = 136\cdot1\omega.$$

The *effective* E.M.F. is determined as follows from equation (16): $E = 83\,(160\cdot8 + 702\,6) = 71{,}662$ millivolts, or 71·662 volts, and in the second case $E = 156\cdot5\,(136\cdot1 + 301\cdot2) = 68{,}435$ millivolts, or 68·435 volts.

The above tests illustrate the double fact already alluded to—viz., that the resistance of a battery decreases as its rate of working increases, its effective E.M.F. falling off at the same time.

Owing to these variations it is evident that the resistance of the battery is less for the C reading than it is for the smaller current c_1; thus the resultant value of b, as given in the above formula, can be proved to be somewhat in excess of its true value with the larger current C. The polarisation, however, has a compensating effect, so that if the tests are taken rapidly one after another and repeated in cyclic order, the error is negligible in practice, and b, therefore, may be considered a mean value between the limits C and c_1. So far as the measurement of E is concerned, it might be objected that since the milammeter method differs in result from the more delicate tests taken in the first instance, the system is useless. Undoubtedly the superiority of refinement is imperative for purposes of insulation tests by direct deflection or condenser throws, but a battery should always be tested under approximately the same conditions as will be required during

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actual working. By increasing the sensitiveness of the milammeter sufficiently to come within range of smaller currents, the E.M.F. can be determined approximately more and more perfectly to its value by null or condenser method.

The application of a milammeter in conjunction with a galvanometer for this purpose will be described progressively.

(*To be continued.*)

THE FINANCIAL BASIS AND DESIGN OF ELECTROLYTIC METAL REFINERIES.*

BY ARNOLD PHILIP, B.SC., A.I.E.E., F.I.C.

(*Continued from page 599.*)

Cost of Dynamos and Switchboard.—It is quite clear that the output of the dynamos must vary in precisely the same manner as the power it is necessary to instal, and as the electrical power developed may be taken as 85 per cent. of the motive power installed, and as the cost of supply and erection of this plant may be taken at about £11 per kilowatt output, the cost of the dynamos and switch-gear, including erection, may be obtained from the expression:

$$\left.\begin{array}{l}\text{Cost of dynamos and switchboard,}\\ \text{including erection, in pounds}\end{array}\right\} = 0{\cdot}056\text{TD}. \quad . \quad . \quad (5)$$

For a works having an output of 1,000 tons per annum, and employing a current density of 10 amperes per square foot, the dynamos would, therefore, cost £560.

Cost of Electrolytic Vats.—If the anodes and cathodes in an electrolytic vat are packed as closely together as is possible, having due regard to the avoidance of a short circuit, which is the more liable to occur the more closely the anodes and cathodes are permitted to approach each other, it is evident that, however or wherever the vats are set up, provided that they are as closely packed as possible, the yield of copper per cubic foot of vat space must depend only on the current-density employed. The following results, obtained from various writers on the electrical refining of copper, show how, at the same current density, the output of copper per annum per cubic foot of vat space varies from this fixed value. The variations which are actually observed are due to the greater or less distance between the anodes and the cathodes (the greater the distance the less the copper output per cubic foot of vat space) and the different heights of the lower ends of the electrodes above the bottom of the vats (this greater height is necessitated sometimes in dealing with anodes giving large quantities of mud deposit, and, of course, reduces the output of the vat per cubic foot). Sederholm states that in American refineries from 1·5in. to 2·5in. space is allowed between the lowest portion of the electrodes and the bottom of the vats. Lastly, the larger the vat the less fraction of the available vat space is lost in clearance between the electrodes and the sides of the vat. The size of the vat must not, however, be too great, or inconvenience in manipulation is found to occur. The smallest annual copper output per cubic foot at unit current-density is, therefore, to be expected from small vats with the electrodes far apart, and having the lower ends high above the bottom.

Table III.—*Particulars Concerning Vat Space Required at various Refineries.*

Works.	Authority.	Vol. of each vat in cub. ft.	No. of vats.	Total vat space in cub. ft.	Output of copper in tons per annum.	Cur. density in amps. per sq. ft.	Cubic vat space per ton per year per unit cur. density.	Dis. between anode and cathodes in inches.
Biache ...	Watt	75	20	1,500	128·6	1·932	22·54	2·7
Anaconda..	*Elect.*, Vol. 38	132·4	1,200	158,000	64,280	10 (?)	24·717	2
Elliott ...	Watt	30·25	240	7,260	578·6	8·888	117·5	3·5
Elkington (Pembrey)	Gore	42	200	8,400	643	10	99·64	2·75
Anaconda..	†	140	1,400	196,000	47,250	13	53·93	2·0

From these results it is evident that, with a reasonably satisfactory distance between the anodes—say, about 2·7in. to 3in.—a space of 60 cubic ft. of vat per ton of copper produced per year, at a current-density of 1 ampere per square foot, should be amply sufficient. The cost of well-made electrolytic vats of pitch pine, lined with lead, should not be greater than 4s. per cubic foot if the vats have a capacity of at least 80 cubic ft.; smaller vats cost more per cubic foot, and the amount of capital which should be invested in vats for a given annual output of T tons of copper obtained with a current density D is given by the expression:

$$\text{Cost in pounds of vats} = 12\frac{\text{T}}{\text{D}}. \quad . \quad . \quad . \quad (6)$$

The cost of vats for an output of 1,000 tons of electrolytic copper per annum, if a current density of 10 amperes per square foot is employed is, therefore, £1,200.

Cost of Electrolyte.—The cost of the electrolyte per cubic foot naturally varies as the cost of copper sulphate. The solution employed contains about 12lb. of copper sulphate crystals per cubic foot, and has a density of 17·5° Baumé. Sixty cubic feet of this strength of solution costs, if copper sulphate is £15 per ton, £4. 16s. 4d., whilst if copper sulphate costs as at the date at which this Paper was written (March, 1901), £25 per ton, the cost of 60 cubic ft. of the electrolyte becomes £8. 1s. 2d.

The capital it is necessary to put down in electrolyte is given by the expression:

$$\text{Cost in pounds of electrolyte required} = \frac{0{\cdot}3\text{TS}}{\text{D}}, \quad (7)$$

where S = price of copper sulphate crystals per ton in pounds. Thus the cost of the electrolyte solution for an output of 1,000 tons of copper per annum, and using a current-density of 10 amperes per square foot, is £833. 6s. 8d. if copper sulphate crystals cost £25 per ton.

Cost of Copper Anodes.—The amount of capital invested in anodes, for a given output of tons of refined copper per annum at unit current-density, depends upon the thickness of the anodes employed. Of course, the thinner the anodes are cast the less amount of capital need be sunk in this form, and it is desirable, therefore, that the anodes shall be as thin as possible, down to perhaps 0·25in.,* for the amount of capital invested in this way is usually an important sum. It is interesting to note that a current of 99·54 amperes running day and night for 360 days will deposit an amount of copper weighing one long ton, and the anode *surface* required, if a current-density of 1 ampere per square foot is employed, is, therefore, 99·54 sq. ft., or, as both sides of the anode plate are available, a plate having an area of 49·77 or, say, 50 sq. ft., is required per ton output per year at unit current-density. Therefore, if the current-density is D amperes per square foot of anode surface, and if the output of refined copper is T tons per annum, whilst the cost of anodes is P pounds per ton, and t is the thickness of the anode plates in inches, the cost of the anodes required is obtained from the expression:

$$\text{Cost of anodes in pounds} = \frac{t\text{TP}}{\text{D}}. \quad . \quad . \quad (8)$$

Thus, for example, if the cost of anodes is £70 per ton and the thickness 1·0in. whilst the output of the refinery is 1,000 tons per annum and the current-density is 10 amperes per square foot, the cost of the anodes required would be £7,000. This is equivalent to 100 tons of copper—that is, the weight of the anodes is 10 per cent. of the annual copper output of the works. At Anaconda the weight of the anodes is 10·85 per cent. of the annual output. (*Electrical World and Engineer*, Vol. XXXVII., pp. 186, 187; abstracted in *Science*

* Copyright. From a forthcoming work by the Author, entitled: "The Electro-plating and Electro-refining of Metals."

† From Paper in the *Electrical World and Engineer*, Vol. XXXVII., pp. 186, 187; abstracted in *Science Abstracts*, Vol. IV., 1901, p. 423. The output of copper here given is stated to be the *actual* output. The output in the other Anaconda return in this table is that *calculated* from the electrical output of the dynamos installed.

* The difficulty with thinner anodes is that they have to be so frequently replaced and the remains of the old ones re-melted and re-cast that the charges for these operations become excessive, and it is therefore more economical to employ thicker anodes, notwithstanding the larger capital thereby necessitated.

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Abstracts, Vol. IV., 1901, p. 423.) It is probable, therefore, that t should be slightly over 1in. instead of 1in. as here taken.

Cost of Copper in Stock, including Cathodes and Copper Leads, &c.—Gore states that at least a weight of copper equal to the weight of the anodes employed must be considered as in stock in the form of copper leads, cathode plates, and stock of copper for fresh anodes. The cost of the copper leads may, however, be estimated with moderate accuracy from the known details of the copper refinery at Anaconda and from the following considerations:—If the output of the refinery and the current-density at the anodes is fixed, and the current-density per square inch cross section of the conductors ($=a$) is varied, it is clear that the weight of copper employed in these conductors varies inversely as a. Again, if a is kept constant and the current-density D at the anodes is also constant, we may say that the volume of the vats must be increased either (1) by adding more vats of the same size in series, or (2) by setting up a fresh set of the same number of vats in series with a separate dynamo—*i.e.*, duplicating the plant, or (3) by increasing the width of the vats only, their length remaining constant. In all these three cases the weight of copper employed in the conductors must vary directly as the output of copper T. But the volume of the vats may also be increased (4) by increasing the length of each vat only; it may then be seen that both the cross-section of the copper conductors and their length must be increased in the same ratio—that is, the weight of copper employed in the conductors will vary directly as T^2. Lastly, in an intermediate case (5), if the dimensions of the vats are altered so as to double or treble, &c., their volume, and therefore their output, whilst the vats are kept at constant depth and of similar form of plan, then each of the horizontal dimensions of the vats must be multiplied by the square root of the factor by which the output has been multiplied. That is, the length of the conductor must be increased by multiplying it by the square root of this factor, whilst to maintain the current-density in the conductors fixed the cross-section of the conductors must be also increased by multiplying them by the factor by which the output is to be increased: this, therefore, means that the weight of the copper employed as conductors must be varied directly as $T^{3/2}$. As for moderately large installations some maximum size of vat is employed for reasons of economy and convenience of handling, and also on account of the cheaper cost per cubic foot of vat and its larger output per cubic foot, it is a reasonable supposition that some form of the first three of the foregoing methods of increasing the vat space will be adopted, and in this case we have the weight of copper employed as conductors varying directly as T.

Lastly, the weight of conductors used is independent of the anode current-density D, if the output T is kept constant and the current-density in the conductors a is also fixed.

The equation for the weight of conductors used along the sides of the vats is, therefore, of the form $W = K'\frac{T}{a}$, where W is the weight of conductors in tons, and K' is some constant; or, if P' is the cost of refined copper per ton in pounds, then

$$\text{The cost of conductors in pounds} = K'\frac{P'T}{a}.$$

I have made an estimate of a probable value of this constant K' from the following details concerning the Anaconda refinery obtained from a Paper in *The Electrician* (Vol. XXXVIII., p. 144).

At Anaconda a 1,270kw. dynamo of 75 volts and 3,600 amperes runs 200 tanks in series; each tank is 250cm. long. The total length of tanks is, therefore, 50,000cm., and adding one-fifth of this length to allow for inter-connection between the vats and connection to the dynamo, the total length of these leads must be 600 metres each, for the positive and negative, and this length of lead has a cross-section of $\frac{3,600}{a}$ sq. in.; its volume is, therefore, $\frac{1,200 \times 100 \times 3,600}{2{\cdot}54a}$ cubic in., and the weight in tons is $\frac{120,000 \times 3,600 \times 62{\cdot}4 \times 8{\cdot}9}{2{\cdot}54 \times 1,728 \times 22{\cdot}40 \times a}$. If it is remembered that 100 amperes per vat yields an output in 360 days of 24 hours each of one ton of copper, we have, using the formula $W = K'\frac{T}{a}$ already obtained,

$$\frac{120,000 \times 3,600 \times 62{\cdot}4 \times 8{\cdot}9}{2{\cdot}54 \times 1,728 \times 22{\cdot}4 \times a} = K'\frac{200 \times 36}{a}.$$

Whence $K' = 3{\cdot}39$.

Thus, if W = the weight of copper in tons used as conductors, T = the annual output in tons of the refinery, and a is the current-density per square inch cross-section employed in the copper conductors, we have $W = 3{\cdot}39\frac{T}{a}$, and if P' is the price per ton in pounds of the refined copper of which the leads are made, then the capital sunk in leads is found from the equation

$$\text{Prime cost of copper conductors in pounds} = 3{\cdot}39\frac{P'T}{a}. \quad (9)$$

Thus, if P' = £75 per ton, and the output of refined copper per year is 1,000 tons, whilst the current-density in the copper conductors is 250 amperes per square inch, the prime cost o the necessary copper leads would be £1,017.

The above estimate only, however, includes the cost of the two positive and two negative copper mains running the whole length of the vats, and allowing an extra length of one-fifth of the total length of the vats for inter-connections of vat to vat and to the dynamo, but it does not include the cost of the cross-bars on the vats from which the anodes and cathodes hang; these cross-bars may be conveniently made of flat iron bars, as at the Anaconda Works, or old steel rails of small scantling may be used. The cost of this part of the conductors may, therefore, be reduced to a very small amount, and will probably be amply covered by allowing about a fifth of the cost of the copper in the main conductors. The total capital invested in conductors, whether of copper or iron, may be taken as being fairly represented by the expression

$$\text{Cost of copper and iron conductors} = 4{\cdot}05\frac{P'T}{a}. \quad (10)$$

And thus for 1,000 tons output per annum at a current-density in the copper of 250 amperes per square inch, the copper costing £75 per ton, would be £1,215.

If for the remaining copper in stock for casting fresh anodes, and for the cathodes a third of the amount actually invested in the anodes is allowed, a sufficient provision for copper will have been made. At Anaconda the anodes are renewed in each vat every 34 days—*i.e.*, about one-tenth of the total weight at a time. (*Electrical World and Engineer*, Vol. XXXVII., pp. 186, 187.)

Collecting all the amounts of capital for copper anodes, cathodes, stock anodes, and copper and iron conductors together, we obtain the expression for the capital invested in these items:

$$K = 1{\cdot}3 + \frac{tTP}{D} + 4{\cdot}05\frac{P'T}{a}. \quad . \quad . \quad . \quad (11)$$

If the thickness of the anodes is 1in., and the anode copper costs £70 per ton, whilst the output of the refinery is 1,000 tons per annum, and the current-density at the anodes is 10 amperes per square foot, whilst the current-density in the copper conductors is 250 amperes per square inch, and the copper of which they are made cost £75 per ton, the total amount of money invested in the above-mentioned items of anodes, cathodes, stock anodes and the current carrying conductors from formula (11), £10,548. This amount is half as much again as the amount of capital invested in anodes alone—namely, £7,000—and this is lower than Gore's estimate that the total copper in stock must weigh at least double the amount employed as anodes. Probably, if it were desired to reap as far as possible the advantages of a low market in which to buy anodes, it might be advisable to hold rather more copper in stock. The question of the rise and fall in price of the copper, however, as it is pratically incalculable, has been excluded from consideration in the present investigation.

Cost of Circulating and Purifying Plant for Treating Electrolyte.—The amount of the capital invested under this head is not large per ton output per annum, and in the absence of any very reliable details on this point I have supposed it to

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be represented by a quantity proportional to the output, but independent of the current-density, which must very closely represent the true facts of the case, and the following expression may be employed to calculate out this quantity:

Prime cost of circulating plant in pounds = 0·4T. . (12)

That is, for a refinery having an output of 1,000 tons per annum the cost of the circulating plant would be £400.

At the Anaconda refinery, where the output is 64,280 tons per annum, one 30 B.H.P. steam-driven air compressor is used for the circulating plant; but, of course, the chief cost under the heading of the circulating and purifying plant is that of the lead pipes, lead-lined tanks and lead burning. F. R. Badt, in some published estimates for a copper refinery having an annual output of 5,357 tons (*Electrical Engineer* of New York, Vol. XIII., 1892, p. 598), states that the electrolytic vats would cost £1,500, the pipes £800, the sheet lead lining £5,600, the lead burning £300, and the steam injector £200, being a total of £8,400 for the vats and circulating plant, whilst these two items, when obtained by the formulæ developed here, work out at £5,857 for the vats, and £2,142 8 for the circulating plant, giving this a total of £7,499·8, results which only differ by about 10 per cent. in their totals.

(*To be continued.*)

A SIMPLE TELEPHONIC RECEIVER FOR WIRELESS TELEGRAPHY.*

BY L. BLEEKRODE.

Whilst engaged in some testing experiments with an installation for wireless telegraphy (Popoff system) between the Hook of Holland and the Government lightship, lying at a distance of 16km. from shore, it occurred to me to try telephonic communication. As the necessary apparatus, now constructed by different companies, could not be procured without much delay, I made myself a most simple arrangement, yet yielding excellent results, an account of which may interest those occupied in similar experiments.

I fixed two parallel pieces of carbon (as used in an ordinary arc lamp) having a length of 5cm. on a square piece of wood, and made with it a circuit including a couple of dry elements (small size) and an Ader telephone; the circuit was completed by placing three or four common sewing needles loosely in transversal direction on the carbon rods. The apparatus is ready for use when the insulated wire of the signal mast (antenna) is joined to one carbon and the other is connected to the earth conductor. The letters from the Morse alphabet are very distinctly heard by this most simple device as shorter and longer taps in the telephone, and at the given distance the telegrams were easily read by sound, by a trained operator, as they were sent from the ship, and more quickly, of course, than they could be delivered by the usual coherer arrangement combined to the Morse writer; besides, it does not require special care to keep it in working condition. Yet it is sensitive enough to make audible the peculiar noise which accompanies the motion of the interrupter combined with the induction coil when it is operated by hand to produce the spark.

I believe that such a receiver may prove very useful for temporary installations of wireless telegraphy, as anyone may carry it, along with all its accessories, in his pocket and put it at once in action when an insulated wire can be fixed to some elevated post, earth connections being always at hand.

I also investigated this arrangement in my laboratory with the view to ascertain whether it is really auto-decohering, as has been claimed recently for circuits where a telephone is used and carbon as coherer substance. Indeed, it seems that no tapping or any other arrangement is required to keep the telephone in good receiving condition. But when I substituted a sensible aperiodic galvanometer (Weston's construction) for the telephone, and operated with a small induction coil and Leyden jar (spark 3mm.) in an adjacent room, every discharge produced a deflection of the needle, which did not return to its former position unless a slight tapping was applied near the carbons, otherwise each new spark increased the deflection obtained by the former. It may be that the self-induction of the coil of the telephone is sufficient for decohering, which factor is not so active when a galvanometer is substituted.

I examined other substances than the steel needles—namely, copper, nickel, platinum, carbon, this also in powder (as used in the Mix and Genest telephone), and they all gave the same result, and this was obtained in the best way when, before the sparking of the coil, the transverse wire, by slightly tapping, had obtained a contact sufficient to transmit a small portion of the circuit current. But I observed that, sometimes with platinum, and also with carbon, the deflection was reduced to zero, when the sparks set in, indicating that the resistance was increased by the electric waves, instead of diminishing, as was usually the case.

I found that a certain pressure exerted on the transverse wire, lying on the carbons, did not prevent the influence of the electric waves on the contact surfaces. When a load of 1·5kg., and even of 5kg., was placed on the needles (protected from immediately touching them by a glass plate), the deflection of the galvanometer set as well in, and the telephone answered as distinctly to the sparks, produced in another room, as before.

It is obvious that the described arrangement proves also to be a very delicate microphone, but a slight pressure applied in the same way on the transverse wires makes it directly insensible to sound impulses, as was to be expected.

* From *Nature*.

THE ELECTROLYSIS OF GAS MAINS.*

BY JAMES SWINBURNE, M INST.C.E.

(*Concluded from page 644.*)

We may now consider the precautions and measures taken to minimise corrosion of pipes. The first thing is to keep the resistance of the return rails as low as possible. The resistance is chiefly at the joints, and it is difficult to make good contact by means of the fish-plates. The rails are, therefore, "bonded," or electrically joined by bonds of flexible copper. Sometimes, to make better joints, the rails are electrically welded, or welded and cast by Goldschmidt's process, or joined by pouring fused iron round them from a portable cupola. In a long line, or where the traffic, and, therefore, the return current, is large, no amount of bonding will do. The Board of Trade here come in with a regulation that a tramway must not spend more than 7 volts on its return rails. What are called "suckers" are therefore introduced. Fig. 4 shows the system with suckers. The suckers are insulated conductors which draw off from various points of the system. They generally have what are called "negative boosters" in their circuits. A "booster" is a machine for adding a little pressure to a circuit; a negative booster subtracts pressure or sucks. It is an electric motor, driving a generator, the generator being so arranged that it sucks in proportion to the current, so that the far end of the sucker, where it joins the rails, is kept at nearly zero pressure, or not more than 3½ volts below it. Thus, in Fig. 4, an insulated conductor, C, is

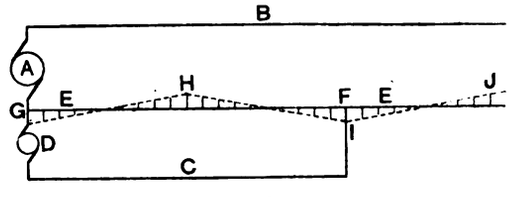

FIG. 4.

taken from the point F of the rails through a negative booster, D, to the generating station. The potential of the rails is represented by the line GHIJ, which shows that some sections of the track are positive and some negative. The rails are insulated to some extent incidentally by being embedded in concrete, which is a very bad conductor when dry, but according to many measurements conducts well when wet. It might be worth while to saturate it with some waxy, tarry, or greasy material when quite dry. Tarring the rails, or coating them, does not insulate them permanently. A layer of asphalt keeps the ground under it dry and increases the resistance.

The Board of Trade regulations do more than limit the difference between different parts of the earthed system. They provide that, with earth plates at the station at least 20yds. apart, with not more than an ohm resistance to earth in parallel, these plates shall only collect 2 amperes per mile of tramway, or 5 per cent. of the total current. Any rails must not be more than 4½ volts above any neighbouring pipes or 1½ below them. These pressures are determined with Leclanché cells. They make various other minor regulations.

Sometimes, instead of using suckers, the flow of electricity is helped along the rails, as it were, by what we may call "helpers," or "helpers home." These are "boosters" arranged in the rail circuits so as to help the flow, as it were. Thus, suppose the engineer decided to keep within a limit of 4 volts maximum difference of pressure in his rails. At maximum load a length of rails might have 4 volts drop of pressure, from +2 to −2 volts, the middle being at the zero or earth pressure. At the −2 point the rail would be severed, and the electric circuit led through a conductor to a booster, which would add 4 volts and return it to the next section at +2 volts. The system is shown in Fig. 5, in which C and D are the boosters inserted in the rail circuit E. The potential of

* Lecture before the Incorporated Gas Institute.

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each of the sections varies from positive to negative, as shown by the inclined lines FG, IJ and KL. Helpers are not used as far as I know, but the idea, though old, has been recently revived.

Little or nothing more can be done to protect the pipes by dealing with the return-rail track. Something can, however, be done to the pipes. As has been explained, it is not the entry of the electricity into the pipes that does the harm, it is where the electricity leaves the metal and goes into the damp earth—that is to say, where the pipe is acting as anode. If all the parts of the pipe that might act as anode are connected by wires to the rails, or to the station, so that the electricity can be carried off without passing into an electrolyte, there is no electrolysis, and the pipes are safe. The region round the station is clearly that where the pipes may be anodes. This region is, therefore, often known as the "danger area"; and if metallic connection is made from the negative terminal of the station to the pipes in the danger area, the pipes are safe. This increases the current in the pipes; but that does not matter to the pipes unless there are joints which cause the electricity to pass round by the earth. The increase of current means increase of corrosion of the train-rails; but that is the tramway peoples' look out. When suckers are used, they are arranged so that they reduce the pressure of the rails where they join below the earth, so that the rails are then negative to the earth. They, therefore, make local danger areas. The pipes should thus, where possible, be connected to the rails there.

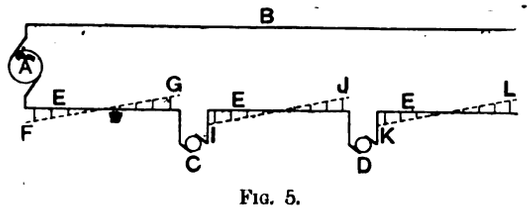

FIG. 5.

We have now mentioned practically all the methods known of keeping down the chances of electrolysis by designing the tramway to produce as little effect as possible. We have, of course, only dealt with the overhead single-trolley system, which is universally used in this country. One cure is to depart from the system altogether. For instance, we might have both conductors overhead. This would get rid of electrolysis altogether; but the method is so inconvenient, so costly, and so unsightly, that it is almost out of the question. Unless there were much stronger evidences of real damage from electrolysis than any we have so far, Parliament would never put such a thing on tramway companies. The double trolley has been used in one or two places, but the results are not encouraging. Some of the conduit or culvert systems, in which the electric conductors are in a sort of long nearly-closed conduit with a narrow slit along the top, have both conductors insulated; but this gives rise to difficulties at crossings and turn-outs. Surface-contact systems can also be designed to have no earthed conductors; but in their case also it is very much more difficult to insulate both conductors.

The precautions in design and working which can be taken by the tramway engineers are thus:—(*a*) Good bonding of rails, and rails of large section. (*b*) Suckers to the rails from the power houses. (*c*) Insulation of rails by concrete, and so on. (*d*) Inserting "helpers" in the rail circuits.

There is still another system which has not received the attention at the hands of electrical engineers that I would suggest it deserves—that is, the "three-wire" system. Along one line the overhead wire is at a pressure of 500 volts; along the other it is negative, at − 500 volts. The circuit is then, not from the rails to the power house, but merely across to the other rails and home by the next tramcar and the − 500-volt overhead wires. The system is more complicated, and there are 1,000 volts between neighbouring overhead wires, as well as the usual 500 between one and the earth. There is also difficulty in balancing, so that there is approximately the same current on each side. Connections from the rails to the power house are still necessary, but they are smaller and much less numerous for a given area.

We may now consider what the gas and water companies can do to protect their pipes. Throughout the danger area they should be metallically connected with the power house or the suckers. Coating with Angus Smith's composition, or asphalt, tar and the like, prove to give little or no protection. It is found that wrought-iron pipes are corroded more quickly than cast, especially close-grained cast iron. In this country wrought iron is only used for service pipes, as far as I know. It would be an advantage to destroy the electrical continuity of pipes by occasionally packing joints with sulphur, sulphide of iron, or something other than lead. Lead does not make a good electrical joint. Pouring lead round does not remove the bituminous coating of the pipes. Lead also soon coats itself with insulating compounds such as hydrated oxide, which prevents its making good electrical contact. This should be done, especially in places where the ground happens to be dry and well drained. It has been proposed to adopt earthenware or stoneware pipes. Such schemes are of little value. The pipes are already down, and, generally speaking, will remain down unless something serious happens to them.

The insulation of occasional joints in water pipes would also be of advantage. It might be supposed that this would do little, because the water conducts, and would, therefore, make a passage round the insulated joint. The water supplied to houses is, however, such a very poor conductor that the current carried by it may be neglected. Insulating the joints in this way may, however, sometimes do harm. For instance, suppose a line of pipe is carrying a current which is taken to the power house by a metallic wire connected to it for that purpose, the pipe might have no current leaving it, and, therefore, no corrosion. If the pipe is insulated at a joint, it will introduce a local resistance; and the electricity will leave the pipe and go into the earth close to the joint, entering the pipe again a little further on. One side of the joint thus becomes anode with corrosion, while the other becomes cathode, which does not matter. Insulating joints does not, therefore, necessarily help. It reduces the current, but at the expense of local corrosion, unless the joint is in very dry ground. If joints are insulated at very frequent intervals, the pipe will be so discontinuous as a conductor that it will pick up no appreciable current. Insulation of joints is, therefore, a good measure when taken judiciously; but it is not always possible, as a company cannot well open up the roads on purpose to break the joints and re-caulk the mains. In America it has been proposed to make gas and water pipes of stoneware. Such pipes could, of course, be made, and in some ways it might be easier to render them gas-tight. They might also be made strong enough to stand a steam-roller without being buried very deep. But any change of that sort cannot be considered seriously in this country except for new mains. Practically the only thing the pipe-owning companies can do to safeguard themselves or to lessen the effects of stray currents, is to insert insulating joints at intervals where possible, and to connect the pipes metallically with the power house, or the rails in danger areas—that is to say, in areas where the pipes are apt to be anodes. Cast-iron pipes are sometimes joined up with wrought iron or lead service pipes, often with brass couplings. Such metals in damp soil set up local currents of their own, which eat the lead or wrought iron apart altogether from any tramways.

The next, and perhaps the most important question is: How much damage are electrical tramway systems doing now, and how much will they do in the future? We hear a great deal about the damage done in the United States; and there is no doubt that there has been a great deal of trouble there. The statements in the technical press are exceedingly difficult to deal with. There is strong partisanship, and great exaggeration. In addition, many of those dealing with the matter have very inaccurate notions about electrolysis. The conditions in America are different, but especially they have been different. Damage by electrolysis is essentially a matter of time; and the corrosions that are now making themselves evident in America are the results of past working. Electrical tramways have been in extensive use there for some 12 years; and it might appear that the present state of the pipes show us what to expect here in 10 years or so. This, however, is not so. In America, especially in the early days of tramways, the rails were of small section; and they were very badly bonded. They were largely laid in mud, which forms the bed of many American roads. But, more than all this, they frequently allowed 30 volts in the rails, or three times our permissible maximum.

We have developed electrical tramways slowly in this country. One result of our British way of doing things is that we now put our tramways down well. The Board of Trade also limit the pressure allowed between points in the rails; and the tramway engineers generally keep very much within this limit, for their own sakes. It must be remembered that the tramway people to not want to eat pipes. They may be made liable for damages some day or other if they do. But there is another point. Any stray electricity that gets into pipes must have left the rails, and must have corroded them proportionately. But the current in the pipes is only a fraction, generally a very small fraction, of the whole stray current; so that if there is corrosion of pipes, there is a much greater corresponding corrosion of the tramway rails. In their own interests, therefore, electrical engineers keep the stray currents down as low as they possibly can. Of course, if a considerable part of the stray current goes along a pipe, and frequently leaves it to go round an insulated joint, returning to it after the joint, there is corrosion wherever it leaves the metal. If there are many such joints, the total corrosion of the pipes may be comparable with that of the rails, or even greater, though the current from the rails is greater than that in the pipes. But the frequency of such insulated joints in practice sends the resistance up, so that there is then comparatively little current in the pipe-circuit.

The most remarkable fact about electrolytic corrosion is that it is clearly not so great as might be expected. It has even been said

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that earth conducts like metals, non-electrolytically, so that electricity can leave rails or pipes and go into the earth without the corresponding corrosion. This theory is far too good to be true. The components of the soil are mostly insulators in themselves. Such substances as silica (sand), and the various silicates of which clays are composed, and chalk, are all insulators, and the conduction is due not to them, but to the salts dissolved in the water that moistens them. No transparent body can conduct otherwise than electrolytically. This theory appears to me, for one, quite untenable.

It is much more probable that, in estimating the corrosion of pipes, people are apt to overestimate the difference of electrical pressure between points in the earth. Take a simple case of a long, straight, single rail on the surface of comparatively badly conducting earth. Suppose it is at 2 volts above the ground in pressure. The ground just in contact with the rail will be raised to 2 volts. The earth a long way from it, on the other hand, will be at zero pressure, if not disturbed by some other source of electrical pressure. There is thus a gradual fall of from 2 volts to zero as the distance from the rail increases. But the rate of decrease of pressure is much greater close to the rail than far off it—in fact, the rate at which the pressure decreases is approximately inversely proportional to the distance. The result of this is that the pressure falls quickly as the distance from the rail increases. Another way of putting it is that the earth itself in the immediate neighbourhood of the rail acts as a sort of coating; the 2 volts being nearly all spent on it. The pressure of the earth a short distance from the rail will thus be very little above zero.

If a good conductor, such as a pipe with electrically conducting joints, were laid in earth which was 2 volts above zero pressure, and if the pipe were kept at zero pressure by being connected to a power house, or by going into a region where the earth was at (say) 2 volts, it would, if of equivalent size and shape, pick up a current equal to that leaked by the rail already discussed. But if it is laid in a region at a minute fraction of a volt above the normal, it will only pick up a corresponding current. One of the few Papers which gives definite information in a useful form is by Larsen and Faber.* These observers measured the currents in pipes following the tracks, and found values which are serious. These observations go to show that pipes close to lines with large pressure drops will, if not protected by metallic connections, be seriously corroded in course of time.

It is probable, in spite of this special case, that pipes pick up much more minute currents than is generally believed. Another reason for supposing that the pipes do not take up very large currents is that there are earth currents due to natural causes. Now, earth currents would cause electrolysis just as much as stray tramway currents. But pipes have been in the ground for not very far off a century; and pipes 50 years old are often found to be as good as new. Yet the earth currents have been going on all the time. Unfortunately, we have few useful data about earth currents. What we want to know is the differences of electrical pressure between one region and another. The observations are made by the telegraph authorities, and they have nearly always given their results in terms of the current in their wires. They have given these without stating their resistances, so that their figures are useless. A book by an eminent German professor has recently been published furnishing figures involving an enormous amount of work. They deal with Germany, but convey no information, because the data which would make them valuable have been inadvertently dropped out. Fortunately, a few telegraphists, instead of reading the deflections of a galvanometer, have tried how many telegraph battery cells had to be put in to reverse the current; and from this we can get a rough idea of the differences of pressure between different regions. I may mention that Varley once found between London and Ipswich a difference of pressure of about 140 volts, or 2¼ volts fall of pressure per mile. Such pressures are variable; but they are comparable with the disturbances due to electrical tramways.

I have measured the currents in pipes where there are no tramways within many miles, and found them comparable with those found near working tramways. Yet they do not seem to do so very much harm. It is possible that all corrosion of pipes, apart altogether from tramways, is produced by or accompanied by electrolysis. Dissolved oxygen, or oxidising solutions in the earth, would attack iron without electrolysis; but it is doubtful if the moisture in the earth contains such matters. The decaying vegetable matter and humus, and in towns decaying animal matter, would all be reducing agents, and prevent any direct oxidation of iron.

Though what I have been saying may tend to allay fears as to the ravages of electrolysis, I certainly do not mean to say tramways will do pipes no harm. They certainly will do them no good. The question is: How much harm will they do? Electrolysis involves damage of the most insidious kind. It means a gradual corrosion of pipes until they either break or develop leaks in all sorts of unexpected places. Whether it will really damage the property of gas companies to a serious extent, I, for one, cannot say. It is a matter of time. The best thing gas and water companies can do is to watch their pipes carefully, inspecting them whenever they are open for other purposes. When the road is opened and a pipe uncovered, it would be as well to measure the electrical current in it. It is quite easy to measure the current in a pipe. The fall of pressure over a given length, excluding any joints, can be taken with a sensitive galvanometer. The resistance can be calculated, or got by measuring a similar pipe. From these data the current is got. By including a joint, the resistance of the joint can be found. The measurements of current should be taken day and night, to see if the current is due to tramways. Another measurement that is important is the relative pressure of the pipe and neighbouring earth. If the pipe is positive to the neighbouring earth, it is acting as an anode, and is, therefore, being corroded, and ought to be metallically connected with the power house. If the pipe companies cannot get legal protection, the best thing they can do is to make friends with the tramway people. Where the electrical tramways and the gas and water are owned by a local authority there ought to be no difficulty, but even otherwise the electrical company and the pipe owners would do well to work together. To make these electrical tests involves some electrical knowledge, and gas and water companies do not want to employ electricians on their staffs. The tramway people could generally make these tests for them without any great difficulty, and arrange experiments with them.

As to what the right course for Parliament to take may be, there is much to say on both sides. On one side it would not do to veto earthed returns, because this would throttle an industry. It is quite certain it would injure the tramway industry enormously to forbid earth returns. This means depriving the public of means of locomotion; and depriving the tramway shareholders of profits. The tramway shareholders are part of the public, and have a right to be considered. So are the gas and water companies, and their shareholders. In addition, they were there first. But the evil of vetoing earthed returns is serious and certain, while the evils of electrolysis are comparatively remote, and uncertain; so taking industry broadly, Parliament has so far decided to allow earth returns. The next question is as to whether pipe companies should have damages if their pipes are eaten. This seems obviously fair. But there is very serious difficulty in carrying such protection clauses into effect. A gas company find their pipes eaten in one district. The first thing is to prove the corrosion is electrolytic, and not due to natural causes. This is in itself not necessarily easy. Suppose it is clear that the failure is due to electrolysis, the electrolysis may be due to natural earth currents. If not, and it is due to an electrical system, who is to say which system? In small towns where there is only one tramway system, the chance of appreciable electrolysis is small. In large towns there are, or soon will be, several tramway systems, and probably some electrical railways. It would be very difficult for a London company to decide who ate their pipes, and still more difficult to bring the crime home by the clumsy and expensive method of arbitration. To make the tramway people liable for any damages is obviously fair, the real difficulty is to carry the matter out. Such a liability is for that reason very serious to the tramway. A small tramway—which we will for this example suppose really innocent—is liable to be mulcted in damages that might ruin it, by a mistake of judgment of an arbitrator, or of experts called before him. This is a very serious liability.

To sum up, there is electrolysis, and your pipes are being eaten; but whether the corrosion is really serious or not can hardly be settled yet. Tramways are increasing in all directions, but they are also being more and more carefully designed. The large systems use lead-covered cables themselves, which are infinitely more easily damaged by electrolysis than gas pipes, because the lead is easily corroded, the conductors are continuous, and the cables are generally near the tramlines. The electrical tramways are thus more likely to damage themselves than their neighbours by any bad design or careless working. It behoves gas and water companies, however, to watch carefully. The question of electrolysis is not really settled. In the course of years we may have more information, and we may then find either that the stray currents are practically harmless, or that new laws have to be made.

* *Elektrotechnische Zeitschrift*, 22, pp. 1038-1043. December 19, 1901.

An Electric Rice Mill for Siam.—According to *Indian Engineering*, a local prince prominently identified with the agricultural development of Siam is about to establish a rice mill capable of handling about 133,000lbs. of white rice per day. The mill is to be driven by electricity, and the boilers will use rice husk as fuel. The pearling and polishing machines used in Siam at present damage the grains very much, breaking and pounding the rice, and, it is believed, impairing its taste. If there is any surplus power available in the rice mill driven by electricity it is intended to utilise it in driving electric vehicles.

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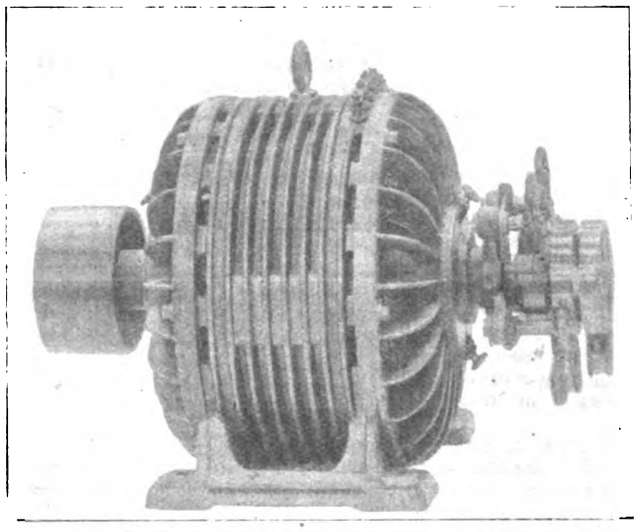
A NEW TYPE OF ASYNCHRONOUS ALTERNATING-CURRENT MOTOR.

Messrs. De Grelle, Houdret & Co., of 130, London Wall, E.C., sole representatives of the Brunswick Engineering Works (Ltd.), are placing on the market a new alternating-current asynchronous motor. It differs from other motors in that it has a ribbed case instead of a smooth cylindrical case, as generally used, and for this it is claimed that there is perfect ventilation and, consequently, low temperatures after continuous running. The motors are exceedingly light in weight, and possess great stability from the manner in which the ribs are built up. Automatic oiling arrangements are fitted to all bearings, and the machines are built in sizes from ½ H.P. to 50 H.P. They may be designed to work on one, two, or three-phase 40 to 60-period circuits at 100 to 2·0 volts. The makers guarentee a



BRUNSWICK "RIBBED" TYPE A.C. MOTOR.

higher efficiency for these machines than for any smooth cylindrical-cased motors now in use, and they fit cog-wheel gear for speed reduction when required. We give an illustration showing the method of construction, &c.

THE FIXATION OF ATMOSPHERIC NITROGEN.

An article in the *Electrical World and Engineer* of New York describes a process of electrical fixation of atmospheric nitrogen in operation at Niagara Falls. The basic principle of the process depends upon phenomena discovered more than 100 years ago, and admitted as a fact of academic interest only. In 1785 Priestly discovered that when an electrical spark was discharged through air the air immediately surrounding the same underwent a chemical change. This phenomenon is familiar to all who have had to do with electrical machines that produce sparks or arcs. After such a machine has worked for a time a pungent odour is noticed, which has often been ascribed to the closer union of oxygen atoms producing ozone. While it is not impossible that such a reaction may take place, it now seems probable that the pungent odour which obtains in the neighbourhood of an electric spark is due for the most part to oxides of nitrogen. The spark causes the nitrogen and oxygen in the atmosphere to unite and form NO or NO_2 in very minute quantities, and it was not thought worth while to ascertain the exact amount until Mr. Charles S. Bradley took up the problem in 1899. He associated himself with Mr. B. R. Lovejoy, and together they set to work to design machinery to produce these oxides on a commercial scale by means of the electric spark. The system developed into the production of a large number of arcs in a confined space, through which a regulated volume of air is passed and which emerges laden with nitric oxides and peroxides, which are conducted away and utilised in forming important commercial compounds. Investigations soon proved that a static spark was not very effective in producing the desired result, and a great deal of money was spent in finding out just what form of electric spark would produce a maximum chemical union of nitrogen and oxygen in the air. Alternating and direct-current arcs of different voltages were tried, and the result has been emphatically in favour of the high-voltage direct-current arc. It has been found best to use a voltage of about 10,000, and allow it to jump electrostatically through the air a short distance, thereby establishing the arc, and then rapidly separating the contacts until the arc breaks.

To produce this power a different character of machine from any yet made was necessary, and, to provide a machine for their immediate needs, Mr. Bradley took a large direct current series arc machine and rearranged its circuits to suit his purposes. The fields are separately excited, and the arcs are connected in multiple with the terminals of the machine. In each arc circuit is placed an inductance coil, which is carefully adjusted for best results. This prevents the arc forming a short circuit on the machine, and, as the motion of the arc drawing contact is exceedingly rapid, the load of an arc drawn in this way is very light indeed.

The machine, readapted, is capable of operating a Bradley-Lovejoy device making 414,000 arcs per minute. The device itself consists of a box of metal provided with openings to admit the air and properly circulate it, and containing rows of fixed contacts. Each of these contacts is insulated with great care, and to each is connected a wire passing first to an inductance and thence to the positive pole of the dynamo. The negative pole is a revolving cylinder equipped with properly-spaced projections which come very near, but do not touch, the fixed contacts in the surrounding box. This cylinder is driven by a vertical electric motor at 500 revs. per min., and as there are six sets of contacts in line with the fixed contact on the wall of the cylinder, each fixed contact, therefore, provides 3,000 arcs per minute. The air is driven through the apparatus at the rate of about 5 cubic ft. per arc contact per hour. In the apparatus there are 138 contacts, six rows of 23 each. It may be well understood that the exact voltage, the correct amount of inductance, the number of breaks per minute, and the arrangement of the contacts with reference to the air circulation, and last, but not least, the proper state of the arc, are matters which involved an infinite amount of careful investigation.

The air passing from this machine emerges laden with 2½ per cent. of oxides of nitrogen, and by simply leading these gases through water in sprinkling towers, well known to chemical processes, there results nitric and nitrous acid. The latter rapidly evaporates and re-combines with water again, the result being that ultimately all of the fumes are converted into nitric acid. If these gases are brought into contact with caustic potash, KOH, saltpetre, KNO_3, is the result, and if brought into contact with caustic soda, NaOH, nitrate of soda, $NaNO_3$, is the result. In fact, it is easily possible to form almost any of the nitrates by this simple combination with appropriate bases. When it is remembered that the nitrates form one of the most important classes of chemical reagents, it will be readily seen that this process reduced to one of commercial profit will be one of the most important developments of the period. Over 1,000,000 tons of nitric acid are produced yearly by treating natural nitrates with sulphuric acid, and it is claimed for this system that the cost of production will control the market, and, moreover, the acid is chemically pure.

CORRESPONDENCE.

THE STANDARDS IN EWING'S HYSTERESIS TESTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the testing of iron or steel stampings for hysteresis by means of my hysteresis tester, the hysteresis of the sample is found by comparison with two or more standards whose hysteresis is known. Experiments which have recently been made here lead me to doubt whether in all cases the standards maintain their quality so well as I have hitherto supposed, and it now appears desirable that users of the instrument should see that the values of the hysteresis which they assume in their standards are checked from time to time. If this precaution is taken the apparatus may be relied upon to give consistent and accurate results.

I would advise users of the instrument, if they have not recently had their standards re-tested, to do so.—Yours, &c.,

Cambridge, Aug. 11. J. A. EWING.

ELECTRICAL TRAMWAYS AND OMNIBUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following is the calculation Mr. Charles Bright asks for:—

A bicycle is about 6ft. long. Allowing an equal headway, 440 cycles would extend a mile in length, and at 8 miles per hour 3,520 cycles in single file could pass a given point in an hour.

Two cars passing take up, say, 16ft. of the width of the road. In this space six files of cycles might run side-by-

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side, three in each direction. This gives the theoretical maximum carrying capacity, at 8 miles per hour, of that much of a road as would be used by trams, as 10,560 cycles per hour in each direction.

A similar calculation for trams is as follows:—The new London County Council cars (described in your issue of 4th ult.) are 33ft. 6in. overall length. Allowing an equal amount of headway, this gives 79 cars per mile of line, and at 8 miles per hour, 630 cars would pass a given point each hour. Each car accommodating 66 passengers, this gives a total carrying capacity of 41,580 passengers per hour in each direction, as against 10,560 on cycles—*i.e.*, the maximum theoretical carrying capacity of a double track of lines is almost *four times* as great per tram as per cycle.

Of course, these figures are never likely to be even approached in actual use of roads. Cars must stop to take up and set down passengers. Cyclists in the inner files will wish to get out to turn down by-streets. Traffic at cross roads will interrupt the flow both of cycles and cars. Trams will not invariably be full, nor will the cyclists' ranks, and in addition, the marshalling and dispersion of cycles or cars at the beginning and end of the section would be out of the question. But considerations such as these will affect both modes of conveyance to much the same degree. And even if the ratio of practicable maximum to this absolute figure is but half as great in the case of trams as with cycles, nevertheless the carrying capacity of the cars will still be almost double that of cycles using an equal width of roadway.—Yours, &c.,

Manchester, Aug. 6. EDWARD V. CLARK.

HERTZIAN TELEGRAPHY AND SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The recent experiments in Hertzian telegraphy between England and America are obviously of very great interest and scientific importance. But if Hertzian telegraphy is to be put to an accurate test, as to the distances which may be covered across a sea or ocean, should not the experiments and tests be made across seas which are entirely free from artificial conductors? There are a rather large number of telegraph cables lying across the Atlantic, roughly connecting those parts of the two countries where the Hertzian experiments have been made. Would it not be possible to select some sea range, free from artificial conductors, across which such experiments might be made? With our present knowledge of the subject it would hardly be prudent to say that 10 or more submarine cables in no way modify the results.

In a Paper read before the Royal Society on May 1, 1902, it was stated that the distance between vessels (furnished with high conductors) across which definite signals could be made, was about 140 nautical miles. I venture to suggest that experiments made, for example, between such places as Thurso, in the north of Scotland, and Reijavik in Iceland (places free from artificial conductors), would be of much value and yield definite evidence on the point.—Yours, &c., J.-S.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Telegraphic und Telephonic." By J. Noebels, A. Schluckebier and O. Jentsch. Handbuch der Elektrotecnik Series. Vol. XII. (Leipzig: S. Herzel.) 30m.

"Die Elektrophysik und die Theorie des Electromagnetismus." By Dr. C. Heinke and Dr. H. Ebert. Handbuch der Elektrotechnik Series. Vol. I. Part 1. (Leipzig: S. Hirzel.) 18m.

"Die Gewinnung des Aluminiums und dessen Bedeutung für Handel und Industrie." By Adolphe Minet. Monographien über angewandte Elektrochemie Series. Vol. 1. Part 1. (Halle-a-S.: Wilhelm Knapp). 7m.

"The American Invaders." By F. A. McKenzie. (London: Grant Richards). 2s. 6d.

"Year Book of the Armour Institute of Technology, Chicago," 1902–1903. (Chicago: Armour Institute of Technology Press.)

LEGAL INTELLIGENCE.

Free-Wiring Agreements.

LONDON ELECTRIC SUPPLY CORPORATION v. GREENBERG AND LAKE.—At Westminster (London) County Court last week, Judge Woodfall heard an action in which the London Electric Supply Corporation sought to recover from Messrs. Greenberg and Lake two years' minimum rental of the use of electrical fittings.

Mr. H. AINSWORTH, for plaintiffs, said the corporation had an agreement with defendants to fit up an installation through the National Wiring Co., and one of the terms of the contract was that defendants should pay a minimum weekly rental of 1d. per light for five years.

The defence was that plaintiffs were asked to remove the fittings, and partly did so.

Mr. AINSWORTH said that did not affect the matter. It had been held that so long as defendants had the right to use the fittings they must pay.

Mr. LAKE, one of the defendants, said plaintiffs were asked to take away the fittings and took the arc lamps, and subsequently the meter. Even had they wanted to do so they could not have used the electric light without a meter, though the 60 odd lights were still fixed.

Plaintiffs said the meter would not have been taken away unless they had been asked to remove it.

His HONOUR, in a lengthy judgment, found for defendants with costs. He said the facts here were quite different to those in the case of the London Electric Supply Corporation *v.* Priddis. In that case the defendant could have made use of the fittings, but here the defendants could not, as the meter was taken away. Besides, the contract was for the use of the fittings, but defendants had not had this user. Plaintiffs, when told to remove the fittings might have declined, but not only did they take away the lamps, but also the meter. He had nothing to do with the Wiring Company. Even when plaintiffs took the meter away they might have protected themselves, but they did not. He should, if necessary, have been prepared to find the plaintiffs acquiesced in putting an end to the agreement, but he did not think that necessary. Plaintiffs' claim was for payment "for the use of the installation." If defendants had not the use of the installation it was neither law nor common-sense that they should be asked to pay for it. The judges, in deciding the case of Priddis, did not mean to say that they must pay if the installation was defective. Plaintiffs might appeal if they wished.

NATIONAL ELECTRIC WIRING CO. v. DAVIS.—At Greenwich (London) County Court last week, before Judge Addison, K.C., the National Electric Wiring Co. sued for the recovery of £25. 15s. damages for wrongful conversion of electric light fittings erected by plaintiffs on premises occupied by defendant. Mr. Drake, for plaintiffs, said the company agreed to put in an electric light installation, receiving in payment a rent of so much per unit of electrical energy used, with a minimum charge per lamp, the customer having the right to purchase after a stipulated period. The installation was supplied on the usual agreement with the then tenant. That tenant vacated the premises, but the agreement was continued with another tenant (defendant's immediate predecessor), who left owing rent, and leaving behind certain fixtures. The landlord, unaware of the terms on which the installation had been fitted, came to an agreement with defendant that the latter should put a new front in the shop, receiving in consideration £25 and the fixtures left by his predecessor in tenancy. In June, 1899, upon defendant entering upon occupation, he was informed by an official of the local electric supply company, with whom plaintiffs had an agreement for the collection of their charges, that the installation was their property, and the terms upon which he could use it were set out. Defendant refused to sign an agreement, claiming the installation as his property, but stating that if it belonged to plaintiffs they had better take it away, as an electrical engineer had offered to put in an installation for £6. The supply company continuing to supply current, and defendant hearing nothing further about the matter, concluded that plaintiff company had dropped their claim.

After hearing evidence, His Honour found for defendant, with costs.

Flooding Electricity Supply Mains.

On Wednesday the High Bailiff for Westminster (London) (Mr. John Troutbeck), and a common jury, heard the claim of the St. James' and Pall Mall Electric Lighting Co. against the Postmaster-General for damages for alleged flooding of mains whereby the supply of electric current was interrupted.

Mr. LLEWELLYN DAVIES, for plaintiffs, said the Postmaster-General had statutory authority to lay down telephone and telegraph wires under the streets, and he was bound to make compensation for damage caused through the exercise of those powers. The company was empowered under a provisional order to supply electric current in the parish of St. James', Westminster. In January last contractors working for the Postmaster-General opened a trench for laying down telephone wires. The plaintiff company's mains were enclosed in culverts which were practically watertight, but during the operations one of defendant's workmen struck with his pickaxe a very old 2in. service water pipe. The water quickly filled the trench and got inside the culvert. It speedily reached boiling point, and the joints were severed, and a short circuit formed. The whole of the generating machinery at both stations was stopped, and the supply of electric current suspended for half an hour throughout the district, and for a full hour in the locality of the accident. A morning performance was in progress at the St. James's Theatre, which, save for a few gas burners, was in almost darkness for an hour, and the Trocadero Restaurant was in

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the same predicament. Under agreement the plaintiff company had had to pay the Carlton Hotel Co. a penalty of £10 for interruption of supply, and the actual expenditure by plaintiffs in consequence of the accident was £165. 10s. 6d., less £19. 11d. received for old wire, &c., or a total claim of £145. 9s. 8d., but in addition counsel held the company were entitled to damages for the injury done to their business. Up to that time there had never been a failure of the company's light during their 10 years existence.

For the defence Mr. CLAVELL SALTER contended that as the damage was not caused by the Postmaster-General in the exercise of his powers under the act, plaintiffs could not recover; and he submitted that the damage to the company's reputation was too remote for consideration.

The HIGH BAILIFF instructed the jury that they had power to award damages, and judgment was given for plaintiffs for £145. 19s. 6d. and costs.

Electrolytic Plating Apparatus Co. v. Morrison.

In the King's Bench on Tuesday, before Mr. Justice Darling, a motion was made on behalf of plaintiffs for judgment in default of defence. The action was for infringement of patents, which had been certified as valid in two previous actions, and plaintiffs now claimed an injunction to restrain defendant from manufacturing, selling, supplying or using any mechanism, machinery, apparatus or device made according to the manner described in plaintiffs' patent specifications. Plaintiffs also claimed damages and an account of profits, delivery of infringing articles and costs.

Judgment was entered accordingly.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Preston Corporation require a resident electrical engineer capable of designing and superintending the construction and working of electric tramways. An advertisement contains further particulars. Applications to the town clerk (Mr. H. Hamer), Town Hall, Preston, by noon, Sept. 8.

An electrical draughtsman is required by large shipbuilding and engineering works, to be experienced in design of electricity generating stations. See advertisement.

Taunton Corporation Electricity committee require an assistant engineer. Applications to borough electrical engineer (Mr. E. B. Thornhill) by Aug. 22. See advertisement.

An assistant engineer is required for the Dewar-place electricity station, Edinburgh. Applications to resident engineer by Aug. 22.

The Visitors committee of the County Asylum, Thorpe, Norwich, require a working engineer to take charge of the whole of the engineering and electrical plant. Applications to Mr. P. E. Hansell, The Close, Norwich, by Sept. 2. See advertisement.

A meter inspector is required by Bradford Corporation. Applications to the city electrical engineer (Mr. R. A. Chattock, M.I.E.E), Town Hall, Bradford. See advertisement.

A first-class cable jointer is wanted for the Barnsley electricity works. Applications to borough electrical engineer, Mr. S. E. Bastow. See advertisement.

Two cable jointers are required by Poplar (London) Borough Council. Applications to distributing engineer (Mr. D. Macfarlane Macleod), electricity works, Glaucus-street, Bromley-by-Bow, E. See advertisement.

A lecturer and demonstrator in physics is required at the University College, Bristol. Applications by Aug. 30.

Demonstratorships of chemistry and physics and the lectureship of mathematics in the South-Western Polytechnic, Chelsea, S.W., are vacant. Applications by Sept. 2.

There is a vacancy for an instructor in physics and electrotechnics at the Polytechnic School of Engineering, Cairo. Salary about £430 per annum, rising to £553. Applications before 25th inst. to Mr. R. Holt, c/o Sir B. Baker, Queen Anne's Gate Mansions, London, S.W.

Mr. J. Scott, of Blackburn, has been promoted district manager of the National Telephone Co. at Leeds, and Mr. Remington, chief electrician of the company at Manchester, succeeds Mr. Scott at Blackburn.

Mr. Wm. Clark, chief engineer of the Glasgow Tramway department, has been appointed manager of the Lisbon electric tramways at a salary of £1,500 per annum.

Mr. James Quick has been appointed principal of the municipal technical institute at Limerick.

Halifax Guardians have appointed Mr. Thomas Cox electrical engineer at the hospital.

Mr. P. P. Wheelwright, mains superintendent at Blackburn, has been appointed chief assistant engineer at £175 per annum.

Mr. F. J. Humphrey has been appointed shift engineer at Colchester.

Mr. P. Coveney has been appointed tramways manager at Ashton-under-Lyne.

Ashford.—The Council have under consideration a proposal to erect an electricity station at the gas works.

Ashton-under-Lyne.—The Hurst electric tramway route will be officially inspected to-morrow (Saturday).

Audenshaw.—An extension of one year for the completion of the municipal electric tramways has been granted.

Berwick.—The Urban Electric Supply Co. possess a provisional electric lighting order for this town, and will commence the work of establishing electricity supply at an early date.

Beverley.—Sanction to a loan of £14,784 for electric lighting has been obtained. Edmundson's Electricity Corporation will discuss with the Council the terms on which the company will erect and run electricity works.

Birkenhead.—The electric supply accounts for the year ended March 31, just issued, show total receipts £7,187. 0s. 11d., including £6,761. 9s. 4d. from the sale of current. Generation expenses were £1,659. 15s. 4d., repairs and maintenance £397. 14s. 11d., distribution £285. 6s. 2d., rates and taxes and insurance £189. 10s., management £925. 14s. 7d., interest and sinking fund instalment £3,503. 9s. 6d., leaving net profit £225. 10s. 5d.

Blackburn.—The question of providing mechanical stokers at the electricity works is under consideration by the Electricity committee.

Blackpool.—An unfortunate interruption of electricity supply occurred on Saturday evening. About 9:8 p.m. the electric lighting was suddenly cut off, both private and public lighting being entirely suspended, owing to a fire on the main switchboard at the works, which necessitated the shutting down of the plant operated through the switchboard, and this was promptly done by the engineers in charge. The borough electrical and tramway engineer (Mr. C. Furness) was soon at the works. With buckets of sand the fire was quickly extinguished, but not before considerable damage was done to the main cables and switch gear. On examination it was found impossible to give a supply until repairs had been effected and new cable and fuses substituted. The work of repair was promptly commenced, and current was switched on for lighting early on Sunday morning. The tramway switchboard was not damaged, and, therefore, no interruption of the tram service occurred. Mr. Furness highly commends the engineers in charge, whose prompt action in shutting down the lighting plant and using a plentiful supply of sand prevented further disaster. The cause of the fire is attributed to one of the main high-tension feeder fuses arcing after the fuse had blown. The lighting board was of a very old type, and is considered in many of its details obsolete compared with the later type of board used in many of the alternating-current stations. Mr. Furness, who, with his staff, worked with great energy throughout the night in order to give supply as soon as possible, will, at the earliest moment, submit a report on the matter to the Electricity and Tramways committee.

Bohemia.—The charge for the public telephone service in the city of Prague is £4. 5s. 3d. per annum for any distance from the central exchange up to 500 metres and 16s. 8d. per 100 metres or portion thereof. A further charge is made as rental of apparatus of £2. 10s. per annum, and the connecting service fee is £1. 13s. 4d. per annum. For the use of call office instruments the charge is 2d. for three minutes' conversation. The installation and rental payments have to be made half-yearly, in January and July. At Dec. 31 last there were 68,885 miles of telephone line erected in Prague.

It is announced that the Austrian Government is about to expend £833,000 on the extension of the telephone system in Austria. The number of telephone districts or nets in Austria at Dec. 31 last was 199, each provided with public "speaking stations," and also 107 in inter-urban centres. In the scheme of the Austrian Government for the extension of the telephone system 200 new telephone areas are projected in different parts of the empire; 50 of these new telephone areas will be situated in Bohemia.

The city of Prague is exceptionally well served with electric tramways on the overhead system, and the system of guard wires adopted is said to have been eminently successful as regards accidents from falling telephone and telegraph wires.

At Tetschen, on the Saxon frontier, there is now being held an industrial exhibition, in which electrical plant and apparatus occupies a conspicuous place.

Bradford.—The dispute between the Corporation and the Shipley Council in regard to the rent to be paid by the Corporation for the Shipley electric tramways has been referred to the arbitration of the Board of Trade.

Brierley Hill.—The Midland Electric Corporation for Power Distribution has been asked to state their terms for electricity supply for lighting, and the time when such supply can commence.

Broughty Ferry.—On Monday the Council decided to erect 12 arc lamps in the principal thoroughfares, an amendment to erect 20 being rejected.

Bury (Lancs.).—The Council have decided, on the recommendation of the Tramways committee, to adopt the overhead system of traction.

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Camberwell (London).—The General Purposes committee reported to the Borough Council last week a conference with representatives of the County of London Company with respect to its proposal to sell its undertaking within the Council's area and giving the sum expended by the company as approximately £158,956. The company had laid about 25 miles of mains in the district, and would be prepared to treat on a basis many thousands of pounds lower than that provided in the purchase clause under its Act of 1896—viz., the total expenditure chargeable to capital account, plus 33 per cent., together with such a sum as should make up to 5 per cent. interest since date of order. The committee recommended that no action be taken in the matter and this was confirmed.

Cardiff.—The Provincial Tramways Co. offer to accept £26,000 for the depôts used when running their lines, now electrically equipped and owned by the Corporation. The borough engineer's valuation was £20,038.

At a meeting of the Electric Lighting committee last week, the town clerk (Mr. J. L. Wheatley) reported that the Corporation had no power to carry on the business of selling or letting motors on hire. At Bradford, where this was done, the Corporation had statutory powers, and Bristol Corporation were promoting a bill to obtain those powers. It was resolved to recommend the Corporation to apply for such powers.

The electrical engineer (Mr. Arthur Ellis) submitted to the same meeting plans for lighting certain of the tramway routes from the tramway pillars in place of pillars now used, and it was resolved to light certain thoroughfares in this way. Mr. Ellis also reported application from tenants on the Bute estate for current for power and light, but the Bute trustees had refused permission to lay down mains on their land. A committee is to wait upon Sir W. T. Lewis to obtain the necessary permission. It was resolved that out of the tramway profits £500 should be set aside to form a reserve.

Carnarvonshire.—The County Council, having receive d an application from Mr. Assheton Smith for support in his application for a provisional order to supply electricity to Port Dinorwic and the Dinorwic quarries and district, have appointed a committee to report upon the advisability of the Council themselves applying for electric lighting powers.

Coal Cutters.—Electric coal cutters are to be adopted at the Byers Green Colliery, Auckland, by Messrs. Bolckow, Vaughan & Co.

Croydon.—The Corporation have adopted the accounts of the electricity department for the year ended March, 1901, and also the recommendation of the Lighting committee that, of the £4,118. 7s. 8d. in hand, £3,000 should be placed to reserve and the balance carried forward.

The chairman of the committee (Ald. Miller) stated that the current generated had increased by 71 per cent., and the net increase of revenue was 54 per cent. The gross profits were over 6 per cent., against something over 5 per cent. last year. The accounts showed a profit of £2,520. 10s. 4d. The number of consumers had increased by 31 per cent., and the increase of 8 c.p. lamps was represented by 78,386, against 59,241, or 32 per cent. The revenue from the lamps had slightly increased, the average being about 2d. per lamp. The average price per unit obtained was 4¼d., against 4½d. last year. Since March 25 they had had a demand for 5,351 8 c.p. lamps. For arc lighting the charge was reduced by £3 per lamp.

Crystal Palace Co.'s School of Practical Engineering.—On Friday last the certificates awarded by the examiners for the summer term were distributed by Dr. T. Kirk Rose, F.C.S., assistant assayer to the Royal Mint.

Crewe.—Sanction to a loan of £1,300 for extensions of the electric lighting mains has been obtained by the Council. A consulting engineer is to be engaged to prepare a report on proposals received for the construction of electric tramways in the district.

Dalton.—A provisional order is to be applied for by the Council, and an application by Edmundson's Electricity Corporation for an order is, we understand, to be opposed.

Darlington.—The borough electrical engineer (Mr. J. R. P. Lunn) declines to be bound by the condition attached to the increase of his salary by £50 per annum—viz., that he should remain in the service of the Corporation for three years, and the matter has, therefore, been referred back.

Deptford (London).—The Borough Council will oppose the application of the County of London Co. for a provisional electric lighting order.

Dublin.—An agreement has been entered into between the Corporation and Trinity College authorities by which the Corporation obtain authority to erect a sub-station on the college grounds. In return the Electric Light committee have agreed to supply current for lighting the Provost's house, and to the engineering school and laboratories at motor rates. If supply be required for other buildings the college authorities will pay ordinary rates. An agreement has also been entered into with the Port and Docks Board as to the erection of a sub-station on the quay.

Glasgow.—At the Corporation meeting last week the accounts of the telephone department, abstracted in our last issue, were presented and adopted. On July 29 the number of instruments applied for was 7,658 and the number of subscribers connected was 6,050.

Mr. J. Alexander (chairman of the Telephone committee) said that some people considered they had been rather slow. In London, where they started about eight months before Glasgow got their licence, £1,000,000 was the sum granted. In Glasgow they began work in connection with their exchange in March, 1901. In London the exchange was finished in January, 1902, and had only 2,000 customers connected. The time taken in the construction of the Glasgow system had beaten all records. He could not find any exchange in the world that had made such progress as Glasgow terminal exchange had done. After quoting the figures given in our last issue, Mr. Alexander said the original scheme had been greatly extended. It was for 5,250 completed lines, with direct accommodation and switchroom space for 5,250 more. Instead of this, pipes had been provided with a capacity of 27,000 lines and cables actually laid containing 14,572 pairs of wires, of which only 5,470 had been used at May 31. No depreciation had been allowed for, as the system was not yet completed, and what work had been done was not yet one year old.

Mr. Burrell contended that preliminary expenses (amounting to £16,000) should not be placed to capital account, but should be divided over five years, and if that had been done the proportion of those expenses applicable to this year would amount to £2,400. As to depreciation, he thought it should be written off to correspond to the lifetime of the undertaking. A sinking fund should be treated in the same way. The reason given by the convener for not having a depreciation account this year was wrong. The Corporation in all its enterprises wrote off certain amounts for depreciation, and provided a sinking fund. If to the £2,400 of preliminary expenses were added the sum that should have been put to depreciation, there would have been, instead of a profit of £398, a deficit of upwards of £4,000. He therefore moved that the accounts be taken back.

Mr. Bruce Murray seconded, and said Glasgow's telephone enterprise had attracted the attention of the whole world. In one sense that was a fortunate circumstance, because the more criticism that was directed to municipal enterprise the better, but it placed upon the Corporation the responsibility of putting forward accounts upon a basis that would stand examination. Was the criticism made by the Press favourable? His experience was that the Press usually took an exceedingly sound view of any matter it discussed. He did not infer that the accounts presented were incorrect. He objected to the inference that the telephone system of Glasgow was being worked at a profit. That was not the case. The Council must remember that the Post Office had the power, under their agreement, to take over the whole of the enterprise on Dec. 31, 1913, and the Post Office would only take over such portions of the plant as they thought suitable. No attempt had been made by the Telephone committee to provide for this contingency, and no explanation, except in the most general terms, was given of the large capital expenditure.

Mr. W. F. Anderson considered the Council had to face a hostile opposition. Their engineer (Mr. A. R. Bennett) had put down £70,000 worth of work underground which had as yet yielded no return, and it was unreasonable to ask that depreciation should be written off on that amount.

Mr. Burt considered the position of the telephone accounts to be very satisfactory. The only question was whether the accounts should be made up in such a way by allowing for depreciation as to show a debit instead of a credit balance. He objected to handing over a great asset to the next generation at the expense of the present.

The amendment was then withdrawn and the accounts approved.

The accounts of the tramway department were presented at the same meeting by Mr. Walter Paton.

The gross revenue (he said) was £614,413, an increase of £124,944. Working expenses had increased by only £3,264, accounted for by the enormous saving which had taken place by the adoption of electric compared with horse traction. Electric traction had cost during the year 7½d. per car-mile against 9½d. during the previous year. Working expenses last year were 64 per cent. for electric traction against 87 per cent. for horse traction. Beyond that was the enormous improvement and immense saving in cost of working electric compared with horse traction. In the transition from horse to electric traction, the capital loss had, he said, been £283,923. £190,000 had been lost in permanent way, and £93,000 in cars, preliminary expenses, alterations of buildings, &c. The tramway department has been such a profitable concern from the beginning that they actually had a reserve fund of £283,900, and that would meet the whole conversion from the one form of traction to the other. So they took that fund and wrote off the item completely. They had further charged to depreciation £67,402, which they were assured was ample. In addition, they charged to permanent way renewal fund £44,554, and towards sinking fund they had placed £36,974, these items together amounting to £148,930. The capital spent on the tramways was £2,396,917, and that had been written down by depreciation to £2,080,000, so that the actual debt applicable to the tramway department was £1,884,605. The committee were allowing £450 per single mile out of revenue each year for renewal of line, which would renew the whole line in 10 years. By arrangement between the Tramway and Finance committees they were to pay £12,500 for three years to the common good, and after that the sum was to be £15,000. During the year they had carried 163,000,000 passengers, 56,000,000, or over 1,000,000 a week, at a halfpenny. They reduced the fares, but he believed the loss incurred would be more than made up by the increased number travelling. In the tramways the Corporation had a magnificent asset.

The accounts were approved.

We have received a copy of the tenth annual report of the electricity department. The receipts amounted to £103,940. 6s. 1d., and the expenditure to £51,440. 9s. 9d., leaving £52,498. 10s. 1d. to

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meet interest (£29,416. 10s. 2d.) and sinking fund instalment (£8,567. 19s. 11d.), resulting in a net profit of £14,514. 6s. 3d., from which is deducted £3,083. 10s. proportion of cost of lamps and fittings supplied to consumers consequent on change of voltage, charged to current revenue, leaving a surplus on year's working of £11,430. 16s. 3d.

The Electricity committee have decided that, as the surplus is insufficient to provide for general depreciation of the whole capital of the undertaking, as certain plant and buildings have been disposed of at a price less than nominal book value, and as a considerable amount of plant has been, or shortly will be, thrown out of use in Waterloo-street and Kelvinside stations, owing to change of pressure from 100 to 250 volts (which plant will not probably realise its full book value), the most prudent course to follow is to apply this money to reduction of capital accounts involved, and they recommend that various sums be written off to the amount of £11,430, 16s. 3d. As the surplus this year is a moderate one, and as contribution to sinking fund, at increased rate of 2½ per cent., upon amount borrowed under the Glasgow Corporation (Tramways and General) Order, 1901, will begin with the year 1902-3, the committee do not recommend any alteration in the charge for electric current during the current year. The quantity of electricity sold to private consumers during the year was 8,384,696 units, compared with 6,290,819 in the previous year, an increase of 33·28 per cent. The number of consumers on May 31, 1902, was 5,374, compared with 4,031 in 1901, an increase of 33·31 per cent. There were 242 consumers of the equivalent of five hours or over per day of their maximum demand throughout the year, amounting to 1,486,625 units in all. The number of motors in use and supplied off the Corporation mains was 682, with a total of 3,086 H.P., compared with 427 of 1894 H.P. in 1901. The total number of arc lamps erected and in regular use for street lighting was 500, compared with 348 in 1901, and the quantity of electricity consumed for street and stair lighting was 897,317 units, against 523,172 last year. The equivalent number of 8 c.p. lamps connected to the mains on May 31 was 491,306, compared with 368,342. The maximum load upon the generating stations during the year occurred on Nov. 8, when it was 7,950kw. The steam plant at Port Dundas had been increased during the year by the addition of one 2,500 H.P. Willans engine, bringing the total I.H.P. available in that station to 12,100. At Pollokshaws-road station the two 2,400 H.P. engines from the Glasgow Exhibition had been erected during the year. The actual available I.H.P. at Pollokshaws-road was 4.400. The H.P. at Waterloo-street had been reduced by the sale of two 240 H.P. engines, and by the dismantling of one 240 H.P., and two 120 H.P. engines. The available I.H.P. in working order at Waterloo-street therefore stands at 2,320, while in the Kelvinside station the figure remains as last year (1,080 H.P.). The total available I.H.P. in working order amounts to 19,900, though so much of it as is in Waterloo-street—viz., 2,320 I.H.P.—is being gradually thrown out of use, as the result of change of pressure of supply and the connection of old consumers on to the supplies from the new stations. A little over 1½ miles of distributing mains have been laid in Kinning Park, under arrangement with the Council of that burgh. The supply of current in Kinning Park commenced on Dec. 31, and 15 public arc lamps were started on March 20. An arrangement has been entered into with the tramways department for a supply of current during the heavy demand experienced in the winter afternoons. The committee have under consideration the question of utilising gas engines, possibly in conjunction ultimately with gas producers, for further extensions of plant, which will probably be necessary in a year or two. Under the Glasgow Corporation (Gas, &c.), Order, 1902, additional powers were conferred upon the electricity department, which will entitle them (1) to require any consumer wishing a stand-by supply of electrical energy to enter into a special agreement with the Corporation before they can demand supply; and (2) to sell or let for hire (but not to manufacture) electric motors and fittings.

Glasgow Infirmary.—The new electrical pavilion of the Royal Infirmary was opened recently. Some 12 years ago an electrical department was added to the hospital, improvements were made about six years ago, and in 1896 a special department for X-ray work was added. The new pavilion consists of four large well illuminated rooms, equipped with the most modern and approved apparatus. Electric supply is obtained from the 250-volt mains of the Glasgow Corporation. Photographic dark rooms and other arrangements necessary for the work have been provided. The sources of energy employed are a gas engine, dynamo, battery of accumulators, and a transformer. In the first room the transformer is ready to change the 250-volt current to the required voltage for medical and surgical purposes; the distributing switchboard is in this room. Three complete sets of Finsen's light apparatus for the treatment of lupus and other affections have been provided, and also modifications of this method for the application of ultra-violet rays. Apparatus for treating nervous diseases by the use of high frequency currents has also been fitted up; and also a large Wimshurst machine constructed by Lord Blythswood and presented by his lordship. The X-ray department has been refurnished with the newest switchboards, coils and operating tables, and the older types of apparatus for constant and interrupted currents for diagnosis and treatment have been replaced by those of the most modern kind. A large electromagnet for the extraction of metallic substances from the human body has been specially designed, and the general department includes electric drills, saws, trepines and electric probes for detecting the presence of bullets, &c. This important electro-medical department is under the direction of Dr. John Macintyre.

Hartlepool.—Last week the Electricity Supply committee recommended the Council to approve a draft agreement with the Northern Counties Electricity Supply Co. for a supply of electric current within the borough. The Hartlepool Electric Tramway Co. now offer to supply current for lighting the town upon more favourable terms, and point out they are able to supply current from mains already laid. Their offer is conditional on the Corporation extending the company's lease of the tramways by seven years. The subject has been referred back.

Hebden Bridge.—A scheme for generating electricity at the gas works by means of the present waste power from the water-gas plant has been adopted by the Council on the advice of their consulting engineer, Mr. Walter Emmott, of Halifax.

Hove.—The Council's consulting engineers (Messrs. Lacey, Clirehugh and Sillar) recommend the construction of a system of electric tramways between Hove, Shoreham and Brighton. The estimated cost is £103,700 for the overhead system, and £149,700 for a combination of the overhead trolley and conduit systems. The total length of line is a little over 7 miles. The Council are also advised to expend £114,000 in putting down electric lighting plant to supply the equivalent of 15,000 8 c.p. lamps. The estimated profit on the overhead system is £3,636, on the conduit £8,666, and on lighting £816. The Council are recommended to promote a bill with the above objects.

Infirmary Lighting.—On the recommendation of their Infirmary Management and Visiting committee, the City of London Guardians have approved the plans and specifications of Mr. Adrian Collins for the electric lighting of the infirmary at £1,500, and the Local Government Board has been asked to sanction the obtaining of tenders from Messrs. Pinching and Walton, Lund Bros. and the General Electric Co. without the necessity of advertising for sealed tenders.

Light Railways.—The Board of Trade have, after modification, confirmed the Doncaster Corporation Light Railways (Deviation, &c.), the Llanelly and District Light Railway, the Derwent Valley Light Railway, and the Vale of Rheidol Light Railway (Amendment) Orders.

The Light Railway Commissioners have issued an order authorising an extension of the Southend Council's tramways from Southend to Shoebury.

Liverpool.—The City Council have authorised a deputation consisting of the general manager, chairman and deputy-chairman of the Tramways department and the city engineer and city electrical engineer to visit the United States and Canada, to inspect and report upon the latest progress made in electric traction.

Louth.—The Council have decided to establish electricity supply at an estimated cost of £10,000.

Luton.—The Electric Light committee has arranged with Messrs. E. Wiseman & Co. to hold an exhibition of electric lighting fittings, cooking and heating appliances, &c., in October. The Corporation will supply current free of charge.

Lynn.—A further report on the proposed electric lighting of the docks has been prepared by the borough electrical engineer (Mr. Pilling), and the Council have authorised Councillors Floyd and Gemmel to make a formal offer to the company.

Manchester.—The foundation stone of the Ardwick electric car shed and offices was laid by Mr. Wainwright, vice-chairman of the Tramways committee, on Thursday last.

Melbourne.—The Victorian Minister for Railways is considering a scheme for the construction of about 50 miles of electric tramways in Melbourne and suburbs.

Merthyr.—The District Council have consented to the local tramways company increasing the speed of the tramcars on portions of their system from 6 to 8 miles an hour.

Mold.—The National Electric Wiring Co. have been instructed by the Council to prepare a report upon electric lighting.

Municipal Telephony.—Oldham Town Council have applied for a licence to establish a municipal telephone system.

Newcastle-on-Tyne.—The Tramways committee have offered to supply electric energy for lighting the municipal buildings at 3d. per unit. The city engineer is reporting on the offer.

Okehampton.—The Council having come to terms with the local gas company, the proposal to adopt electric lighting has been abandoned.

Ossett.—The Council have decided to engage an electrical engineer to prepare a report on electric lighting and refuse destruction.

Plymouth.—The Tramways committee have authorised the borough electrical engineer (Mr. E. G. Okell) to obtain tenders for the overhead equipment of the tramways through the Pounds estate at an estimated cost of about £2,000.

Prestwich.—A loan of £21,000 is to be obtained for the construction of electric tramways. Salford Corporation have been asked the terms on which they would take over the Prestwich electric lighting order and supply current in bulk in the district.

Reading.—The Reading Electric Supply Co. offer to supply current for lighting the principal thoroughfares at 2d. per unit.

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Rothesay.—The official inspection of the electric tramway between Rothesay and Port Bannatyne will take place on Tuesday. The contractors for the permanent way construction and overhead equipment were Messrs. Dick, Kerr & Co.

Royal Assent.—The following Acts of Parliament (with electrical clauses) received the Royal assent on Friday last :—

Pacific Cable (Amendment).
Tramways Orders Confirmation (Nos. 1 and 2).
Electric Lighting Orders Confirmation (Nos. 7 and 8).
Greenock and Port Glasgow Tramways (Extension) Order Confirmation.
Rossendale Valley Tramways.
Liverpool Tramways and Electric Supply (Garston Transfer).
London County Council (Subways and Tramways).
London County Council (Tramways and Improvement).
Metropolitan District Railway.
Great Northern and City Railway.
Birmingham and Midland Tramways.
Devonport Corporation (General Powers).
Saddleworth and Springhead Tramways.
Wigan Corporation.
North Staffordshire Tramways.
Mexborough and Swinton Tramways.
Swansea Corporation.
Nottingham Corporation.
Great Northern and Strand Railway.
Liverpool Corporation.
York Corporation.
Eastbourne Corporation.
London United Tramways.

St. Petersburg.—Reporting on the trade of St. Petersburg and district in 1901, Mr. Consul-General J. Michell states that the business in electric fittings and installation work is principally in German hands, but Russian consumers are beginning to understand that the cheap German article is of little permanent value, and costs more in the long run than the more expensive fittings of British manufacture. Mr. Michell considers that trade in this branch of industry has a good future, and that British manufacturers should spare no effort to prove the superiority of their manufactures.

Sheffield.—The Tramways committee offer a prize of £5 for the best destination indicator for the electric trams.

South Lancashire Electric Tramways.—The first section of the South Lancashire Electric tramway system, a line a little more than 3 miles in length, connecting Liverpool with Prescot and St. Helens, was opened for traffic on June 24, and the results of the working are so far very satisfactory. The cars run at frequent intervals, nominally every 15 min. but in practice far oftener. The traffic returns from the opening until 6th inst. show that during that period the total passengers carried was 176,194, an average of over 4,000 per day. The weekly average receipts have risen as high as 36·62d. per car mile. It is considered probable that before another year elapses Liverpool and Manchester will be connected by electric tramways.

South Shields.—Last week the Council decided to apply next session for powers to equip and work electric tramways. The borough electrical engineer (Mr. J. H. Cawthra) was instructed to furnish the Tramways committee with a report on various systems of electric traction, and also to prepare estimates.

Southampton.—An electric tramway between Onslow-road and Portswood-road is to be constructed at an estimated cost of £7,475.

Southport.—Application has been made for sanction to a loan of £16,500 for the construction and equipment of certain electric tramways in the town.

Stafford.—The Council on Tuesday agreed to apply for a provisional order authorising the supply of electricity to the parishes of Castle Church, Basurch Hopton and Coton, Tillington and Seighford outside the borough area on condition that a higher charge be made to persons to whom electric current is supplied than to town consumers.

Stoke Newington (London).—The Borough Council have obtained a provisional order which contains a clause authorising the supply of electricity in bulk by the Borough Councils of Islington and Hackney, but the Board of Trade refuse to consider the matter except upon application from the Islington and Hackney Councils. A request by Stoke Newington to Islington to make application to the Board has been referred by the Islington Council to their Electric Lighting committee with power to act.

Suez.—The report on the traffic of the Suez Canal for 1901 is to the effect that the percentage of ships using electric light for navigation by night was 93 7, against 91·2 in 1900.

A joint-stock company is about to be formed to take over and work a concession granted by the Egyptian Government for supplying electric current to Suez and Port Tewfik for 20 years. The same company will erect ice-making machinery and cold storage accommodation. It is estimated that the prospects of the company regarding its electric lighting undertaking are distinctly favourable, and the demand for cold storage facilities at Suez is considerable.

Sutton-in-Ashfield.—The Council are conferring with the Derbyshire and Notts Electric Power Co. as to the company's proposals for electricity supply in bulk.

Swinton.—The Council have been informed by the Lancashire Electric Power Co. that the company will be in a position to supply electric current at latest by "the commencement of the lighting season of 1903."

Sydney.—The new Pyrmont (N.S.W.) bridge, which was opened on June 28, has an electrically-operated swing span of 223ft.

Walton-on-the-Naze.—A committee has been appointed to obtain estimates of the cost of electricity works.

Warrington.—The Board of Trade have prolonged the period for the completion of the Corporation tramways to Aug. 6, 1903.

West Bromwich.—To meet the increasing demand for electric current application has been made for a further loan of £10,000 for electric lighting extensions.

West London Tramways.—The Isleworth and Twickenham extension of the London United Tramways was opened for traffic on Wednesday.

Westminster P. O. Telephone Exchange.—An exchange, to be called the Victoria Exchange, in connection with the Post Office London telephone service, was opened on Tuesday.

Wirkworth.—The Derbyshire and Notts Electric Power Co. are conferring with the Council as to the company's electricity supply proposals.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

St. Petersburg (Russia) Town Council require tenders for the reconstruction of the existing three horse-drawn tramways in the city to electric traction, and for the construction and equipment of an electric power station. Conditions of tender, application forms, &c., can be obtained, on request, either by post or telegraph, from the Stadt-Amt., St. Petersburg, Russia, where projects have to be lodged and tenders sent by the 1st (14th) Nov. next. An advertisement gives additional particulars.

The *Metropolitan Asylums Board* invite tenders for an electric fire alarm installation at the Orchard Small-pox Hospital, near Dartford, in accordance with the plans and specifications prepared by the engineer to the Board (Mr. W. T. Hatch). Specifications, &c., at the offices, Embankment, London, E.C. Tenders by 10 a.m. Aug. 28. See advertisement.

West Ham Corporation invite tenders for steam exhaust, feed water and drain piping, water softener, steam traps and separators; also circulating and air pump, discharge piping, water purifier and vapour pipes. Specifications, &c., from the borough electrical engineer (Mr. James K. Bock) after 22nd inst., and tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, Stratford, by 4 p.m. Sept. 4. An advertisement contains further particulars.

The Urban District Council of *King's Norton and Northfield* are prepared to lease their powers under their electric lighting order of 1898. Some particulars are given in an advertisement, and further inquiries should be addressed to the Council's engineer (Mr. A. W. Cross), 23, Valentine-road, King's Heath. Offers to the clerk (Mr. Edwin Docker), 10, Newhall-street, Birmingham, by Sept. 18.

Leicester Tramways committee invite tenders for tramway track material, feeder cables, telephone and test wires, overhead electrical equipment and copper bonds, steam-raising plant, engines, generators, batteries, boosters, switchboard, overhead travelling crane, electric tramcars, &c., &c. Tenders by noon Sept. 3.

Malvern Urban District Council invite tenders for two Lancashire boilers (with feed-water heater and pipe work), engines, alternators, exciters and switchboard, high and low-tension concentric cables and transformers. Tenders to chairman of Gas, Water and Electricity committee by Aug. 23.

The directors of the *North-Eastern Railway Co.* invite tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders to secretary, York, by noon Oct. 7.

Rugby Urban District Council invite tenders for one 150kw. and one 60kw. high-speed steam alternators (three-phase), switchboard, underground mains, arc lamps, public incandescent lamps, &c., and meters. Tenders to clerk by 3 p.m. Aug. 20.

Pemberton Urban District Council invite tenders for feeder cables, overhead electrical equipment, engines, dynamos, boiler, rail bonds rails, fishplates, &c., and switchboard. Tenders to clerk by noon Aug. 20.

Ilford District Council invite tenders for a combined track-watering and sweeping car on maximum traction truck with complete electrical equipment. Tenders to chairman of Council by noon Aug. 19.

Poplar (London) Electricity committee require arc lamp carbons. Tenders to town clerk, Council offices, High-street, Poplar, E., by Aug. 25.

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Bexley Electric Lighting and Traction committee invite tenders by Sept. 4 for tramway permanent way, bonding and overhead equipment, car bodies, trucks and electrical equipment.

Plymouth Corporation invite tenders for overhead-line construction, &c. Tenders to borough electrical engineer, Prince Rock, by Aug. 23.

Accrington Watch committee invite tenders for nine arc lamps and pillars. Tenders to chairman, Town Hall, Accrington, by noon Aug 19.

Manchester Tramways committee require car-cleaning materials. Tenders to general manager by 1 p.m. 16th inst.

Bury Tramways committee require rails, fishplates, points and crossings, &c. Tenders by 28th inst.

Swansea Corporation require telephone conduits, cables, poles, instruments, &c. Tenders by Sept. 1.

Harrogate Corporation require tenders for wiring the Kursaal. Tenders by 18th inst.

Bristol Guardians require tenders for boilers, &c., and for wiring and electric fittings for the infirmary. Tenders by noon, Sept. 10.

Doncaster Corporation invite tenders by 28th inst. for ejector condenser plant, with pumps, &c.

Aberdeen City District Lunacy Board invite tenders for an electric light installation at Kingseat Asylum, Newmachar. Tenders to clerk, 20, Union-terrace, Aberdeen, by 10 a.m. 25th inst.

Edinburgh Corporation require tenders by 26th inst. for cast-iron pillar boxes for street section fuses.

The British Municipality and British Municipal Extension at *Tientsin*, China, invite proposals for the lighting of the concessions by electricity. Offers by Nov. 30. Mr. A. W. Harvey Pellingham is secretary and engineer.

The Portuguese authorities at *Lourenço Marques* will shortly invite tenders for the supply of eight electric conveyors of the Temperley type. British firms wishing to tender for the supply of these machines should apply for particulars direct to his Excellency the Governor, Lourenço Marques, Portuguese East Africa.

The *Norwegian State Telegraph* department invite tenders until noon of 18th inst. for solder tin. Specifications from technical department of Board of Telegraphs, Christiania, and from inspectors of telegraphs at Trondhjem, Bergen, Stavanger, and Arendal. Apart from usual custom duties, a preference of from 10 to 15 per cent. is given to native manufactures.

The *Norwegian State Railway* authorities also invite tenders until Sept. 13 for quantities of telegraph wire, porcelain insulators, insulator holders, &c. Particulars from Inspector of Telegraphs, Stoners Gade, Christiana.

TENDERS RECEIVED AND ACCEPTED.

We recently announced that the Sydney Municipal Council had given the contract for the supply and erection of electricity generating plant at £46,089. We are now able to give a complete list of the tenders submitted. In their report the consulting engineers (Messrs. Preece & Cardew) state that :—

Complete tenders were received from 21 firms, most of whom submitted three alternative tenders, making 58 tenders in all. Of the 11 lowest tenders five (Nos. 1, 3, 4, 7 and 9) are for plant of British manufacture throughout, four (Nos. 2, 5, 8 and 11) include a considerable amount of plant which would probably be of foreign make, and two (Nos. 6 and 10) are for foreign plant throughout. The foreign plant specified was, they knew, of good quality, and in the case of the electrical machinery quite equal to British make. Only three patterns of boiler were tendered for; all, except one, quoting the Babcock and Wilcox, and many the Stirling as an alternative, the third boiler being of German make. For the large units the tenders for engines might be divided into high speed of over 200 revs., and low speed of about 100 revs. The guarantees of steam consumption given with several high-speed engines were so satisfactory that, considering the increased expense of the plant and also of the necessary buildings, crane, &c., with slow-speed engines, Messrs. Preece and Cardew recommended the adoption of the higher speed type. Of the 11 lowest tenders four included Browett-Lindley engines, five Ferranti and two engines by the Augsberg and Nurnberg Works. The guaranteed economy in steam consumption of the steam alternators with the Ferranti engine is some 10 per cent. better than that of the sets with Browett-Lindley and Augsberg engines. The Ferranti engine appeared the best selection. Most of the tenders for alternators were from electrical manufacturing firms, and provided for alternators of their own manufacture. There was little to choose between most of the machines. As regards exciting energy, that of Messrs. Dick, Kerr & Co. guaranteed the best results, and their regulation was also good. The five lowest tenders and three others each provided for a Tudor battery, which was a satisfactory pattern. The motor-generators, like the alternators, would in most cases be made by the firms tendering. The designs and prices of switchboards naturally varied considerably. Messrs. Preece and Cardew consider that tenders Nos. 2, 5, 6, 7 and 9 provided the most satisfactory arrangements of the lower tenders, but of those they considered the Ferranti switch gear included in tenders Nos. 7 and 9 by far the best, most convenient and safest. No firm had sent in a complete tender for the generating plant with steam turbines in place of ordinary engines, but Messrs. C. A. Parsons & Co. had submitted a tender for turbines and alternators only. The four lowest tenders with Babcock-Wilcox boiler and Ferranti engine were :—

British Thomson-Houston Co.	£49,711
Dick, Kerr & Co.	49,827
Mather and Platt	50,124
J. G. White & Co.	50,422

The British Thomson-Houston Co., Dick, Kerr & Co. and Mather and Platt had not quoted for Ferranti switch gear, but were prepared to substitute it at the price quoted by Ferranti Limited (£6,399), and as Messrs. Preece and Cardew preferred the Tudor battery to that quoted by the British Thomson-Houston Co., the final figures of the four firms were :—

Dick, Kerr & Co.	£49,072
Mather and Platt	50,528
British Thomson-Houston Co	51,588
J. G. White & Co.	52,444

On the whole, therefore, the tender of Messrs. Dick, Kerr & Co., at £49,072, was recommended for acceptance, with plant, &c., entirely of British manufacture by a purely British firm, although no doubt was entertained that each of the other firms would carry out the contract satisfactorily. The selection of the Ferranti engine enables the engineers to appreciably reduce the size of the generating station.

The following is the complete list of tenders sent in, in order of amount. The figures in parentheses show the time (*in months*) required for completion of contract. (*a*), (*b*), (*c*), (*d*) indicate alternative tenders. The amount of the tender includes five boilers, one superheater, three condensers, three air-pumps, two 600kw. sets, one 300kw. set, battery of accumulators, pipe work, five motor generators, static transformers, main and exciter switchboards and sub-station switchboards :—

1	Mather and Platt (*a*)	£46,089	(15)
2	J. G. White & Co. (*a*)	46,731	(15)
3	Dick, Kerr & Co. (*a*)	47,155	(12)
4	Mather and Platt (*b*)	47,614	(12)
5	J. G. White & Co. (*b*)	47,850	(15)
6	Siemens & Halske (*a*)	48,214	(18)
7	Ferranti Limited (*a*)	48,495	(12)
8	Crompton & Co. (*a*)	48,633	(18)
9	Ferranti Limited (*b*)	48,903	(12)
10	Witting Bros. ... (*a*)	49,566	(15)
11	British Thomson-Houston Co. (*a*)	49,711	(12)
12	Crompton & Co. (*b*)	50,030	(—)
13	Lahmeyer Elec. Co. (*a*)	50,091	(15)
14	Brown, Boveri & Co. (*a*)	50,283	(12)
15	Brit. Schuckert Co. (*a*)	50,518	(22)
16	Allgemeine E.G. (*a*)	50,700	(—)
17	British Thomson-Houston Co. (*b*)	51,203	(12)
18	Johnson & Phillips (*a*)	51,458	(18)
19	Brit. Schuckert Co. (*b*)	51,499	(23)
20	Ferranti Limited (*c*)	51,818	(12)
21	Brown, Boveri & Co. (*b*)	51,943	(12)
22	Witting Bros. (*b*) ...	52,055	(—)
23	Dick, Kerr & Co. (*b*)	52,119	(12)
24	Crompton & Co. (*c*)	52,488	(—)
25	Johnson & Phillips (*b*)	52,498	(18)
26	Mather and Platt (*c*)	52,629	(13)
27	Siemens Bros. & Co (*a*)	52,740	(14½)
28	Elec. Construc. Co. (*a*)	52 862	(—)
29	Siemens & Halske (*b*)	53,056	(—)
30	D. Bruce Peebles & Co. (*a*)	53,096	(15½)
31	J. G. White & Co. (*c*)	£53,284	(15)
32	Brit. Schuckert Co. (*c*)	53,358	(19)
33	Lahmeyer Electric Co. (*b*)	54,491	(15)
34	J. G. White & Co. (*d*)	53 669	(15)
35	Elec. Construc. Co. (*b*)	53,777	(—)
36	Brush Co. (*a*)	54,113	(16)
37	Siemens & Halske (*c*)	54,582	(18)
38	D. Bruce Peebles & Co. (*b*)	54,899	(12)
39	D. Stewart & Co. (*a*)	54,913	(15)
40	British Westinghouse Co. (*a*)	54,941	(15)
41	Allgemeine E.G. (*b*)..	54,972	(—)
42	Siemens Bros. & Co. (*b*)	55,105	(14½)
43	Elec. Construc. Co. (*c*)	55,735	(—)
44	Brown, Boveri & Co. (*c*)	55,958	(12)
45	General Elec. Co. (*a*)	56,083	(12)
46	British Westinghouse Co. (*b*)	56,436	(15)
47	General Elec. Co. (*b*)	56,466	(12)
48	D. Stewart & Co. (*b*)	56,660	(15)
49	D. Bruce Peebles & Co. (*c*)	56,840	(12)
50	D. Stewart & Co. (*c*)	57,184	(15)
51	General Elec. Co. (*c*)	57,289	(—)
52	Brush Co. (*b*)	58,238	(16)
53	Allgemeine E.G. (*c*).	58,952	(—)
54	Dick, Kerr & Co. (*c*).	59,067	(18)
55	Siemens Bros. & Co. (*c*)	65,350	(18)
56	Musgrave & Sons (*a*)	71,418	(18)
57	Musgrave & Sons (*b*)	71,449	(18)
58	Musgrave & Sons (*c*)	72,232	(18)

The following tenders have been received for supplying and erecting electric lighting plant at Kinfauns Castle, N.B., to the specification of the consulting engineer, Mr. Morgan Williams, M.Inst.C.E.

Mavor and Coulson (*accepted*)	£1,939	5	0	and	£2,079	5	0
Ernest Scott and Mountain	2,360	10	0				
Middleton and Townsend	2,295	3	6	and	2,190	0	0
Lowdon Bros. & Co.	2,058	19	6	and	2,008	19	6
Macaulay, Clarke & Maclaren (four tenders)	2,020	15	0	to	2,090	15	0

The Hyde, Stalybridge, Mossley and Dukinfield Tramway and Electricity Board have accepted the tender of Messrs. Dick, Kerr & Co. for three 500kw direct-coupled three-phase alternators (Yates and Thom engines), and that of Messrs. J. P. Hall & Co. for three 50kw. direct-coupled continuous-current exciters (Belliss engines). The contract for construction of the permanent way, copper bonding, &c., has not yet been let.

Bradford Corporation have accepted the following tenders :—

Collinson Bros., wiring new conditioning house.

G. A. Steinthal, wiring new fire station.

Easton & Co., converting Town Hall passenger lift from hydraulic to electric power.

British Thomson-Houston Co., half-yearly supply of incandescent lamps.

Cole, Marchent and Morley, exhaust steam oil separators for new electricity generating station.

Bolton Municipal Technical School authorities have placed an order with Messrs. Witting Bros. for the preliminary equipment of the new dynamo room. The plant and machinery comprises single and polyphase alternators, single and polyphase motors, direct-current motors, direct-current dynamos, transformers, a rotary converter and a complete switchboard.

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Lowestoft Corporation received the following tenders for rails, fishplates and bolts :—

	English rails.	Foreign rails.
A. Penny & Co. (*accepted*)	...	£6,053 0 0
McLeod & Co.	£8,365 7 3 ...	...
E. Nuttall & Co.	8,115 5 0 ...	6,474 0 0
W. Griffiths & Co.	8,091 5 0 ...	...
Macartney, McElroy & Co.	7,882 5 6 ...	...
A. Faulkes	7,466 12 6 ...	7,829 0 0
W. Scott & Co.	7,454 15 0 ...	...
P. and W. McLellan	7,431 10 0 ...	6,743 10 0
J. G. White & Co.	...	6,467 7 0

The tender of Dick, Kerr & Co. and E. Le Bas & Co. were not to specification, and those of the Barron Hæmatite Steel Co. and Ibbotson Bros. were incomplete.

Lowestoft Corporation also received 10 tenders for the permanent way construction, the amounts varying from £33,136. 3s. 4d. (the tender of G. Wimpey & Co., which was accepted) to £51,803. 10s. 5d.

Messrs. R. W. Blackwell & Co., 59, City-road, London, E.C., have received the complete contract for equipping the Chester tramways on the overhead trolley system. The amount of the contract is over £40,000, for the construction of 3 miles of track and overhead equipment and the supply of 12 cars complete for running.

Brompton and Kensington Electricity Supply Co. have placed an order with Messrs. Witting Bros. for two motor generators, each compriaing a Heyland motor driving a continuous-current generator, for accumulator charging.

Stockton-on-Tees Town Council have placed an order with Messrs. Worth, Mackenzie & Co. for condensing and cooling plant for the electricity works at £2,096, or £170 more than the amount of the lowest tender, it being considered advisable to let the work to a local firm.

Spennymoor District Council have accepted the tender of the Northern Counties Electricity Supply Co. for supplying current to 20 incandescent lamps for lighting a portion of the district at 42s. per lamp per annum.

Newport (Mon.) Tramways committee have accepted the tender of Mr. A. Krauss for the reconstruction of tramways at £33,000.

Southampton Town Council have accepted the tender of Messrs. Babcock and Wilcox for a water-tube boiler at £850.

Dublin Corporation have accepted the tender of Messrs. Morton and Anderson for the construction of a cast-iron subway under the Grand Canal Dock for the electricity department at £2,079. 8s.

Derby Town Council have accepted the tender of Fuller-Wenström Electric Mfg. Co. for a motor pump at £53, and that of Brown's Foundry Co. for cast-iron condenser piping at £35.

Eccles Town Council have accepted the tender of the Gilbert Arc Lamp Co. for eight arc lamps for the tramways standards at £112. 16s.

Warrington Corporation have accepted the tender of the British Thomson-Houston Co. for 11 electric tramcars complete at £5,996.

Hampstead (Borough) Council have accepted the tender of Messrs. T. Parker (Ltd.), for the supply of a dynamo at £760.

Grimsby Corporation have accepted the tender of Hewins and Goodband for extensions to the electricity station buildings at £973. 13s. 8d.

Salford Town Council have accepted the tender of Walter Scott (Ltd) for 1,450 tons of tram rails at £6. 17s. 6d. per ton, and fish and sole plates at £8. 7s. 6d. per ton.

Motherwell Town Council have accepted the tender of the Lancashire Dynamo and Motor Co. for a steam dynamo at £4,280, and that of Babcock and Wilcox for a boiler at £1,190.

BUSINESS NOTICE.

Messrs. Baxter and Caunter are about to remove to 86, Charing Cross-road, London, W.C. Telephone number 3453 Gerrard.

LIQUIDATIONS.

On Tuesday Sir James Gell, judge of the Manx Chancery Court, approved the agreement between the liquidators of the Isle of Man Tramways and Electric Power Co. and Mr. E. Schenck, of London, the purchaser of the company's system of electric tramways, for the extension of the date of completion of the sale to Nov. 14.

A meeting of the Scarborough District Lighting Co. (Ltd.) will be held on Sept. 10 at York-chambers, Westborough, Scarborough, to receive an account of the winding-up.

The Davy Electrical Construction Co. (Ltd.) is to be wound up voluntarily. Mr. G. Frampton, 37, Casselden-road, Harlesden, is liquidator.

A meeting of the Direct Telephone Exchange Syndicate (Ltd.) will be held at 52, Leadenhall-street, London, E.C., on Sept. 12 to receive an account of the winding-up. Mr. T. Featherstone Smith is liquidator.

Catalogues and Price Lists Wanted.—In an advertisement Mr. John Denham, electrical engineer to the Cape Government Railways, announces that he requires catalogues and price lists of electrical plant and apparatus, including engines (steam, oil and gas), direct-coupled generating sets and motors, (alternating and continuous-current), boilers, feed-heaters, condensers, pumps, &c., electric cranes, cables, wires, electric lamps, fittings, measuring instruments, &c.

Sale by Auction.—Messrs. Percy Huddleston & Co. will sell by auction, at the Ballsbridge and Clontarf tramways depôt of the Dublin United Tramways Co., on Thursday, 21st inst, at 12 o'clock precisely, valuable fixed machinery and plant, comprising 7 water-tube boilers, four 150 I.H P. Willans compound engines, a 300 H.P. M'Intosh and Seymour engine direct-coupled to three-phase alternator, two 150 H.P. engines coupled direct to continuous-current dynamos, a combined vertical engine and dynamo (110 volts 75 amperes), two 120kw. three-phase alternators, four 60kw. three-phase motors, a 500-volt motor-generator, two sets of Green's economisers, travelling crane, condensing plant, steam valves and piping, switchboards and instruments. The fixed plant can be inspected a week previous and on morning of sale. Catalogues may be obtained from the secretary (Mr. R. S. Tresilian), and of the auctioneers, 72, Finsbury-pavement, London, E C. See also advertisement.

Plant for Sale.—Particulars of some electric lighting plant for sale are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Particulars are given in an advertisement of plant for sale suitable for mill lighting or complete installation of 500 lights.

Works Sites.—Particulars are given in an advertisement of land, with railway siding, which Messrs. H. Arnold & Son, Doncaster, have for sale.

Exhibition.—There is now being held at the Agricultural Hall, London, an exhibition of ironmongery, hardware and domestic electrical goods. The Consolidated Telephone Construction and Mfg. Co. have an extensive display of all kinds of telephone apparatus, testing instruments, switches and switchboards, circuit breakers, &c. The Conduit and Insulation Co. show a variety of specimens of steel-armoured insulating conduits, with all the latest improvements. Messrs. W. F. Dennis & Co. have a goodly display of telegraph and telephone wire. Messrs. L. M. Ericsson & Co. show a useful assortment of intercommunication wall and table telephone sets and telephone instruments for magneto and battery ringing. Messrs. Falk, Stadelmann & Co. show electric lamps and globes, electric bells and telephones. Messrs. Hunt and Mitton have an excellent exhibit of engine and boiler mountings, lubricators, gauges, &c. The Keith and Blackman Co. always make a feature at this hall of their well-known electric fans for ventilating and drying purposes. The Portable Electric Light Co. display a number of novelties in portable lamps for use as torches, &c., and also make a good show of reading lamps, searchlights, fancy candles and electroliers and lamps for table decoration, &c. At the stand of the Simplex Steel Conduit Co. there is the usual well-arranged display of the special types of wiring conduits for which this company have attained an excellent reputation. The Union Electric Co. show a quantity of electric motors and some special types of electric lamps. The exhibition remains open until the 22nd inst.

Nernst Electric Lamps.—On the occasion of the lighting of the Canadian arch, Parliament-street, London, on the 9th, 10th and 11th inst., 600 1-ampere Nernst lamps were used, the installation being carried out by the Electrical Co., 122–124, Charing Cross road, London, W.C. The lighting was very effective.

Imports of Electrical Goods.—The value of the electrical goods imported into this country during July was £51,868, against £42,107 in July, 1901, and £129,022 in July, 1900. The total value for the seven months ended July 31 was £407,279, compared with £595,073 and £549,275 in the corresponding periods of 1901 and 1900 respectively.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Aug. 7 to 12, with the ports of destination :—

Africa—Cape Town, £2,152 ; East London, £20. *Australasia*—Melbourne, £1,147 ; Sydney, £1,785 (including £206 telegraph material) ; Wellington, £282. *Belgium*—Ostend, £10. *Brazil*—Rio Janiero, £854 (telegraph material). *Channel Islands*, £129. *Chili*—Antofagasta, £50 (telegraph material). *China*—Foochow, £25. *Denmark*—Copenhagen, £704. *Germany*—Hamburg, £35 (telegraph material). *Gibraltar*, £135. *Holland*—Amsterdam, £145 ; Rotterdam, £50 (telegraph material). *Hong Kong*, £17. *India*—Bombay, £260 ; Calcutta, £339 (including £68 telegraph material) ; *Norway*—Christiana, £793 (including £74 telegraph wire). *Sekondi*, £25. *Straits Settlements*—Singapore, £204. *U.S.A.*—New York, £18. Total (for six days), £9,179, against £18,212 in the corresponding six days last year (Aug. 8 to 13.).

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

June 18, 1902.

13,792. M. B. FIELD. Glasgow. Fault indicator.
13,795. J. T. MILL. Free wheel magneto fire alarm.
13,797. T. E. R. PHILLIPS and F. A. M. ALLINGHAM. Enclosed spring swivelling trolley standards and trolley heads.
13,802. J. R. CRISP and J. F. MOORE. Sunderland. Speed indicator.
13,814. W. G. INGLEFIELD. Manchester. Travelling electric lighting devices.
13,851. BRITISH THOMSON-HOUSTON CO. Electric motor controllers. (J. B. Sinn, U.S.)
13,852. BRITISH THOMSON-HOUSTON CO. Switches or circuit-breakers. (R. H. Read, U.S.)
13,853. BRITISH THOMSON-HOUSTON CO. Switches. (E. M. Hewlett and T. E. Button, U.S.)
13,854. SIEMENS BROS. & CO., L. MORAES, G. FERREIRA and R. WILKIE. Switches worked by electromagnets or solenoids.*
13,858. J. W. KIRK. Electric light carrier ring adjuster and ring.
13,868. H. BEAN and C. PORTILLO. Current-taking devices.
13,877. A. J. BOULT. Electric railways. (L. Negro, Italy.)

June 19, 1902.

13 882. C. THORNTON. Generation of power by gravity and momentum.
13,914. H. OPPENHEIMER. Telephone connections on the party-line system. (A.G. Mix and Genest, Germany.)
13,932. A. J. BOUNEVIALLE and A. C. BOUNEVIALLE. Electric signalling apparatus for locomotives.
13,933. BRITISH THOMSON-HOUSTON CO. Variable speed direct-current shunt motors. (C. P. Steinmetz, U.S.)
13,934. BRITISH THOMSON-HOUSTON CO. Electric current transformers for high-voltage circuits. (A. R. Everest, U.S.)
13,945. H. BEEMER. Germany. Arc lamps.*
13,950. A. M. PONTI. Eastleigh. Electromagnetic machine.
13,956. L. W. WINSHIP. Thermo-electric indicator. (A. Heinz et Cie., Belgium.)*
13,961. A. F. BERRY and BRITISH ELECTRIC TRANSFORMER MFG. CO. Measuring or indicating alternate currents.

June 20, 1902.

14,001. J. G. CHILDS. Electromagnetic brakes.
14,062. A. J. BOULT. Telephotographic or tele-autographic apparatus. (L. Sémat, Egypt.)

June 21, 1902.

14,109. I. A. TIMMIS and E. W. TIMMIS. Electromagnets.
14,129. W. FRIESE-GREENE. Dovercourt. Printing by electricity in colours.
14,133. H. BAKER and CASTNER-KELLNER ALKALI CO. Carbon electrodes with electric leads.
14,134. A. T. SMITH, H. BAKER and CASTNER-KELLNER ALKALI CO. Carbon electrodes.
14,135. H. BAKER, A. T. SMITH and CASTNER-KELLNER ALKALI CO. Electrolytic cells.
14,136. W. A. GORMAN and A. GRAHAM. Telephones for diving and like purposes.*
14 138. H. H. LAKE. Controlling electric motors. (General Electric Co., U.S.)
14,139. H. H. LAKE. Regulating electric currents. (General Electric Co., U.S.)
14,140. H. H. LAKE. Electrical indicators. (General Electric Co., U.S.)
14,141. H. H. LAKE. Electric switches and motor starting devices. (General Electric Co., U.S.)

June 23, 1902.

14,158. E. HOLDEN. Swindon. Brakes for electric cars.
14,194. L. G. NILSON and I. H. KUH. Electrical interrupters*
14,195. L. G. NILSON and I. H. KUH. Controllers for motors.*
14,196. L. G. NILSON and I. H. KUH. Driving mechanism for electric vehicles.*
14,201. A. FAYOL. Overhead trolley or collectors.
14,202. H. LEITNER and R. N. LUCAS. Self-regulating dynamos for train lighting.
14,203. L. G. NILSON and I. H. KUH. Electro-gasoline vehicles.*
14,205. H. C. BRASIER. Electric sparking devices for explosion engines. (Date applied for Feb. 11, 1902, date of application in France.)*
14,223. W. SCHUSTER and H. AST. Electromagnetic friction clutches.*

June 24, 1902.

14,254. J. MACDONALD. Glasgow. Generation of electricity.
14,270. E. W. SMITH. Generators of electric currents.
14,286. T. A HEARSON. Control of electric vehicles. (F. J. Sprague and E. R. Carichoff, U.S.)
14,293. H. H. LAKE. Control of speed of electric motors. (General Electric Co., U.S.)
14,294. H. H. LAKE. Regulating devices for dynamo-electric machines. (General Electric Co., U.S.)
14,295. H. H. LAKE. Electric protection devices. (General Electric Co., U.S.)
14,296. H. H. LAKE. Systems of electrical distribution. (General Electric Co., U.S.)

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each

1901.

4,863. ROSSETTER. Combined electromagnetic and carbon microphone.
9,959. BOHM. Incandescent lamp globes.
11,552. HUDSON. Lifeguard for electric cars.
12,089. SPAGNOLETTI. Automatic electrical signalling for railways.
12,094. TREMAIN. Electric cables.
12,121. PETCH. Fluid pressure machinery for pressing together copper segments and insulating strips of electric commutators and for compressing the discs of armatures.
14,511. MARSHALL and WOODS. Electric light apparatus for medical purposes.
15,679. VOELKER. Incandescent lamps.
17,320. CORBIN. Electrolytic manufacture of chlorates, &c. (Date applied for, March 25, 1901.)
19,748. LOUBERY and BAUDRY. Electricity meters.
25,433. HARDING. Speed-regulating device for electric carriers.

1902.

382. TRIESE. Galvanic cells.
1,136. GEBR. SIEMENS UND CO. and VIERTEL. Electrodes for arc lamps.
1,417. WYATT. Electric meter.
2,084. WILKINSON. Joints and joint-boxes for conductors.
2,816. ALLISON (Banks). Electric battery.
3,024. CRUVELLIER. Traction by the surface contact system.
3,533. CROOK. Winding and circuit closing devices for electric clocks.
4,372. KIP. Electric warp and weft controlling mechanisms.
5,104. SOC. G. ET P. DE MESTRAL. Arc lamps and electrodes. (Date applied for Sept. 4, 1901.)
5,592. WILLIAMS and EDWARDS. Electric self-registering target. (Date applied for, Aug. 20, 1901.)
6,481. SHOEMAKER. Wireless telegraph systems.
7,062. HÄLLER and NOISET. Overhead trolleys.
7,661. BETTS. Electrolytic refining and depositing of lead.
8,486. JUSTICE (Rowland Telegraphic Co.) Operating and controlling electric telegraphic and similar printing machines.
8,643. NALDER and NALDER BROS. AND THOMPSON. Damping the oscillations of shafts carrying hands of electric measuring instruments.
8,670. CARBONE. Arc lamps.
8,717. FAIRBURN-HART (General Electric Co.). Luminous gas electric lamps
8,784. LAKE (Thomas). Rail bonds for electric railways.
8,809. GHEGAN and GRISWOLD. Electric circuit controllers.
8,843. WIEDEMEYER. Disinfecting by electric light irradiation.

COMPANIES' MEETINGS AND REPORTS.

Liverpool Overhead Railway Co.

At the meeting on Tuesday the chairman (Sir Wm. B. Forwood) said that in gross revenue they had taken less than in the corresponding half of last year by £3,580, and had carried 356,000 fewer passengers, or about 7 per cent. decrease. The mileage was also slightly less, on account of Dingle station having been closed for some weeks. The expenditure showed a reduction for the half-year of £1,391. It was difficult to make any material reduction in expenditure, since theirs was a railway which was largely automatic, and which employed comparatively little manual labour. By adding £1,500 to renewal fund this fund now amounted to £22,300. They had had their permanent way reported on by an expert, who found no appreciable depreciation whatever in the line as compared with its condition 10 years ago. On their locomotive power they had effected a saving of £1,111, due mainly to cheaper coal. On repairs and renewals they had saved £90, and on traffic expenses £384. Rates and taxes continued to grow, and for the half-year showed an increase of £118. These rates and taxes represented about 1¼ per cent. on their capital, but the tramways which competed with their line entirely escaped that impost. Their gross earnings amounted to £37,938, and working expenses to £29,287. After paying debenture interest (£3,400) they had £5,300, which, with the balance from 1901 and £300 over-provided for the Dingle calamity gave £9,292. The 5 per cent. preference dividend absorbed £3,000, and £2,500 was required to pay 1 per cent. on the ordinary shares, leaving £3,792 to be carried forward. They had suffered much from the competition of the Corporation tramways in tapping the Overhead Railway traffic at several points. They had lost £700 through the closing of the Dingle station for repairs, and they had felt the slackness of trade at the docks and the diminution of holiday traffic through counter attractions. The amalgamation of so many steamship lines had also affected them, as when those lines were working independently there was a considerable amount of movement from one dock to another, and this had diminished by the concentration which had taken place. To provide improvements and to allow for an accelerated service, they had decided to try the effect of new up-to-date electrical equipment. Their new electric motors were to be iron-clad, and the guards' rooms would also be protected, so that it would be impossible for any such disaster as the Dingle fire to occur again. They hoped to have trains with the new equipment running by September. They were also reducing fares over parts of their lines. In reference to the negotiations with the Lancashire and Yorkshire Railway Co. as to the extension at Seaforth, he could not say the negotiations were quite ended. The directors had some hesitation in spending £30,000 to make that connection, but it would come sooner or later once the great suburban lines found themselves under the necessity of adopting electric traction.

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Schattner Electricity Meter Co. (Ltd.).

The annual general meeting was held on Tuesday, Mr. R. STEWART BAIN presiding.

The CHAIRMAN said: You will see from the trading and profit and loss account that there is a profit on the year's working of £1,261. 9s. 11d., compared with £1,149. 17s. 1d. at June, 1901, but while the present account is for 12 months, the account to June, 1901, was for 15 months, so that the increase is at the rate of about 12 per cent. per annum, and this in face of the keen competition which exists in the meter trade, which has had the effect of considerably reducing the prices received for our meters. It speaks well for the economy and efficiency exercised in manufacture that we have been able to make this profit when prices have been reduced by nearly 30 per cent. We have expended £106 in acquiring additional patents. This includes the cost of the new demand indicator which I referred to last year. We are doing a good business with this instrument, which is most efficient and inexpensive. Additions to our plant and machinery include new labour-saving tools and machines. We have not found it necessary to make the final call on our shares as we did not require the money. The general results, after providing for depreciation, is the profit £1,261. 9s. 11d., to which is added £347. 2s. 8d. brought forward, making £1,608. 12s. 7d., and we recommend that a further £100 be written off alteration to works, that a reserve account be opened with £500, that a dividend of 6 per cent. be paid, and the balance, £333. 12s. 7d. carried forward. I am glad to say the present position and prospects of the company are very hopeful. In addition to the demand indicator we have placed several new instruments on the market during the year, including an accumulator-charging meter, a new type standard meter and a new type prepayment meter. During the year our prepayment meter received the official approval of the Board of Trade, and is the only meter of this kind which has received this distinction. Electric prepayment meters have not yet come so much into use as gas prepayment meters, but signs are not wanting that they are making considerable progress in this direction. We received one order during the year for over 1,000 of our prepayment meters, and the orders for the current year show a very satisfactory increase compared with the corresponding period last year. I now move the adoption of the report and accounts.

Mr. REGINALD J. WALLIS-JONES seconded, and it was carried unanimously.

The retiring director (Mr. R. Stewart Bain) was re-elected, as were the retiring auditors, and a hearty vote of thanks to the chairman terminated the proceedings.

BAKER STREET AND WATERLOO RAILWAY CO.—At the meeting last week the chairman (Mr. T. J. Hare) said that during the half-year £66,000 had been expended on capital account. The transfer of the construction contracts to the Metropolitan District Electrical Traction Co. only took place on March 7, and during the current half-year the capital expenditure would be considerably higher. Satisfactory progress was being made with the works. Between Baker-street and Waterloo there was about 6 miles of single tunnel, and only about 1½ miles remained to be constructed. At the stations the lift shafts, staircase shafts, &c., were well forward. The Metropolitan District Electrical Traction Co. notified that, under the powers of their agreement they would supply the company with electric energy at a price to be agreed upon, or, failing agreement, to be settled by arbitration. The construction contracts and agreements had been transferred by the Traction Company to the Underground Electric Railways Co.

BLACKPOOL ELECTRIC TRAMWAYS (SOUTH), LTD.—A meeting of debenture stockholders was held on Thursday last. Mr. J. S. Harmrod Banner presided, and stated that the trustees had the whole of the money subscribed on debentures (some £150,000) safe in the bank, awaiting further action. The arrangements with the Electric Tramways Construction Co., who issued the prospectus, were not of a satisfactory character, and certain conditions had not been carried out. The trustees, therefore, proposed a scheme by which the construction of the electric tramway should be proceeded with and completed independently of the Construction Company. £30,000 had been separately provided for the purchase of the remaining interest of the old company, and the funds then available would be ample. Resolutions to carry on the new scheme were carried.

GREAT NORTHERN RAILWAY CO.—At the meeting on Friday, the chairman (Lord Allerton) said that of the £300,000 estimated expenditure in the current half-year, £60,000 was for work connected with the construction of the underground station and connecting line at Finsbury Park for the Great Northern and City Railway. No burden was thrown upon the revenue of the Great Northern, because interest upon the outlay would be borne by the Great Northern and City Co. Dealing with the traffic receipts, he said that there was a decrease in gross receipts from passengers in the West Riding of Yorks. district of about £9,000, of which £8,000 was directly traceable to stations where electric tramway competition existed in its severest form. He hoped that when the Great Northern and City and the Great Northern and Strand underground lines were finished the Great Northern Railway would have outlets for their suburban traffic which would be second to none in London.

GREAT WESTERN RAILWAY CO.—In the directors' report for the June half-year it is stated that, under the provisions of the Metropolitan Railway Act of 1902 the Hammersmith and City Railway, owned jointly by the Great Western and Metropolitan Companies, is to be adapted for electric traction, as is also that portion of the Great Western line between the Hammersmith and City Railway and the Metropolitan Railway at Bishop's-road, Paddington. The shareholders will be asked to authorise expenditure on this account to the extent of £825,000.

LONDON AND NORTH-WESTERN RAILWAY.—At the half-yearly meeting on Wednesday the chairman (Lord Stalbridge) said the directors were carefully watching and considering the question as to whether any economy could be effected by the adoption of electric traction, and at the proper time would tell the shareholders what they proposed to do with regard to the operation of any portion of their lines electrically. They thought it better, however, to wait until they were thoroughly prepared to make a statement on the subject. In their expenditure, fuel and light had increased by £14,000 odd, a great part of that expenditure being due to increased use of electric lighting for carriages, but economy was likely to result in the long run. Rates and taxes showed an increase in the year of £23,362.

LONDON AND SOUTH-WESTERN RAILWAY CO.—At the half-yearly meeting last week the chairman (the Hon. H. W. Campbell), referred with satisfaction to the decrease of expenditure in working the Waterloo and City Railway. As to the Metropolitan and Metropolitan District Co.'s proposals for the equipment for electric traction of those portions of the London and South-Western system over which those companies had running powers, the London and South-Western Co. were arranging to carry out that equipment themselves, retaining the right to use the equipment for electrical working themselves should they at any time decide to do so. They would watch the working of these branches very closely in order that at the proper time they might see how far it would be possible for them to adopt electrical working for the suburban traffic on the London and South-Western lines. Until they had secured their three lines into Waterloo it would be premature to attempt to adopt electric traction for their suburban traffic. The chairman paid a handsome tribute to the valuable services of the general manager (Mr. Owens), the secretary (Mr. Godfrey Knight) and the remainder of the company's large staff.

MATHER AND PLATT (LTD.)—The report for the year ended June 30 states that the net profit, after charging depreciation and directors' remuneration, is £81,049. 16s. 4d., to which is added from last year (£10,295. 1s. 5d.), making £91,345. 1s. 5d. After payment of the 5 per cent. preference dividend, the directors recommend a dividend of 7 per cent. on the ordinary, the transfer of £30,000 to reserve (making it £110,000), leaving £17,092 to be carried forward. The new works at Newton Heath are in full operation.

MIDLAND RAILWAY CO.—At the meeting on Friday the chairman (Sir Ernest Paget), referring to the subject of electric traction, said that at present the directors did not intend to electrify their system, either in the whole or in part. So far as the Midland was concerned, there was really no part of the railway which would lend itself particularly to that mode of traction. Although they had no present intention of doing anything in that direction, he believed engineers generally considered that electricity would in the future be the mode of traction. The change, however, would be gradual. The company owned 2,700 steam locomotives, and those had cost between five and six millions sterling, so they could not possibly contemplate the scrapping of such a large number of locomotives all at once. Three or four hundred engines were sent into the works every year for repairs or renewals, and he believed the policy would be to renew those as electric motors, and adapt a certain portion of the system for their use. That process would go on until the whole line was "electrified," but it must take some time. There was one portion of the line upon which electric traction might be used—that portion of the Cheshire Lines from Manchester to Liverpool. The Cheshire Lines belonged to the Great Northern, the Midland and the Great Central Companies, and he thought it would be a very useful object lesson to those companies to "electrify" that portion, and watch results before dealing with their own systems.

NORTH-EASTERN RAILWAY CO.—In the directors' report for the June half-year it is stated that passenger traffic revenue in the neighbourhood of Newcastle has suffered from the competition of tramways, and the directors consider the best method of meeting this competition is to increase the train service on the lines affected. They are advised this can best be done by adopting electric traction, and have decided to seek tenders for the electrical equipment of the lines extending from Newcastle Central to New Bridge-street, viâ Tynemouth, including the Riverside branch. (The official announcement of these tenders appeared in *The Electrician* for Aug. 1.)

NORTH METROPOLITAN TRAMWAYS CO.—At the meeting on Tuesday the chairman (Mr. George Richardson) said that it was the worst report since the formation of the company, inasmuch as they were unable to declare a dividend for the half-year. The bill for the electrification of the company's lines in Middlesex had passed both Houses of Parliament, and by arrangement with the Middlesex County Council and the Metropolitan Electric Tramways Co., it was proposed to apply to the Board of Trade for consent to the sale of those lines to the latter company. If the sale were carried out, the shareholders of the North Metropolitan Co. would receive the present value of the unexpired term of 23 years for which those lines were held, and in view of the approaching termination of the lease of the London lines, and of possible difficulties with the London County Council, the directors considered it prudent to take advantage of the present offer and to obtain now the full value of their Middlesex tramways rather than to continue to work them. The directors of the Electric Tramways Co. also considered it advisable, in view of the purchasing of the Middlesex lines, that they should acquire a controlling interest in the North Metropolitan Co., and they had purchased nearly 78,000 shares out of a total of 110,923. A provisional agreement between the North Metropolitan Co., the Middlesex County Council and the Metropolitan Electric

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Tramways Co. was agreed to, and the directors were authorised to apply to the Board of Trade for consent to the proposed sale of the Middlesex portion of the company's tramways.

PAISLEY AND DISTRICT TRAMWAYS CO.—At an extraordinary meeting on Monday it was resolved to ascertain definitely whether the Council are to take over the tramway undertaking, the price to be such amount as would enable the shareholders to receive 20s. in the £1, or failing that, by compulsory purchase of that portion within the burgh; and failing both, whether the town would grant a 32 years' lease, so that the company may convert the lines to electric traction, taking the supply of current from the Corporation on terms to be agreed upon.

SOUTH METROPOLITAN GAS CO.—The chairman (Sir George Livesey), referring to the subject of municipal trading at the meeting of the company on Wednesday, said the company had succeeded in inducing Parliament to impose an important condition on two boroughs in their district owning electricity works, which would, it was hoped, form an important precedent. He believed the present rage for municipal trading was likely to produce disaster. Certain people had got themselves elected on various local authorities, and the result had been the spending of the ratepayers' money with most lavish hand by embarking upon all sorts of trading ventures, of which they knew nothing, and of which they had made a great mess. One of these was electric lighting. Newington had expended £80,000 on electric lighting, and had made a serious loss on its trading of £3,000 to £4,000 for the past year. Seeing that Bermondsey and Woolwich were applying for provisional orders, the company opposed, and submitted that the orders should be granted subject to electric lighting paying its way. The Board of Trade did not grant the company's request, but the directors petitioned the House of Lords Committee, who gave them all they asked. The effect of that decision was that rates were not to be used to make up losses on the supply of electric current. After the first year an estimate was to be made every year of the probable total expenditure, and such a charge was to be made for "the supply of energy, so that, as far as was reasonably practicable, the revenue for the year shall not be less than the expenditure of that year." That was rather a far-reaching enactment, and he thought it would have some effect in stopping the rage for municipal trading.

TAFF VALE RAILWAY CO.—At the meeting on Tuesday the chairman (Mr. R. L. G. Vassall) referred to the threatened competition of electric tramways, and said that the directors proposed to watch and see what was being done or would be done by other companies for the introduction of electric traction, and being guided by the experience thus gained, decide whether they would or not electrify any part of their lines.

NEW COMPANIES, STATUTORY RETURNS, &c.

PETERBOROUGH ELECTRIC TRACTION CO. (LTD.)—Reg. Aug. 5, capital £60,000 in £5 shares, to carry on business of electric and general engineers, electricians, manufacturers of and dealers in railway, tramway, electric, and other apparatus, users, suppliers of electricity, &c. The subscribers are Lord Vaux of Harrowden, E. Garcke, W. J. Greer, T. E. A. Baker, B. Kingsford, F. C. Cocking and C. H. Godward. Registered office, Donington House, Norfolk-street, W.C.

PETER PILKINGTON (LTD.)—Reg. Aug. 8, capital £30,000 in £10 shares, to acquire the business now carried on by Mr. W. R. Pilkington, at Accrington, and to carry on the business of manufacturers of power hammers, forges and forging machinery, mechanical and electrical engineers, &c.

WIRELESS CONTROL SYNDICATE (LTD.)—Reg. Aug. 7, capital £20,000 in £1 shares, to adopt an agreement with R. Steele, and to carry on business as electricians, suppliers of electricity, manufacturers and dealers in electrical appliances and apparatus used in the electric control of mechanical operations at a distance without wires or other tangible connections, &c.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—According to return to July 17 the capital is £200,000 in 20,000 ordinary, 100 founders' and 19,900 preference shares of £5 each, all of which have been taken up. £1 has been called up on the ordinary and £5 on the founders' and preference shares, and £120,000 has been received. Mortgages and charges nil.

EVERED & CO. (LTD.)—The return to April 10 gives the capital as £200,000 in 20,000 shares of £10 each, all of which have been taken up. £10 has been called up on 3,504 and £7 on 6,380 shares. £79,700 has been received. £91,044 considered as paid, being £10 per share on 6,744 and £7 per share on 3,372. Mortgages and charges £50,000.

W. T. HENLEY'S TELEGRAPH CO. (LTD).—The return to July 4 gives the capital as £400,000 in 40,000 preference and 40,000 ordinary shares of £5 each, of which 35,000 preference and 35,000 ordinary have been taken up. £5 per share has been called up on 35,000 preference and 29,000 ordinary shares, and £320,000 has been received. £30,000 considered as paid on 6,000 ordinary shares. Mortgages and charges £48,050.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The return to July 15 gives the capital as £500,000 in 60,000 ordinary and 40,000 preference shares of £5 each, of which 58,000 ordinary and 40,000 preference have been taken up. £5 has been called up on 42,000 ordinary and 40,000 preference and £410,000 has been received. £80,000 considered as paid on 16,000 ordinary shares. Mortgages and charges £179,947.

WEST AFRICAN TELEGRAPH CO. (LTD.)—In the return to July 17 the capital is £400,000 in 40,000 shares of £10 each, of which 23,109 have been taken up. £231,090 has been received. Mortgages and charges £139,300.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 3/16d. per oz. (Aug. 14). Consols (2¾ per cent.) 95 3/16—95 5/16 for money, 95 5/16—95 7/16 for account; 2½ per cent. 95½—95¾ (Aug. 14). Consols Pay day, Sept. 1; Stocks and Shares Continuation Day, Aug. 26; Ticket Day, Aug. 27; Pay Day, Aug. 28; Mining Share Carry-over Day, Aug 25.

CITY AND SURREY ELECTRIC RAILWAY CO.—It is reported that, at a meeting of the shareholders of this company on Friday last, it was unanimously resolved to amalgamate with the National Electric Traction Co. The following shareholders were (it is stated) appointed to act on the board of the National Electric Traction Co. to represent the City and Surrey Co.:—Messrs. A. Howell, W. T. Holmes, and S. Peter Braun.

FERRANTI LIMITED.—The transfer books of the 6 per cent. cumulative preference shares will be closed from 16th to 30th inst. inclusive, preparatory to payment of dividend for the period to June 30.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The 5 per cent. preference dividend and an interim dividend at the rate of 8 per cent. per annum has been declared on the ordinary shares of the company.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Aug. 2	1,320	+ 333	9	10,335	+ 2,498
Ayr Corporation	„ 9	493	...	12	4,764	...
*Birmingham Tramways.	„ 9	5.214	+ 39	5	25,176	+ 642
*Blackburn Corporation..	„ 8	819	+ 121	20	16,403	+ 3,150
Blackpool Corporation...	„ 7	2,103	- 115	19	17,793	- 1,048
Blackpool and Fleetwood	„ 9	1,775	- 368	6	6,517	- 1,167
Bolton Corporation	„ 10	1,644	+ 186	19	30,948	+ 1,973
Bradford Corporation ...	...	...	...	...	...	...
Brighton Corporation ...	„ 10	1,487	...	37	25,917	...
Brisbane Tramways.....	June 25	2,232	+ 415	25	59,277	+ 5,365
*Bristol Trams & Carriage	Aug. 8	6,283	+2,910	5	26,265	+ 4,257
*Buenos Ayres & Belgrano	July 13	2,823	+ 79	2	5,759	+ 431
Burnley Corporation ...	Aug. 9	704	+ 335	‡19	13,457	+ 4,906
Calcutta Tramways Co...	„ 10	R26.555	+R4,729	6	R147,085	+R24,436
Cardiff Corporation	„ 9	2,125	...	19	25,106	...
Carlisle Tramways Co....	...	...	...	...	...	...
Central London Railway	„ 9	6,859	+1,034	6	39,431	+ 3,529
City & South London Ry.	„ 10	2,686	+ 905	6	16,274	+ 5,225
Cork Elec. Tramways Co.	...	...	...	...	...	...
Devonport & Dist. Trams	„ 1	494	+ 41	30½	12,790	+ 444
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	„ 9	354	- 19	19	4,473	- 135
Dublin & Lucan Railway	„ 10	184	+ 13	6	805	- 87
Dublin Southern Dist....	„ 8	1,355	- 6	†6	6,444	- 705
Dublin United	„ 8	4,306	- 121	†6	22,878	
Dudley—Stourbridge ...	„ 1	793	+ 63	30½	21,894	+ 3,050
*Dundee Corporation ...	„ 6	790	+ 120	...	...	...
East Ham Council	„ 11	639	+ 29	7	3,792	+ 469
Gateshead & Dist. Trams	„ 1	854	+ 215	30½	21,643	+ 3,273
Glasgow Corporation ...	„ 9	12,826	+ 784	10	117,598	- 1,212
Greenock & Port Glasgow	„ 1	574	+ 378	30½	14,641	+ 8,697
Hartlepool Tramways ..	„ 1	330	+ 47	30½	7,410	+ 827
Hull Corporation	„ 9	2,407	+ 551	19	33,525	+ 1,333
Isle of Thanet Co.	„ 9	2,050	- 40	6	8,020	- 464
Kidderminster & Dist....	„ 1	145	+ 6	30½	3,586	+ 34
Leeds Corporation	„ 9	6,417	+1,004	20	103,528	+17,150
*Liverpool Corporation...	„ 2	10,750	+ 943	31	295,235	+24,731
Liverpool Overhead Rly.	„ 10	1,797	- 120	‡6	9,864	- 703
Manchester Corporation	„ 9	5,916	+3,539	60	163,237	...
Merthyr.....	„ 1	188	- 63	30½	6,137	- 883
Middleton	„ 1	299	...	18½	5,781	...
Newcastle-on-Tyne Corp	„ 9	2,911	...	...	...	...
Oldham, Ashton & Hyde.	„ 1	554	+ 41	30½	15,693	+ 599
Perth (W.A.) Elec. Trams	„ 8	1,002	+ 202	¶31	33,507	+ 5,383
Poole & Dist.....	„ 1	310	- 21	30½	7,257	- 121
*Portsmouth Corporation	„ 9	2,771	+1,412	...	...	...
Potteries	„ 1	1,522	+ 88	30½	44,020	+ 1,632
Salford Corporation ...	„ 11	2,692	+ 901	19	49,478	...
*Sheffield Corporation ...	„ 10	4,843	+ 842	6	26,025	+ 3,196
Southampton Corp.	„ 7	1,279	+ 16	...	...	...
Southend Corporation...	...	...	...	...	...	...
Southport Tramways ...	„ 1	338	+ 110	30½	7,157	+ 2,486
*S. Staffordshire Trams...	„ 1	732	- 71	30½	23,439	+ 573
Sunderland Corporation.	...	...	..	...	...	...
Swansea Trams.....	„ 1	487	- 55	30½	13,988	+ 1,343
Taunton Trams.....	„ 1	69	...	30½	1,864	...
Tynemouth & Dist.	„ 1	448	+ 40	30½	8,129	+ 704
Weston-super-Mare	July 30	236	...	12½	2,432	...
Wigan Corporation	„ 31	257	+ 74	18	4,237	+ 1,820
Wolverhampton District	Aug. 1	305	+ 236	30½	4,921	+ 3,285

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 5 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi. Dend.	Name.	Previous Week's Price, Aug. 6.		Price Wednesday, Aug. 13.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Aug. 13. Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Hl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾	¾	¾	¾	...	...	...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103	106	103	106	4 6 0	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	5 12 0	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10⅝	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101	104	101	104	4 6 7	...	...	...
20,000	5	4/6	Brompton & Kensington Elec. Supply Ord	9½	9¾	9½	9⅝	4 2 1	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9½	9⅝	9½	9⅝	3 11 10	March and September	...	...
30,000	5	3/6	Calcutta Elec. Supply Ordinary	8	9	7⅞	8⅛	3 10 7	...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	107	106	108	3 14 8	...	...	...
50,000	5	6/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	10	9	10	5 0 0	February and August	9 1/16	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	5⅝	5⅝	6	3 15 0	,, ,,	5⅝	5 1/16
40,000	5	...	Do. City Undertaking 4½% Cum. Pref.	...		4½	5	...	...	...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	105¾	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5¼	5⅜	5¼	5⅜	2 12 2	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8¾	9¼	8¾	9¼	5 5 8	February and August	9⅜	9 1/16
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	11½	12½	12	13	4 12 4	January and July	12¼	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December	...	...
£300,000	Stock	4½%	Do, 4½% 2nd Deb. Stock Certs. (all pd.)	101	104	101	104	4 6 7	...	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½	9¼	8½	9⅜	4 4 3	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12	12⅝	12	12½	4 16 0	March and September	12½	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	109	112	109	112	4 1 1	...	110⅝	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5⅝	6¼	5⅝	6¼	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10	11	10	11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6¼	6⅝	6¼	6⅝	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105	108	105	108	3 15 0	...	...	...
£111,000	5	...	London Electric Supply Ordinary	1½	1⅝	1½	1⅝	...	...	1 1/16	1 1/16
49,840	5	3/0	Do. 6 per Cent. Preference	4¼	4⅜	4¼	4⅜	6 6 4	...	...	...
£150,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	94	99	95	100	4 0 5	Mar., June, Sept., Dec.	93½	96½
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15½	16½	15½	16½	3 18 9	April and October	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	108	112	108	112	4 0 5	June and December	110½	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	98	101	99	102	3 9 2	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary	13½	14½	13½	14½	4 2 9	March	14¼	...
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	97	100	97	100	4 0 0	...	...	...
300,000	1	...	Rand Electric	¾	⅞	¾	⅞	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 7 0	April and October	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	15⅝	15¼
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9¼	8½	9½	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97	100	97	100	3 10 0	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅞	2½	1⅞	2½	..	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2½	3	2⅛	3	..	...	...	...
110,000	5	5/6	Westminster Electric Supply Ordinary	10½	11½	10½	11½	4 15 8	March and September	11⅝	11
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5⅜	6⅛	5⅜	6⅛	4 0 0	...	6	5 13/16
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (to 260,007)	4½	4⅝	4⅜	4⅝	4 11 5	April and October	4 5/16	4 5/16
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9	11	9	11	2 14 7	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	8½	9¼	8½	9⅛	5 5 3	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	93	98	93	98	4 11 9	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½	14½	13½	14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3⅜	4¼	3⅜	4¼	...	...	3 1/16	...
75,000	5	2/6	Do. 5% Cum. Pref.	4½	5	4½	5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	102	105	102	105	4 5 9	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd	21	22	20½	21½	3 14 2	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106	108	106	108	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7½	7	7½	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9¼	10	9½	10	5 0 0	May and November	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	103⅝	105⅝	103⅝	105⅝	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12⅛	13⅛	12½	13½	6 13 4	...	13½	12 7/16
100,000	10	6/0	Do. 6% Cum. Pref.	12½	13	12½	13	4 12 4	February and August	12 13/16	12⅝
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	125¾	...
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅜	1⅞	1⅜	1⅞	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4½	5½	4½	5⅛	5 14 3	...	...	...
27,500	5	10/0	Do. "B"	5	5⅛	5	5⅛	5 9 1	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103	106	103	106	4 14 9	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	95	98	95	98	5 2 0	...	...	...
70,000	10	6/0	Calcutta Tramways	7	7⅛	7	7⅛	4 0 0	...	7 1/16	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	109	107	109	4 3 1	...	107¼	...
£80,000	1	1/2½	Cape Electric Tramways Shares	2⅛	2⅜	2⅛	2⅛	6 4 6	...	2 1/16	2 1/16
£1,860,014	Stock	4%	Central London Ordinary Stock	105	108	105	108	3 14 0	June and December	107	106
£494,093	Stock	4%	Do. 4% Preferred Stock	106	109	106	109	3 13 4	...	...	...
£494,993	Stock	4%	Do. Deferred Stock	103	106	103	106	3 15 6	...	1 4½	...
£898,201	100	4%	Do. 4% Deb.	115	118	115	118	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5	5⅛	5	5⅛	4 10 9	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	04	101	104	3 16 11	...	...	...
£1,330,000	Stock	3½%	City and South London Railway Con. Ordinary	71	73	71	73	3 11 11	February and August	72¼	71
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	...		...		...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	133	127	130	3 7 0	,, ,,	...	...
£200,000	Stock	6%	Do. (1896)	127	30	126	129	3 17 6	...	128½	...
£150,000	Stock	...	Do. (1901)	121	125	121	125	4 0 0	...	124½	...
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	...	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11½	12½	11½	12½	4 8 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½	15½	14½	15½	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½	4⅞	4½	4⅞	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	101	99	102	4 18 0	...	...	...
78,500	10	8/0	Great Northern and City Railwy Pref, Ord. (4%)	8	9	8	9	3 6 8	...	8½	...
30,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	13⅝	13½	13⅝	4 7 3½	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	108	110	108	110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4¼	5	4½	5	5 0 0	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4½	4⅝	4½	4⅝	3 3 2	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	10	10½	10	10½	4 15 3	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	99	101	99	1 1	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	10⅜	11½	1 ⅜	11½	4 8 11	...	10 1/16	10⅛
30,999	10	2/3	Do. (£7, 10s. paid)	8	8½	8	8½	4 8 6	...	...	...
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	107	109	107	109	3 13 3	...	...	...
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	81	83	81	83	...	...	81⅜	...
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112	117	112	117	4 5 7	...	...	...
$850,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908)	106	108	106	108	4 14 5	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	105	107	105	107	4 4 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½	4½	3½	4½	6 13 4	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93	98	93	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100	103	100	103	4 17 5	...	102	...
13,334	10	8/0	Potteries Electric Traction Ordinary	8½	9½	8½	9½	4 4 3	...	...	...
10,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9½	10½	10	11	4 10 11	February and August	10 1/16	...
£420,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108	111	108	111	4 1 10	...	...	...
150,000	1	...	South Lancashire Electric Traction & Power Ord.	...		...		...	...	...	...
51,132	1	...	Do. 6% Preference (14/0 paid)	...		...		...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...		...		...	,, ,,	...	...
100,000	Stock	...	Do. 4½% Debenture Stock (70% paid)	...		...		...	January and July	...	...
£140,200	Stock	8%	Waterloo and City Ordinary	93	95	93	95	8 8 0	June and December	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug 6.	Price Wednesday, Aug. 13.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 13. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)...	98 102	98 102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph.....	2⅜ 4⅛	3⅜ 4⅛	...	June and December ..	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70 80	70 80	...		89½	...
£758,840	Stock	15/0	Anglo-American	45 48	45 48	6 1 7	Feb., May, Aug., Nov.	46	...
£3,105,580	Stock	30/0	Do. Preferred.....	89 91	89 91	6 6 4	" "	90½	90
£3,105,580	Stock	2/0	Do. Deferred	6⅜ 7	6⅜ 7⅛	1 7 7	" "	7⅛	...
$18,333,300	$100	$1⅜	Commercial Cable Capital Stock.....	155 165	155 165	4 17 0	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock.....	95 97	95 97	4 2 6	" "	96	...
16,000	10	4/0	Cuba Submarine Ordinary	5 6	5 6	6 13 4	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12⅜ 13⅜	12⅜ 13⅜	7 8 2	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅜ 3⅛	2⅜ 3⅛	5 14 4	April and October.....	...	
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7⅜ 8⅛	7⅜ 8⅛	5 17 8	" "	...	...
£80,000	50	4½	Do. 4½ per Cent. Debentures	99⅞ 103⅞	99⅞ 103⅞	4 7 8	January and July	...	...
60,710	20	4/0	Direct United States Cable	10 11	10 11	5 18 2	Jan., Apr., July, Oct.	10⅛	...
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos.	99 102	99 102	4 8 3	June and December ...	100	99½
£4,000,000	Stock	65/0	Eastern Ordinary ... xd & bonus ..[to 1,200) (red.)..	117 127	117 127	5 10 3	Jan , Apr., July, Oct.	120½	118
£1,955,555	Stock	17/6	Do. 3½ per Cent. Preference Stock	87 90	87 90	3 17 8	" "	89	87½
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108 112	108 112	3 12 2	May and November ...	108	...
300,000	10	2/6	Eastern Extension	11½ 12½	11½ 12½	5 12 0	Jan., Apr., July, Oct.	11⅝	11⅜
£320,000	Stock	4½	Do. 4 per Cent. Debenture Stock	107 112	107 112	3 11 4	February and August	...	...
£300,000	100	4½	*Eastern and S. African 4½ Mort. Deb., 1909	98 101	93 101	3 19 3	February and August	...	...
£200,000	25	4½	Do. 4 per Cent. Mauritius Sub. Debs.(red.)...	100⅞ 103⅞	100⅞ 103⅞	3 18 3	May and November ...	...	...
150,000	10	5/0	Great Northern of Copenhagen	25 27	25 27	5 11 1	January and July	26⅜	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (with Nos	99 102	99 102	4 8 1	June and December ...	...	...
17,000	25	37/6	Indo-European.....[1 to 1,200) (red.	38 42	38 42	5 19 1	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 .	101 105	102 106	5 16 7	March and September	...	...
£100,000	100	4½	Pacific & European Tel. 4% Guar. Debs. (red.)	99 102	99 102	3 18 5	June and December...	99	...
15,609	10	...	*West African Telegraph Shares	3⅜ 4⅛	3⅜ 4⅛	...	...	...	...
£189,800	100	5%	Do. 5% Debentures (red.)	100 103	...	...	March and September	...	...
80,008	2½	...	West Coast of America.....	⅛ ⅜	⅛ ⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97 100	97 100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	¼ ½	¼ ½	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Pref.	4⅜ 5⅜	4⅜ 5⅜	11 8 6	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3 4	3 4	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99 102	99 102	4 18 0	January and July	...	...
207,920	10	3/0	Western Telegraph (late Brazil'n Submarine)	11⅛ 12⅛	11⅛ 12⅛	5 16 4	Mar., June, Oct., Dec.	...	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1908)	101 104	101 104	4 16 2	June and December...	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)...	97 100	97 100	4 0 2	...	...	...
			TELEPHONES.						
44,000	£5	5/0	Chili Telephone (fully paid)	3⅜ 4⅛	3⅜ 4	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	2/0 2/3	2/6 2/9	10 18 2	April and October.....	...	...
72,690	1	2½%	Monte Video Telephone Ordinary	⅜ ½	⅜ ½	5 0 0	November	...	...
86,492	1	1%	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock	95 99	95 99	6 1 3	...	97⅛	96⅛
200,000	5	0/1½	Do. Preferred Shares (£3. 10s. paid)	4⅜ 4⅞	4⅜ 4⅞	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	55 60	56 60	7 10 0	...	57⅜	57⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12 14	12 14	4 5 9	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ..	11 13	11 13	5 12 4	" "	...	...
250,000	5	2 6	Do. 5 per Cent. Non-Cumulative 3rd Pref ..	4⅞ 5⅛	4⅞ 5⅛	4 17 6	" "	6⅛	4⅛
£3,000,000	Stock	3%	Do. Debenture Stock 3½ per Cent. (red.	95 98	95 98	3 11 5	June and December ...	97⅝	97
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102 106	102 106	3 15 6	...	102½	...
171,504	1	0/8½	Oriental	1⅛ 1⅛	1⅛ 1⅛	5 12 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4⅜ 5⅜	4⅜ 5⅜	6 13 4	July	7	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜ 5	4⅜ 5	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) ...	101 104	01 104	4 16 2	June and December ...	...	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.....	⅛ ¼	⅛ ¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛ ¼	⅛ ¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	¼ ⅜	¼ ⅜	12 0 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7½ 7⅝	7½ 7⅝	6 9 0	July and February ...	...	...
80,000	5	3/0	Do. 6 per Cent. Preference	5⅜ 5⅝	5⅜ 5⅝	5 4 4	January and July	5⅝	...
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	101 104	101 104	4 6 1	...	...	...
200,000	...	3/0	British Westinghouse 6% Preference.....	5⅝ 6⅛	5⅞ 6⅛	4 18 0	...	6⅛	5⅛
£500,000	Stock	...	Do. 4 per cent. Mortgage Deb. Stock	... ...	... ...	...	...	101	101
105,731	...	...	Brush Electrical Engineering	1⅛ 1⅜	1⅛ 1⅜	...	March	...	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅛ 2	1⅛ 2	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	102 105	102 105	4 7 5	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	93 98	93 98	4 11 6	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15⅛ 16⅛	15⅛ 16⅛	4 10 11	" "	16⅛	...
40,000	5	4/0	Do. 5 per Cent. Cumulative Preference..	5⅛ 6	5⅛ 6	5 0 0	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb.(red.).....	00 113	00 113	3 19 8	November and May ...	...	...
450,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid).....	1 1⅛	1 1⅛	4 16 0	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	94 99	94 99	4 11 0	...	...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	⅜ 1	⅜ 1	9 2 0	March	...	...
85,000	3	1.9⅜	Crompton and Co. (Nos. 1 to 54,000)	2⅜ 3⅛	2⅜ 3⅛	6 19 0	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb.(red.)..	103% 106%	101% 06%	4 14 4	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid) ..	⅜ ⅝	⅜ ⅝		February and August	...	...
17,139	5	...	Do. (£5 paid).....	1⅜ 2⅜	1⅜ 2⅜		" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb.Stock(red.) ..	74 78	74 78	5 3 0	June and December...	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock ..	78 83	78 83	5 2 10	...	...	...
150,000	5	4/0	Edmundson's Electricity Corporation Ord.....	6⅛ 6⅜	6⅛ 6⅜	5 3 3	Half-yearly	6⅜	...
30,000	5	3/0	Do. 6% Cumulative Preference	6 6⅛	6 6⅛	4 12 4	...	6⅛	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	106 109	106 109	4 2 8	...	106⅜	...
113,100	2	1/3½	Electric Construction Co.	1⅜ 2	1⅜ 2⅛	5 6 8	January and July	...	...
31,320	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅛ 3	2⅛ 3	4 13 4	July	...	...
£152,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	97 100	93 10	3 19 6	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	⅜ 1	⅜ 1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	⅜ 1⅛	⅜ 1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	9⅜ 10⅛	9⅜ 10⅛	4 17 7	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	99 102	99 102	3 19 5	...	...	...
35,000	5	5/0	Henley's Telegraph Works Ordinary	16 17	16 17	4 8 3	February and August	16⅛	...
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛ 5⅜	5⅛ 5⅜	3 18 3	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb.Stock(red.) ..	111 115	111 115	3 18 3	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	4 13 0	" "	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 18 5	March and September	170½	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½ 15½	14½ 15½	6 9 0	July	...	...
37,350	12	12/0	Telegraph Construction and Maintnce.	36 39	37 40	5 19 10	March and July	33½	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	... ...	... ...	5 14 3	...	...	...
20,000	5	3/6	Do. 5 per Cent. Cumulative Preference	... ...	... ...	4 8 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	... ...	... ...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.....	... ...	... ...	...	" "	...	...
			FINANCIAL, INVESTMENT, &c.						
19,000	5	3/0	Electric and General Investment 6% Cum. Pref. ...	5⅛ 5⅜	5⅛ 5⅜	5 9 1	...	5⅛	...
180,227	10	2/6	Globe Telegraph and Trust	9 10	9 10	5 5 0	Jan., Apr., July, Oct.	9⅛	9⅛
180,042	10	3/0	Do. 6 per Cent. Preference.....	12⅜ 13⅜	12⅜ 13⅜	4 8 11	" "	13⅛	13
11,220	8	4/0	Reuter's.....	6⅜ 7⅜	6⅜ 7⅜	5 6 8	April and October.....	...	...
3,303	£100 Cert	6%	Submarine Cables Trust	110 120	110 120	5 0 0	"	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption

† The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

ON another page will be found a short account of the electrical illumination of the Fleet on the Solent last week. No plain recital of what was seen, and not even the fine word-painting and picturesque articles of our daily contemporaries, could do justice to this elaborate display and describe adequately the magnificent splendour of the spectacle. The British electrical engineer has a two-fold reason to be proud; for only Britain's fleet could have mustered in such strength, and only electricity could have completed the splendid and impressive picture which fitly concluded the celebration of our King's coronation.

IT is with extreme regret that we announce the probable postponement of the trial of electrical vehicles, promoted by the Automobile Club, owing to the lack of entries. It was proposed to give exhibitions of hill-climbing speed, electrical and commercial efficiency and recuperation, in addition to which runs to Brighton, Esher, Windsor and Ascot were to have been indulged in during the week commencing on Monday next. Up to yesterday at noon only two entries had been received, and these were, moreover, both from one firm—viz., the British Electromobile Co. The trials were originally fixed for some date previous to that mentioned but had to be postponed for a similar reason, and now, after waiting a considerable time, no additional competitors have come forward.

THIS is not only disappointing, but it is a serious blow to the electric vehicle industry, in that it is tantamount to an admission of either lack of enterprise on the part of car builders or inability to provide a vehicle capable of performing the requisite feats. It is hopeless for manufacturers of these cars to attempt competition with makers of cars propelled by other means if they deliberately allow such an opportunity as this to escape them, particularly at a period when so much is being said in their favour. We cannot imagine that an electric vehicle capable of running from London to Windsor and back (the most onerous requirement of the programme) does not exist, and yet we only find one firm willing to attempt this. The Automobile Club numbers amongst its members many of the most prominent men in England and the Continent, who practically keep the motor-vehicle industry afloat. Notwithstanding this, our manufacturers of electric motor cars refuse to come forward in response to an invitation to demonstrate the suitability of electricity as a means of motor-car propulsion at the very moment when electrical engineers were hoping that the manufacture of electric vehicles would form an important branch of the industry.

THE annual report of the POSTMASTER-GENERAL for the year ended March 31, 1902, just issued, will be read with mixed feelings, so far as the telegraphic section of it is concerned. On the one hand, extensions and improvements in both telegraph and telephone services betoken greater public facilities and greater protection against interruptions, which are sure to be highly appreciated. On the other hand, the constantly growing expenditure which these improvements have entailed cannot but be regarded with considerable misgivings. As usual, the traffic has greatly increased, and the receipts proportionately so. But the expenditure, which has gone on increasing disproportionately for some years past, assumes an unusually high figure in the present report. Some part of this is accounted for under the heading of wages; some part to breakdowns, one of which last December alone cost £80,000 to repair. To safeguard against such losses in future, or at all events to provide protected alternative routes so that revenue shall not suffer, a vast outlay has been incurred in laying down underground wires on the great main

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routes between London and the North, and between some of the principal provincial towns. The London–Birmingham line, now completed, has cost £165,000, while the contemplated extension northwards is estimated as involving an expenditure of £700,000. A system of coast communications for life-saving purposes is now fairly completed, connecting all coastguard stations and shore lighthouses with the main lines at a cost of £70,000. Particulars relating to telephone extensions will be found in another part of this issue; but apart from these, capital for which has been specially provided by Parliament, it will be seen that an expenditure has to be borne by the telegraph far in excess of the normal growth of its revenue. Putting one against the other for the past financial year the net deficit works out at £651,806, or £314,165 more than last year. And if to this be added the interest on original capital—which ought to be paid but never is—the deficit amounts to little short of a million!

THOSE who endeavour, for their own ends, to prove that electric lighting is dangerous, are too apt to go to America for statistics, so that a word of caution is not out of place. In a recent report of the Electrical Bureau of the National Board of Fire Underwriters, quoted by an American contemporary, it is shown that a $65,000 loss, reported as the result of a fire caused by electricity, was found to have been incurred through the spontaneous combustion of some oiled rags. Again, a loss of $165,000 occurred in the celluloid room of a factory, and was attributed to the use of electricity. This was afterwards found to have been caused by overheating the celluloid on a softening press; and, to add insult to injury, a $4,000 loss, laid at the door of the long-suffering electrical engineer, was found to have been due to the overturning of a candle in a store-room. Some fires which took place, however, were actually traced to the electrical installations, but in all cases they would have been prevented if proper care and reasonable precautions had been taken. Thus, in one instance an open fuse was employed to protect a motor in a pattern shop; in another, a towel had been thrown over an incandescent lamp in a hotel chambermaid's closet and left there until it caught fire, and so on. It is impossible to guard against every form of foolhardiness and carelessness, but, without a doubt, no fire can arise through a properly fitted electrical installation without some outside contributory fault or negligence, and electric lighting remains, as it has always been, by far the safest mode of illumination.

WE have received from Mr. A. R. BENNETT a long letter with regard to a report made by Sir W. H. PREECE to the Telephone Committee of the Bristol Corporation. This report, which is still before the Committee, and has not been published, has come into Mr. BENNETT'S hands notwithstanding. It contains, Mr. BENNETT alleges, certain inaccurate statements—chiefly in the form of figures—and Mr. BENNETT can evidently correct these by writing to the Committee directly. He has shown us a copy of the report in question, and we fail to see that the inaccuracies in it are sufficient ground for the tone of his letter. Mr. BENNETT assures us that he has always lived in the belief that direct references to each other's work should be avoided by professional men unless such references can be made courteous and complimentary, and we have, therefore, less hesitation in withholding his letter. When the report has been made public property, however, we shall be ready to publish any corrections which Mr. BENNETT can show us are necessary.

British Academy.—It is announced that the King has been pleased to grant a charter, dated August 8th, incorporating the "British Academy for the Promotion of Historical, Philosophical and Philological studies."

Police v. Motors.—According to the *Autocar* the East Sussex Standing Joint Committee has authorised the chief constable to obtain a set of electrical apparatus, consisting of a battery, bells and wire, at a cost of £9, for the purpose of enabling the police to check the speed of motor cars on the public highway.

German Atlantic Cable.—The cable steamer "Von Podbielski" recently returned from a sounding expedition on the line of the proposed second Atlantic cable, which is about to be submerged by the Deutsch-Atlantische Telegraphen-Gesellschaft of Cologne. The track of the cable has been definitely decided upon, and the manufacture of the first section is making progress.

American Electrochemical Society.—The first volume of the *Transactions* of the new American Electrochemical Society has just reached us. Among other Papers in it are: "The Electrical Reduction of Lead," by Pedro G. Salom; "A Zinc-Bromide Storage Battery," by Herbert H. Dow; "The Electrolytic Rectifier," by C. F. Burgess and Carl Hambuechen; "A New Type of Electrolytic Meter," by Dr. Konrad Norden; and "Electrolysis by an Alternating Current," by Joseph W. Richards, Ph.D.

The National Telephone Co.'s Exchanges.—This company's subscribers will doubtless be glad to hear that the following exchanges are now connected directly with the chief fire station in the neighbourhood:—Avenue, London Wall, Holborn, Bank, Gerrard, King's Cross, Eastern, Deptford, Battersea, Paddington, Westminster, Hop and Kensington. The company greatly regret the inconvenience caused to some subscribers by the unfortunate Falcon-street fire, which burned down 230 of their lines, most of which were junctions to the Holborn exchange.

Protection of Public Buildings from Lightning.—Mr. Killingworth Hedges, in a letter to *The Times*, advocates greater care being taken to ensure the immunity of public buildings from lightning. He states that the electric light mains of the British Museum would form an excellent path for a lightning stroke, and a most disastrous fire might occur. While thousands have been spent in safeguarding the National Gallery from fire by purchasing the neighbouring buildings, yet its lightning conductor, says Mr. Hedges, is of the most elementary form, and constitutes a source of real danger.

New Cable-Laying Steamer.—Messrs. David J. Dunlop & Co., of Port Glasgow, launched from their yard, on Wednesday, the steel twin-screw cable-laying and repairing steamer "Iris," built for the Pacific Cable Board. Her dimensions are: Length on load line, 285ft.; breadth, moulded, 40ft. 6in.; depth, moulded to spar deck, 25ft.; gross tonnage, about 2,300 tons. The "Iris" has been built to Lloyd's A1 class as a spar-deck steamer, and is fully equipped beyond their outfit requirements. Four cable tanks are provided. The construction of the vessel was under the direct superintendence of Mr. R. Alexander, chief engineer, and Capt. Lacy will take command.

A Result of the German Industrial Depression.—The German "Techniker-Verband" has issued a memorandum calling attention to the unfortunate relation between supply and demand in the case of German engineers. While, on the one hand, there is a decrease in the demand for additional

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technically-trained men on account of the general industrial depression in Germany, the increasing number of technical educational establishments are continually turning out more engineers, and, in consequence, many of the latter are unable to find employment.

A New Shallow Underground Railway for Berlin.—A scheme has been adopted by the Berlin municipal authorities for an electrically-driven shallow underground railway to connect the north and south of the city, and the construction of the line has been confided to the Company for the Construction of Underground Railways. The railway will be 12·2km. long, of which 10·15km. are in Berlin itself and the remainder in the suburb of Schöneberg. Fifteen stations have been selected, and the line will be for the greater part on the shallow conduit system, but it will cross the Spree under the bed of the river. It will be double track and standard gauge throughout.

Churches Struck by Lightning.—During the evening of the 14th inst., a severe thunderstorm passed over the parish of Swanscombe, Kent, and during its progress it was discovered that the parish church had been struck by lightning. Only a part of the chancel was saved, all the fine oak ceiling and furniture being destroyed by fire. The church with its Saxon tower and spire steeple was built in the thirteenth century, and is said to be one of the oldest in the county.——On Wednesday last, the parish church of Aldenham, Herts., was also struck. The spire was practically destroyed, and three persons standing under the belfry had a narrow escape. Some cleaning rags became ignited and filled the church with smoke, but the fire was soon extinguished.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Santa Cruz—Teneriffe	July 7, 1902
Puerto Plata—Martinique	July 10, 1902
Anjer—Kalianda	Aug. 2, 1902
Nagasaki—Fusan	Aug. 5, 1902
Guantanamo—Mole St. Nicholas	Aug. 5, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Cape Town—Mossamedes	Aug. 16, 1902

New Zealand Telegraphs.—The official report of the New Zealand post and telegraph service for year ended March 31, 1902, just received, shows a continued improvement in the finances of the latter. Notwithstanding increased outlay on extensions, and necessarily augmented charges for salaries consequent on the reduced rates and enlarged traffic, the net revenue during the past year was such that a balance on the right side may very shortly be expected. The number of inland telegrams has more than doubled since the sixpenny rate was introduced in 1896, whilst expenditure over revenue now amounts to only a few thousand pounds. Telephone exchange connections number 9,260, and the subscriptions for the year amounted to £55,542. The report contains many interesting particulars relating to the new Pacific cable sections, and to the one completed between Western Australia and Natal.

Explosion near Drury Lane.—An unfortunate accident occurred in a street near Drury-lane on Monday, in which are electric lighting mains belonging both to the Charing Cross and Strand Electricity Supply Corporation and the Metropolitan Electric Supply Co. The former company's mains in this street are laid "solid" in bituminous compound contained in wooden troughs, and those of the Metropolitan Electric Supply Co. are triple-concentric cables laid directly in the ground. An explosion of gas occurred in a butcher's shop lying on the route of the mains, and this was followed by a fire, and the proprietor was slightly injured. No actual interruption in the supply of either of the companies took place, except in the houses in the street itself, where mains had, of course, to be disconnected; but it seems that considerable heat was developed by leakage current, and that about half-an-hour after the explosion, before they had found it necessary to disconnect the main, the Metropolitan Company discovered that a severe short had subsequently developed on their cable. The volts on their system were low in consequence for a considerable time, until this section could be disconnected. The Charing Cross mains are at a considerably lower depth than the Metropolitan mains at this place. At present it has not been determined which of the two mains, if either, was responsible for the occurrence, but a possible explanation is that gas was liberated owing to a fault on the solid mains having overheated the bitumen or melted a gas pipe. It does not seem probable, at any rate, that the triple concentric main, the outer of which is the middle wire of the low-tension three-wire system, could have produced sufficient external heat to cause the damage half-an-hour before the short-circuit was felt.

Post Office Telephones.—From the Postmaster-General's report for 1901–2 we extract the following particulars relating to the telephone service:—

The total number of trunk-wire conversations during the year was 10,080,716, or, reckoning each conversation as involving at least two spoken messages, a total number of 20,161,432 messages (an increase of 12·31 per cent. over that of the preceding year). The gross trunk revenue was £238,720, as compared with £211,209.

The central exchange of the London telephone system was opened on February 24th last, and about 500 subscribers had been connected on March 31st. Provision was made in the first instance for the accommodation of 5,400 subscribers, but the number of applications received has been so great that arrangements have had to be made for an early extension of the switchboard so as to accommodate over 10,000 lines, with a corresponding addition to the number of junction wires for connections with other exchanges. The service at this exchange has worked very smoothly, and many expressions of satisfaction have been received from the subscribers. The central battery system of supplying all the electricity required from the exchange has fully justified its adoption. The speaking on the lines has been found to be very good, and their freedom from the accidents to which an overhead system is necessarily exposed justifies the hope of a more regular and satisfactory service than has hitherto been possible in London. Exchanges have also been opened at Putney and Kingston-on-Thames, and other suburban exchanges are in process of construction at Wimbledon, Richmond, Chiswick, Twickenham and Croydon. More important exchanges are about to be opened in the neighbourhood of Victoria-street, Westminster, and in Cromwell-road, S.W. They will be known as the "Victoria" and "Western" exchanges, and will serve the intervening districts between the areas of the central exchange and of the suburban exchanges mentioned above. Other important exchanges which are being constructed are one situated on the north side of Oxford-street and one in Finchley-road; they will be opened as soon as possible. These exchanges will serve large districts to the north of the areas served by the Victoria and central exchange areas. Surveys for the construction of other exchanges and underground systems of wires have been made in outlying parts of the London area, and it is probable that exchanges will be established at Sutton and Epsom, which will serve the remaining districts to the west of the Croydon area and south of the Kingston and Wimbledon areas. The surveys of certain districts in the north-west of the London area are about to be undertaken.

The demand for telephone service is increasing very rapidly, and the metropolitan system will, in the course of the next few years, have to be developed to an extent which would have seemed impossible a few years ago. Dissatisfaction is necessarily caused by the slow rate at which the demand can be met, as it is hardly possible for individual subscribers to realise the amount of work involved in the general construction of the system. Already over 600 miles of underground pipes have been laid, and about 330 miles of cable, containing from 200 to 432 wires, have been drawn into them. The arrangements for the distribution of these wires into smaller cables for connection with the premises of subscribers, involve an enormous amount of minute work, requiring great care and skill. The installation of subscribers' instruments can be undertaken only as this work is completed, and is a comparatively simple affair. Out of the capital sum of £2,000,000 authorised by the Telegraph Act of 1899 an expenditure of £972,317 was sanctioned up to March 31st last. The authorised expenditure on the London system at that date was about £795,846.

On November 18, 1901, an agreement was made with the National Telephone Co. for inter-communication between the subscribers to the systems of the company and the Post Office in the London area. It has involved a large amount of additional work in connecting the exchanges of the two systems by numerous junction wires, and in the internal arrangements necessary for communication between exchanges worked on different principles. The work has, however, been carried out with much skill by the engineering staff of the Post Office, which has been greatly aided by the co-operation of the staff of the National Telephone Co. There is no previous instance of the combination of two systems of the same size or with so many differences in the mode of working; and it is very satisfactory that the communication between Post Office subscribers and those of the company is now as rapid and as efficient as between the subscribers to the same system.

During the year telephone licences were granted to the Corporations of Brighton, Chard and Portsmouth, and to the Norwich Mutual Telephone Co. Applications for licences from several other corporations and from one or two local companies have been received. The systems of the Corporations of Glasgow and Tunbridge Wells have been opened for use, but no other municipal exchanges have yet been established, although active steps in this direction are being taken by some of the corporations concerned.

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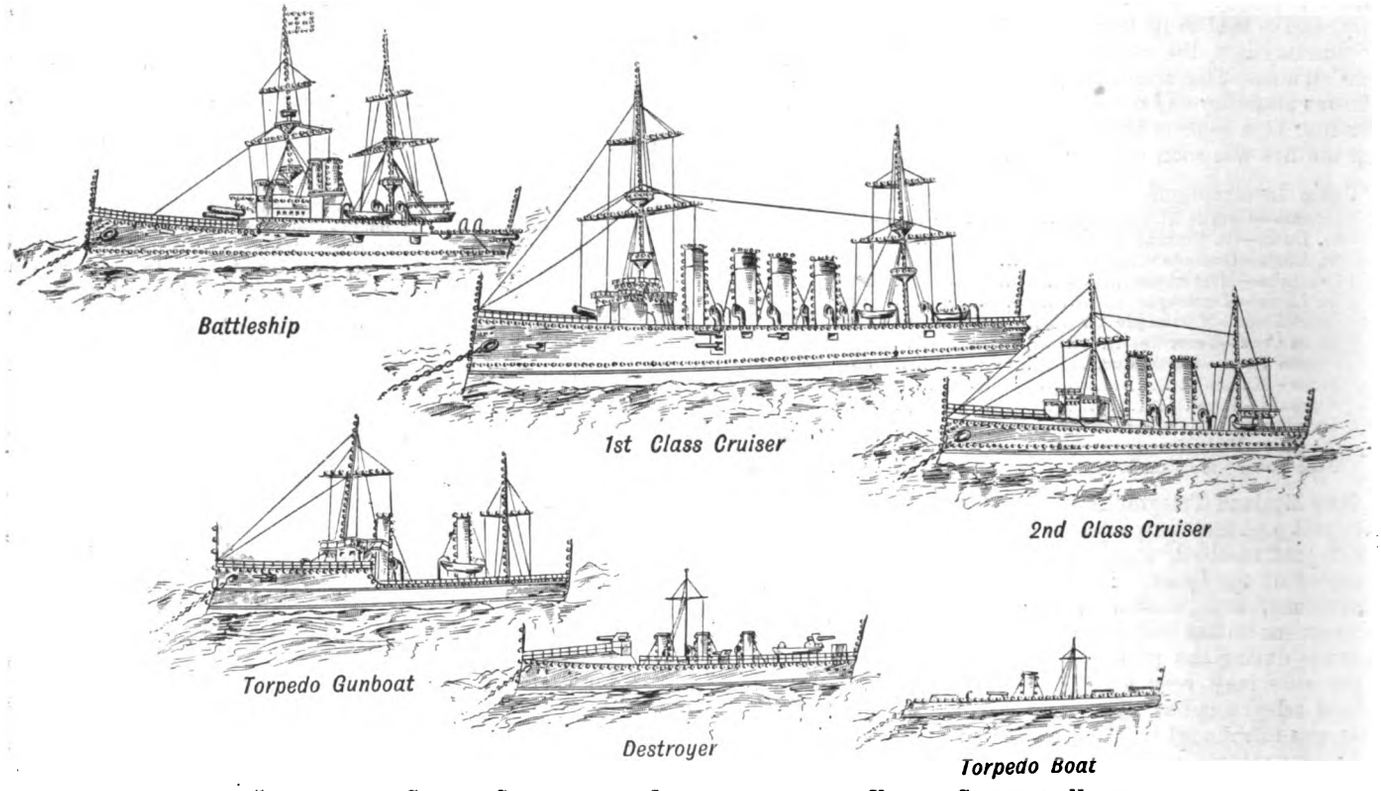
THE ILLUMINATION OF THE FLEET AT SPITHEAD.

At the conclusion of the Review at Spithead by the King last Saturday there were two particularly fine displays of electric illuminations—one by Nature and the other by the assembled warships. The latter was timed to commence at 9:30, but 15 minutes before that time rain commenced to fall in torrents, and flash after flash of lightning illumined the great ships out upon the water. Just after 10 o'clock, however, a signal rocket went up from the "Victoria and Albert," and instantly out of the darkness appeared to spring thousands upon thousands of lights, and the ships were simultaneously outlined against the sky. The individual lamps could be discerned on those near at hand, but golden bars indicated long lines of lamps in the distance, and the whole effect was very beautiful. Unfortunately, during the time that the illuminations continued, the storm raged with unabated vigour, and visitors who were on the Solent on Friday evening were to some extent more fortunate in seeing a rehearsal of a large portion of the programme under a cloudless sky, and through being with a startling and impressive effect. The beams of light on this occasion were coloured blue, red, gold and green, and were thrown in all directions, first on the clouds, then on shore, on water, on vast clouds of steam emitted by the ships themselves, and lastly every lamp was directed with one accord above the "Victoria and Albert," which had for several minutes the appearance of being under a canopy of coloured lights. Once more there came thunder, but this time of a Royal salute of 21 guns from each ship, and by the time the roar had died away the fleet had again disappeared, and all became darkness and silence.

The technical details of the illuminations were carried out on the lines adopted in 1897. Battleships were outlined on the forecastle, superstructure, quarter-deck, masts, funnels, bridges and waterline. First and second class cruisers, naturally, had, as a rule, a smaller number of lamps than battleships, and had one complete line fore and aft, with masts, funnels, &c., as on battleships. Third class cruisers of low freeboard and torpedo gunboats were illuminated with the same general arrangements as cruisers, with the exception of the waterline lights, which were omitted. Destroyers and torpedo boats were also similar to cruisers, but the masts and waterline were



SKETCH OF THE GENERAL SCHEME OF THE ILLUMINATIONS ON THE VARIOUS CLASSES OF VESSELS.

a clear atmosphere; but seen even through the mist of rain the sight was a glorious one, which will long be remembered by those who had the good fortune to witness it.

The King's yacht was resplendent in a rich shade of orange with a water line of green, and even the ladder marked out; she also carried coloured masthead lights, and the admirals' flags were displayed in their true colours according to rank. On all the warships of the fleet, however, there was complete uniformity with regard to colour, plain lamps being employed throughout. For about an hour the lights blazed on, and then as suddenly as they came they disappeared, leaving everything in perfect darkness with the exception of the "Victoria and Albert," which alone remained illuminated. The storm had somewhat abated, but the rain continued to fall steadily, and there was not even a ray of light from the moon. The special installation of electric light, which had been arranged along the sea front of the dockyard, was also switched off, and this tended to accentuate the darkness, out of which the lines of the King's yacht were alone visible. Once more a signal rocket ascended, and instantly the search lights came into

omitted. Certain rules and regulations were laid down by the Admiralty for guidance of commanding officers, and various directions given with regard to arrangement of lamps on circuits and methods of connecting them. It was suggested that circuits should be divided into sections of not more than 48 lamps, the number varying according to circumstances. The terminals, to which certain of these temporary circuits were connected, were wired with 42-ampere leads, so that there was no fear of overloading, even with 48 16 c.p. lamps at 80 volts (the Admiralty standard pressure). The cable was cut into pieces of definite length, so that it could be re-issued to ships for permanent use. The spacing of the lamps was as follows:—5ft. apart on the hull, 6ft. apart up and down masts, funnels, &c., 4ft. around bridges, charthouse, &c., and on the masts there was a line both before and abaft. The lamps were supported by the cables and connecting wires themselves and kept close up to the cables to prevent their being blown about by the wind, and to keep them at the correct distance from each other. The waterline lamps were placed 8ft. above the ship's water-

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line in order to be clear of boats and the wash of the water. A rather novel point suggested by the Admiralty was the adoption of an extempore lamp-holder. It is well known that the service lamp is of the old type with platinum loops, and that when used in the ordinary permanent way it requires no bayonet holder, but merely a spiral spring. This method is, however, not at all suitable for temporary work, and it was, therefore, suggested to use a cork grooved at the sides and base, care being taken that the grooves were of such a depth as to firmly hold the neck of the lamp and to allow the wires to be farther apart than the loops of the lamps. A piece of twine bound round the cork converts it into a very serviceable fitting.

The largest number of lamps on any one ship was 1,000 for those of the "Diadem" class, 950 for the "Majestic," and the smallest vessels of the fleet had at least 300 lamps each. In addition to this, there was a fine display on the foreign vessels and on several of the private yachts and liners which were also in the Solent.

THE ELECTRIC SUPPLY STATION AT NEPTUNE BANK, NEWCASTLE-UPON-TYNE.

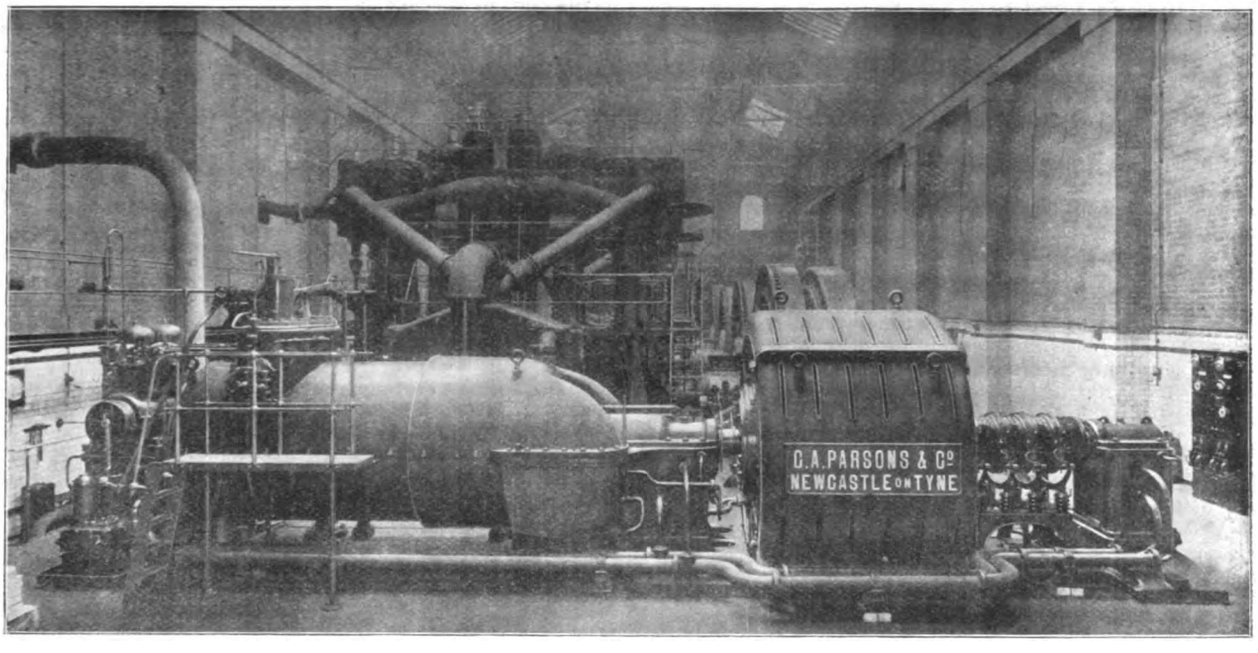
At the recent meeting of the Institution of Mechanical Engineers, at Newcastle-upon-Tyne, Mr. W. B. Woodhouse, of Wallsend-on-Tyne, read a Paper describing the Neptune Bank power station. Our readers will remember that a fully-illustrated technical description of this important power station appeared in *The Electrician*, Vol. XLVII., pp. 319, 359, 397. It will be unnecessary, therefore, for us to reprint here the full text of Mr. Woodhouse's Paper. We give below a brief abstract, which, through the courtesy of Messrs. C. A. Parsons & Co., we are enabled to illustrate with a recent photograph of the Neptune Bank machinery room, showing the new Parsons turbo-alternator.

The Newcastle-upon-Tyne Electric Supply Co. has the distinction of being the first to supply electric power in bulk in this country. The Walker and Wallsend Union Gas Co. obtained an Act of Parliament in 1899, authorising supply in Wallsend and Willington, a district of great manufacturing importance, extending along the riverside. The Supply Company, having in view the construction of a new power station, entered into an agreement with the Gas Company, whereby the latter took power in bulk from the Supply Company, and distributed to its own customers. That portion of Newcastle originally supplied from the Pandon Dene station, the Walker Urban District and Gosforth, are included in the area in which the Supply Company is authorised to distribute power. The whole scheme has been developed and carried out by Mr. Charles H. Merz, consulting engineer to both companies.

The station started to supply power to local works in November, 1900. Three-phase currents, at a pressure of 5,500 volts and a frequency of 40 cycles per second, are transmitted to the various sub-stations, in which, by means of synchronous motor generators and stationary transformers, conversion is made to 480 volts direct current for power and lighting on the three-wire system, and to 440 volts alternating three-phase currents for power alone. The station is some 350yds. from the river, and stands next to the Riverside line of the North Eastern Railway, from which there is a siding. Coal is delivered to this siding and the trucks are handled by a small electric locomotive, running on an elevated track to the boiler-house, on the floor of which the coal is deposited.

Boiler-house.—This is a steel and corrugated iron building, 160ft. long and 52ft. wide; its floor is on the same level as the engine-room basement. It contains eight Babcock and Wilcox boilers, supplying steam at 200lb. per square inch pressure, with a superheat of 120°F. The superheaters are situated between the drums and the main tubes, and the degree of superheat of the steam delivered is adjusted by diluting it with saturated steam. Each boiler has a heating surface of 4,020 sq. ft. and a grate area of 74 sq. ft., and is capable of evaporating 14,000lb. of water per hour from and at 212°F. Two of these boilers are fitted with Vicars' stokers and four with the Babcock and Wilcox chain grate; the stoker gear is electrically-driven and takes a maximum of 5 H.P.

Fuel.—The fuel burnt is Northumberland small coal having a calorific value of about 11,000 B.T.U. per pound; and with natural draught about 23lb. per square foot of grate area is burned per hour. The ashes are discharged into trucks in the ash tunnel below the boiler-house floor, and are lifted from a hopper, at the end of the tunnel, by a bucket elevator to a large hopper outside the boiler-house; from this hopper the ashes are discharged into railway trucks. The main flue, which is of brickwork, runs the whole length of the boiler-house; at the west end is a Green's economiser of 280 tubes and a steel chimney lined with firebrick, 130ft. high and 6ft. 9in. diameter at the top; at the east end a similar economiser and chimney are in course of erection; at this end is an induced draught fan direct coupled to a three-phase motor.



MACHINERY ROOM AT NEPTUNE BANK POWER STATION.

As the cost of coal is the most important item in the production of electrical energy, complete combustion is of primary importance, but it is also of importance to obtain the maximum evaporation from the boilers installed. Where no economiser is used, and the flue gases at the base of the chimney have a temperature of 500°F. to 550°F., a good draught can be usually depended on, but where, due to an economiser, this temperature is, say, 250deg., then one is at the mercy of climatic conditions, the boilers cannot be worked to their full capacity, and up goes the cost per unit. If the capital charges per unit are to be kept low, induced draught becomes a necessity.

The steam-pipes are of solid drawn steel tube, the main header extending the whole length of the boiler-house; the valves are so arranged that any boiler and the engine behind it may be isolated from the rest of the steam plant. The Belliss engines and the feed pumps are not supplied direct from the main header, but from a smaller pipe, running along the boiler-house below the level of the engine-room floor.

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The efficiency of a power station can only be maintained by systematic and regular tests of all the plant in the station; the boiler-house economy is of first importance. In addition to making periodic tests on the evaporative power of the fuel employed, two instruments are in use that deserve mention. The first, known as Arndt's econometer, indicates continuously the percentage of carbon dioxide in the flue gases; it is essentially a delicate balance, one scale-pan being replaced by an inverted glass jar. A sample of the flue gases is drawn through this, and a variation of density causes the pointer of the balance to deflect. As carbon dioxide differs largely in density from the other flue gases, a scale beneath the pointer is graduated to read the percentage of carbon dioxide present. The fact that one can see at a glance the effect of any change in the firing of the boilers is of great value. Leaky flues may be detected by means of an Orsat apparatus, by which a volumetric analysis of the flue gases is readily made; the percentage of free oxygen is estimated at various points in the flue, an increase showing a leakage of air. Pockets for thermometers are provided in the various steam and water pipes and the boiler feed is measured by a Kennedy water meter.

Engine-room.—This room is 160ft. by 52ft. The Weir feed pumps and the motor-driven centrifugal circulating pumps are in the basement; the boiler feed can be drawn from either of two hot wells situated at the ends of the building or direct from the water service main. Direct current is generated for station power and exciting, and for the Wallsend network. The dynamos for these purposes are of British Thomson-Houston Co.'s manufacture, and are direct-coupled to Belliss and Morcom engines—two of 300 B.H.P. running at 380 revs. per min., and one of 75 B.H.P. running at 500 revs. per min.

The engines for the three-phase generators are all of local make. A brief description follows:—One 1,400 I.H.P. engine by Messrs. the Wallsend Slipway and Engineering Co. This is a three-crank triple-expansion engine with cylinders whose diameters are 17·5in., 28·5in. and 48in. the stroke of each being 36in., running at 100 revs. per min. The cylinders are jacketed, with reducing valves at the medium-pressure and low-pressure jackets; when running at three-quarter load with superheated steam, the efficiency is much the same with jacketed and unjacketed cylinders; at light loads the jacketing is advantageous. The Corliss valves are worked by rocking levers from the crank-shaft eccentrics; governing takes place on the high-pressure cut-off only, by means of a Whitehead spring governor and trip gear. The condenser and air-pump are mounted on the back frame of the engine with the circulating pump in the basement beneath it. The magnet-wheel and flywheel are mounted on one shaft carried by spherical seated bearings with forced oil lubrication; the extreme diameter of the wheel is 17ft., and it weighs about 43 tons. Of exceptional interest are the figures of the steam consumption of this engine given in Table I.

There are three 1,400 I.H.P. triple-expansion four-crank engines, made by Messrs. Wigham, Richardson & Co.; these engines are fitted with crank-shaft governors with shifting eccentrics, and govern on the high-pressure and medium-pressure cylinders. The high-pressure and medium-pressure cylinders have double-beat valves, and the trip-gear is very compact. The engines are balanced for primary forces and couples, so that the cranks are necessarily not at right angles; due, however, to the four cranks the variation of crank effort is small. The situation of the air pump, condenser, &c., is as in the Slipway engine. All these engines are direct-coupled to three-phase generators, with stationary armatures and rotating magnets, made by the British Thomson-Houston Co. One 1,500kw. turbo-alternator, by Messrs. C. A. Parsons & Co., running at 1,200 revs. per min. The alternator is direct-coupled to the turbine, and is mounted on its own bearings; a forced circulation of oil and cooling water passes round each bearing. The air pump and condenser are situated beneath the turbine, the three-throw air pump being direct-coupled to a slow-speed motor running at 100 revs. per min. The circulating pump is direct-coupled to a 45 H.P. motor. As a prime mover of electrical machinery the steam turbine approaches the ideal; it runs steadily, is free from vibration, and needs little attention; the question of steam consumption has been the difficulty. In a communication made to this Institution last year* the steam consumption per kilowatt-hour was given for a number of turbines; the figure steadily improved with the size of the machine. The Neptune Bank turbine bears comparison best with that supplied by Messrs. Parsons to Elberfeld, a machine of 1,000kw. output. The figures of a test made at Neptune Bank are given in Table II., from which it will be seen that the Elberfeld results are beaten. With units of 3,000kw. to 6,000kw. output, such as will be demanded in the near future, the turbine promises to outstrip all competitors.

Table I.—*Steam Consumption of Slipway Engine at Various Loads.*

Pounds of water per hour.		Mean total.	
Per I.H.P.	Per kilowatt.	I.H.P.	Kilowatts.
10	21·8	364	250
10·03	18	594	497
9·94	16·89	1,005	850
10·42	17·09	1,437	1,177

Table II.—*Steam Consumption Tests of Slipway Engine and Parsons Turbine.*

—	Slipway engine.	Parsons turbine.
Mean revolutions per minute	101·2	1,200
Mean total .....I.H.P.	1,030	—
Mean total .....kilowatts load	625	1,442
Pressure of steam at engine stop valve...lbs. per sq. in.	193	196
Superheat .....Deg. F.	90·5	76
Vacuum in condenser .....inches	26	27
Pounds of steam.....per I.H.P. hour	10·35	—
Pounds of steam .....per kilowatt-hour	17·1	18

Parallel Running.—The following are the considerations governing the design of engines driving alternators in parallel. All these engines are direct-coupled to alternators which have to be run in parallel, and a large portion of whose load consists of synchronous machinery. If at any instant there be a phase difference between two alternators in parallel—that is, one alternator ahead of the other in phase—there will be a cross-current flowing between them, the synchronising-current tending to draw them together into phase. An irregularity of torque, such as that due to uneven crank effort, will cause an alternator to swing ahead of the co-phasal position and return to an out-of-phase position in the opposite direction, the synchronising current exerting a controlling force proportional to the phase displacement. A continuation of the swinging may be aggravated by external circumstances, such as a periodic variation of the load due to the inertia of synchronous motors on the system; and although a heavy flywheel on the engine smoothes out the irregularities of torque, yet once the "hunting" has started, the flywheel tends to keep up the hunting.

Again, as the engines are required to take their share of all loads, it is important that the drop in speed from no-load to full-load shall be the same in each engine.

As a variation of velocity occurs twice in a revolution with a single-crank engine and eight times in a revolution with a four-crank engine, it is obvious that, for the same percentage variation of angular velocity, the phase displacement will be four times as great with the single-crank engine. The engine specification should, therefore, refer to phase displacement and not to variation of angular velocity. With modern alternators the maximum phase displacement should not exceed 6deg., equivalent to a synchronising current about 10 per cent. of short-circuit current; degrees of phase displacement being degrees of angular displacement multiplied by the number of pairs of poles in the magnet wheel. With a high-speed engine the allowable angular displacement becomes greater, for with the same frequency of alternation the number of poles is less.

There are several methods of measuring a variation of angular velocity, the best known being the use of a tuning-fork to trace its vibrations on a paper cylinder driven by the engine; electrical methods, such as driving a small direct-current dynamo from the flywheel; the most sensitive is the stroboscopic method used in conjunction with photography.

As a means of observing extreme cyclic irregularity and hunting, the Horn tachograph is to be commended; it records the variation of speed on a moving paper and greatly facilitates the setting of the engine governors to give the same percentage drop of speed on load.

Once hunting is started, by whatever cause, the sensitiveness of the governor becomes of importance; in this connection it may be mentioned that a dash-pot designed with a large and a small by-pass has been found successful in many cases. The main by-pass is normally closed by spring valves, thus reducing the sensitiveness of the governor; but on a change of load the pressure of the plunger continues long enough to open these valves until equilibrium is restored.

Cooling Pond.—The circulating water for the condensers is cooled in a Körting cooling pond, the water being sprayed through nozzles into the air. Over a portion of this pond stand the car-sheds of the Tyneside Tramways Co., the pipes carrying the spraying nozzles being led in flues, through which a rapid circulation of air is caused by means of an exhausting fan. The make-up water is pumped from the river Tyne by a three-throw Pearn pump situated close to the river; this pump is electrically-driven and is started and stopped from the power-house.

Switchboards.—The high tension switchboard is made by Messrs. Ferranti, and is divided into panels for the various machines and feeder cables. The machine switches and all fuses break circuit through oil. Two sets of wattmeters are fitted for metering the power supplied to the Gas Company and the Supply Company respectively. The direct-current switchboard, made by Messrs. Reyrolle, is in three sections. The panels carrying the field and compounding switches are beneath the gallery; the panels on the gallery carry the machine switches, ammeters and voltmeters, and the feeder panels beneath are fitted with circuit-breakers and wattmeters. The cables

* *Proceedings*, 1901, page 808.

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and instruments used in connection with a water-testing pond for artificially loading any machine in the station, are a permanent arrangement; as above-mentioned, systematic tests are part of the station routine.

The resident engineer during the construction of the station has been Mr. H. L. Riseley.

A NEW MOTOR CAR SPEED INDICATOR.

Messrs. Elliott Bros. have recently brought out an instrument for measuring speed, known as the Highfield and Beeton patent speed indicator, which has been specially designed to comply with the Board of Trade regulation that every electric tramcar shall be fitted with a suitable instrument indicating the speed at which the car is travelling. This regulation is as follows:—

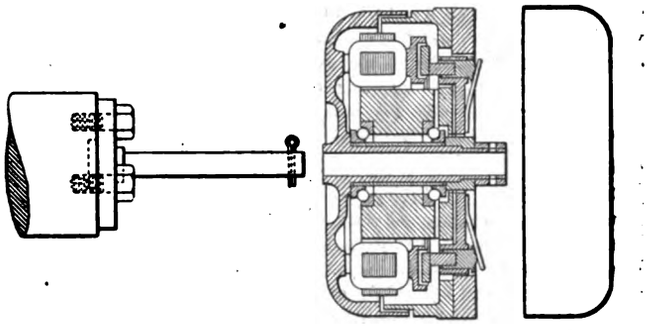
"I. Every motor carriage used on the tramways shall comply with the following requirements:—

"(a) It shall be fitted, within six months from the date hereof, or such further period as the Board of Trade may prescribe, with an apparatus to indicate to the driver the speed at which it is running."

The apparatus consists essentially of a small magneto-generator, attached direct to the motor frame, and two indicating instruments, one on each platform, the scales of which are calibrated to read in miles per hour. These instruments can be fixed in the most convenient position, so that the motorman can see the speed at which the car is travelling without altering his position.

The instruments themselves are in reality small voltmeters, and can be calibrated in revolutions per minute in the case of revolving shafts, or in periodicity in the case of the application of this apparatus to indicate the speed or periodicity of alternating-current generators. In this latter case, the indicating instrument can be fixed on the switchboard, and in all cases it can be at some considerable distance from the revolving shaft in question.

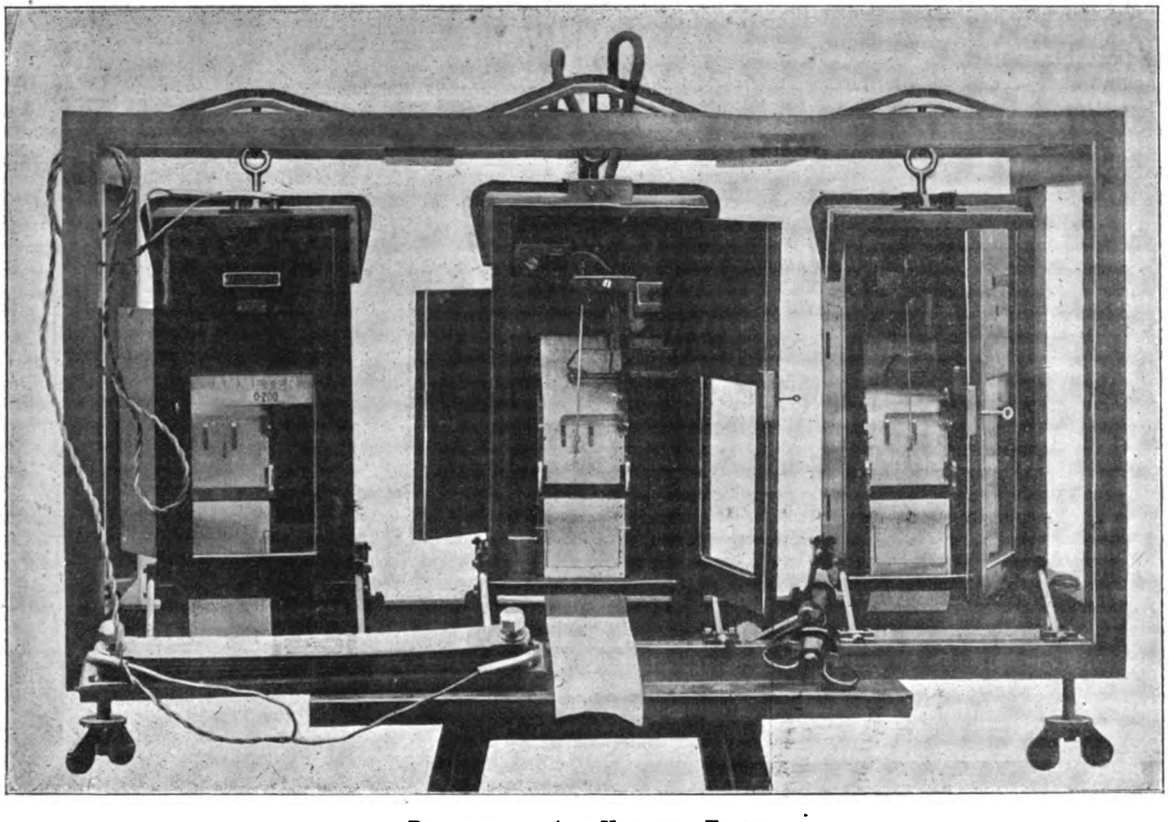
The amount of current taken, and the special construction of the field, enable the indications of the voltmeter and the voltage of the small generator to be directly proportional to the speed. Great attention has been paid to the method of its construction, with the object in view of allowing the generator to be very readily attached to any revolving shaft. In the instrument shown the arrangement consists of a small steel



View showing Method of Coupling Generator to Motor Shaft.
Scale: ½ full size.

stem with a flange attached to it, which can be bolted, by means of three set screws, into the end of the axle of the car motor. Holes can be drilled in the screws securing this flange to the axle, and a wire put through them, and secured, to prevent any chance of their slacking back, owing to vibration. Secured to this stem by means of one steel split pin is the armature or the revolving part of the magneto. The stem also carries a small ball race, on the outer part of which is mounted the magnet system, which consists of two iron pole pieces inside the revolving armature, attached to two bent permanent magnets supplying the field. Attached to the plate on which the magnets and these pole pieces are fixed are two brush holders, with connections in the ordinary way.

The complete magnet system is covered over with a shield to keep out dirt, after the whole arrangement has been mounted upon the steel stem, and the magnet system of the magneto is kept from turning round by means of a small stay, which can be fixed in any convenient position to some part of the framing of the car. The stay is not rigidly fixed,



Recorders on Anti-Vibration Frame.

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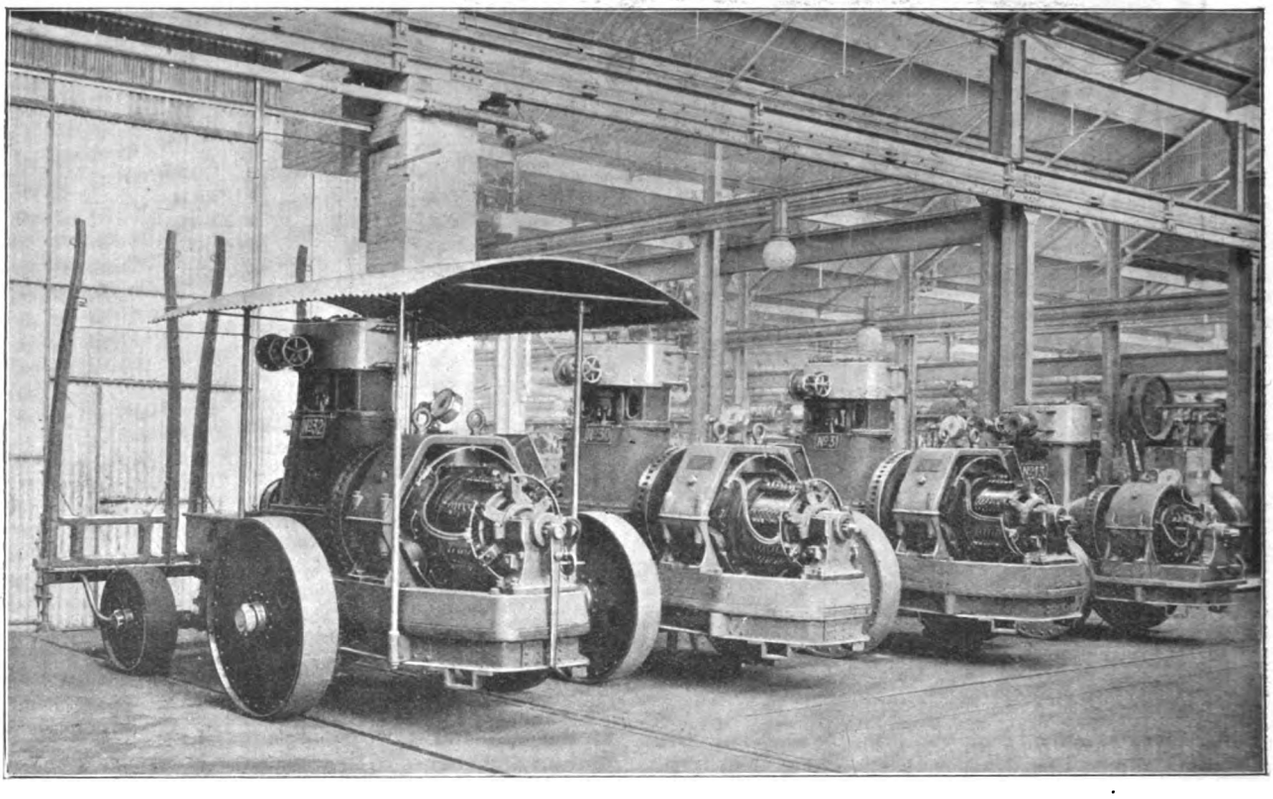
as the alignment of the magneto-generator does not in any way depend upon it. In the case of considerable end play of the axle which carries the arrangement, the armature and magnet system move together, and they, of course, do the same in the event of the axle bearings wearing away and the whole shaft dropping to some extent. The pole pieces are directly connected together by a piece of iron, so as to shunt the magnetic field considerably, with the object in view of keeping the strength of the magnets constant.

We also show an illustration of Messrs. Elliotts' recorders on an anti-vibration frame specially designed to work in conjunction with the speed indicator on motor cars. It will readily be seen that, in the absence of some device of this kind, the record of current or speed would be absolutely useless. Although the vibration on a trolley car is small, yet it is more than sufficient to cause serious discrepancies in the readings recorded by one of these instruments. Not only can the speed be recorded, but the actual current, power and volts, if necessary, can be observed on any car at any time by an inspector. The advantage of having cars equipped with apparatus of this sort is apparent. Should an accident happen, the performance of the car at the actual instant can be accurately checked. The evidence of bystanders with regard to speed can be proved or disproved beyond dispute, by the production of a strip of paper giving the speeds of the car throughout the day, from the moment that it left the shed in the morning. The recorders are merely hooked on to the top of the frame and anchored at their bottom corners by means of stout indiarubber. There ought to be no difficulty in designing a small speed recorder for use on private motor cars, and its cost would probably soon be saved in police court fines for "furious driving." The driver could defend the action with all confidence provided the recorder showed that he had been travelling below the limit; but, on the other hand, those who drive with disregard for human life and limb would stand self-condemned. There seems to be just as much need for Board of Trade regulations with regard to speed recorders on private cars as on public tramcars.

PORTABLE ELECTRIC LIGHT MACHINERY.

To meet the need of an electric light plant which can be readily transported from place to place on military or naval service, the portable generating set shown in the accompanying illustration has been designed and manufactured by Messrs. W. H. Allen, Son & Co. As will be seen, the plant consists of one of this firm's high-speed enclosed compound forced lubrication engines, directly coupled to a six-pole dynamo of the same firm's manufacture, and mounted on a transporting carriage. The combination is capable of giving an output of 600 amperes at 105 volts when running at a speed of 400 revs. per min., steam being supplied at a pressure of 110lb. on the square inch at the engine stop valve.



The particular plants shown are a selection of several which have been constructed by Messrs. W. H. Allen, Son & Co. for the temporary lighting of any part of H.M.'s dockyards. Each plant is intended to be drawn by horses, the carriage being rigidly built and mounted on four wheels with broad treads and substantial axles, the whole being sufficiently stable to enable the plant to be transported over rough ground without injury to any part. The base-plate of the engine and dynamo is arranged so that it can be lifted off the carriage and bolted down on a fixed foundation if required. The carriage is covered with a roofing of galvanised corrugated iron, with waterproof curtains hanging from rails on the sides and ends. Boxes fitted with waterproof lids, with padlocks and keys, are provided for stowing tools, spare parts and stores. The weight of the complete plant is 8 tons 19 cwt.

It is of interest to record that one of these sets was lately fitted on board the Royal yacht "Victoria and Albert." It was found that the engines and dynamos which were already there created too much vibration, and as the plant we illustrate is a silent working engine, it was decided to fit this type on the yacht. The work was undertaken and completed in less than seven days, which is a record for the large amount of work necessary. The trials took place on Sunday, July 13th; and it was gratifying to all concerned to find that, with the engine working at full load and delivering 60kw., not a sound could be heard in the Royal apartments. Stringent tests were made by the Dockyard and other authorities to ascertain the vibration, and bowls of water were placed in various parts of the ship, but not a trace of vibration could be detected.

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AUTOMATIC DEVICES FOR STOPPING STEAM AND ELECTRIC MOTORS.

There have been introduced by the Consolidated Engine Stop Co., of 100, Broadway, New York, a number of different automatic devices for stopping steam engines or electric motors at any time and from any distance. We have all heard of cases where the belt has come off the governor pulley with occasionally disastrous results, or where a man has met with an accident in some distant part of the works, and who, until another person's attention is called to him, has been quite unable to do anything with regard to shutting down the engine. These accidents will occur at times despite the most extreme care that can be exercised with the idea of preventing them. Something quite unforeseen may occur at the very moment that it is least expected, and therefore it is prudent to employ a mechanical "look-out" that is always expecting something to happen, although it never may. The "Monarch" system is a system of automatic devices for use in steam and electric plants, specially designed to fulfil this condition. It consists of four units—that is, the engine stop for automatically closing down the engine in cases of emergency, the speed limit for automatically preventing an excessive speed of an engine, the vacuum valve for automatically opening communication between the interior of the condenser and the atmosphere, and the circuit-breaker trip for automatically tripping the circuit-breaker in cases where generators are operated in multiple, each device performing its functions automatically when the necessity arises, and the whole constituting a system that absolutely insures the safety and integrity of the plant under all operative conditions and at all times.

Fig. 1, which shows a vertical section of the "Monarch" stop, serves to illustrate the complete mechanism of the device and its operation. The mechanism is enclosed in a cylindrical iron case, or shell, the upper half opening on hinges. Passing through this shell, or case, turning on ball bearings, is a steel shaft 1½in. in diameter, on the outer end of which is attached a drum or pulley, to which is bolted a sprocket wheel H, as illustrated in Fig. 2. Around this drum passes a wire cable G, to which is attached a weight which serves as power to operate the device. Inside the case and fastened to the shaft is a ratchet wheel F, engaged by a pawl B, which prevents the weight from turning the shaft in the direction that closes the valve. This pawl is held in engagement with the ratchet by vertical lever D, which is held in position by the left end of the armature lever E. The magnets A are placed in circuit with an electric battery, and when the circuit is closed by pressing a button the armature end of the lever E is pulled down, releasing the upper end of the vertical lever D, which also serves as a hammer, striking a lug on the pawl B, throwing it out of engagement with the ratchet, thus allowing the shaft of the stop to revolve and close the valve by means of sprocket chain attached to the sprocket wheel of the stop engaging a similar sprocket wheel attached to throttle-valve stem, the weight, as before mentioned, furnishing the power. At the opposite or right end of the stop is a dash-pot, as illustrated in Fig. 1, which consists of a cylinder into which the piston P fits closely. On this end of the shaft is cut a square threaded screw S, passing through a nut fastened in the centre of piston P, so that as the shaft revolves, by means of this screw, the piston is carried into the cylinder, and the air behind its inner face is compressed, forming a perfect cushion.

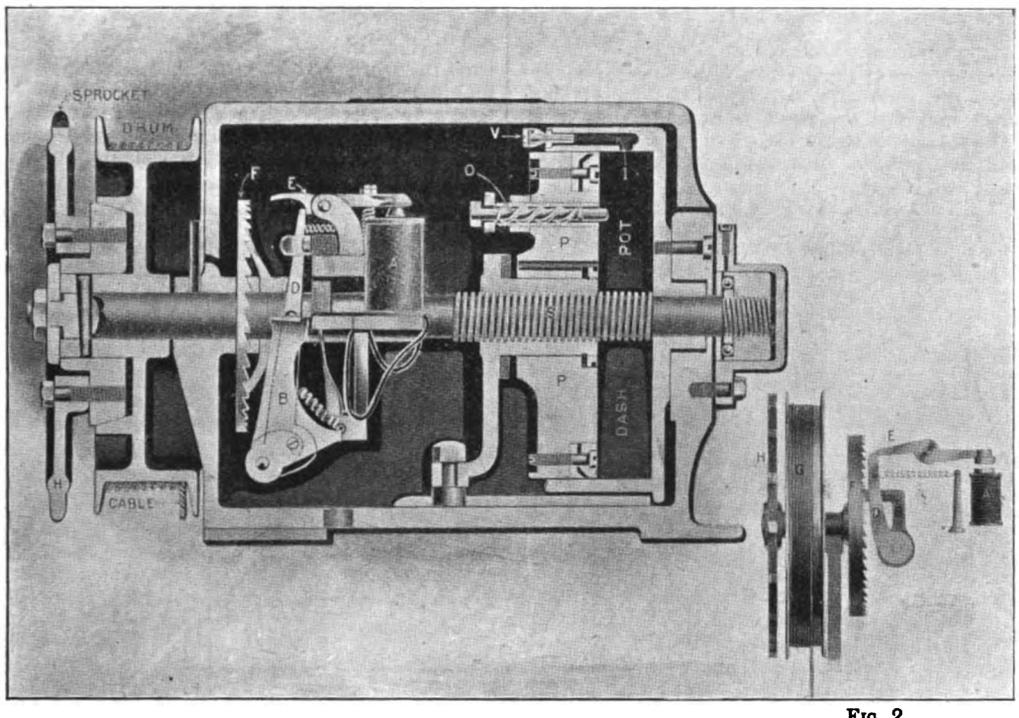

Fig. 1.—Mechanism of Monarch Engine Stop.

Fig. 2.

The speed at which the stop acts may be accurately adjusted by turning the by-pass valve, V, that governs the amount of air that is forced through the air passage I as the piston moves in. Below this by-pass valve V, and in piston P, is located the releasing valve O; this releasing valve O, which is opened by contact against the bottom of the dash-pot, is adjustable. After the piston has cushioned, and the throttle valve of the engine is near its seat, the compressed air in chamber I escapes through this releasing valve O, allowing the throttle valve to take its seat softly, but yet with sufficient force to close it tightly.

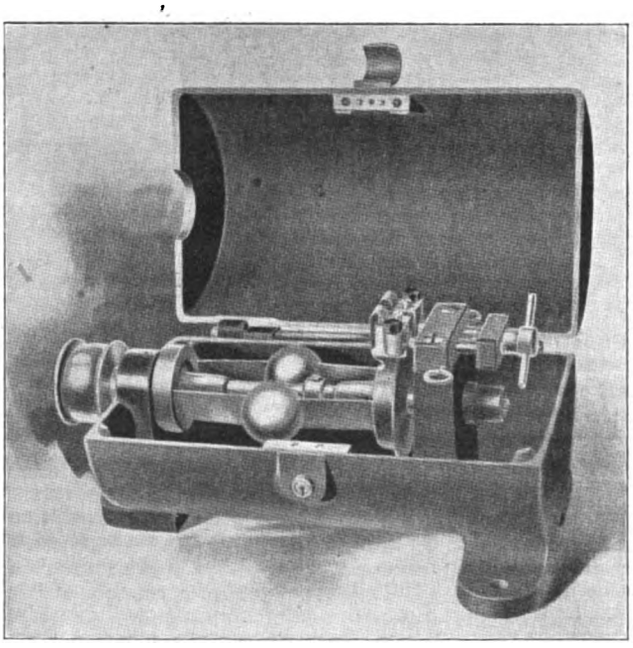

Fig. 3.—Monarch Speed Limit.

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The purpose of the automatic stop is to provide means for stopping the engine in those emergencies where the loss of property and life may depend upon the promptness with which this is accomplished. Great disaster may be averted by a few seconds, and it often happens that at critical moments the engineer is not at the throttle; or, again, that through the blowing out of a cylinder head, the bursting of a steam pipe, or fire in the engine-room, it may be impossible for him to reach the throttle at all.

By the use of the automatic stop the engine may be closed down from any part of the building by the mere pressing of a button. These buttons operate the stop through electrical connection, and may be located at any convenient points and at as many as may be desired. When an emergency arises the means to stop the engine are ready at hand at the most remote place of factory or shop. Besides, at these times, moments are precious and the stop works instantaneously. The throttle valve is closed in from three to ten seconds after the button has been pushed—quicker by many times than any human hand could work.

In connection with the system an electrical gong is connected with the stop, and is placed in the engine-room. It notifies the engineer in case the stop is brought into action.

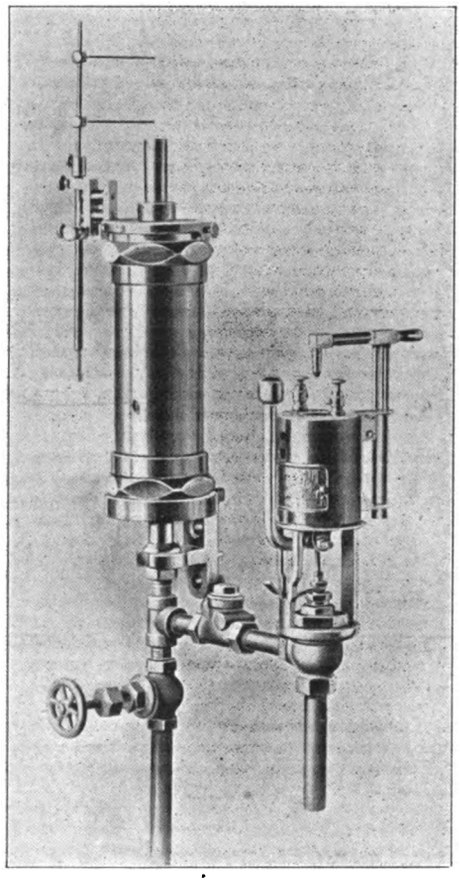

FIG. 4.—CORLISS ENGINE STOP.

pleting the circuit and putting the stop in operation. As stated, these terminals can be adjusted at will, so that the circuit is not closed until the engine reaches any desired speed. The shaft of this machine is run on ball bearings, requiring but one-quarter of a pound pull to drive it, and is driven by a belt from the main or flywheel shaft of the engine, which is guaranteed to sustain a weight or pull of 275lbs.

The Corliss engine stop (Figs. 4 and 5) is designed for use in those cases where it is desirable to have the stop apply directly to the governor instead of to the valve. While differing in mechanical construction from other stops, it is, like them, operated automatically and accomplishes the same end. The machine consists of three parts: a cylinder which is attached to the governor column; a valve for admitting steam to the cylinder, with an electromagnet for releasing the valve, which may be placed in any convenient place; and the speed limit. The valve k is held closed by the armature g of the electromagnet o. When the circuit pp' is closed, the movement of the armature g releases the lever h, which in turn releases the valve k, allowing the steam to open the valve and pass into the cylinder a and to force the piston c upward. This engages a clamp d attached to the side rod m and raises the governor balls

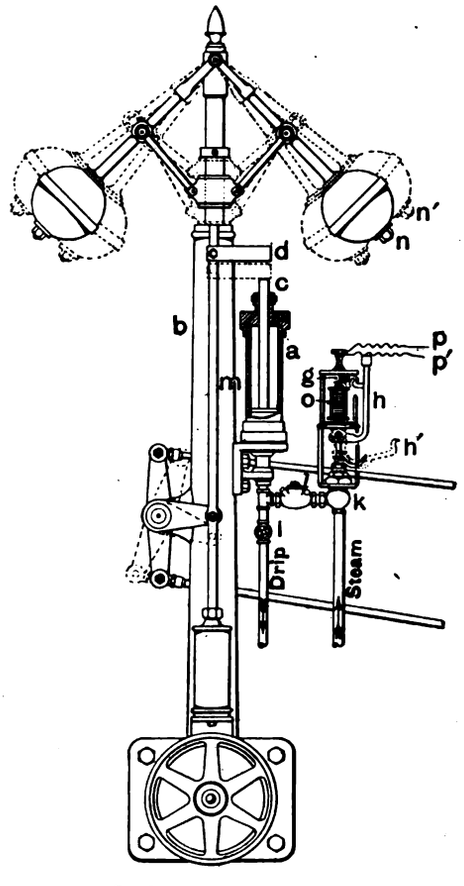

FIG. 5.—DIAGRAM OF MECHANISM.

Some of the most disastrous accidents have been from bursting flywheels due to "runaway" engines, and it is worthy of note that many of these accidents have been in plants using the most modern and expensive machinery. These accidents have cost many lives, and the losses from damage to machinery and plants aggregate an enormous sum.

The speed limit (Fig. 3) is a device for automatically preventing an excessive speed of the engine. With this device the maximum speed can never approach the danger point. The speed limit is directly connected to the main flywheel shaft and can be set to act at any number of revolutions. When the speed of the engine exceeds the desired number of revolutions, no matter from what cause, the speed limit operates the stop automatically by electrical contact, immediately shutting off the steam and thereby providing absolute surety against "runaways."

The construction of the "Monarch" speed limit is very simple. The machine is enclosed in an iron case, and occupies a space of only 7in. by 12in. It can be readily applied to any engine, and consists of a pair of governor springs arranged on a horizontal shaft and provided with the usual central balls. When the speed increases beyond the desired point, the balls, separating by the centrifugal force, move a sliding collar on the shaft to which they are connected until this collar comes in contact with two electrical terminals, thus completing the circuit and putting the stop in operation. As stated, these terminals can be adjusted at will, so that the circuit is not closed until the engine reaches any desired speed. The shaft of this machine is run on ball bearings, requiring but one-quarter of a pound pull to drive it, and is driven by a belt from the main or flywheel shaft of the engine, which is guaranteed to sustain a weight or pull of 275lbs.

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Multiple Wireless Telegraphy.—The *Electrical World* of New York states that two operators of the De Forest Wireless Telegraph Co. have succeeded in receiving two distinct messages in two different telephone receivers both attached to the same "responder." One was received at the rate of about 30 words per minute and the other at about 10 words per minute, the latter evidently emanating from a foreign station. Our contemporary also states that the De Forest operators established a record a few days ago in short-distance transmission by sending a message at the rate of 52 words per minute, which was actually read.

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THE CAPABILITIES OF THE MILAMMETER AND THE GALVANOMETER IN GENERAL AND SUBMARINE CABLE TESTING.

BY C. W. SCHAEFER.

(*Continued from p. 679.*)

To Measure a Simple Resistance.—It is easily seen from equation 15 that if we know the E.M.F. and internal resistance of a battery, we are able to measure a simple resistance unaffected by extraneous influences such as earth currents and the like.

The expression for this purpose is

$$R = \frac{E}{C} - (b + m). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

A description of an experience on a cable-repairing expedition will give an excellent illustration of the practical value of this simple method, which, in the absence of a milammeter, would have entailed great anxiety and a delay of several hours.

A heavy surf prevented the safe landing at a cable hut, and to reach it a long detour had to be made, whilst, for reasons of transport, the instruments had to be reduced to a minimum. A Weston milammeter, ordinary signalling mirror, key and a sounder, including a few dry cells, were the only accessories taken ashore, the mirror arriving in a useless condition owing to the destruction of the suspension through jolting!

Having failed to communicate with one of the stations, a test was taken as follows:—

The resistance of the millammeter was 1·2ω, and the constant per milliampere was 4·35 scale divisions. The resistance of the cells was practically negligible.

With 3 cells = 4,380 millivolts observed deflection = 114 divs.,

$$\therefore \quad \frac{114}{4{\cdot}35} = 26{\cdot}2 \text{ milliamperes.}$$

With 4 cells = 5,840 millivolts observed deflection = 151 divs.,

$$\therefore \quad \frac{151}{4{\cdot}35} = 34{\cdot}71 \text{ milliamperes.}$$

$$\therefore \quad \frac{4{,}380}{26{\cdot}2} - 1{\cdot}2 = 166\omega, \quad \text{and} \quad \frac{5{,}840}{34{\cdot}71} - 1{\cdot}2 = 167\omega.$$

The E.C. was almost negligible, and it was evident by the absence of polarisation with either zinc or carbon that no intervening submarine defect was responsible for the failure to communicate, and it was suspected and subsequently proved that the lightning guard wire had broken and somewhat imperfectly earthed the cable at the distant end. It is always advisable to estimate the "appreciation" in making a measurement, which, in the case where the four cells were used, would be $\frac{167 + 1{\cdot}2}{151}$, or nearly 1·11ω per division. At the same time, a quarter of a division could easily be appreciated, and consequently the *total* appreciation would be well within a quarter of an ohm. It follows from this that, in order to minimise the error due to any slight error of observation, the deflections should always be made as great as possible, for, in common with other deflection methods, the resultant percentage error will be $\lambda = 100\frac{d}{c}$, where d is the defect or excess on the *true* reading c. It may be of interest to relate that the instrument used above was requisitioned in lieu of the signalling galvanometer on a cable 1,200 nauts long, having a KR of about 3·5 millions.

To Measure the Resistance of Earths.—Where resistances have to be measured in which differences of potential result in *earth* or other currents, the procedure requires modification. This applies generally to the measurement of resistances of "earths" in which it is the exception rather than the rule to find two at the same potential. The following method has given very satisfactory results in practice.

A cell or battery having an E.M.F., E, and internal resistance, b, is first joined up through a milammeter, m, and a resistance, R, of such value that a conveniently large reading, c_1, is obtained.

Then

$$\frac{E}{R_1} = c_1, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

where $R_1 = b + m + R$. Next, in simple circuit with this system, join through on one pair of the earths (see Fig. 1), taking care to leave all other conditions unaltered. Then depress the battery key K again, and note the current c_2, which will be

$$\frac{E + e}{R_1 + x_1} = c_2 \quad \text{or} \quad c_2 = \frac{E}{R_1}\left(\frac{R_1}{R_1 + x_1}\right) + \frac{e}{R_1 + x_1}, \quad . \quad . \quad (21)$$

where e represents the natural potential difference of the couple, which in this case is assumed to produce a current in the same direction as that due to the battery, whilst x_1 is the true resistance of the two earths A and B. Reverse the testing current and note the reading c_3, or

$$\frac{E - e}{R_1 + x_1} = c_3, \quad \therefore \quad c_3 = \frac{E}{R_1}\left(\frac{R_1}{R_1 + x_1}\right) - \frac{e}{R_1 + x_1}. \quad . \quad . \quad (22)$$

Equating (21) and (22), after substituting value $\frac{E}{R_1} = c_1$, as given in equation (20), we have

$$c_2 - c_1\left(\frac{R_1}{R_1 + x_1}\right) = c_1\left(\frac{R_1}{R_1 + x_1}\right) - c_3,$$

$$\therefore \quad x = R_1\left\{\left(\frac{2c_1}{c_2 + c_3}\right) - 1\right\}. \quad . \quad . \quad . \quad . \quad . \quad (23)$$

This, then, provides for the elimination of the effects of a steady E.C., and it is only necessary to place a reverser in both the battery and milammeter circuits, so that the changes may be made with fair rapidity, to minimise possible errors by polarisation of the battery or the earths themselves if imperfect. A tray or secondary cell, or in the absence of these, ordinary cells placed in parallel, can be made quite constant enough to admit

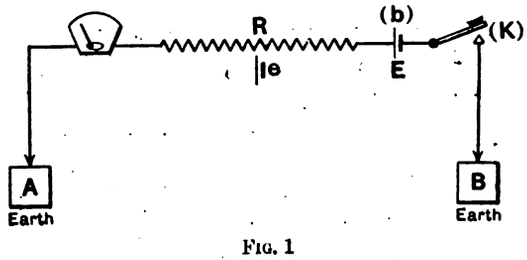

FIG. 1

of good results being obtained. It is not necessary to know the value of E or e, whilst by placing a few cells in parallel the polarisation of the battery can be minimised, and its resistance b made so small as to be ignored. It is important that both E and R_1 should be reduced to their lowest practicable limits, especially when the resistance of the earths to be measured is small. The reason is sufficiently evident upon consideration of the fact already alluded to, that if D represents the total deflection in divisions, the appreciation per division corresponds to $\frac{1}{D}$th part of the *total* resistance in circuit during the test. The process has to be repeated with earths A and W, and then with B and W, so as to find the individual resistance of each earth by the usual formulæ:

$$\begin{aligned} &A + B = x_1, \qquad A + W = x_2, \qquad B + W = x_3 \\ &\therefore A = \tfrac{1}{2}(x_1 + x_2 - x_3),\ B = \tfrac{1}{2}(x_1 + x_3 - x_2),\ W = \tfrac{1}{2}(x_2 + x_3 - x_1), \end{aligned} \quad (24)$$

Example.—Three dry cells were joined in parallel, and the preliminary reading c_1 was 121·5 milliamperes steady with $R_1 = 11{\cdot}3\omega$. The battery resistance b was so small as to be negligible. The three earths to be tested were taken in couples:—

$$\text{With A + B} \begin{cases} c_2 = 104{\cdot}7 \\ c_3 = 98{\cdot}5 \end{cases} \quad \therefore \quad 11{\cdot}3\left\{\left(\frac{2 \times 121{\cdot}5}{104{\cdot}7 + 98{\cdot}5}\right) - 1\right\} = 2{\cdot}15\omega,$$

$$\text{With A + W} \begin{cases} c_2 = 59{\cdot}5 \\ c_3 = 57{\cdot}0 \end{cases} \quad \therefore \quad 11{\cdot}3\left\{\left(\frac{2 \times 121{\cdot}5}{59{\cdot}5 + 57{\cdot}0}\right) - 1\right\} = 12{\cdot}3\omega,$$

$$\text{With B + W} \begin{cases} c_2 = 58{\cdot}0 \\ c_3 = 57{\cdot}5 \end{cases} \quad \therefore \quad 11{\cdot}3\left\{\left(\frac{2 \times 121{\cdot}5}{58{\cdot}0 + 57{\cdot}5}\right) - 1\right\} = 12{\cdot}4\omega,$$

from which

$$A = \frac{2{\cdot}15 + 12{\cdot}3 - 12{\cdot}4}{2} = 1{\cdot}02\omega,$$

$$B = \frac{2{\cdot}15 + 12{\cdot}4 - 12{\cdot}3}{2} = 1{\cdot}13\omega,$$

$$W = \frac{12{\cdot}3 + 12{\cdot}4 - 2{\cdot}15}{2} = 11{\cdot}3\omega.$$

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The ease with which this process is carried out is remarkable, and it has the advantage over the bridge method in being a continuous test, in which any imperfections in the earths are revealed at once.

If the current due to the natural potential difference between the earths is great enough to be used without any auxiliary battery, it is merely necessary to take *two* current readings respectively with resistances $(R+m)$ and $(R+m+d_1)$ in circuit.

Then n being the ratio of currents, the formula is

$$x_1 = \frac{d_1}{n-1} - (R+m). \quad . \quad . \quad . \quad . \quad . \quad (25)$$

To Find the Resistance of a Galvanometer.—Join up a battery through the milammeter m and resistances r_1 and s, the former being adjustable for varying the current, whilst s should be a resistance capable of carrying that current without any heating error. The galvanometer G having an adjustable resistance, R_g, in simple circuit with it, is shunted by s, as shown in Fig. 2.

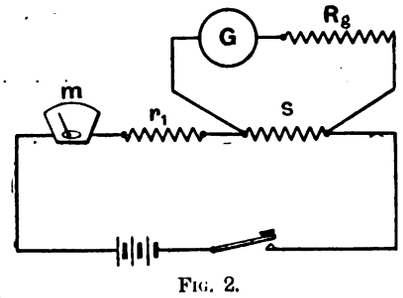

FIG. 2.

1. Make $R_g = 0$, and, with a current, c, through the milammeter circuit, get a conveniently large deflection, D, on the galvanometer. Then

$$c\left(\frac{s}{G+s}\right) = D, \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

the deflection representing the current through G.

2. Next unplug R_g in the galvanometer circuit, and with shunt s_1 get a convenient deflection, d, the current now being c_1, in the milammeter circuit. Therefore

$$c_1\left(\frac{s_1}{G+R_g+s_1}\right) = d, \quad . \quad . \quad . \quad . \quad (27)$$

the deflection representing the current through G.

With a Thomson or other galvanometer, giving deflections proportional to the currents, we have

$$D/d = k \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (28)$$

Practically, it will be convenient to keep both c and s constant, in which case, after dividing equation (26) by equation (27), and introducing value of $D/d = k$, we get

$$G = \left(\frac{R_g}{k-1}\right) - s. \quad . \quad . \quad . \quad . \quad . \quad (29)$$

The battery selected for this test should be a constant one, and the deflections should be corrected for scale error.

Example.—A Sullivan galvanometer having a shunt, s, across it of 0·2ω, gave a corrected deflection of 414 divisions, the current in the milammeter circuit being 80 milliamperes.

By unplugging 630ω in R_g the deflection became 207 divisions.

$$\therefore \quad G = \left(\frac{630}{\frac{414}{207}-1}\right) - 0{\cdot}2 = 629\ 8\omega.$$

The real resistance as determined by bridge was 626ω at the time. This method, depending as it does upon the constancy of s, and the accuracy with which not only c, but also the deflections D and d are estimated, together with the probable slight disproportion, even when scale error is allowed for, should never be adopted except as an approximation, preference being given to Thomson's or ordinary bridge method.

It is only described as one of the applications to which a milammeter may be put in an emergency.

To Find the Constant of a Galvanometer by Milammeter.—The connections for this purpose are similar to those used for finding the resistance of a galvanometer (see Fig. 2), except that the resistance R_g is not required. Let c be the current through milammeter in *microamperes*, s the shunt, G the galvanometer, and d the number of divisions deflection on it.

The current through the shunt will be $\frac{cG}{G+s}$.

Then

$$\frac{csG}{d(G+s)} = v_m, \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)$$

the number of *microvolts* at the galvanometer terminals per unit deflection.

$$\therefore \quad \frac{cs}{d(G+s)} = \frac{v_m}{G} = a_m, \quad . \quad . \quad . \quad . \quad : \quad (31)$$

the number of *microamperes* per division.

Consequently, to find the "constant," it is merely necessary to divide the E.M.F. (*volts*) of the battery intended to be used by the *microamperes* per unit deflection, or

$$E/a_m = D, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (32)$$

the number of megohms necessary to produce unit deflection, or the number of divisions per megohm.

When the resistance of the galvanometer is very large in comparison with the shunts across it, equations (30) and (31) simplify to

$$cs/d = v_m, \quad . \quad . \quad . \quad . \quad . \quad . \quad (30A)$$

and

$$\frac{cs}{dG} = \frac{v_m}{G} = a_m. \quad . \quad . \quad . \quad . \quad . \quad . \quad (31A)$$

These simplifications could always be applied provided the current were measured in the shunt circuit alone, but this would necessitate the galvanometer being placed as a shunt on $(m+s)$. But since $(m+s)$ should be known very accurately, and m being more susceptible of change than the platinum-silver or other low coefficient resistance coils that would ordinarily be used for s, the plan is not to be recommended. Although in practice s can generally be made so small in comparison with G that equations 30A and 31A suffice, it is always best to adopt their parent formulæ without limitations.

Example.—The current through a circuit consisting of a Sullivan galvanometer having a resistance 639·5ω, shunted by a resistance of 1ω was 29·6 ÷ 2 = 14·8 milliamperes (14,800 microamperes); whilst the deflection on galvanometer amounted to 338 divisions. Required to know the "constant" with 21·46 volts. The microamperes per division are

$$\left\{\frac{14{,}800 \times 1}{388(639{\cdot}5+1)}\right\} = 0{\cdot}05954.$$

Therefore, the constant would be $\frac{21{\cdot}46}{0\ 05954} = 360{\cdot}4$ divisions per megohm. The actual constant observed with 1Ω in circuit was 358 divisions, or only an error of about 0·7 per cent.

Observe, that since the figure of merit of a galvanometer is defined as the reciprocal of the current per unit deflection, from equation 31 it is evident that it may also be determined by dividing the galvanometer resistance by the "microvolts per division," the result being in megohms per volt-division.

In finding the constant of a galvanometer by milammeter when a universal Ayrton-Mather or Sullivan universal shunt is used, it is important that for reasons of simplicity the shunt should be full open—that is to say, plugged in the $\frac{1}{1}$th section—and allowance should be made for the resistance of the shunted galvanometer, for instance:—

The joint resistance of a Thomson marine galvanometer 7,216ω having a universal shunt of 30,000ω across it was

$$\frac{7{,}216 \times 30{,}000}{37{,}216} = 5{,}817\omega.$$

With $c = 45{,}300$ microamperes, and $s = 1\omega$, the deflection was 376 divisions

$$\therefore \quad \frac{45{,}300 \times 1}{376(5{,}817+1)} = 0{\cdot}0207 \text{ microampere per division.}$$

$$\therefore \quad \text{Constant} = \frac{\text{E.M.F. in volts}}{0{\cdot}0207}.$$

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To Find the E.M.F. of a Polarisable Battery.—It follows as a corollary to equation (32) that if, with a battery, the E.M.F. of which is to be determined, we insert a known high resistance H.R., the product of the current (microamperes) represented by the deflection and the total resistance in circuit (megohms) will give the result in *volts*, or

$$E = D \times a_m \times (H.R. + b + G). \quad . \quad . \quad . \quad . \quad (33)$$

Example.—A galvanometer had a current-constant $a_m = 0{\cdot}06446$ microampere, and on inserting a total resistance $H.R. + b + G = 0{\cdot}5016\Omega$, the deflection was 329 divisions.

$$\therefore \quad E = 329 \times 0{\cdot}06446 \times 0{\cdot}5016 = 10{\cdot}638 \text{ volts.}$$

The result by null-method with slides was 10·650 volts. In most cases b is so small relatively to H.R. that it may be ignored, but with standard cells having small plates, such as the usual pattern of Clark's, fallacious results are often obtained when comparisons are attempted through resistances, these apparent discrepancies of E.M.F. being generally solely due to their internal resistance, which sometimes runs up to several thousands of ohms.

(*To be continued.*)

A NEW ENCLOSED ARC LAMP.

The present system of operating two direct-current enclosed arc lamps in series on circuits of 200 to 250 volts, although very satisfactory, is not an ideal one. For the proper regulation of the arc a

Fig. 1

differential control, requiring two sets of windings, is necessary, and if the lamps are to be independent of each other they must have automatic cutouts and substitutional resistances, features which make the lamps rather complicated in construction and somewhat difficult to adjust. The wiring for series lamps is apt to be more expensive than for the simple parallel type, and it is often found necessary to operate two lamps when one would give sufficient light.

There is undoubtedly a large field for a lamp to operate singly on 200 to 250-volt circuits, giving a quality of light equal to that obtained with a series multiple lamp. A multiple lamp operating singly within these limits of voltage with a small current and an arc of about 150 volts has been used to some extent, and has proved very satisfactory for certain classes of work, but the combination of small

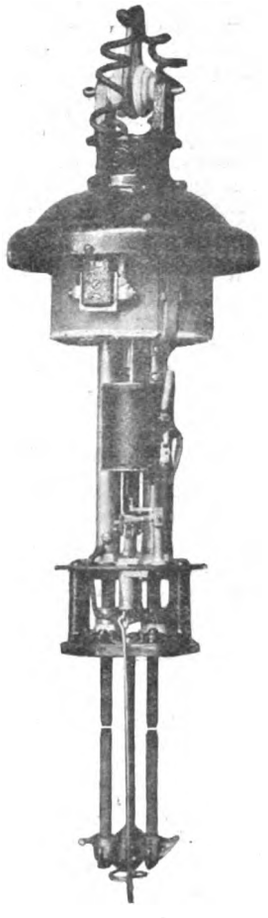

Fig. 2.

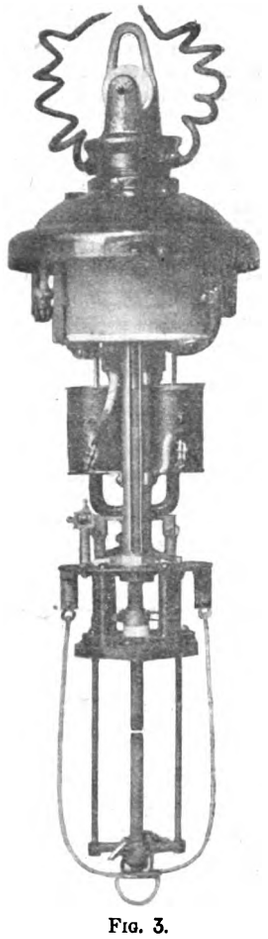

Fig. 3.

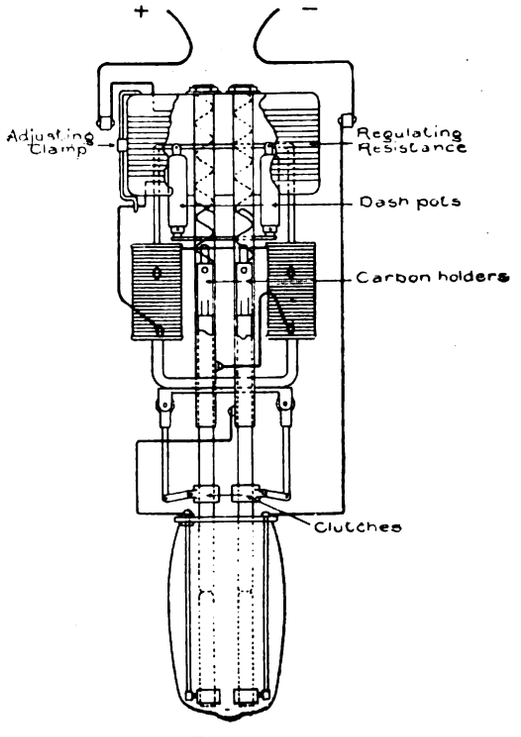

Fig. 4.

current and long arc gives a purple tinge to the light, which is sometimes considered objectionable.

The British Thomson-Houston Co. have brought out an enclosed arc lamp for single operation on high voltage direct-current circuits, which, they state, is quite as efficient as the long arc multiple lamp,

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and gives a perfectly white light equal in quality to that from a standard 5-ampere 80-volt arc. To obtain these advantages it is necessary to divide the voltage equally between two arcs, and this is what is done in the B.T.H. "twin-carbon" lamp. The standard lamp takes 2¾ amperes and the two arcs are in series with 80 volts at each arc; and the makers point out that it offers special advantages in cases where the consumers' supply is being changed from 100 or 200 volts alternating to 200 or 250 volts continuous, as alternating lamps operating in parallel can be replaced by twin carbon lamps without changing the wiring or the arrangement of the lamps.

The controlling mechanism is very simple, consisting of a steadying resistance and a pair of magnets connected in series with the two arcs across the 200 to 250 volt line. A single armature operates the clutches for both carbons, so that both feed together, and it is impossible for one arc to rob the other to an appreciable extent. The carbons are placed very close together, so that to the observer the effect is the same as if the light emanated from a single arc; 11mm. carbons are used, and with 12in. upper and 5in. lower the lamp will burn 130 to 150 hours with one trimming.

The twin carbon lamp has been designed along the same lines as the other B.T.H. enclosed arc lamps, and is really only a new combination of parts of a standard mechanical design. All lamps are weather-proof and have solid copper casings. No sliding contacts or springs are used, and all parts of the mechanism are readily accessible for inspection or repair. Fig. 1 is a view showing the lamp complete with inner and outer globes. Figs. 2 and 3 are inside views from different points showing the twin carbons, steadying resistance, magnetic coils and general mechanism of the lamp. The inner globe is held in position by a wire cradle attached to the frame by two spiral springs shown in Fig. 3. These keep the globe pressed up against the globe-cap excluding the air. Fig. 4 is a diagram showing the various connections of the lamp.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Encyclopædia Britannica." New Volumes. No. 4. Ele–Gla. (London: *The Times.*)

"L'Electricité à l'Exposition de 1900." By E. Hospitalier and J. A. Montpellier. No. 12. (Paris: Vve. Ch. Dunod.)

"Calendar of the Glasgow and West of Scotland Technical College." Session, 1902-1903.

"Proceedings of the Cambridge Philosophical Society." Vol. XI. Part VI. Easter Term, 1902. (Cambridge: University Press.) 2s. 6d.

"Proceedings of the Royal Society." No. 464. Vol. LXX. (London: Harrison & Sons.) 2s. 6d.

"Induction Coils for Amateurs." No. 11. The "Model Engineer" series. Edited by Percival Marshall. (London: Dawbarn and Ward.) 6d.

ELECTRICITY WORKS ACCOUNTS.

Chester Municipal Electric Supply Works.

It is not surprising that, with the very low cost figures which are habitually shown by this undertaking, there should occasionally be a slight increase shown in the expenses. In the year ended at March 31st last the load-factor at Chester was lower than in the preceding year by 0·6. This is really sufficient to account for the slight increase in the total costs of (deducting public lighting costs) only 0·034d. per unit. It is the management and property charges that were accountable for the slight rise there was in the total, the rates and taxes having gone up 0·04d. and management costs 0·03d. per unit.

The aggregate costs still stand at a value quite 0·5d. under what they might have been expected to be from a study of municipal costs in 1900–1, and the capital expenditure, in its relation to the output, shows up equally favourably.

In these circumstances it is not surprising that the financial results shown are excellent, produced as they were on a total revenue of only 3·26d. per unit. The working profit, amounting to 6·6 per cent. on the mean capital, was all set aside either in capital charges or else in reserve.

Tunbridge Wells Municipal Electric Supply Works.

In the year covered by the second column of our analysis of this undertaking's accounts the increase in the lamp connections (at 8,113 lamps) was larger than in any preceding year. A great improvement has been effected in the costs, and, making allowance for the undoubtedly high price of coal at this place, the works costs are now very satisfactory. We learn from the engineer's report that the price of coal in 1899–1900 was 20s. 9d., in 1900–1 36s. 6d., and last year 27s. 2d. per ton, exclusive of costs of unloading, and that the price paid for water is 9d. per 1,000 gallons supplied. The chief seat of increased economy was the collective management and property charges. In 1900–1 these expenses were considerably too high at 0·67d. per unit. They have now been reduced to the comparatively satisfactory value of 0·55d. per unit sold. Included in the establishment charges is £210 paid to the district fund as the proportion of general salaries and establishment charges.

In view of the moderate total revenue of 3·96d. per unit, exclusive of public lighting renewals and attendance, the working profit of 6·46 per cent. on the mean capital is a good result, and is the more creditable considering the high price paid for fuel.

At the load-factor of 13·4 per cent. the capital expenditure relatively to the output works out remarkably low. It is to this fact that, in spite of the necessarily high fuel cost, is due the respectable financial results shown.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Isle of Wight (Company)	Dec. 20, 1901
Accrington (Municipal)	July 25, 1902	Islington (Municipal)	Nov. 23, 1900
Ayr (Municipal)	Oct. 11, 1901	Kens'gton & Knightsb'(Co.)	Apr. 11, 1902
Barnsley (Municipal)	June 27, 1902	Kingston-upon-Hull (Mun.)	July 13, 1900
Bath (Municipal)	April 20, 1900	Kingston-on-Thames (Mun.)	June 20, 1902
Bedford (Municipal)	Aug. 8, 1900	Lancaster (Municipal)	July 25, 1902
Belfast (Municipal)	Aug. 8, 1902	Leeds (Municipal)	June 27, 1902
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 26, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal	Oct. 4, 1901	Leyton (Municipal)	Nov 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Sept. 13, 1901
Bristol (Municipal	Aug. 8, 1902	Morley (Municipal)	July 25, 1902
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	July 11, 1902	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	July 11, 1902	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Nov. 29, 1901
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1903
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 16, 1901	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 28, 1900	Richmond (Company)	June 29, 1900
Crewe (Municipal)	July 11, 1902	Salford (Municipal)	Jan. 24, 1902
Croydon (Municipal)	Nov. 22, 1901	Scarborough (Company)	Dec. 20, 1901
Crystal Palace District (Co.)	Sept. 13, 1901	St. Helens (Municipal	Jan. 10, 1902
Derby (Municipal)	Jan. 26, 1900	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. Pancras (Municipal)	July 5, 1901
Dover (Company)	May 2, 1902	Sheffield (Municipal)	Feb. 1, 1901
Dundee (Municipal)	Dec. 6, 1901	Shoreditch (Municipal)	Jan. 31, 1902
Eastbourne (Municipal)	Mar. 14, 1902	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Edinburgh (Municipal)	Dec. 6, 1901	South London (Company)	May 16, 1902
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 4, 1902
Folkestone (Company)	May 2, 1902	Southampton (Municipal)	Aug 1, 1902
Glasgow (Municipal)	Sept. 27, 1901	Southport (Municipal)	Jan. 17, 1902
Gloucester (Municipal)	Aug. 20, 1901	Stafford (Municipal)	Aug. 16, 1901
Great Yarmouth (Mun.)	Dec. 13, 1901	Sunderland (Municipal)	Aug. 1, 1902
Greenock (Municipal)	Aug. 30, 1901	Taunton (Municipal)	June 16, 1899
Guildford (Company)	Oct. 19, 1900	Tunbridge Wells (Mun.)	Nov. 1, 1901
Halifax (Municipal)	Dec. 27, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hammersmith (Municipal)	Nov. 15, 1901	Walsall (Municipal)	May 23, 1902
Hampstead (Municipal)	Nov. 22, 1901	Wandsworth (Company)	May 9, 1902
Hanley (Municipal)	Aug. 9, 1901	Westminster (Company)	April 4, 1902
Harrogate (Municipal)	Jan. 25, 1901	Whitehaven (Municipal)	Feb. 8, 1901
Harrow (Company)	Dec. 21, 1900	Winchester (Company)	June 20, 1902
Hastings (Municipal)	July 18, 1902	Windsor and Eton (Co.)	July 19, 1901
Hereford (Municipal)	Jan. 17, 1902	Woking (Company)	Dec. 22, 1899
Hove (Company)	July 18, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Huddersfield (Municipal)	May 23, 1902	Woolwich (Company)	May 31, 1901
Hull (Municipal)	July 4, 1902	Worcester (Municipal)	April 18, 1902

REMARKS.

CHESTER.—*a* 63,257 used in batteries and transformers. *b* There are 96 10-amp. open type and 69 4-amp. enclosed arcs, and 313 16 c.p. glow. *c* No lands. *d* 9,363 on street lamps. *e* Over-expended. *f* Engineers' department. *g* Insurances. *h* Less 5 per cent. discount for cash and discounts up to 15 per cent. according to quantity. *i* According to quantity. *j* 59,195 used in batteries and transformers. *k* In "reserve" fund. *l* Accumulators £1,245, street lamps £9,959. *m* To "reserve" fund.

TUNBRIDGE WELLS.—*a* No land, £568 on transformer chambers. *b* Meters £2,818, public lamps £3,003, and transformers £2,074. *c* Over-expended. *d* Coal £3,615, coke £616. *e* Carbons £42, globes, fittings, repairs, &c., £29. *f* Engineer £350, assistant engineer £150. *g* Proportion of general salaries and establishment charges—to district fund £190 in 1900-1 and £210 in 1901-2. *h* Insurance £32, proportion of stock expenses £25. *i* Maximum demand system (1 hour scale). *j* Meters £3,851, public lamps £3,269, transformers £2,074. *k* Coal £3,777, coke £349. *l* Carbons £52, globes, repairs, £43. *m* Engineer £400, assistant engineer £150. *n* Stock expenses £24, law £12, insurance £34. *o* Registered at Christmas for about 5 minutes.

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	CHESTER.		TUNBRIDGE WELLS.	
Undertaking Worked by	Chester Corporation.		Tunbridge Wells Corporation.	
Date of Commencement of Supply	December, 1896.		1895.	
System of Supply	3-wire continuous-current, with batteries.		Alt.-current trans. sub-stations and house [transformers.	
Chief Engineer	F. Thursfield.		H. L. P. Boot.	
YEAR ENDED	MAR. 31, **1901.**	MAR. 31, **1902.**	MAR. 31, **1901.**	MAR. 31, **1902.**
QUANTITIES—				
Units generated	944,857	1,024,046	702,574	800,160
„ **SOLD (TOTAL)**	780,567	840,960	564,827	659,000
„ sold to consumers	513,854	521,763	374,220	447,403
„ sold for public lighting, &c.	266,713	319,197	190,607	211,597
„ sold for traction	nil	nil	nil	nil
„ used on works	100,933[a]	123,892[j]	9,087	12,600
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	29·7	28·0	15·4	18·0
Actual maximum supply demanded	527 kilowatts	587 kilowatts	470 kilowatts	560 kilowatts[o]
Load factor	16·9%	16·3%	13·7%	13·4%
Number of public lamps	165 arc, 313 glow[b]	173 arc, 392 (16 c.p.) gl'w	74 arc, 400 (16 c.p.) gl'w	75 arc, 315 (16 c.p.) gl'w
Number of consumers	510	597	600	730
Connections to mains in 8-c.p. lamps at end of year	37,085	38,715	35,260	43,373
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	960	960	1,170	1,170
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£100,000 / £104	£100,000 / £104	£64,682 / £55·3	£64,682 / £55·3
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	100,000 / 104	100,000 / 104	64,682 / 55·3	64,682 / 55·3
RECEIVED (TOTAL)	83,000 / 86·4	83,000 / 86·4	55,000 / 47·0	64,682 / 55·3
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	83,000 / 86·4	83,000 / 86·4	55,000 / 47·0	64,682 / 55·3
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	17,000 / 17·7	17,000 / 17·7	9,682 / 8·28	nil / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	17,000 / 17·7	17,000 / 17·7	9,682 / 8·28	nil / —
REPAID (TOTAL)	nil / —	nil / —	3,615 / 3·09	4,403 / 3·76
RESERVE OR SINKING FUND	6,026 / 6·28	8,574 / 8·93	1,260 / 1·08	2,172 / 1·86
DEPRECIATION FUND	3,897[k] / 4·06	4,659[k] / 4·85	— / —	— / —
EXPENDED (TOTAL)	83,542 / 87·0	92,470 / 96·3	56,013 / 47·9	65 935 / 56·3
Lands and buildings	12,805[c] / 13·3	15,937[c] / 16·6	10,340[a] / 8·84	10,996[a] / 9·40
Plant	41,935[d] / 43·7	45,637[l] / 47·5	27,926[b] / 23·9	35,305[j] / 30·2
Mains	28,464 / 29·6	30,558 / 31·8	16,473 / 14·1	18,344 / 15·7
Miscellaneous	338 / 0·352	338 / 0·352	1,272 / 1·09	1,291 / 1·10
BALANCE OF CAPITAL ACCOUNT	−542[e] / −0·565	−9,470 / −9·86	−1,013[c] / −0·866	−1,253[c] / −1·07
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£11,444 / 3·519d.	£12,753 / 3·640d.	£9,691 / 4·119d.	£11,220 / 4·088d.
Revenue from supply	7,920 / 2·436d.	8,783 / 2·508d.	7,569 / 3·215d.	8,816 / 3·211d.
„ meters, &c.	310 / 0·095d.	363 / 0·104d.	315 / 0·134d.	364 / 0·133d.
„ public lighting	3,153 / 0·970d.	3,504 / 1·001d.	1,518 / 0·646d.	1,886 / 0·687d.
„ supply for traction	nil / —	nil / —	nil / —	nil / —
„ miscellaneous sources	61 / 0·019d.	99 / 0·028d.	289 / 0·123d.	155 / 0·056d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£6,038 / 1·857d.	£6,906 / 1·971d.	£7,340 / 3·119d.	£7,279 / 2·649d.
TOTAL WORKS COSTS	5,034 / 1·548d.	5,599 / 1·598d.	5,756 / 2·445d.	5,768 / 2·101d.
Generation of electricity	*3,974 / 1·222d.*	*4,101 / 1·171d.*	*5,365 / 2·280d.*	*5,350 / 1·949d.*
Fuel (including cartage, &c.)	2,043 / 0·628d.	1,963 / 0·561d.	4,231[d] / 1·797d.	4,117[k] / 1·500d.
Oil, waste, water, stores	370 / 0·114d.	311 / 0·089d.	215 / 0·091d.	315 / 0·115d.
Wages at station	1,084 / 0·333d.	1,016 / 0·290d.	603 / 0·256d.	612 / 0·223d.
Repairs and maintenance at station	478 / 0·147d.	811 / 0·231d.	316 / 0·134d.	306 / 0·111d.
Distribution of electricity	*84 / 0·026d.*	*167 / 0·048d.*	*95 / 0·040d.*	*73 / 0·027d.*
Wages, &c.	84 / 0·026d.	167 / 0·048d.	95 / 0·040d.	73 / 0·027d.
Repairs, renewals of mains, &c.				
Public lighting	*976 / 0·300d.*	*1,331 / 0·380d.*	*296 / 0·126d.*	*344 / 0·125d.*
Attendance	512 / 0·158d.	629 / 0·179d.	224 / 0·095d.	249 / 0·091d.
Renewals	464 / 0·143d.	702 / 0·200d.	72[e] / 0·031d.	95[l] / 0·035d.
MANAGEMENT AND PROPERTY CHARGES	1,004 / 0·309d.	1,307 / 0·373d.	1,585 / 0·674d.	1,512 / 0·551d.
Net rents	*23 / 0·007d.*	*19 / 0·005d.*	*76 / 0·032d.*	*45 / 0·016d.*
Rates and taxes	*129 / 0·040d.*	*268 / 0·077d.*	*294 / 0·125d.*	*203 / 0·074d.*
Management	*851 / 0·262d.*	*1,020 / 0·291d.*	*1,216 / 0·517d.*	*1,264 / 0·460d.*
Salaries	526[f] / 0·162d.	603[f] / 0·172d.	822[m] / 0·349d.	835[m] / 0·304d.
Stationery, &c.	80 / 0·025d.	70 / 0·020d.	53 / 0·023d.	44 / 0·016d.
Establishment charges	139 / 0·043d.	220 / 0·063d.	246[o] / 0·105d.	250[o] / 0·091d.
Law charges &c.	106[g] / 0·033d.	127[g] / 0·036d.	95[h] / 0·040d.	135[n] / 0·049d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£5,406 / 7·24%	£5,845 / 6·64%	£2,351 / 4·76%	£3,941 / 6·46%
Sum carried to Depreciation Fund	1,400 / 1·87%	700[m] / 0·795%	— / —	— / —
Sum carried to Reserve Fund	1,903 / 2·55%	2,397 / 2·72%	1,314 / 2·66%	1,586 / 2·60%
Net interest on loans (incl. Debenture charges)	2,103 / 2·82%	2,748 / 3·12%	1,531 / 3·10%	1,915 / 3·14%
Net profit for the year	nil / —	nil / —	−494 / −1·00%	440 / 0·722%
BALANCE FROM LAST ACCOUNT	— / —	— / —	2,039 / 4·13%	1,545 / 2·53%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	1,545 / 3·13%	1,985 / 3·26%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	52·75%	54·2%	75·8%	64·8%
Expenditure per mean kilowatt capacity	£7. 3s. 10d.	£7. 3s. 10d.	£6. 5s. 5d.	£6. 4s. 5d.
REVENUE PER MEAN KILOWATT CAPACITY	£13. 12s. 5d.	£13. 5s. 7d.	£8. 5s. 7d.	£9. 12s. 0d.
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	6s. 7d.	6s. 9d.	6s. 1d.	6s. 6d.
Price charged for lighting, per unit	4½d.[h]	4½d.[h]	6d. to 3d.[i]	6d. (1 hr.) to 3d.[i]
Price charged for power, per unit	2½d. to 1½d.[i]	2½d. to 1½d.[i]	3d.	3d.
Price charged for public lighting	£21 & £14 per arc, 8d. unit	Same as in 1900-1.	—	1½d. per unit.
Receipts per unit for private supply	3·701. [for glow.	4·05d.	4·85d.	4·73d.
„ „ public lighting	1·96d.	1·63d.	1·54d.	1·75d.
„ „ traction	—	—	—	—

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ELECTRIC TRACTION ON THE NORTH-EASTERN RAILWAY.

An important step towards the "electrification" of our main railway systems has been made in the determination of the North-Eastern Railway Co. to introduce electric traction on their Tyneside lines. In some cases, railway companies, when threatened with competition by new electric lines, have been satisfied with leisurely appointing experts to investigate and report on the matter. In other cases, in which the traffic receipts have been affected by the competition of electric tramways, directors of railway companies have promised their shareholders to consider the claims of electric traction. But the North-Eastern Company have gone further than this, and have actually invited tenders for the electrical equipment of some 40 miles of double-track line—the specifications for which we summarise in an article in another part of this issue. Electric traction has demonstrated its utility—we may say its indispensability—in the case of purely urban railways of the "tube" type, and when the Metropolitan-District scheme is completed we shall have a large system of underground urban railways with suburban extensions. The lines which the North-Eastern Railway is about to equip electrically, however, do not constitute a case in which peculiar conditions necessitate a particular solution. They are typical of the suburban steam-driven railway of which there are hundreds of miles in this country; and the electrical engineer must regard with particular gratification the practical steps which the North-Eastern are taking to give electric traction a fair trial under what has hitherto been regarded as steam railway conditions. Should this experiment prove successful, other railway companies will be obliged to follow the lead of the North-Eastern, and a new era for electric traction will be entered upon.

We use the word "experiment" purely in the sense of commercial experiment in relation to the re-equipment of the lines in question. Were the problem merely that of building a new system of suburban lines, there can be little doubt that electric traction would be selected for such a system without hesitation. Whatever the relative merits and demerits of continuous and polyphase currents, or of the single-phase and series systems championed by Mr. MORDEY and Mr. SWINBURNE, electric traction has proved itself undoubtedly superior to steam traction for dealing with a mass of traffic in the neighbourhood of a large town. The question to be settled is whether this superiority is so great that the financial results will justify a wholesale replacement of rolling stock, and an expensive addition to the existing line in the shape of electric conductors. Present knowledge and experience in electric traction lead to the conclusion that this will be so, especially when this reconstruction is undertaken while the line is still in a healthy financial position, and has not already been deprived of a most remunerative portion of its traffic by tramway competition. Not only should electric traction effect an economy in the

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working costs, but it may be expected to attract new traffic as it has done in the case of "electrified" tramways, and augment the profits by increasing the turnover.

In view of the ultimate effect, therefore, which the remodelling of the North-Eastern Railway Co.'s Tyneside lines may have upon the electrical engineering industry, the extreme broadness of Mr. C. H. MERZ's specification is not altogether unwelcome. Mr. MERZ, as consulting electrical engineer to the North-Eastern Railway Co., is evidently of opinion that the third-rail continuous-current system is the one best adapted to the requirements of the case, but he leaves it open to manufacturers to tender an alternative system if they can show that it would be beneficial. In some respects, however, Mr. MERZ errs on the side of allowing too much latitude. It is right in such a case as this to draft a specification in such a way that manufacturers are at liberty to employ their standard plant and the methods which their engineers have worked out for similar contracts; but it is wrong to give the contractor no guide with regard to the efficiency of working which is to be required and upon which the cost of the system will be largely dependent. The number of sub-stations and feeding points is not specified, and neither is the drop of voltage or loss of power which may be allowed between generating station and motor. The acceleration required of the motor is not stated, nor even the range of forward and backward speed, or the probable variation of load during the day. Information as to these and similar matters should have been placed at the disposal of the firms tendering. They are asked to send in detailed descriptions of the schemes they propose, and will have to acquaint themselves very thoroughly with the local conditions affecting the lines in question, so that no effort should have been spared to save them from unnecessary expense in the preparation of their tenders and to avoid the need for alternative tenders from the same firms. In this, however, although Mr. MERZ errs, he errs on the right side, for, as we have pointed out, more is involved than the electrical equipment of a portion of the North-Eastern Company's system. It is the proverbial thin edge of the wedge, which will open up to electrical engineers a large new field for their industry; and the big electrical engineering firms should, in view of the future, willingly put themselves to considerable trouble and expense to obtain the first place.

Before concluding our remarks on this subject, we wish to say a few words on the question of reliability of electrically-driven railways, a question which is alluded to in the columns of our esteemed contemporary *Engineering* in the course of an able criticism of Mr. MERZ's specification. Our contemporary asks: "Will he advise his clients that certainty in operation is worth paying for, or will he encourage them to take risks for the sake of cutting down expense? Has he absorbed sufficient of the spirit of the railway engineer to regard a breakdown as the worst form of extravagance? Without some knowledge of his views on these points, contractors are groping in the dark in tendering, for they do not know whether it is excellence of design or cheapness of cost that will secure the order." This is not merely unfair to Mr. MERZ; it is unfair to the electrical engineer. From the very nature of the electrical engineering industry, freedom from breakdown is the prime condition that is worked to in every electrical undertaking. Its necessity is impressed upon the mind of the electrical engineer from his student days and pupilage onwards. There is no need for him to "absorb sufficient of the spirit of the railway engineer" to make him regard a breakdown as the worst form of extravagance. Power will be bought from the Newcastle-upon-Tyne Electric Supply Co., which already supplies about 5,000 H.P. to ten of the large engineering works on the Tyne (including some of the largest works in this country) and several smaller works, all of whom are practically dependent on the continuity of their electrical supply. A company which is already meeting this large demand for electric power continuously is in a particularly favourable position to increase its capacity in order to supply an additional 3,000 H.P. or 4,000 H.P. (which will probably be the power required by the railway company) with absolute freedom from breakdown. And as regards the distribution and utilisation of the power on the line itself, electrical engineers have ample experience in this, and breakdowns on electrically-driven lines are, and doubtless will continue to be, as rare as on steam-driven railways. On this head the North-Eastern Railway Co. need have no misgivings. The only element of uncertainty is the precise gain, measured in pounds sterling, which will be brought about by the adoption of electric driving; and in this respect also we do not believe that the directors of the North-Eastern Railway Co. will have reason to regret their determination to employ the electric motor in place of the locomotive engine on their suburban lines.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

The New Volumes of the Encyclopædia Britannica. (Edinburgh and London: A. and C. Black and *The Times*. 1902.)

THIRD NOTICE.

The third of the new volumes of the "Encyclopædia Britannica," embracing from "Chicago" to "Elduayen," contains few articles of direct interest to electrical engineers. It opens with an excellent "Prefatory Essay" on "The Influence of Modern Research on the Scope of World History," by Mr. Henry Smith Williams, chiefly devoted to pointing out the effect the study of archæology has had in changing our point of view with regard to the chronology of ancient history. Passing by articles on China, Cholera and the Christian Church, and an excellent survey of the improvement in chronographs during the past 20 years by an occasional contributor to *The Electrician*, the Rev. F. J. Jervis-Smith, we come next to a chronological table of the "leading events in every country" since 1875. In this we regret to see that scientific invention and landmarks in engineering progress are not considered "leading events." To our mind the invention of the telephone in 1876 was an event of greater importance than, for instance, the creation of Mr. Disraeli Earl of Beaconsfield; and we do not think we can be accused of rashness in asserting that the world has obtained more satisfaction and benefit by the discovery of X-rays than the award of the poet laureateship to Mr. Alfred Austin which was announced almost simultaneously. Yet the elevation of Disraeli to the peerage and of Austin to the laureateship are chronicled as important events, while the claims of Graham Bell and Röntgen are ignored.

"Coal," by Mr. H. Bauerman, lecturer in metallurgy at the Ordnance College, Woolwich, is the next article that claims our attention. In this we should have welcomed more detail as to electric coal cutting and some account of the present status of the miner's electric safety lamp. "Compass" is an excellent article from the pen of Capt. E. W. Creak. "Copper" (by Mr. James Douglas, a past-president of the American Institute of Mechanical Engineers), contains a short section (unillustrated) on electrolytic refining, reference being made to "Electro-chemistry" for more. This section, however, is well and clearly written, and contains one or two useful quantitative data. There is a good article on the general design and utility of "Destructors" by Mr. W. H. Maxwell, containing much on their application to electricity works. A paragraph on "difficulties" is rather too hopeful, however,

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especially as to the differences in load-curve of a destructor and an electricity works; a useful system of thermal storage has yet to be developed.

"Dynamo" is written by Mr. C. C. Hawkins, and is to a certain extent disappointing. So much progress has been made in dynamo design since the article on Electricity was written for the previous edition of the "Encyclopædia Britannica," that Mr. Hawkins might fairly have started his subject *de novo*. At times Mr. Hawkins' essay is not sufficiently clear in explaining elementary conceptions, and at other times it is too general and non-technical in character. The addition of two good large-scale drawings, of a modern continuous-current machine and a modern alternator respectively, accompanied by a clear and concise description of these two machines and their constituent parts, would have rendered the article what it should be, and there is much redundant matter that might have been omitted to make room for this. We must protest against the use by Mr. Hawkins of the word "inductor" for that part of a closed conducting circuit which cuts magnetic lines of force. The word inductor rather implies that which induces than that which is subjected to an inductive effect, and, in fact, the word "inducteur" is used in French to indicate the field magnet and not an armature winding. The iron inductor in an inductor alternator performs an entirely different function to the copper "inductor" of Mr. Hawkins, and if the latter meaning were adopted it would lead to a most undesirable confusion of terms.

An article on "Dynamometer," by Prof. W. E. Dalby, includes an excellent illustrated description of the Froude water brake, but does not mention the Foucault current brake which is now extensively employed for testing small motors. "Education," by Sir Joshua Fitch, refers only briefly to technical education, as a separate article will be devoted to this subject. The following articles in the third volume may also be mentioned:—"Condensations of Gases" (Prof. J. D. Van der Waals), "Conduction of Heat" (Prof. H. L. Callendar), "Differential Equations" (H. F. Baker), "Diffraction Gratings" (the late Prof. H. Rowland), "Dimensions of Units" (Dr. J. Larmor), and "Dynamics, Analytical" (Prof. Horace Lamb). There are also biographies of Warren de la Rue, Prof. Dewar and Mr. T. A. Edison.

Les Applications Pratiques des Ondes Electriques. By Albert Turpain. (Paris: C. Naud). 412 pp.

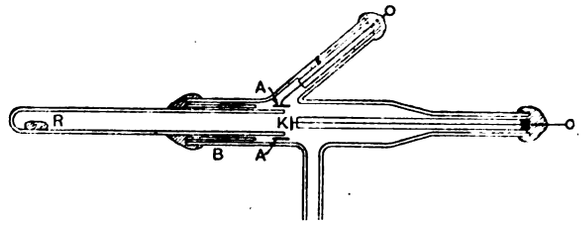
This collection of all the matter likely to be of important service to the electrical engineer concerned with wireless telegraphy and high-frequency currents is of considerable utility at the present time. The various types of instruments concerned in the operations are described both historically and practically. Thus we have descriptions of the original Hertz exciter, as well as the subsequent devices of Sarasin-de la Rive, Blondlot, Lodge, Righi, Lebedew and Bose. As regards the detection of electric waves, it is well realised that the coherer holds the field, but it is of some interest to remember that before the work of Branly and Lodge the Hertzian wire-ring, the electrometer, the telephone, the galvanometer, and the vacuum tube had all been used as detectors. Among the coherers described are those of Popoff (iron filings), Marconi (silver nickel), Blondel (regenerative), Tommasina (auto-decohering carbon), and Tissot (magnetic, nickel filings). The anti-coherers devised by Neugschwender and Aschkinass are also described, but it is strange that Schäfer's name is omitted. We also have a mention of Righi's silver strip resonator, Lebedew's thermo-electric resonator, and Bose's steel-wire coil coherer. Altogether, the list may be said to be fairly complete, and what illustrations are given of the various intruments are very clear and instructive. The manifold types of induction coils and interrupters are exceptionally fully treated, but, as the author rightly observes, this is "due to the importance of choosing a good interrupter and a good coil in order to reproduce the various phenomena described." We have thus the coils devised by Apps, Davis and Elihu Thomson, as well as the high-tension transformers of Wydts-de Rochefort (pasty insulator) and Klingelfuss (horse-shoe core). Among interrupters of the Foucault type we find those devised by Wydts and de Rochefort (mercury-platinum contact), Margot (spring contracted by electro-dynamic force), Villard (tuning fo.k), Grimsehl (water current), and the revolving interrupters of Ducretet-Le Jeune, Lacroix and Lévy. The Wehnelt and Simon interrupters are similarly dealt with. The third chapter gives an historial account of the development of wireless telegraphy, and as full a description of the Marconi, Slaby and other systems as was available up to the end of 1901. The three remaining chapters are less immediately connected with wireless telegraphy, dealing as they do with wire wave telegraphy, Tesla currents and the application of high-frequency currents to electric lighting. An exceedingly valuable appendix contains a list of French, British, German and American patents in respect of wireless telegraphy. They begin with Marconi's patent of November, 1896, and comprise, besides Marconi's six further patents, Slaby and Arco's German patent of December, 1898, Braun's patent of October, 1898, and Kitsee's nine American patents, beginning May, 1899. We also find a description of Jammeson and Trotter's proposed wireless torpedo steering gear, and Orling and Braunerhjelm's "commande à distance" apparatus.

E. E. F.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Luminescence of Metallic Vapours.—P. Lewis has studied the fluorescence of metallic vapours under the influence of cathode rays. This fluorescence is interesting as shedding light upon the phenomena produced by the impact of electrons upon metallic molecules, not in the solid state as dealt with by Thomson, but in the gaseous state. In order to avoid a current through the metallic vapour, the apparatus shown in the diagram was used. AA was a ring anode surrounding the cathode K. The metal R was contained in a hard glass tube B, cemented in with sealing wax. The cathode rays thus



proceeded at right angles to the lines of current. Sodium vapour showed an orange coloured glow below red heat, in which the D lines could be observed. At a red heat this glow became greenish-yellow, and lines appeared in the red, green and blue. But all these lines only appeared when the cathode rays were strong enough to produce a fluorescence of the glass wall, and they disappeared on deflecting the cathode rays magnetically. Potassium showed the yellow potassium lines and the D lines due to impurity. Magnesium vapour showed the green triplets at a low red heat. Mercury vapour showed well defined and characteristic lines. Zinc showed the violet triplet below red heat. Sulphur, selenium, and tellurium gave a feeble blue continuous spectrum.

[P. Lewis, *Physikal. Zeitschr.*, August 1, 1902.]

Transition Resistance.—An electric spark, or more properly speaking, a self discharge, cannot occur until the difference of potential of the electrodes possesses a certain value. For small distances, l, between the electrodes the discharge potential V may be described as a linear function of l. The minimum amounts to several hundred volts, about 320 in Kelvin's experiments on plate electrodes and Borgesius' experiments on globular electrodes. Maxwell supposed that there might be a condensation of air at the surface of the electrodes, leading to an increase of resistance, and his explanation was in favour until Borgesius showed by an optical method that no such condensation takes place. Latterly, the favourite explanation, or rather expression, has been "transition resistance." But that there is no ohmic resistance between a metal and a gas may be shown by ionising the gas between the electrodes, but not the gas immediately covering their surfaces. The

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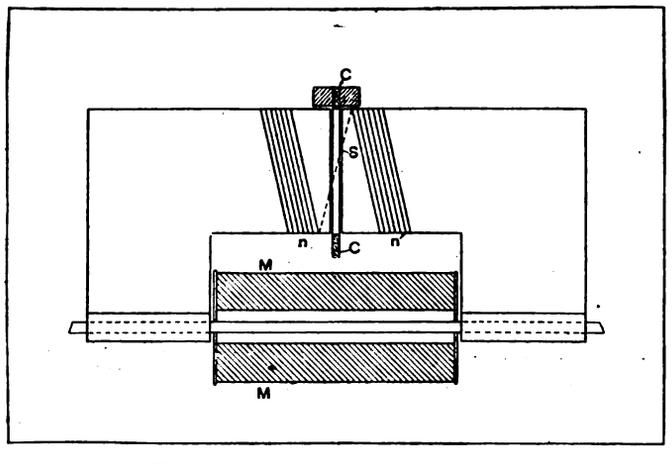
resistance then practically disappears. J. Stark bases his own explanation upon the theory of ionic shock. The discharge potential has its minimum value when the distance between the electrodes equals the mean free path of the positive ions. These must be capable of ionising by ionic shock before any discharge can take place.

[J. STARK, *Physikal. Zeitschr.*, August, 1, 1902.]

Electric Response of Living and Dead Matter.—J. C. Bose is gradually making some headway in his attempts to co-ordinate the phenomena of living and dead matter. According to Waller, "the most general and delicate sign of life is the electric response," and in order to demolish the conception that this electric response is due to a special "vital force," the author proceeds to reproduce the various forms of the electric response to stimulus in animal, vegetable and mineral matter. A nerve, a vegetable fibre and a wire show similar responses to mechanical shock when stretched between two unpolarisable electrodes. Platinum and some other metals also show "fatigue"—*i.e.*, the diminution of the reaction on repeated application. In other cases, again, there is an increased reaction. The effect of heat is the same in animal and vegetable tissue, as it reduces the reaction and eventually "kills" the tissue—*i.e.*, makes it incapable of response. The "stimulating" effect of sodium carbonate upon the response of platinum, and the "poisoning" effect of potash or oxalic acid upon tin are striking analogies, and so is the stimulating effect of a small dose of a substance which in larger quantities acts as a poison. It now remains for the author to finally dispose of "vital force" by restoring the capacity of response in dead animal or vegetable matter, as it can be restored in metals.

[J. C. BOSE, *Journ. de Phys.*, August, 1902.]

Effect of Alternate Currents on Hysteresis.—The effect on the hysteresis cycle of passing an alternating current longitudinally through an iron wire has been studied by Fienzi,



Gerosia and Klemencic. Z. E. Crook has endeavoured to discover if there is an effect due to the current independent of that produced by the circular magnetism. The first question to be solved was how to eliminate the electromagnetic action so that the effect of the current alone could be studied. This was done, approximately, by making use of the principle discovered by Ampère, that when two adjacent currents in parallel conductors flow in opposite directions, the external field of force of the one tends to destroy that of the other. In order to be effective in destroying the internal as well as the external magnetic actions of the current, it was necessary to build up the iron from very thin laminæ, and send the current in opposite directions in each alternate layer. A bar of iron was made up of 18 strips of sheet iron, each 40cm. long and 0·045cm. thick. These were joined at the ends and insulated from each other by strips of shellaced paper. The yoke shown in the diagram, and already described (*The Electrician*, Vol. XLVII., p. 245, June 7, 1901), was used. In another arrangement two thin sheets of iron were rolled up into a compact tube. It was found that the residual magnetism left in the iron was stronger when an alternating current was present during magnetisation. But the alternating current, as magnetically compensated, has a distinct effect. For low current-densities the reduction of the residual magnetism in iron is proportional to the current strength, and, therefore, also to the reduction of the area of the hysteresis cycle. The effect of the compensated current is about one fourth of the total effect of the current and circular magnetic effect together.

[Z. E. CROOK, *Am. Journ. Sc.*, August, 1902.]

Magnetic Effect of Electric Displacement.—J. B. Whitehead has attempted to follow up the work of Röntgen, Thompson, Nicolaieff and Blondlot, and to obtain a definite magnetic effect from an electric displacement current, as predicted by Maxwell's theory. The method was to subject a piece of dielectric to an alternating electric field and also to an alternating magnetic field, the directions of the two being at right angles in space; to adjust the phases of the two to give the maximum effect of the displacement current reaction against the magnetic field, and to look for motion of the dielectric in a direction perpendicular to the plane, including the directions of the electric and magnetic fields. Four different modifications of the apparatus were used, but in each of them a block of dielectric, consisting of rock-salt, glass or paraffin, was hung rigidly at each end of a light beam which was suspended horizontally by a quartz fibre attached at its centre. The phase of either the electric or the magnetic field on one block being 180deg. from that of the other, and the other field having the same phase for each block, the reaction of the displacement current on the magnetic field would be opposite at the two ends of the beam, causing a couple to act on the fibre suspension. The quartz fibre used was of unusual length, 101·6cm., and had a diameter of 0·0006cm. It thus served to measure an extremely small couple. But the result was, except in one instance, distinctly negative. The author sums up as follows:—"The mass of the evidence of this research is against the presence of the magnetic effect of electric displacement in an amount given by Maxwell's expression. The single positive result obtained with the final form of the apparatus must be questioned, for although the favourable conditions under which that result was observed could not be obtained a second time, it is thought that at times they were approached sufficiently to give traces of any effect as great as that noticed."

[J. B. WHITEHEAD, *Am. Journ. Sc.*, August, 1902.

Plant Growth and Ionisation.—In a series of experiments now in progress at the Harvard Botanic Garden, A. B. Plowman has observed some interesting phenomena in the relations of plants to electricity. The experiments have been of a widely varied nature, dealing with both static and kinetic charges, through a range of potential from 0·5 to 500 volts. Either platinum or high-grade carbon—usually the latter—was used for electrodes, and special care was taken to insure normal conditions of temperature, light, and moisture. Among other facts recorded in the course of these experiments is the following:—Seeds placed near the anode are always killed by currents amounting to 0·003 ampere or more, if continued for 20 hours or longer, while seeds placed near the cathode are in most cases but little affected, and under some conditions are apparently stimulated by such currents. The author arrives at the general conclusion that *negative charges stimulate*, and *positive charges paralyse*, the embryonic protoplasm of plants. This is strikingly in accord with the conclusions reached by Matthews in his experiments on the nature of nerve stimulation, in which he shows that the sciatic nerve of the frog is stimulated by negative ions, and rendered less irritable by positive ions. Another phenomenon observed is that when seedlings are grown in an aqueous culture-medium through which a weak current of electricity is flowing, the root-tips turn toward the anode. An attempt has been made to show an anology between this movement and a similar turning of root-tips "up stream" against a water current. However, the analogy is of little value, owing to the fact that in the electrolyte there is a streaming of ions in *both* directions. Hence, the question is not so much a matter of the direction of the electric current as it is of the difference

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in effects of the two streams of ions. The side of the root toward the anode is being bombarded by a stream of *positive* ions moving toward the negative electrode, while the side toward the cathode is exposed to the stream of *negative* ions on their way to the anode. Consequently the side of the root toward the cathode is stimulated, and that toward the anode is retarded, in its growth, and of necessity the root-tip curves toward the anode. Seedlings grown in ordinary soil show this curvature even more strikingly. The main axis of the plant is frequently curved almost 90deg. just below the surface of the soil. The curvature is toward the anode and away from the cathode, whether these be in circuit or isolated.

[A. B. PLOWMAN, *Am. Journ. Sc.* August, 1902].

Capacity of a Cable.—A. Schweitzer has examined the capacity of a Felten and Guillaume cable 185 metres in length, having an external diameter of 47mm., a core diameter of 5·7mm., and an exterior conductor of internal and external diameters 15·3mm. and 17·2mm. respectively. It was provided with two lead mantles and two iron bandages. The total volume of the polarised dielectric was 29,290cc. The author endeavoured to find a change in the dielectric constant of the insulating medium on varying the E.M.F. The capacity was determined by discharging the cable through a ballistic galvanometer. The charging potentials successively employed were 10, 100 and 1,000 volts respectively. In each case the charge was completed in 25 seconds at the most. Discharge was completed in 10 seconds. Taking these times into account, 84 different charging potentials, ranging from 0·77 to 1,840 volts, were applied, under conditions which kept the temperature of the cable constant. The capacity was found to be 0·03715 microfarad, and the dielectric constant 3·569. The extreme values of the dielectric constant were 3·583 and 3·554. The variations were within the errors of observation. It appears, therefore, that within the potentials mentioned the capacity of the cable shows no alteration.

[A. SCHWEITZER, *Mitt. Phys. Ges. Zürich*, No. 2, 1902.]

THE FINANCIAL BASIS AND DESIGN OF ELECTROLYTIC METAL REFINERIES.*

BY ARNOLD PHILIP, B.SC., A.I.E.E., F.I.C.

(*Continued from page 681.*)

Total Capital Invested.—From the above discussion of details, and adding up the items of capital expenditure given in the formulæ from (1) to (12), we obtain the following expression for the total amount of capital, K, invested:

Capital invested in pounds

$$= 150 + (4{\cdot}05P'/a + 0{\cdot}5)T + 0{\cdot}176TD + (19{\cdot}5 + 0{\cdot}\dot{3}S + 1{\cdot}\dot{3}tP)T/D, \quad . \quad (13)$$

where P′ = price of refined copper per ton in pounds.
P = ,, anode ,, ,, ,,
T = output of refined copper per annum.
D = current-density in amperes per square foot at anodes.
S = price per ton of copper sulphate crystals in pounds.
t = thickness of anode plates in inches.
a = amperes per square inch allowed in the copper current conductors.

Or, if in a given refinery P′ = £75 per ton, P = £70 per ton, T = 1,000 tons per annum.

D = 10 amperes per square foot.
S = £25 per ton.
t = 1·0in.
a = 250 amperes per square inch.

Then cost of offices	=	£250	$150 + 0{\cdot}1T$
,, buildings	=	750	$7{\cdot}5\frac{T}{D}$
,, power plant	=	1,200	$0{\cdot}12TD$
Then cost of dynamos	=	560	$0{\cdot}056TD$
,, electrolytic vats	=	1,200	$12\frac{T}{D}$
,, electrolyte	=	834	$0{\cdot}\dot{3}\frac{T}{D}$
,, anodes	=	7,000	$\frac{tTP}{D}$
,, conductors	=	1,215	$4{\cdot}05\frac{P'T}{a}$
,, stock copper	=	2,333	$0{\cdot}\dot{3}\frac{tTP}{D}$
,, circulating plant	=	400	$0{\cdot}4T$
Total capital invested		£11,225	K

Annual Cost of Refining.—The next step in our investigation is the examination of the annual costs of running an electrolytic copper refinery. The items of these costs, as has already been pointed out, are:—1. Interest on capital invested, and depreciation and repairs on plant. 2. Total annual cost of labour required in refinery. 3. Total annual cost of melting the refined copper into ingots. 4. Total cost of fuel used for power per annum. 5. Annual salaries of management, engineer, clerical staff, &c. 6. Annual rent and taxes of ground covered by works.

Interest on Capital Invested and Depreciation and Repairs of Plant.—The capital invested in copper may be charged for at the rate of p_2 per cent. There is no depreciation in this material except in so far as the market price may vary, but this may either rise or fall, and cannot be very readily taken into account. If, therefore, the capital invested in copper and copper sulphate is denoted by K_2, the annual charge for interest on this account will be p_2K_2. The remaining capital is invested in material which will depreciate and require repairs. If K_1 is the amount of capital thus invested, and if p_2 is the rate of interest charged on it, whilst p_1 is the percentage rate charged on it for repairs and depreciation, then the annual amount of these charges will be $(p_1+p_2)K_1$.

The annual charge for interest on capital invested in copper and electrolyte expressed in pounds is, therefore,

$$p_2K_2 = p_2\left(1{\cdot}\dot{3}\frac{tTP}{D} + 4{\cdot}05\frac{P'T}{a} + 0{\cdot}\dot{3}\frac{TS}{D}\right), \quad . \quad (14)$$

where p_2 is the percentage rate of interest charged on the capital K_2 invested in copper and electrolyte.

The annual interest upon, and depreciation and repair charges upon, the capital sunk in the remaining plant is in pounds.

$$(p_1+p_2)K_1 = (p_1+p_2)\left\{150 + 0{\cdot}5T + 0{\cdot}176TD + 19{\cdot}5\frac{T}{D}\right\} \quad (15)$$

where p_2 is the percentage charge for interest on the capital K_1 sunk in plant and machinery, and p_1 is the percentage charge for depreciation and repairs on the same capital.

The total capital charges to cover interest, depreciation and repairs are, therefore, $p_2(K_1+K_2)+p_1K_1 = p_2K + p_1K_1$, where K is the total capital sunk in the refinery.

Total Annual Cost of Labour.—The charge for labour may be reasonably fixed from the following considerations:—At the Anaconda Works (*The Electrician*, Vol. XXXVIII., p. 147), where labour is expensive, and is therefore economised as much as possible, 25 men deal with an output of 25 tons of copper per diem, and this is in the most recently-erected portion of the works, where labour saving devices are used at every available opportunity. In the older portion of the Anaconda Works, built at an earlier date, 50 men were required to deal with the same output of copper. The average wages of each man at Anaconda is said to be 12s. 6d. per diem, say, £4. 7s. 6d. per week, which is, of course, extremely high. It is not stated whether this is the complete night and day shifts—*i.e.*, 50 men during the day and 50 during the night. But in the former case the labour would cost £1. 5s. per ton of copper, and in the latter double this, or £2. 10s. But as the total cost of refining 1 ton is not greater than about £8, it is pretty clear that 50 men only are employed to run both

* Copyright. From a forthcoming work by the Author, entitled: "The Electro-plating and Electro-refining of Metals."

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shifts. In the returns made by the Anaconda Mining Co. for the cost of their electrolytic refinery during the year 1897–1898, it is stated that one man at £4 per week is employed to every 140 tons of copper output per annum—that is, the cost of labour is as much as £1. 9s. 8d. per ton.

Gore states ("Electrolytic Separation of Metals," p. 223) that probably about 20 men working day and night can completely deal with about 80 tons per week. This, probably, is meant to represent two shifts of 10 men each, and under these circumstances at £1 per week per man the cost of labour would work out at 13s. 4d. per ton of copper produced; for if this return is meant to represent two shifts of 20 men each, then the cost of labour per ton works out at £1. 6s. 8d., which is nearly as high as is the case in the American Anaconda Works, where labour is very expensive. Probably the following expression will give a satisfactory value for the cost of labour required per annum:

$$\text{Cost of labour in pounds per annum} = 0{\cdot}6wT, \quad . \quad . \quad (16)$$

when w represents the weekly wages in pounds, and T is the number of tons output of refined copper per annum. Thus, for an output of 1,000 tons per annum, and with wages of £1 per week, the annual labour bill will be £666.

Annual Cost of Melting Refined Copper.—The cost of melting the refined copper down into ingots for sale is stated at Anaconda to be as much as 16s. 8d. per ton (*The Electrician*, Vol. XXXVIII., p. 147), but the cost of fuel is high, being £1. 2s. 11d. per ton, and labour is, as already stated, very high. It is probable that 10s. per ton will, in most cases, be an ample amount to cover this charge. As, however, the charge varies with the cost of fuel and the price of labour, and as it, moreover, forms a fairly large percentage upon the total cost of refining a ton of copper, it would be desirable to express the quantity in terms not only of the annual output of refined copper, but also in terms of the cost of fuel per ton and the price of labour.

If m is the cost of melting one ton of the copper, it is probable that the value of m expressed in terms of w, the weekly wages per man in pounds, c the price of fuel in pounds per ton, T the annual output of copper in long tons, would be found from an equation of the form $m = b'cw - b''T$, when b' and b'' are constants.

However, as I am without sufficiently definite data on the values of the constants involved in such an expression, I limit myself to the following somewhat unsatisfactory estimate:

$$\text{Annual cost of melting refined copper in pounds} = 1{\cdot}25mT, \quad (17)$$

where m is the cost of melting one ton, and the factor 1·25 is to allow for re-melting scrap anodes, &c. That is, for an output of 1,000 tons per annum, when m is 10s., the charges under this head would be £625.

Cost of Fuel used for Power per Annum.—The cost of fuel employed in the power plant simply depends upon the B.H.P. to be developed, and it is, therefore, only necessary to calculate out the weight of coal required to develop the B.H.P. employed, in order to obtain a given output of copper per year at a given current density. The necessary B.H.P. has already been found to be $\frac{0{\cdot}12TD}{15}$, see equation (4), and as in a gas generator plant each brake horse-power-hour developed requires always less than 2·5lb. of coal, the total weight of coal employed per annum is under 0·07714TD tons, and if the coal costs c pounds per ton, the annual cost of coal is obtained from the expression:

$$\left.\begin{array}{l}\text{Cost of fuel used for power}\\ \text{per annum} \ldots\ldots\ldots\ldots\end{array}\right\} = 0{\cdot}0771TDc \text{ in pounds} \quad . \quad (18)$$

That is, the cost of fuel per annum for an output of 1,000 tons of refined copper, at a current density of 10 amperes per square foot of anode, with coal costing £1 per ton, would be £771.

Annual Salaries of Management, Engineer and Clerical Staff.—These salaries are independent of the current density employed, and may, I consider, be reasonably expressed by the formula:—

$$\left.\begin{array}{l}\text{Salaries of management, engineer}\\ \text{and clerks in pounds per annum}\end{array}\right\} = 400 + 0{\cdot}136T \ldots \quad (19)$$

Thus, with an output 1,000 tons, the annual disbursements under this head would be £536.

Annual Rent and Taxes of Ground Covered by Works.—This annual charge depends upon the area of the works, and the rent per unit area. We have already seen that the requisite area of the works is $30\frac{T}{D}$ sq. ft., see equation (2), and if R is the annual rent and taxes in pounds per square yard, the annual charge under this head is given by the expression:

$$\text{Annual ground rent and taxes in pounds} = 3{\cdot}33\frac{TR}{D}. \quad (20)$$

Thus, if the annual output is 1,000 tons at a current-density of 10 amperes per square foot of anode, and the rent and taxes is as much as 6d. per square yard—that is, £121 per acre—the annual charge for rent and taxes would be £8. 6s. 6d. The amount for rent and taxes, even if it is 10 times as large as the value here adopted, is a relatively small charge on a ton of copper produced.

The Importance of Current-density.—Having now discussed in some detail the various disbursements which it is necessary to make when conducting an electrolytic copper refinery, we are in a position to observe the great influence which the current-density employed has upon the capital and annual outlay per ton of copper refined per year. There is, in fact, some particular current-density which will yield the most satisfactory financial results, and this particular best density varies with the price of coal, the cost of melting down each ton of refined copper into ingots, the rate of wages paid, the rate of interest paid upon the capital invested, and lastly, but most important, upon the difference in price *at the works* between the price paid for anode copper and the price obtainable for the refined copper, together with the value of the silver and gold separated from it (if this value goes to the refiner, which is not always the case).

The following table gives the current-density in amperes per square foot of anode surface as employed at different copper refineries in America, England, Germany and France.

Table IV.—*Particulars Concerning Current-density Employed at Various Copper Refineries.*

Works proprietor.	Location.	Authority.	Current-density in amperes per sq. ft. of anode surface.
Wohlwill	Hamburg, 1st installation	*Watt ...	1·925
Wohlwill	Hamburg, 2nd installation	*Watt ...	1·11
Œschger, Mesdach & Co...	Biache	*Watt ...	1·932
Hilarion Roux	Marseilles	*Watt ...	0·77
Elliott	Selley Oak, Birmingham...	*Watt ...	8·888
Elkington.....	Pembrey (1).....	†Gore ...	10·0
Elkington.....	Pembrey (2)	†Gore ...	8·0
—	Anaconda, U.S.A.....	‡Philip .	10 to 15

Two things are evident from these figures—namely, first, that the density employed at different works has varied a good deal; and, secondly, that although the density employed varies thus over a considerable range, in no case is it over 15 amperes per square foot. In this connection Mr. S. O. Cowper-Coles, makes the statement that "whereas formerly currents of only 2 to 4 amperes per square foot were thought permissible, to-day current-densities of from 15 to 20 amperes are said to be employed in some establishments, and the end is not yet in sight" (*Journal* of the Institution of Electrical Engineers, Vol. XXIX., p. 260, 1900). I am not, however, acquainted with the details of any electrolytic copper refinery in which a greater current-density than about 15 amperes per square foot has been *successfully* employed over any length of time, and I am strongly of the opinion that it cannot pay to employ a greater current-density than 16 amperes per square foot at the outside, *if the product of the refinery is merely pure*

* These results are calculated from data given by Watt. "Electro-Deposition of Metals," 1889 edition.

† The density is stated as being employed by Gore, "Electrolytic Separation of Metals," p. 204, 1890.

‡ Calculated from details of these works given in *The Electrician*, Vol. XXXVIII., p. 144, 1896.

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refined copper, and not (as in the Elmore process) some manufactured, or partly manufactured, article of copper, such as sheets, tubes, wires, &c.

There is a delusive plausibility in the statement that a largely increased current-density makes the output of a given plant proportionally greater, and thereby increases the profits obtainable in an equal degree. People advancing such views lose sight of the fact that in a given refinery to double the current-density, and therefore the output, the power plant and dynamos must be increased to four times their original size at least.

In order to more clearly bring out the effect which the alteration of the current-density employed in electrolysis has upon the cost of refining each ton of copper, let us imagine that a works which has an output of 1,000 tons of copper per annum at a current-density of 10 amperes per square foot of surface of anode, alters its density to several other current densities, both smaller and greater than 10. Let us then accept the foregoing figures calculated out on a basis of this annual output of 1,000 tons and current-density of 10 amperes, and then modify them by simply inserting some value of current-density other than 10, in the respective formulæ given, and from these calculate the costs of refining 1 ton of copper at the various current-densities selected. It must be remembered, then, that no factor but the current-density is varied in the following calculations. But of course, as the refinery is supposed to have the current-density varied, the costs of the offices, refinery buildings, electrolytic vats, and rent and taxes remain fixed, whilst the power plant, dynamos and circulating plant must be increased for an increase in output as the current-density is raised, but cannot be reduced when the current-density is lowered.

Table V.—*Effect of Varying the Current-density at a given Copper Refinery upon the Available Profits.*

The current density originally employed at the refinery is supposed to be 10, and the output at this density 1,000 tons of refined copper per annum.

	Current density at anode.....	D	5	10	15	20
K_1	Cost of offices	$150+0{\cdot}1T$	250	250	250	250
	Cost of refinery buildings	$7{\cdot}5\frac{T}{D}$	750	750	750	750
	Cost of power plant	$0{\cdot}12TD$	1,200	1,200	2,700	4,800
	Cost of dynamo and switchboard	$0{\cdot}056TD$	560	560	1,260	2,240
	Cost of electrolytic vats	$12\frac{T}{D}$	1,200	1,200	1,200	1,200
	Cost of circulating plant	$0{\cdot}4T$	400	400	600	800
	Capital invested in plant other than metal and electrolyte ...	K_1	4,360	4,360	6,560	9,640
K_2	Cost of electrolyte	$0{\cdot}\dot{3}\frac{TS}{D}$	834	834	834	834
	Cost of copper anodes	$\frac{tTP}{D}$	7,000	7,000	7,000	7,000
	Cost of copper and iron conductors	$4{\cdot}05\frac{P'T}{a}$	608	1,215	1,824	2,430
	Cost of copper in stock.....	$0{\cdot}\dot{3}\frac{tTP}{D}$	2,333	2,333	2,333	2,333
	Capital invested in metal and electrolyte	K_2	10,775	11,382	11,991	12,597
	Total capital charges	$K_1+K_2=K$	15,135	15,742	18,751	22,637
	Interest, repairs and depreciation on capital K_1 at 15% ($p_1=9\%$ $p_2=6\%$)	$K_1(p_1+p_2)$	654·0	654·0	984·0	1,446·0
	Interest only on capital K_2 at 6%	K_2p_2	646·5	682·9	719·5	755·8
	Annual cost of labour	$0{\cdot}6wT$	333·3	666·6	999·9	1,332·0
	Annual cost of melting copper	$1{\cdot}25mT$	312·5	625·0	937·5	1,250·0
	Annual cost of fuel for power ...	$0{\cdot}0771TDc$	193·0	771·0	1,737·0	3,084·0
	Salaries of management, &c. ...	$400+0{\cdot}136T$	468·0	536·0	604·0	672·0
	Annual rent and taxes.....	$3{\cdot}\dot{3}\frac{TR}{D}$	9·0	9·0	9·0	9·0
	Total annual charges	X	2,616·3	3,944·5	5,990·9	8,548·8
	Tons of copper refined annually	T	500	1,000	1,500	2,000
	Cost of refining per ton when 6% is paid on all capital	$\frac{X}{T}$	5·232	3·944	3·993	4·274
	Cost of refining per ton if no interest is paid on capital, but only 9% is charged on the capital K_1 to cover depreciation and repairs	N	3·415	2·999	3·251	3·607
	Profits available per ton when $P''-P=£5$..	$5-N$	1·585	2·000	1·749	1·393
	Total profits under same condition	$(5-N)T$	792·5	2,000·6	2,623·5	2,786·0
	Available percentage profits on total capital under same condition	$\frac{(5-N)100T}{K}$	5·237	12·71	13·99	12·30
	Capital outlay on plant per ton output	$\frac{K_1}{T}$	8·732	4·360	4·373	4·820
	Capital outlay on metallic copper and electrolyte per ton output	$\frac{K_2}{T}$	21·55	11·382	7·994	6·298
	Total capital outlay per ton output	$\frac{K_1+K_2}{T}$	30·282	15·742	12·367	11·118

From the results given on this table it is evident that the percentage profit on the capital invested, under the particular conditions stated, will be greatest when the current-density at the anode is somewhere about 15 amperes per square foot. The direct calculation of the precise value of the most advantageous current-density will be dealt with in the following paragraphs.

Annual Total Profits.—The annual total profits obtainable from any copper refinery may evidently be expressed by the equation:

Profits per annum in pounds

$$= T(P''-P) - p_2(K_1+K_2) - p_1K_1 - 0{\cdot}6wT - 1{\cdot}25mT - 0{\cdot}0771TDc - 400 - 0{\cdot}136T - 8{\cdot}\dot{3}\frac{TR}{D}, \quad . \quad . \quad (21)$$

where $K_2 = 150 + 0{\cdot}5T + 0{\cdot}176TD + 19{\cdot}5\frac{T}{D}$, see equation (15),

and $K_1 = 4{\cdot}05\frac{P'T}{a} + \frac{0{\cdot}\dot{3}ST}{D} + 1{\cdot}\dot{3}\frac{tTP}{D}$, see equation (14).

If these values of K_1 and K_2 are inserted in the formula (21), and if it is remembered that $T=\frac{AD}{30}$, see equation (2), we can obtain an expression for the total annual profits expressed in terms of D, and if this expression is then differentiated with respect to D, and the result equated to zero, a solution for D can be obtained which gives the value which the current-density should have under the given conditions in order that the available profits on the undertaking shall be a maximum. The particular most profitable value of D depends upon almost all the quantities which we have so far considered. This algebraical solution for D does not, however, give a simple formula, and for this reason the problem of determining the best current-density to employ under given conditions has been attacked in a more direct manner. In order to deal with this question it is, however, first necessary to consider.

(*To be continued.*)

ERRATUM.—On p. 680 of *The Electrician* of August 15th, formula (11) should read

$$K = 1{\cdot}\dot{3}\frac{tTP}{D} + 4{\cdot}05\frac{P'T}{a},$$

instead of $$K = 1{\cdot}\dot{3} + \frac{tTP}{D} + 4{\cdot}05\frac{P'T}{a}.$$

Electric Light in Railway Carriages.—According to the *Railway Engineer* the reports of various locomotive superintendents of railways on which the Stone system of electric lighting is in use, place the extra coal consumption at $\frac{1}{20}$lb. to $\frac{1}{10}$lb. of coal per coach per mile, according to the size of coach and amount of light required. It is pointed out, however, that owing to the fact that the haulage of gas-holders and gas-lighted coaches to and from charging stations is entirely done away with, the amount of extra coal consumed is quite inappreciable.

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THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

(*Concluded from page 666.*)

The Bergish Steel Foundry, of 89, Victoria-street, Westminster, exhibited some fine specimens of steel castings at stand No. 45B. Specially noticeable amongst the samples were main line and tramway truck sides, some of which are cast of weldable steel to enable truck makers to stock them and use them for various wheel bases by splicing them with a suitable length of flat-rolled steel. The tensile strength of these castings is given as 28 to 35 tons per square inch, with an elongation of 15 to 20 per cent. in 8in. Other samples illustrate what surface hardness can be obtained on such castings when tensile strength and elongation are not required

BERGISH STEEL BENT COLD.

to be so high. The tensile strength of very soft castings can be raised to over 65 tons per square inch. The suitability of this material for tramway and railway wheel centres was illustrated by some finished samples which showed the high polish of which this material is capable. Some of the samples were twisted in a remarkable way to show the treatment this steel will stand in its cold state, and we show a photograph of motor truck sides bent cold. The electric motor castings showed thicknesses of $\frac{3}{8}$in. close to the thickest parts of the castings. The machined surfaces indicated evenness, freedom from blow-holes, and even softness throughout. The percentage of carbon is stated to be below 0·2 per cent., and curves showing usual permeability and induction characteristics were given.

Of special interest to many tramway engineers who visited the exhibition was this firm's H.B. combined (compressed air) braking, sanding and life-guard lowering apparatus, which consists of geared compressor, compressed air reservoir, regulator and controller valve, brake cylinder, sanding tubes and fender cylinders. The controller valve has six positions. Moving the handle to the right of No. 3, the "stop," an "exhaust," and "sanding" positions are reached. The latter are for the purpose of sanding the rails before starting or while ascending an incline. Moving the handle to the left of the "stop" position, the first braking position is reached, and then the second "braking" position. With both of these movements, automatic sanding of the rails takes place. Should there be danger of a person getting under the car, the controller valve would be moved beyond the second "braking" position, and compressed air admitted to the fender cylinders, whereupon the guard would be rapidly lowered and held down with a force up to 100lb. This effectually prevents limbs of persons getting below the fender.

It will be seen that it is difficult for the car driver to make a mistake with his apparatus, as he cannot "brake" without sanding, and cannot lower the life-guard without having first passed the "brake" positions. The automatic sanding of the rails, when braking, is, of course, a great advantage on greasy roads, where the best brake would be of no use unless they are sanded at the right time and place.

The weight of the apparatus is given as below 4cwt. Locking of the wheels can easily be avoided by setting the regulator valve at a moderate pressure. The brake cylinder with this pressure must be incapable of locking the wheels under any circumstances.

As advantages generally inherent to compressed air brakes, it is claimed that the source of energy supplied to the brake is independent from the current supply, and, therefore, available not only while the trolley is off the line, or the motor switched off, but also when the car is moving at a very low speed, which would not be sufficient to use the motor as generator for braking purposes.

At stall No. 79, Messrs. Kelvin and James White, of Glasgow, had a comprehensive exhibit of Lord Kelvin's patent electrical instruments. These are so well known that it is unnecessary for us to go into detail in describing them, but they represented in all cases the latest type of the particular class of instrument. Ammeters, voltmeters and wattmeters, both indicating, recording and portable, suitable for direct or alternating current, were shown. A sample of this firm's patent circuit breaker, as well as different types of switches, were also shown. The Kelvin S.R., or moving coil instruments, which derived their name from Lord Kelvin's well-known instrument, the syphon recorder, used for submarine cable work in three different types for switchboard use, and samples of the Kelvin electrostatic voltmeters were exhibited; in the latest type a much longer scale instrument is obtained. For high-tension transmission work the open scale dial type is particularly suited, and these instruments are now supplied in an insulated case, so that there is no danger through accidental contact. These instruments are used in the majority of central stations where the system is a high-tension one. A sample of this firm's feeder log was also shown. This instrument records and indicates the current and voltage of the circuit in which it is fitted, and it, therefore, does away with the necessity of readings being taken at stated periods, seeing a continuous record is kept.

Different type of wattmeters for switchboard and portable use, both of the indicating and recording type, and a number of testing instruments were exhibited suitable for testing insulation, conductivity of a rail bond or rail while the cars are running, and also ordinary resistances.

The double-cylinder inverted vertical gas engine with four-pole generator, of which we give an illustration, was exhibited by Messrs. Crossley Bros. at stand No. 112. The cylinders are 11½ins. in diameter by 15in. stroke, made with water jackets and fitted with loose liners. The pistons and cylinders are of specially hard metal, and the connecting rods are made from steel castings. The engine is fitted with a high-speed governor, and each cylinder is fitted with timed ignition valves having a duplicate igniter, which prevents the engine stopping in the event of one tube breaking.

At stand No. 21 Messrs. Hurst, Nelson & Co., of Motherwell, and 14, Leadenhall-street, exhibited a double-decked four-wheel car of the Hurst-Nelson improved type, arranged to seat 57 passengers, having extended canopies, with access to the roof by wide staircases, and improved outside dry seats. Patent life-guards are fitted on each end of the car. The car is mounted on the Hurst-Nelson A1 type cantilever truck riding on carriage springs, and having patent roller bearing axle-boxes.

There was also a maximum traction truck of the Hurst-Nelson B1 type, having a wheel base of 4ft., with 30in. driving and 20in. trailing wheels. Swing bolsters riding on coil springs, which are designed to take all the strains and to give easy riding. Improved brake fitted on truck. The car body can be carried as low as on a four-wheel truck.

A large variety of sand boxes, brake blocks, automatic couplings, roller bearings, and ordinary bearing axle-boxes, destination indicators, foot gongs, &c., were exhibited.

Stand No. 19 was occupied by Messrs. G. F. Milnes & Co., of Hadley, Salop and Birkenhead, who exhibited a top-seat bogie car with vestibule ends, being one of an order of 18 cars supplied to the Tyneside Tramway Co. It was designed for high speed and is capable of seating 83 passengers. All the wheels of the bogie trucks are of the same diameter, and the car is provided with a powerful hand brake connected up to the motorman's brake spindle placed in each vestibule. The item of greatest interest among the exhibits of Messrs. Milnes was a single-deck bogie car for special state occasions, built to the order of the Bournemouth Corporation

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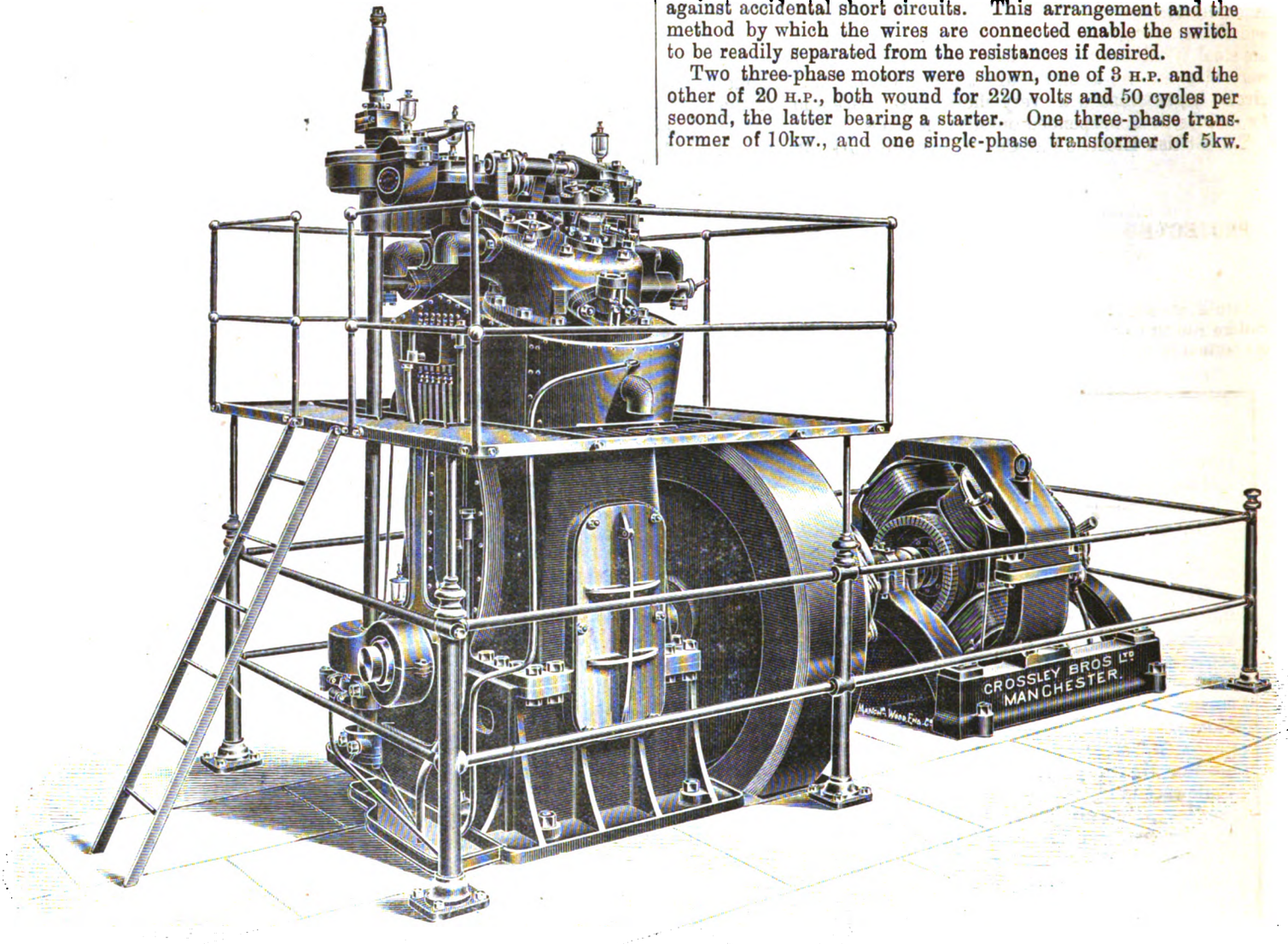
and most elaborately finished. The interior walls are entirely of Chippendale mahogany, with beautifully-carved mouldings and gilt enrichments. The ceiling is hung with Lunesdale tapestry, and the floor is covered with rich crimson Wilton carpet. The windows are richly draped to match the rest of the upholstery, and fitted with blinds of crimson Tammie, and basket chairs are provided for 12 persons, all luxuriously upholstered. Four mahogany tables are provided, and a buffet is fitted in one corner of the car. The car is brilliantly lit by electric light, the electroliers being of antique bronze of handsome design.

Other exhibits on this stand consisted of a top seat four-wheel car, top-seat bogie car with open platforms 22ft. in length and with a carrying capacity of 70 persons, a four-wheel motor truck designed to meet the requirements of high-speed traffic on heavy gradients, a standard maximum traction truck, standard bogie truck with equal wheels and patent lifting jacks.



MESSRS. CROSSLEY BROS.' DOUBLE CYLINDER INVERTED VERTICAL GAS ENGINE OF 30 H.P., WITH GENERATOR.

The International Electrical Engineering Co., of Clun House, Surrey-street, W.C., showed a large variety of controllers, motors, starting devices, arc lamps and carbons at stand No. 13. Two 25—50 H.P., four-pole, 500-volt motors, with controllers, lightning arresters, &c., were shown. Each motor is entirely steel clad, and the armature is removable by allowing the lower half to swing down. Great care is taken with the insulation of the armature, commutator, and field coils, which are flashed during manufacture, and when finally assembled, with a 3,000-volt alternating current.

A novel feature of the motor-starting switches consists in the extremely simple means adopted for retaining the switch arm magnetically in the "full on" position in a starting switch, or on any desired contact in a regulating switch. It consists in winding the retaining coil of the minimum release switch upon an iron bobbin forming the bearing of the switch spindle, and obtaining a closed magnetic circuit through the spindle, and a part of the switch arm, to the back flange of the bearing bobbin, the parts mentioned being made of soft iron. The resistance wires are wound on strong tubes and cannot get out of position. The insulation resistance is of the highest, as the switch slate is partially insulated from the iron frame, and the resistance tubes are held by porcelain insulators. All switches are tested with an alternating current of 2,000 volts before leaving the works. The connecting wires between the switch contacts and the resistances are held in definite positions by a clamp to insure against accidental short circuits. This arrangement and the method by which the wires are connected enable the switch to be readily separated from the resistances if desired.

Two three-phase motors were shown, one of 3 H.P. and the other of 20 H.P., both wound for 220 volts and 50 cycles per second, the latter bearing a starter. One three-phase transformer of 10kw., and one single-phase transformer of 5kw. were also exhibited. The smaller motor has a short-circuited rotor and the larger one a wound rotor. Continuous-current standard, semi-enclosed shunt-wound motors of 6 and 27 B.H.P., in addition to a 15 B.H.P. series wound for 500 volts, were shown. The machines have slotted drum armatures and interchangeable coils.

Messrs. J. G. Brill & Co. exhibited, at stand No. 45, a section of a semi-convertible car, showing the manner of operating the side windows, and spacing of seats, extra width being obtained inside car by use of single walls in place of thick double walls, 7in. or more in width being saved, thus allowing use of more roomy seats. This type of car is designed especially for summer service, as it can be changed from a closed car to practically an open car in five minutes by raising the side windows into the roof of the car.

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There was also a truck known as a "Brill 21E," which is the Brill standard for four-wheel cars. Its side bars are forged solid in one piece, and the spring arrangement is adjusted carefully to prevent undue pitching of car body. Semi-elliptic end springs, spiral car-carrying springs and double cushioned axle-box springs make up the three different sets of springs in this truck. The heavy end cross bars and the diagonal braces hold the truck in perfect alignment. The side bars being solid forgings without bolts or rivets, there are no parts to become loose or wear out, and, therefore, no repairs are needed.

Brake handles, gongs, solid-forged side frames, &c., formed other items of the exhibit, in addition to the Brill 27E. (high-speed) truck, which is specially recommended for carrying cars smoothly when travelling at a high rate of speed. A triple system of springs is used in connection with an equalising spring-suspended swinging bolster. The wheels are steel tyred and the side frames of solid forgings. There were also shown a maximum traction truck and a centre-pivotal bogie truck with very short wheel base and arranged for motors to be suspended outside the axles.

The British Electric Car Co., of Trafford Park, Manchester, amongst their exhibits at stand No. 54 showed a car known as the B.E. standard type; it will accommodate the unusual total of 63 passengers, 39 outside and 24 inside, and its general construction permits of the strongest possible type of car with extended canopy.

A special feature is the registered design of stairway, which describes a full semicircle from the lower to the upper step, causing passengers when leaving the upper deck to move continually in one direction, and thus clear the car quickly. This staircase gives a very clear platform and excellent head room for the motorman, and is safe and easy to ascend.

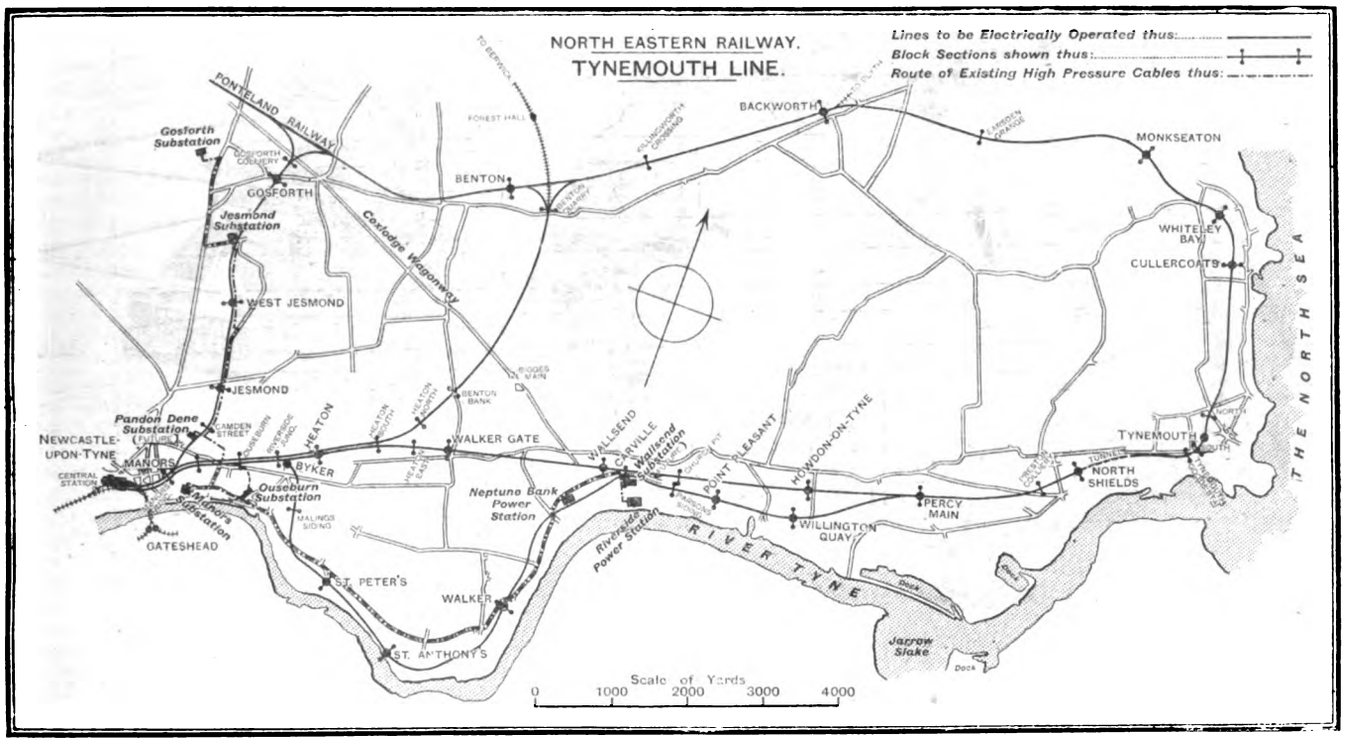
Another feature is the doorway, which is placed slightly eccentric with reference to the centre line of the car, so that passengers leaving the inside are near to the edge of the platform, and in stepping off naturally tend to make use of the portion of the step *nearest* to the car body, thereby not interfering with those descending by the spiral stairway referred to, who would tend to use the portion of the step *farthest* away from the car body. This company also exhibited trucks of the B.E. standard design specially built to prevent sagging and pitching of the car body. Track brakes and patent illuminated destination indicators were also shown.

PROJECTED ELECTRICAL EQUIPMENT OF THE NORTH-EASTERN RAILWAY.

As has already been announced in these columns, the North-Eastern Railway Co. has invited tenders for the electrical equipment of a portion of its lines, and we are now able to give some particulars of the scheme and of the specification to which contractors are invited to tender. The total length of line to be equipped is equivalent to about 80 miles of single track. There are about 4 miles of four-line track from the Newcastle central station to Heaton South Junction; about 35 miles of double track; and some 4 miles of single track at various places. Fig. 1 is a map showing the greater portion of the lines in question, but it does not include the whole of the line extending to Ponteland from Gosforth, whose length is about 7 miles. All the lines are intended for passenger service with the exception of the Quayside branch, which is for goods only. Power is to be supplied by means of 6,000-volt 40 ∿ three-phase current by the Newcastle-upon-Tyne Electric Supply Co., whose works were described in *The Electrician*, Vol. XLVII., pp. 319, 359 and 397, and tenders are now invited for the erection of sub-stations, the provision of all the necessary high-tension and low-tension cables and the electrical equipment of 50 motor coaches and 30 trailer coaches, bogey trucks for the motor coaches only, and two electric locomotives for goods traffic.

Two specifications have been issued, one for the electrical equipment of the coaches and permanent way, and the other for the high-tension cables and sub-station equipment. Although no definite system is laid down in the specification, it is particularly stated that a third-rail continuous-current system at a voltage not greater than 650 volts is preferred, current being supplied to the line by motor generators or rotary transformers at the sub-stations, and the trains being arranged on the multiple unit system. Considerable latitude is left to the contractors, however, even if they adopt this system. Some of the sub-stations already exist (in the positions shown in Fig. 1), but it is left to the firms tendering to choose both the number and positions of the additional sub-stations; and there are, moreover, no definite requirements stated as to drop of volts, efficiency, or the acceleration required from the motors at starting.

On the Quayside branch, which, as stated above, is for goods traffic only, electric locomotives will be used. No new track is asked for, and the present 90lb. rails may be used for the return current. The



MAP OF THE TYNEMOUTH LINE OF THE NORTH-EASTERN RAILWAY, WHICH IS TO BE ELECTRICALLY EQUIPPED.

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North-Eastern Railway Co. will itself build the coach bodies and the under-frames for the motor cars and trailers, and the bogey trucks of the trailers. Fig. 2 shows the proposed arrangement of the electric train, and Fig. 3 the proposed general construction of the under-frames. The weight of each motor car body and under-frame, exclusive of bogey trucks and electrical equipment, will not exceed 18 tons fully loaded, and the weight of each trailer with its two bogey trucks, exclusive of electrical equipment, will not exceed 24 tons.

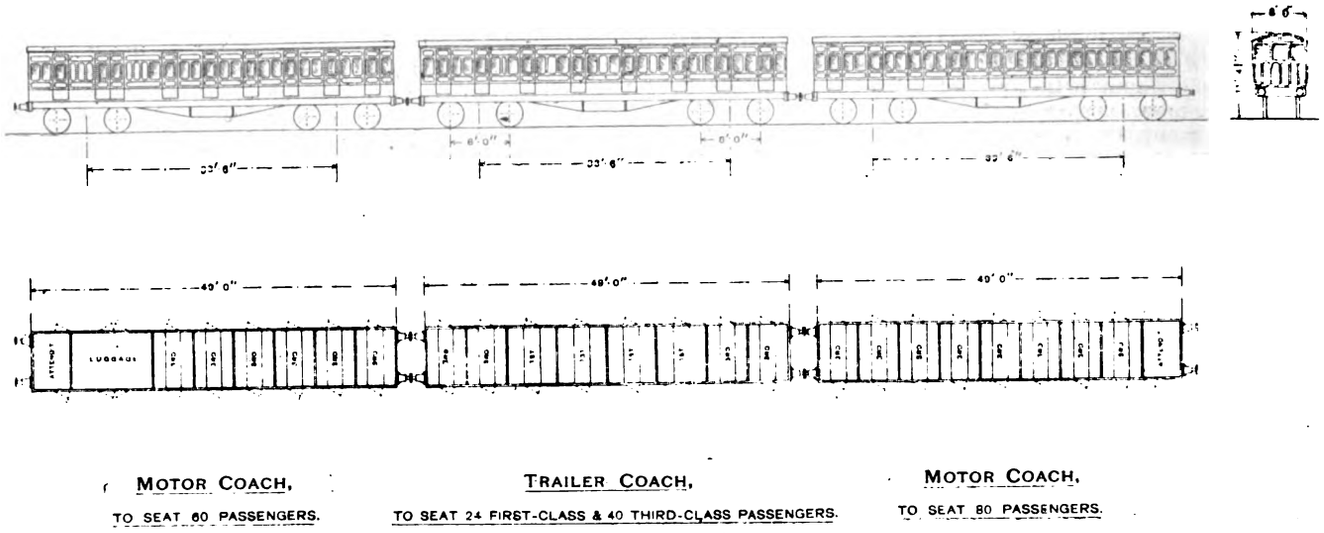

FIG. 2.—PROPOSED ELECTRIC TRAIN.

The passenger train will consist of two motor coaches and one trailer coach, which will run at an average speed of 22 miles an hour between termini, including a stop of 20 seconds at intermediate stations. The system, however, is to be designed so as to be suitable for operating ultimately 47 trains distributed on the various block sections shown on the map. For the goods service it is specified that there will be six goods trains per hour each weighing 150 tons. The Quayside branch of the line on which the goods traffic will be is about three-quarters of a mile long, with a ruling gradient of 1 in 31, the gradient being, however, for a short distance 1 in 27. The electric locomotives will only be employed for drawing the goods traffic up this short branch line to a junction of the Tynemouth branch, from which place the trams will be taken in hand by steam locomotives.

Other points laid down in the specification are that the position of the live rail shall be preferably outside the 4-foot way, and that this rail shall be divided into sections connected together through automatic cutouts situated at the stations. At level crossings there is to be no live rail. The contractors are to do the bonding if required, and to carry out any protection of the live rail that is necessary to

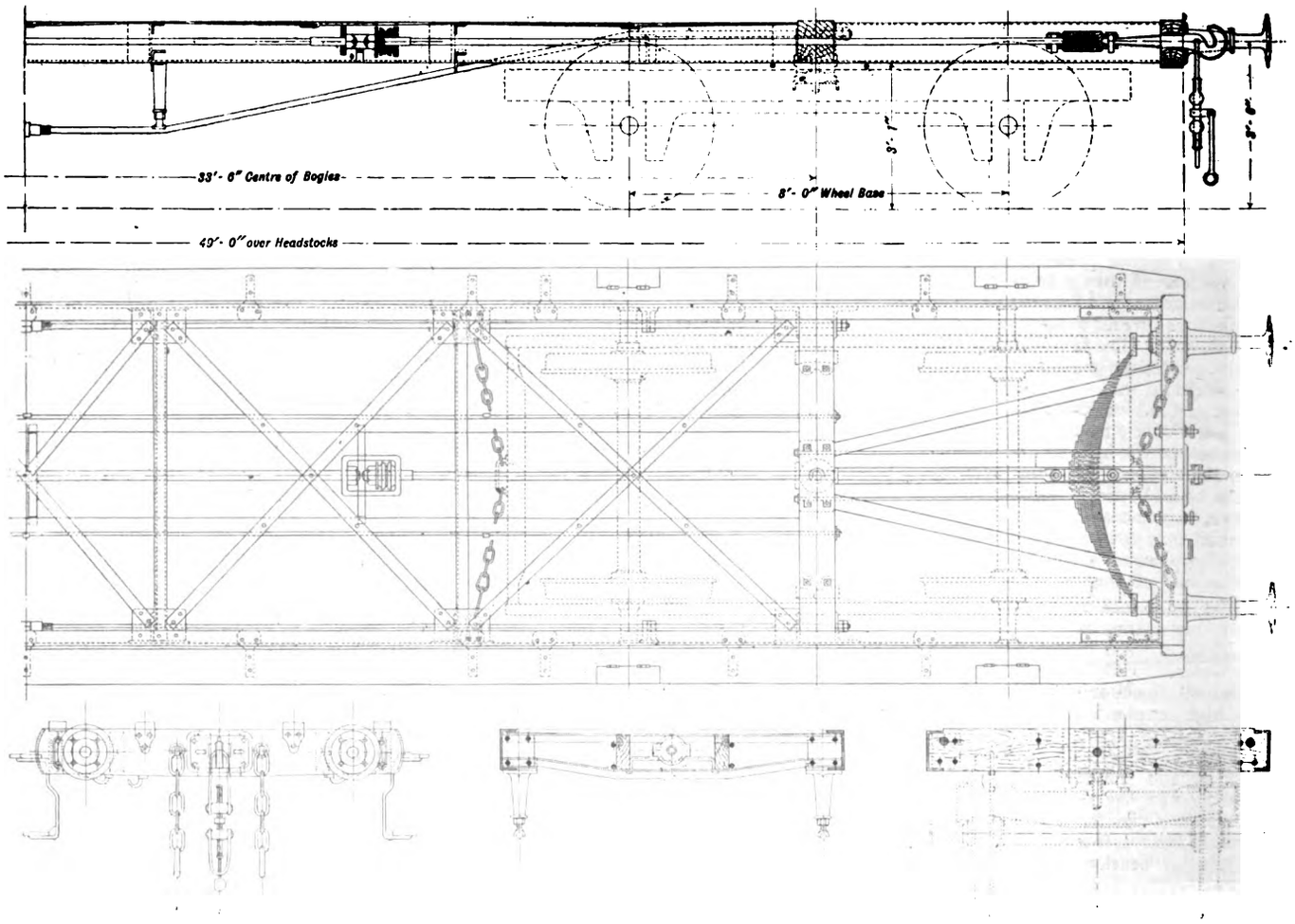

FIG. 3.—UNDERFRAME OF COACHES (PROPOSED).

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reduce danger of contact to persons crossing the line. The live rails are to stand a pressure of 1,000 volts without appreciable leakage. Cables are to be laid solid in earthenware troughs by the side of the track not less than 12in. deep, and a depth of 24in., with a crossing of track or carriage way. The earthenware troughs will be filled with bitumen or similar compound, and covered with hard tiles or bricks at least 2in. thick. Templates will be provided by the railway company for the wheel gauge and tyres, and the railway company will also supply Westinghouse brake gear for the motor coaches; the contractors, however, supplying a motor air compressor, arranged to work automatically both by itself and when working in conjunction with the compressors on other motor coaches. Each bogey truck is to be provided with one motor—*i.e.*, two motors on each motor coach. The motors are to be spring-borne, series-wound, and geared to the axles by machine-cut gear enclosed in dust-proof cases, and run in oil baths. The collector gear, which is to be fitted to each bogey is to be protected by a fuse of approved design. The motor coaches will only contain one driver's compartment. The number of speeds on the controller is not specified, the cspecification merely stating that the two motors on each motor coach are to be placed in series at starting and in parallel at full speed, the switching-in and changing from series to parallel being made through suitable resistances which are gradually cut. Contacts and switches where the circuit is or may be broken are to be fitted with magnetic or othor approved blow-out devices, and each motor car is to have a magnetic blow-out circuit breaker in a convenient position in the driver's cab. The necessary electrical instruments are to be fitted in the driver's compartment, but their precise number or nature is not specified. The locomotives are to be suitable for dealing with trains weighing 150 tons, and capable of starting at full load on any portion of the track. The contractors are required to guarantee the number of Board of Trade units which will be absorbed by a fully-loaded train of two motor coaches and two trailer coaches running from the Newcastle central, via Gosforth, Tynemouth and Wallsend, and back to the Newcastle central station, in 60 minutes, with a 20 seconds' stop at each intermediate station. The maximum rise in temperature of the motors after an 18-hour run under these conditions is not to exceed 50°C. Very full specifications and drawings are to accompany each tender.

In the specification for the high-tension cables and sub-station equipment it is stated that the riverside generating station of the Newcastle-on-Tyne Electric Supply Co. will be supplemented by the existing Neptune Bank generating station, in which some of the generators are coupled to reciprocating engines, and it is, therefore, necessary that the sub-station plant should be capable of working satisfactorily with either generating station separately or with both together. The high-tension cables running to the new sub-stations on the railway may be laid along the public roads and by the side of the railway line and along the Coxlodge waggon way. Firms tendering may propose a higher pressure than 6,000 volts for the new cables and sub-stations if they consider it more economical when the greater transformation is taken into account, but the sub-station will supply continuous current to the working conductor at a pressure not exceeding 650 volts. The transforming plant may, however, comprise either motor generators or rotary converters. The cables are to be suitable for working with the neutral point of the high-tension system either earthed or insulated. The insulation between any core and the lead is not to be less than between any two cores, and the thickness of the lead sheath is not to be less than $\frac{5}{70}$in. for cables over 2in. external diameter over the lead. The high-tension cables are to be laid solid in earthenware troughs similar to the low-tension cables, but instead of bricks or tiles the troughs are to have substantial iron covers. Cables are to be tested at three times the working pressure at the factory, and twice the working pressure after laying and jointing.

The framework of the switchboards is to be of iron, and the framework supporting high-tension parts is to be earthed. There are to be no exposed high-tension parts in front of the board, and all high-tension switches are to be of the oil type with earthed handles fitted with locks and provided with keys in duplicate. The ends of all the high-tension feeder cables are to be fitted with spark-gap devices. No details as to number and type of switchboard instruments are laid down, except that each sub-station is to be provided with integrating and indicating wattmeters and a power-factor indicator dealing with the total output, and two continuous integrating wattmeters in series for measuring the total output, and that the high-tension instruments are to be operated through transformers earthed on the low-tension side.

The maximum temperature rise of the transforming apparatus at full load is specified to be 40°C, and commutating machines are to run sparklesaly up to 25 per cent. overload and without injurious heating up to 50 per cent. overload. All apparatus, moreover, is to be capable of running for one hour at 25 per cent. overload without excessive rise in temperature or injurious sparking. The transforming apparatus must work in parallel with the generating stations without hunting, or falling out of step, or causing other apparatus at present installed on the system to hunt or to fall out of step, the load varying between no load and 100 per cent. momentary overload and being either equally or unequally divided between the different machines and sub-stations.

In each sub-station a motor-driven air compressor, capable of supplying air at 60lb. pressure for cleaning apparatus, is to be provided with the necessary piping, standpipes, valves, flexible hose, &c. A hand travelling crane is to be provided at each new sub-station, and a sufficient number of enclosed arc lamps and incandescent lamps for efficiently lighting each sub-station are to be put in. In this case, also, full specifications and drawings are to accompany the tenders. Tenders are to be sent in by October 7th, and the whole of the contract work is to be completed within 12 months of the date of acceptance of the tender.

MODERN MACHINE METHODS.*

BY H. F. L. ORCUTT.

(*Continued from p. 672.*)

Turret Machines.—The leading characteristics of the modern screw-machine or turret lathe is its adaptability for comparatively short runs. Largely on account of this feature it is rapidly encroaching on the field formerly held by the lathe. The lack of skill and training in properly maintaining and using turret machine tools is the greatest obstacle to its more extensive use in all classes of manufacturing, both of the automatic and hand type. It is pre-eminently the machine demanding the brains and skill of the high-grade toolmaker, a functionary wanting in 80 per cent. of our engineering establishments. A large amount of lathe work now done by skilled men is sure to be shortly done on the turret machine by comparatively unskilled attendants who will eventually beat the trained turner, in respect to output, accuracy and uniformity. This applies to work like studs, bolts, cast-iron and brass parts. Where a good tool maker is available it pays in many cases to set up the turret machine for, say, 20 parts when operated by hand and for several hundreds when machine is fully automatic. The author is aware that in many cases the turret machine has been and is a failure in competition with hand labour on simple machines, but he is sure that this is often where a low standard of workmanship exists and where interchangeability is practically unknown. In brass goods, especially, the demand for cheap work is rampant and, of course, the supply is not wanting. The introduction of the best class of turret machinery would assist to put on the market a superior article at very little, if any, advance over the rubbish now sold, where the loss of even the simplest part necessitates the purchase of an entire apparatus, so little is interchangeability practised. The great advantage in the modern turret machine lies in the possibility of using operators who, in a few weeks, can turn out accurate, uniform work in competition with lathe hands who have served several years' apprenticeship. The common disadvantage to the modern turret machine is the lack of tool makers, who are necessary for keeping machines in good working condition, and the almost universal want of understanding on the part of employers of the value of such men, no matter what wages they may command. For this reason turret machines, which are an unqualified success in one shop, are often condemned as useless in another.

The variety of turret machines, both hand and automatic, is large; simply to enumerate them would require too much space. Different types have been dealt with in the recent Paper by Mr. Ashford.† The subject is an important one, and, in spite of that which is a bugbear to many manufacturers—investment in tools—these machines are slowly but surely encroaching on the field now so largely held by the plain lathes operated by skilled turners using, in most cases, simple tools.

The Vertical Boring Mill.—The loss of time and inconvenience suffered by many shops for the want of a vertical boring mill is considerable. In many respects this machine is nothing more than a surfacing and boring lathe "stood on end." When fitted with a turret slide it forms a machine whose virtues are too little known. Like its horizontal prototype, it suffers from the lack of care on the part of intelligent tool makers. With properly-arranged tools its field of usefulness is very large.

The small type of machine with 27in. or 30in. face-plate and turret slide is especially adapted for chucking operations, for the boring and accurate finishing of holes to limit gauge, and also for facing operations. Work is rapidly chucked, the succesive tools are quickly brought into play, and one man can, in most cases, attend two machines. For general work the vertical mill has the advantages of extreme rigidity and the ease with which work is set and held in place. With these features heavy cuts are possible, and inaccuracies do not occur on account of "overhang." It is practically impossible

* Paper read before the Institution of Mechanical Engineers. Slightly abridged.

† *Proceedings*, 1901, p. 259.

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to construct a horizontal machine with spindle surfaces and face-plate rigidity that can compare with the vertical mill. It is now made with nearly every feature common to the lathe where a tail-stock is not required; it is adaptable for boring, facing and turning, and is provided with full sets of change gears for thread cutting. It is not infrequently the case that one vertical boring mill does the work of two facing lathes, whilst giving more accurate work and effecting a considerable saving in shop spaces.

Drilling and Jig Work.—Drilling is prehistoric as a mechanical operation, and still flourishes in its primitive glory in a great many manufacturing establishments, as far as equipment of machines and tools is concerned. As previously mentioned, a large manufacturer recently told the author that on going into the matter of adopting limit gauges and a modern set of chucking or boring tools, he found that a round hole was not made in his works. Like many others, he had never thought that "drilling" was a class of work which should be specialised as much as milling, turning, or any other operation. In many shops where it would be found profitable to overhaul the drilling department, one would-find (1st) the cheapest machines that can be bought having power enough to revolve the spindle when boring the maximum hole of their respective capacities; (2nd) the cheapest drilling tools that can be purchased (or forged); (3rd) a total absence of jigs or sets of tools, even when parts are made in quantities or accuracy is desirable. Strictly speaking, to do work better than "good enough" is wasteful; but it is surprising to what an extent the nominally "good enough" principle alone rules, even in the many shops where the best class of drilling would be cheapest, all things considered. The many advocates of the cheap drilling machine would do well to note that it is economy to do better work in drilling and boring than is commonly supposed; that cheap rough work can be done on a good drilling machine, and that good cheap work cannot be done on a cheap drilling machine.

Weight and price alone considered, there is no machine tool on the market to compare with what can be purchased in the shape of a drilling machine; this is the temptation to continue in the old way. Those who would work on modern lines must, however, consider where interchangeability and good work are called for; the far-reaching economy of having holes truly cylindrical and accurate to size; that such holes cannot be made on cheap, low-priced drilling machines, with primitive drilling tools; that it pays many times to take work away from the drilling machines entirely, and to finish holes on the modern chucking machine; that satisfactory results from jigs and fixtures, unaided by the accurate drilling machine, are out of the question; that with proper jigs and fixtures the highest class of work can be done on the good drill by het lowest-paid labour, and that this means savings in the fitters' work. A good deal of work formerly thought to be only possible on the horizontal boring mill is now being jigged on the upright drill with profit, even for small quantities—drilling, reaming, facing and tapping.

The usefulness of the drilling machine is greatly extended by properly-designed jigs (Fig. 10), and it is in connection with such tools that the greatest benefits of the accurate drilling machine will be realised. Many jigs, however, are the merest make-shifts and are seemingly designed as rough laying-out boxes or plates, not as tools for turning out accurately-finished work. What are fully as important as the jig itself, but wanting in the majority of cases, are proper boring and finishing tools. It is probably true that, except by the sewing machine, small-arm, ordnance and ammunition makers, the economy of the drill-jig is, with but comparatively few exceptions, little understood; perhaps this accounts somewhat for the continued prosperity of the makers of cheap drilling machines. There are surprising results awaiting those who have not looked into the details of their drilling work.

Portable Machines.—Like many other mechanical operations, portable machine work is not new, but it has recently been extensively developed in large engine works and in the manufacture of electric motors and generators. It is, of course, mainly applicable to heavy work, particularly of bulky or weighty parts where the surfaces to be machined are, compared with the part itself, of comparatively small area. For a great deal of this work it is found cheaper to carry the machine to the work rather than carry the work to the machine. Where it is most completely carried out floor-plates of large area are made use of. The General Electric Co., at Schenectady, have one plate 175ft. long by 20ft. 6in. wide (Fig. 11). This is made up of sectional plates 8ft. 4in. wide by 20ft. 6in. long (Fig. 12). The depth to the bottom of the ribs is 10in. In new works now being erected by the Allis Engine Co. floor-plates 250ft. long are being made.

Nearly all modern portable tools for heavy work are driven with separate electric motor. They consist mainly of drilling, milling, slotting and planing machines. All are arranged with eye-bolts, so that they can be readily lifted by overhead travellers. Many of the machines are of far less weight than the parts on which they operate. The principal advantages connected with their use are—

1. The ease and facility with which they are transported, compared with the parts on which they are operating.
2. A less expensive machine is possible than would be required in case it was big enough to embrace the parts.

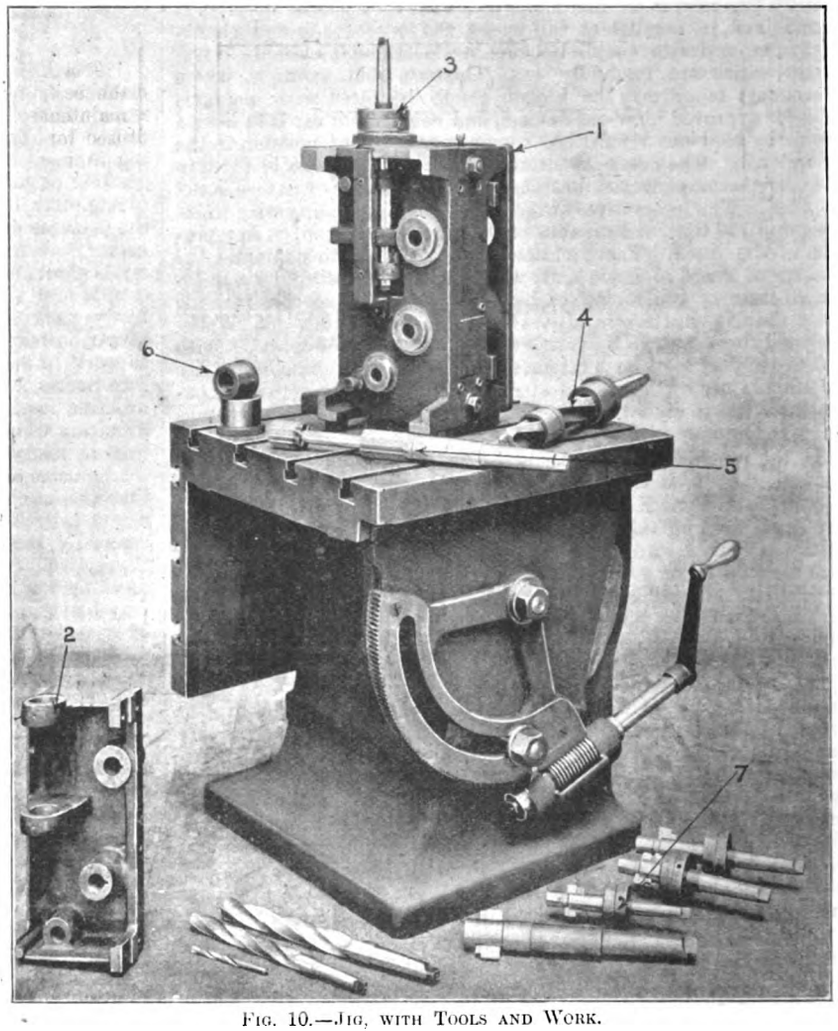

FIG. 10.—JIG, WITH TOOLS AND WORK.

1. Jig.
2. Part to be jigged.
3. Boring Tool with stop collars in place in jig.
4. Boring Tool and two Guide Bushes.
5. Double Reamer for finishing two holes of different diameters.
6. Extra hardened and ground Guide Bushes.
7. Facing Tools, with adjustable stop collars for regulating depth of cut.

3. Tools are rarely idle, as they can be operating upon one piece while another is being set, and can be brought at once to the work.
4. Several machines, like boring, slotting, milling, &c., can be operating on one piece at the same time.
5. Parts do not require resetting for different operations, often more expensive than the machining itself.

Small Tools.—The small tools referred to are those which are indispensable to the successful working of ordinary machine tools: for example, cutters, reamers, taps, dies, arbors, boring tools and gauges. It is remarkable how little attention these important articles receive, even from those who are users of the best class of machinery. Many a valuable labour-saving machine tool is an utter failure, or only half a success, largely on account of ignorance in selection or care of the tools. Throughout the world there is a scarcity of tool makers who understand these little articles. The labour-saving machine is nothing without them, yet scores of manufacturers have capital sunk in badly-designed, inaccurately-made, uncared-for, never-

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inspected small tools. The subject is a big one, and space allows but brief mention of the questions that the modern manufacturer should put to himself. Are the small tools of the right design, so that cuts are easily taken without too severely exerting either operator or machine? Are they well-made and within reasonable limits of

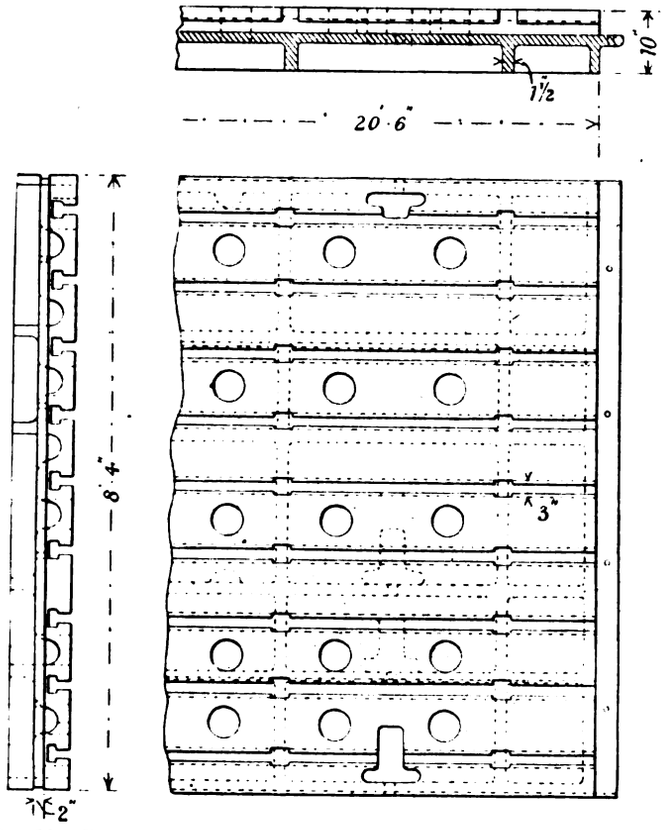

FIG. 11.—END OF ONE SECTION OF FLOOR PLATE. (175ft. by 20ft. 6in.)

accuracy? Without accurate tools it is impossible to employ low-priced wages for high-grade work. Are they made of the best material, having in view wearing qualities on a particular class of work? Are they kept in the best working condition, sharp and in

SURFACE PLATES.

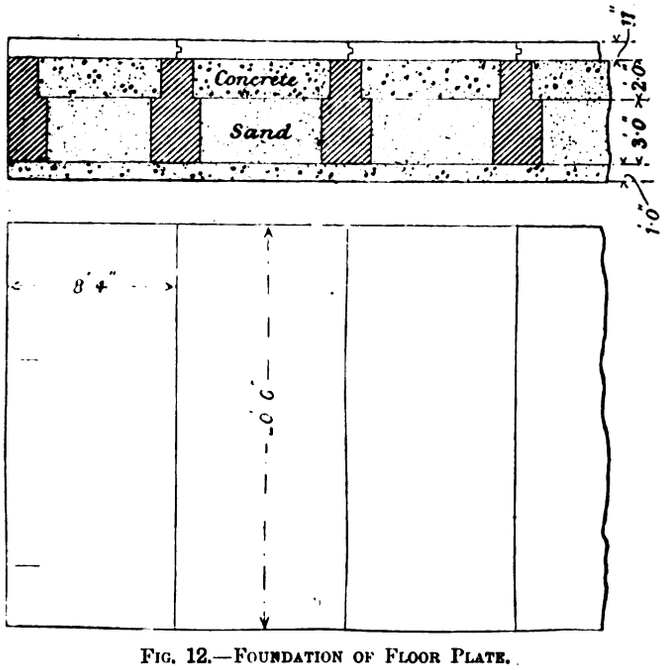

FIG. 12.—FOUNDATION OF FLOOR PLATE.

good repair? Output and quality will fall off if they are not. Are they "scrapped" when past their useful age? Are they cared for in well-arranged tool stores, or does each workman foster his own "kit," add to, take from, sharpen, repair and inspect? It is safe to say that many shops are stocked with ten times as many tools as are necessary, simply for the want of proper stores. One large shop recently found that 2 tons of tool-steel could be dispensed with by arranging tool stores, instead of allowing each man to retain his own complete outfit. Better cut down the quantity and improve the quality. Are they ever inspected? How many taps or reamers cut to size? How many arbors run true? How many teeth in milling cutters cut? How many gauges guaranteed to $\frac{1}{1000}$th of an inch when new (note the degree of accuracy) are no longer accurate to $\frac{1}{100}$th of an inch, are neither round, square, nor oval? How many "home-made" tools are nearly as good as those that reliable makers can supply or as cheap? Last, but not least, how many establishments have a good head tool maker who is familiar with the latest practice, knows the best forms of tools for different classes of work and appreciates the value of keeping tools in the best working conditions? How many take the trouble to train such men, give them the opportunity of studying what others are doing, or pay them sufficiently to induce them to put their brains and intelligence into this work, which demands thoughtful application and the highest mechanical skill? Modern manufacturing cannot be carried on unaided by well-cared-for cutting tools of the best quality. The higher the output per machine and man the greater the importance of the tool question.

Tool Room.—By the term "tool room" is meant an equipment of the best grade of machine tools and small tools necessary for the maintenance and supply of the special tools and fixtures which are used for manufacturing purposes. In an old-fashioned plant this equipment might mainly consist of a forge and a grindstone. In a highly-organised plant making an extensive use of labour-saving machines, fixtures and jigs it must consist of the most accurate machines, such as the universal mill, engine lathes, shapers, boring machines, drills and grinding machines, and also of accurate gauges, the equipment varying in size and variety in accordance with the main plant.

It seems curious, but it is a fact, that many manufacturers do not realise that complicated labour-saving machines and tools, constituting a highly-productive outfit, rapidly degenerate unless the means are at hand for constantly regenerating. They will invest in expensive machines which plain figures show are profitable, but will leave works, managers and foreman nearly destitute as to the means of keeping up the plant. The object of fast-working machines and accurate tools is to save hand-labour. Labour-saving outfits fail in a measure to replace hand-labour if accuracy is lost sight of. Cutting tools will wear, and whether they are adjustable to gauge or of fixed dimensions the allowable limits for wear are really very small if we expect labour-saving tools to compete with the skilled worker. The need of constant renewal is obvious. To attempt this renewal unaided by the very best appliances is uneconomical.

Many manufacturers attempt tool room practice in a groping sort of fashion, a lathe here and there, a milling machine occasionally made use of when not employed in regular work, and a standard set of gauges purchased in an unguarded moment, and carefully kept in the office under lock and key. A few who have fairly good outfits make the mistake of turning their tool rooms into manufacturing establishments of those articles which could be purchased more cheaply and better from a trustworthy maker. Those who proceed on this plan are liable to be constantly behind in respect to the latest design of tools, for the reason that they come so little in contact with those who make a special study of tools and the best ways of producing them.

Others have a vague sense of the need of a tool room, but do not see that this equipment calls for everything of the best. They try to economise in the purchase of outfit, and must surely, therefore, only attain indifferent results. None but machines of the highest accuracy should be allowed in the tool room. The worst offenders of all are those who try to economise the wage account chargeable to tool room. The very best skill and intelligence obtainable should be employed in this department, for on it rests a good part of the responsibility of producing a large or small output. Whether the plant is highly productive or not largely depends upon the head tool maker. To expect brains and intelligence of a high order to seek employment where the wages are low is contrary to all laws of supply and demand. American manufacturers, who generally recognise the value of a proper tool room, commonly pay from 12s. to 16s. per day, and even 20s. per day, for good tool makers.

(To be concluded.)

Electric Power at a Cleveland Ironworks.—At their Thornaby blast furnaces and steel works Messrs. W. Whitwell & Co. are about to adopt electric power for driving the machinery on a somewhat extensive scale. Two sets of generating plant of 250 H.P. each are to be installed, and the whole of the machinery in the shops will be driven electrically. For the lighting of the works, including the blast furnaces and mills, 40 arc lamps and nearly 450 incandescent lights will be required.

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CORRESPONDENCE.

ELECTRICAL TRAMWAYS AND OMNIBUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Mr. Edward Clark's interesting calculation in your current issue. From its date, however, this does not appear to be in reply to my last letter but to the one before, and the want of overtaking powers of a tramway, as against a cycle, seems to be left out of account.—Yours, &c.,

Westminster, Aug. 18. CHARLES BRIGHT.

LEGAL INTELLIGENCE.

Re Electric Lighting Boards (British Mfg. Co.), Ltd.

Mr. Justice Swinfen Eady on Wednesday heard a motion for the appointment of a receiver and manager of this company, and that Mr. Strauss should be appointed.

His lordship made the order in the usual form.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Preston Corporation require a resident electrical engineer capable of designing and superintending the construction and working of electric tramways. An advertisement contains further particulars. Applications to the town clerk (Mr. H. Hamer), Town Hall, Preston, by noon Sept. 8.

The Visitors committee of the County Asylum, Thorpe, Norwich, require a working engineer to take charge of the whole of the engineering and electrical plant. Applications to Mr. P. E. Hansell, The Close, Norwich, by Sept. 2. See advertisement.

Hoylake and West Kirby Urban District Council require a resident electrical engineer at a salary of £250 per annum. Applications (addressed chairman, Electric Supply committee) will be considered on Sept. 2. See advertisement.

An assistant lecturer in mathematics and a demonstrator in engineering are required for the Municipal Technical College, Sunderland. Applications to the secretary by Sept. 8. See advertisement.

A meter inspector is required by Bradford Corporation. Applications to the city electrical engineer (Mr. R. A. Chattock, M.I.E.E), Town Hall, Bradford. See advertisement.

An electrician is required to take charge of plant of about 3,000 lights. Applications to Mr. Geo. Stegmann, 10, North-side, Wandsworth Common, London, S.W. See advertisement.

Dewsbury Corporation require a chief assistant engineer. Applications by Sept. 2.

A headmaster is required for the municipal technical institute, Taunton. Applications to hon. sec. by Sept. 2.

Mr. F. Black, of Northfleet, has been appointed representative of the Gravesend and Northfleet Electric Tramways, Ltd., at the Corporation power station.

Mr. J. A. B. Horsley has been appointed resident electrical engineer at Tonbridge at £150 per annum.

Mr. A. F. Dowden, of Southampton, has been appointed junior shift engineer at Croydon.

EDUCATIONAL NOTICES.

Heriot-Watt College, Edinburgh.—The next session opens on Sept. 30. A three years' course of instruction in mechanical and electrical engineering and technical chemistry is given at the day technical college.

Owens College, Manchester.—Complete theoretical and practical training in electrical engineering is given in this college, and a certificate is granted on the successful completion of the course, which extends over three years. The next session commences on Oct. 7. Prospectuses may be obtained from the registrar.

University College, London.—Some particulars of the course of instruction given at this college, with fees, are set out in an advertisement. Special provision is made for post-graduate and research work in the various subjects taught at the college.

Acrefair.—Negotiations are proceeding between the Council and the Haslingden Electric Light and Power Co. for the erection of electricity works.

American Business Methods.—In a communication from the U.S. Consul-general at Hong-Kong, the experience of two young Americans who recently spent six months travelling in Japan, China and the Philippines for the purpose of soliciting trade is described. The Chinese language was studied by these young men in San Francisco, and sufficient acquaintance with the language acquired to make themselves understood. It was their first trip to the Orient, and but few samples were carried. As the travellers did not know exactly what class of goods the merchants they were visiting required, only a small variety of articles were carried, and these included electrical supplies of the accessory order. It is recorded that an excellent trade was done in these supplies, and the Chinese especially proved ready buyers of the goods. So satisfied were the travellers with their experience that they propose to make a further visit equipped with a much larger outfit of samples. They found that the fact that they could speak, however indifferently, the Chinese language had great weight with the merchants with whom they transacted business. All payments for goods purchased or ordered were made on the letter-of-credit basis.

Ashton-under-Lyne.—The local plumbers' association has protested to the Council against the Electricity committee allowing their cable jointers to make "plumbed joints" in the cables now being laid, on the ground that it is plumbers' work. The electrical engineer (Mr. Appelbee) replies that it is essential that jointers should plumb their own joints, and that no jointer is employed who cannot wipe joints as well as make them. The Council's reply to the association is in accordance with Mr. Appelbee's views.

Aylesbury.—Fresh tenders are to be invited for the Council's electric lighting order.

Barnstaple.—Application has been made by the Council for sanction to a loan of £21,600 for electricity supply.

Batley.—An inquiry was held on Wednesday into the application of the Council to borrow £5,308 for refuse destructor works.

Bexhill.—The Electric Lighting committee have had under consideration the question of permanent or temporary extensions at the electricity works. At the last Council meeting Mr. Dunn said they were handicapped by having the generating station at one end of the town and recommended the erection of a second station. No decision was come to.

Bideford.—Two companies have notified intention to apply for provisional electric lighting orders, but the Council have entered into a three years' contract for gas lighting, and "hope in the near future to themselves apply for electric lighting powers."

Blackpool.—The borough electrical and tramways engineer's report to the Electricity and Tramways committee recommends the provision of a new switchboard at the electricity works.

Brighton.—The electricity station buildings are to be extended to provide for additional tramway plant.

Buenos Ayres.—The United River Plate Telephone Co. has entered an action before the Civil Appeal Court against the Municipality to restrain the latter from removing the company's wires which are alleged to interfere with the working of the Anglo-Argentine Electric Tramway Co. The Municipality has, consequently, ordered the cutting of the wires to be suspended.

Caerphilly.—The Council, who are applying for a provisional order, will probably take electricity in bulk from the South Wales Electrical Power Distribution Co. The latter offer to supply 100,000 units per annum at 1¼d. per unit.

Cefn Mawr.—The Council are making inquiries into the cost of establishing electricity works.

Clacton.—The Council have decided, by a small majority, to retain their electric lighting order.

Darlington.—The electric lighting cables are to be extended.

Dartford.—An inquiry was held here last week into the application of the Council to borrow £28,363 for electricity generating plant and extensions of mains. Opposition was made to the purchase of condensing plant, which, it was urged, could not be used owing to inability to obtain water. It was suggested that boring operations for water should have been undertaken before the plant was purchased; and it was further urged that the consulting engineer ought not to receive his commission on this part of the machinery, but the inspector (Col. Hepper) said that the consulting engineer did not guarantee the undertaking any more than a doctor would guarantee the cure of a patient.

The Council will apply for a loan of £3,000 for the "free" wiring of premises.

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Dewsbury.—An inquiry was held here yesterday into the application of the Council to borrow £10,000 for tramway generating plant.

Doncaster.—The receipts of the Corporation electric tramways from July 14 to Aug. 9 amounted to £716. 3s., and the number of passengers carried on the four routes open for traffic was 171,746. One of these routes (the Hyde Park) was only opened on Aug. 1. The department now issues tokens in quantities of 24 for 2s.

Dundee.—The report of the tramway manager (Mr. P. Fisher) states that the receipts for the year ended May 15 were £35,874. 0s. 9d., and working expenses £24,042. 7s. 6d., leaving £11,831. 13s. 3d. Interest came to £5,076. 7s. 4d., sinking fund £3,415, annual payment to tramway company £2,100, depreciation on plant £903. 13s. 3d., fund for renewal of rails £300, leaving a net profit of £36. 12s. 8d., which is carried to suspense account. Capital expended during the year was £66,187. 16s. 10d., and to date £232,313. 0s. 11d.

Electric Lighting of Office Blocks.—An important addition has been made to the already large installation at the new Westinghouse building and its annexe in Norfolk-street, London, W.C. The building consists of seven floors and basement, each floor designed for about 14 rooms. Three-wire service mains are brought into the building by the Charing Cross and Strand Corporation, supply being by continuous current at 200 volts at the lamps. The main distribution board provides for a separate circuit to each floor, each circuit controlled by double-pole fuses and a single-pole chopper type switch. From this main board a separate circuit is run to each local distribution board for supplying the floors through the double-pole bridge type fuses. All lamp circuits are run back direct to distribution board, no fuses being employed locally. The maximum number of incandescents supplied from any sub-circuit is eight, and, with few exceptions every lamp is furnished with a separate switch. The wiring is carried out in Simplex brazed tube, all tubes being fixed in position as the building work proceeded and the wires drawn in afterwards. The building contains upwards of 700 electric lights and an elaborate system of electric bells for tenants and service, gas fire points, speaking tubes, &c. The total number of lamps on the Law Land Co.'s estate, of which this building forms a part, now supplied is estimated at about 5,000. The whole of the work has been carried out under the supervision of Mr. F. H. Taylor, C.E., 14, Victoria-street, S.W., consulting engineer to the company, by the electrical staff of the Law Land building department.

Electric Traction in Paris.—It is stated that, as the electric haulage of trains between the Austerlitz and Quai d'Orsay stations of the Orleans Railway in Paris have given good results, it has been decided to apply this method of traction between Paris and Juvisy as soon as two additional lines of way are laid.

Gainsborough.—The Council are applying for a provisional electric lighting order.

German Electrical Industry.—In the report of the Bank für Elektrische Unternehmungen, of Zurich, which is controlled by the Allgemeine Elektricitäts Gesellschaft, of Berlin, it is stated that electrical undertakings are by no means prosperous at the present time, and that the existing depression has not yet reached its lowest point. Primary causes are held to be the general depression of trade in Europe and the exhaustion of all the more paying branches of electric installation business. The only remedy proposed for improving the condition of the trade is by organising a union of electrical manufacturers to keep up prices and to avoid inflated payments as "commissions."

Gibraltar.—There was an expenditure in the public works department of the Rock in 1901 of £4,788 in connection with electricity works.

Glasgow.—Four additional tramway routes were officially inspected yesterday.

Great Northern and Strand Railway.—At the Mansion House on Tuesday Ald. Truscott granted an application, under the Lands Clauses Consolidation Act, for a certificate to enable the company to put their powers of compulsory purchase into operation. It was said the company had entered into a contract with the Underground Electric Railways Co. of London to construct the railway in consideration of the allotment to the Underground Company of the whole of the unissued capital of the G. N. and S. Co.

Greenock.—In submitting the past year's accounts of the electricity department to the Council on Tuesday, Bailie Cameron said that there was a deficit of £1,390. During the last six months the works had, however, paid their way. The accounts were approved. A reduction in the charge for current to large consumers has been decided upon.

Hamilton.—Edmundson's Electricity Corporation has been authorised to proceed with their "free" wiring scheme, and the consulting engineer (Mr. R. W. Hogarth) is to include a sum for "free" wiring in his statement to the Secretary for Scotland. If not sanctioned, the Council will apply for the necessary powers in their first application for additional powers.

Horsham.—The Electricity committee have stopped their employés from doing private work in their spare time. This is the outcome of the protest recently lodged by local tradesmen.

Hove.—The Council have decided, on the advice of their consulting engineers (Messrs. Lacey, Clirehugh and Sillar), to apply for powers to construct electric tramways at an estimated cost of £103,700.

Hoylake and West Kirby.—The resident electrical engineer (Mr. E Marples) has resigned, and the Council are advertising for a successor at £250 per annum.

Indo-European Telegraph Co.—At Marlborough House, on the 19th inst., the Shah of Persia, who is on a visit to this country, granted an audience to a deputation from the board of directors of the Indo-European Telegraph Co., consisting of Messrs. J. Herbert Tritton, Chas. Holland and T. W. Stratford-Andrews, chairman and directors of the company. The directors presented an address on behalf of the company, giving expression of their grateful acknowledgment for the protection to the company's line (which traverses Persian territory and terminates in Teheran, the capital of that country) enjoyed so long under the beneficient rule of the Imperial Persian Government. The address, embellished on the model of ancient Persian art, was contained in a gilt casket of beautiful workmanship in oriental style, and emblematical of telegraphs and the commerce of the British Empire and Persia, surmounted by a figure of Mercury, holding in one hand the caduceus of commerce and with the other gathering electric current. The address was graciously received by His Majesty.

Japan.—To the port of Shimonoseki there was imported in 1901 electric lighting apparatus and material to the value of £6,938 and submarine telegraph cable valued at £5,102.

On Aug. 18, 1901, the extensive range of iron and steel works which have been erected by the Japanese Government at Wakamatsu (Kinshiu) were formally opened. The object of these works is "to render Japan independent of outside supplies of steel and iron manufactures." Electric, steam and hydraulic power are all used in the works, there being 31,200 H P. of steam power installed. An electricity generating station forms a part of the works buildings, and a very extensive range of electric cranes is installed. The works are lighted entirely by electricity inside and out, 120 arcs and 1,000 incandescents being employed. The cranes are of American make and nearly the whole of the remainder of the machinery and plant is German.

Johannesburg.—Messrs. Mordey and Dawbarn have been appointed by the Municipality to prepare a complete report on electric lighting and tramways.

Johannesburg 1904 Exhibition.—In connection with the proposal to hold a great industrial exhibition in Johannesburg in 1904 a strong committee has been formed, and the patrons of the exhibition include Lord Strathcona, Sir Robert Herbert, Sir Albert K. Rollit, Sir Alfred Jones, Sir Charles W. Cayzer, Messrs. James Bailey, B. F. Hawksley (trustee of the late Cecil Rhodes), Hon. J. Tudhoye, S. B. Joel, Sir Jamsetjee Jejeebhoy, Bart., the Maharajah of Tangore, K.C.S.I., and the Maha Mudaliyar, C.M.G., of Ceylon. The exhibition will include mining and agricultural machinery, steam, electrical and all kinds of motive power, railways tramways, &c. Offices have been opened in Johannesburg and Pretoria, and at 16, Cockspur-street, Pall Mall, London, S.W.

Keighley.—The question of obtaining electric tramway powers has been adjourned by the Council for 12 months.

King's Norton.—The Council is advertising for tenders for leasing its provisional order, and is negotiating with the city of Birmingham Tramways Co. for the construction of tramways. The Council proposes to bear the cost of equipment and construction, the cars and current being supplied by the company.

Leek.—An inquiry is to be held into the application of the Council for sanction to borrow £10,061 for electricity supply.

Light Railways.—The North Shields, Tynemouth and District Light Railways (Extension) Order has been submitted to the Board of Trade for confirmation. Objections by Sept. 12.

Middlesex County Council propose to construct three lengths of light railway—viz., from Lordship-lane (Tottenham) to Wood Green, from Archway-road to Whetstone, and from Archway-road to Edgware. The total length of these routes is 16 miles, and they will form part of a more extensive scheme estimated to cost about £2,000,000.

Liverpool Overhead Railway.—The trains on this railway are to be supplied with four 100 H.P. motors of the iron-clad type in place of the two motors hitherto forming the power equipment of the trains. The scheduled speed is to be increased from 12½ to 19½ miles per hour, including stoppages. The new service comes into operation in September.

Llandudno.—Owing to increasing demand for electric current, an additional steam dynamo is to be put in.

Malta.—The chief secretary to the Governor of Malta has prepared a report in the Malta blue book for the year 1901, from which

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we learn that an increased revenue of £1,712 has been received from electric lighting compared with the returns for 1900, the total revenue from this enterprise in 1901 being £15,024 16s. 10d. The annual rate of increase has been continuous since 1897, when the works were started. To account for the increase there has been an increase in the charge per unit, and a considerable number of additional connections to the mains. Amongst the items of expenditure during the year was the sum of £580 contributed towards the construction of a workshop in connection with the electric lighting undertaking.

Proposals have been made during the year to connect Malta with Sicily by the wireless system of telegraphy, but no indication is given as to how these overtures have been received.

The island telephone service, a private enterprise, has a line mileage of 440 miles. The Governor's palaces, all Government departments, the charitable institutions and police stations and offices are telephonically connected; the railway department has a separate circuit connecting all the stations, and the island of Gozo can now be communicated with through the military telephone and signal system. It is considered advisable that the facilities for switching on from the military to the civil telephone service should be developed, and that the Government should extend its telephone lines as rapidly as possible, and adopt the military standard of efficiency in the lines and plant in use.

Manchester and Liverpool Electric Express Railway.—Surveys are being made in connection with this scheme, and it is hoped that construction work will shortly be commenced.

Municipal Telephony.—At the meeting of the Brighton Council yesterday, it was decided to omit Hove from the scheme to establish a municipal telephone service for the Brighton area.

West Hartlepool Council have resolved to apply for a municipal telephone licence.

At the next meeting of the Huddersfield Corporation Ald. Sugden will again raise the question of the establishment of a municipal telephone service.

Nantwich.—An inquiry was held on Wednesday into the application of the Council to borrow £12,505 for electric lighting. Evidence was given by the clerk (Mr. Whittingham), the electrical engineer (Mr. Peers), and the surveyor (Mr. Newey). Some opposition was offered by ratepayers.

Newport (Salop).—A committee is ascertaining the likely demand for electric current.

Northfleet.—Negotiations are proceeding between the Council and the Gravesend Council for the transfer of the Northfleet provisional order to Gravesend.

Ormesby.—The District Council is in negotiation with the Cleveland and South Durham Electric Power Co. for a supply of electricity in bulk.

Perth.—The accounts of the electricity department for the first year's working have been issued and show a profit of £12.

Presentation.—Mr. H. F. Foster, electrical engineer to Epsom District Council, has been presented with a marble timepiece as a wedding gift.

Redruth.—A number of 16 c.p. incandescents are to be erected along the tramway route, to which current will be supplied by the Urban Electric Supply Co. at £1. 7s. 6d. per lamp per annum.

Rishton.—The Council decline to take over the Rishton portion of the powers conferred under the Rishton, Great Harwood and Clayton-le-Moors electric lighting order granted in 1901 to Mr. C. Chadwell and others.

Rochester.—The Council have abandoned the proposal to apply for a light railway order, and a bill will be promoted for powers to construct and work electric tramways.

Rowley.—The Council have agreed to construct the proposed new light railway between Brierley Hill, Quarry Bank and Cradley Heath, with a loop line to Rowley, on the basis that the cost of application, construction and maintenance, profits, losses and proceeds of sale be apportioned in accordance with the mileage of the line within the respective areas of the local authorities. The joint commitee for carrying out the intended order is to consist of 10 members, proportionately selected.

Ryde.—The Council have asked the Local Government Board to cancel the sanction given in October, 1900, to borrow £30,000 for electric lighting. The Council obtained a provisional order without a transfer clause, but an agreement had been made with Edmundson's Electricity Corporation to establish and maintain electricity works as sub-undertakers under the Council. The present action of the Council does not affect the Company's scheme.

Servia.—It is announced that the town of Nich is about to be lighted electrically. £24,000 is to be borrowed for the purpose of construction and equipment of electricity works and the supply and laying of the necessary mains and cables.

Spain.—At 10 a.m. of Sept. 23 tenders will be opened at the Town Hall, Celanova, for the installation and working for 20 years or less of a concession for the supply of electricity to the town.

At 10 a.m. of Sept. 19 tenders will be opened at the Town Hall, Cabeza de Buzy, for the erection and equipment of electricity works for a concession for 25 years.

Further particulars are given regarding these concessions in the *Madrid Gazette* for 13th and 16th inst., which can be seen by appointment at *The Electrician* Offices.

So soon as the necessary capital for the construction of an electrical railway between the towns of Vich and Amer (Gerona) is subscribed tenders will be invited for the construction and equipment of this line, the estimated capital expenditure being about £250,000. The concessionaire is Senor Don Teodoro de Mas Y. Nadal, of Vich, Gerona, Spain.

Stirling.—The Council are considering the proposals of a local company to construct electric tramways between Stirling and Bannockburn through St. Ninians, the company taking current from the Council.

Swadlincote.—The Council will oppose the application of the Provincial Electric Supply and Traction Co. for a provisional order

Sweden.—The popularity of the telephone in this country is a feature of electrical development. An excellent service is now being constructed all over the country which embraces nearly every large farm and country seat. The subscription is about £3 per annum plus an initial charge to cover cost of connection.

Swindon.—The Guardians have been notified by the Local Government Board that, as their workhouse is at present lighted by gas, it is not desirable that electric lighting should be substituted. In any case the guardians should obtain current from a public service rather than put down independent plant. The guardians' consulting engineer (Mr. Peers) reports that electric lighting would be cheaper than gas, but that the cost of obtaining current from the Corporation's mains, 3 miles distant, would be prohibitive. A letter to this effect has been sent to the Local Government Board.

United States Consular Reports.—A noticeable feature of the consular reports sent in to the United States Government is the addition of illustrations wherever these will assist United States manufacturers to a better understanding of "foreign" commercial requirements. Much additional interest is given by this means to these always instructive communications.

Visit of the Shah.—Yesterday the Shah of Persia, who, like his predecessor, makes the most of his time when making a visit, inspected the works of the Sir Hiram Maxim Electrical and Engineering Co., at Gillingham-street, Victoria, London, S.W., and was shown over the works by the chairman (Mr. J. de Meray) and by Sir Hiram S. Maxim and other directors and officials of the company. The complete process of incandescent lamp manufacture was explained to His Majesty, who took a lively interest in the proceedings, inspecting each detail with great minuteness. Sir Hiram Maxim subsequently fully explained the working of a number of quick-firing Maxim guns, and the Shah handled some of these machines with considerable dexterity. His Majesty, and a suite of between 20 and 30 members, enjoyed their visit to the works, which lasted for nearly two hours.

Water-power in America.—The *Western Electrician* of Chicago states that it is proposed to erect plant south of Joliet (Ill.) to develop 20,000 H.P. The scheme was originally formulated in 1900, but abandoned. The necessary work preparatory to the setting of the turbines will now be commenced. There is no difficulty anticipated in disposing of the power generated.

Westinghouse Works.—A party from South Australia, including Sir Edwin T. Smith and Mr. Arthur W. Ware, ex-mayor of Adelaide, visited the Westinghouse works at Trafford Park, Manchester, on Friday, making a complete tour of the immense modern workshops. Adelaide has embarked upon a large scheme for the conversion of its horse tramways to electric traction and the construction of new lines, the contract being placed with the British Westinghouse Co.

Wilts. and Somerset Electric Power Scheme.—A syndicate is promoting a scheme for the erection of electricity works for supplying current in bulk to towns and district in the counties of Wilts and Somerset. The generating station is to be situate at Radstock. It is proposed to supply towns within a 15-mile radius, including Trowbridge, Bradford-on-Avon, Westbury, Frome, Bath, Warminster and possibly Melksham, Shepton Mallet, Wells, &c.

Wireless Telegraph Stations.—Tuesday's *London Gazette* contained a list of Marconi wireless telegraph stations. This list includes the following in addition to the list which appeared in "The Electrician" Electrical Trades' Directory and Handbook for 1902, p. 441:—Frinton-on-Sea, Haven (Poole), Malin Head, Innistrahull, Nieuport (Belgium), Belle Isle and Chateau Bay (Labrador) and Sagaponack (Long Island, U.S.A.). This list does not include the British Admiralty stations.

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Withnell.—A committee has been instructed to report upon electric lighting.

Worksop.—The questions of reducing the charges for electric current, and of adopting a system of wiring consumers' premises on the hire-purchase system, are under consideration by the Electric Lighting committee.

Sports.—The sports of the staff of the Peel works of the General Electric Co. took place at Manchester on Saturday, when over 5,000 spectators were present. There were over 300 entries for the 18 events, and competition was in all cases keen. Mr. J. A. Davis won the Eckstein cup, presented by Mr. A. Eckstein, the managing director of the company, to the winner of a 220yds. flat handicap, the finish being a very close one. The electric light department won the departmental team race and the tool shop team the tug of war. Mrs. Eckstein presented the prizes and Mr. A. Brooker, manager at the Peel works, at the close of the sports, moved a hearty vote of thanks to Mr. and Mrs. Eckstein, which was carried with acclamation.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week*]

TENDERS INVITED.

St. Petersburg (Russia) Town Council require tenders for the reconstruction of the existing three horse-drawn tramways in the city to electric traction, and for the construction and equipment of an electric power station. Conditions of tender, application forms, &c., can be obtained, on request, either by post or telegraph, from the Stadt-Amt., St. Petersburg, Russia, where projects have to be lodged and tenders sent by the 1st (14th) Nov. next. An advertisement gives additional particulars.

By command of the *Postmaster General* tenders will be received until 10 a.m. of Sept. 29 for the supply of Swedish, Norwegian or Finland red fir telegraph poles, and for creosoting same, in accordance with particulars set out in an advertisement elsewhere. Forms of tender and particulars of Mr. S. C. Hooley, controller of stores, G.P.O., London, E.C.

West Ham Corporation invite tenders for steam exhaust, feed water and drain piping, water softener, steam traps and separators; also circulating and air pump, discharge piping, water purifier and vapour pipes. Specifications, &c., from the borough electrical engineer (Mr. James K. Bock), and tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, Stratford, by 4 p.m. Sept. 4. An advertisement contains further particulars.

West Ham Corporation also invite tenders for tramway permanent way construction and paving, including copper bonding. Tenders by 4 p.m. Sept. 4.

Kirkcaldy Corporation invite tenders for the supply and delivery of electricity meters. Specifications, &c., from the town clerk (Mr. Wm. L. Macindoe), to whom tenders by Sept. 8. Specification can be seen at, but not obtained from, the office of the consulting engineers (Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. See also advertisement.

Limerick Corporation invite proposals for wiring consumers' premises on hire-purchase or other system. Particulars are given in an advertisement, and additional information can be obtained from the consulting engineer, Mr. J. Enright, 202, Holland-road, London, W. Proposals to town clerk (Mr. W. M. Nolan) by Sept. 1.

Leicester Tramways committee invite tenders for tramway track material, feeder cables, telephone and test wires, overhead electrical equipment and copper bonds, steam-raising plant, engines, generators, batteries, boosters, switchboard, overhead travelling crane, electric tramcars, &c., &c. Tenders by noon Sept. 3.

The directors of the *North-Eastern Railway Co.* invite tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders to secretary, York, by noon Oct. 7.

The *Metropolitan Asylums Board* invite tenders for an electric fire alarm installation at the Orchard Small-pox Hospital, near Dartford. Tenders to the offices, Embankment, London, E.C., by 10 a.m. Aug. 28

King's Norton and Northfield Urban District Council are prepared to lease their powers under their electric lighting order of 1898. Offers to Mr. E. Docker, 10, Newhall-street, Birmingham, by Sept. 18.

Manchester Electricity committee require tenders for steelwork for a high level railway at Stuart-street station. Tenders by noon Sept. 1.

Manchester Tramways committee require tenders for electrical repairing stores, fitters' tools, &c. Tenders by 1 p.m. 30th inst.

Bury Tramways committee require rails, fishplates, points and crossings, &c. Tenders by 28th inst.

Swansea Corporation require telephone conduits, cables, poles, instruments, &c. Tenders by Sept. 1.

Bristol Guardians require tenders for boilers, &c., and for wiring and electric fittings for the infirmary. Tenders by noon, Sept. 10.

Doncaster Corporation invite tenders by 28th inst. for ejector condenser plant, with pumps, &c.

Stretford Council require tenders for steelwork and overhead power travelling crane. Tenders by 30th inst.

Blackpool Electricity and Tramways committee require about 310yds. of 20in. gauge tramway rails and 10 waggons. Tenders by Aug. 31.

Edinburgh Corporation require tenders by 26th inst. for cast-iron pillar boxes for street section fuses.

Glasgow Corporation invite tenders for cast-iron columns, bases, and brackets, and steel poles for arc lighting. Tenders by 25th inst.

The British Municipality and British Municipal Extension at *Tientsin*, China, invite proposals until Nov. 30 for lighting concessions by electricity. Mr. A. W. Harvey Pellingham is secretary and engineer.

The Portuguese authorities at *Lourenço Marques* will shortly invite tenders for eight electric conveyors of the Temperley type. British firms wishing to tender should apply for particulars to his Excellency the Governor, Lourenço Marques, Portuguese East Africa.

The *Norwegian State Railway* authorities invite tenders until Sept. 13 for telegraph wire, porcelain insulators, insulator holders, &c. Particulars from Inspector of Telegraphs, Stoners Gade, Christiana.

Malagon (Ciudad Real, Spain) Municipal Council invite tenders until Sept. 20 for an electric lighting concession for 20 years. Tenders to El Secretario del Ayuntamiento.

Amsterdam Municipality invite tenders until Sept. 8 for delivery and laying of the entire network of cables for the municipal electricity works. Particulars from director of electrical works, O. Z. Achterburgwal 213, Amsterdam.

TENDERS RECEIVED AND ACCEPTED.

Messrs. Drake and Gorham have secured a further order from Harrods' Stores for 84 Jandus arc lamps to be used for the lighting of the extension of premises in Brompton-road, London. With this addition Messrs. Harrods will have over 300 Jandus lamps in regular operation.

Messrs. Willans and Robinson have received an order through the Lancashire Dynamo and Motor Co. for a 575 I.H.P. compound engine for direct coupling to a dynamo of the latter company's make for traction purposes at Wrexham.

Elmton-cum-Creswell Parish Council have accepted the tender of John Davis & Son (Derby) for the supply and erection of electricity generating plant at £590. 10s.

An order has been placed with Messrs. Willans and Robinson for a 360 I.H.P. compound engine for driving spinning machinery by a rope drive at Bahia, S. America.

Warrington Guardians have accepted the tender of Messrs. Morton and Sampson for electric lighting extensions at the workhouse at £59. 10s.

The Australian Federal Government has accepted the following tenders:—B. Diercks & Co. (Proprietary) for 2½ miles of 78 pairs metallic return telephone cable at £529. 8s. per mile; 2½ miles of 52 pairs at £386. 6s. per mile; 5 miles of 39 pairs at £324 per mile and 5 miles of 26 pairs at £243 per mile; also that of Siemens Bros. & Co. for 2½ miles of 13 pairs metallic return telephone cable at £177 per mile. The tender of Messrs. Diercks & Co. has also been accepted for three Hookham or other approved types of recording kilowatt meters (capacity 150 to 200 amperes, 100 volts, continuous current) at £7. 10s. each and two meters (50 amperes, 110 volts, continuous current) at £5. 17s. each. The tender of Messrs. Lawrence and Hanson has been accepted for rheostats, wound with No. 6 platinoid wire on porcelain formers, at £1. 5s. each.

The tender of the Australian General Electric Co. has been accepted by the Melbourne City Council for the supply of 63,350 incandescent lamps for £2,418.

BUSINESS NOTICES.

St. Helens Cable Co., whose London address has hitherto been 32, Victoria-street, S.W., have now taken additional offices at 30, Victoria-street.

Messrs. J. G. Irving and J. S. Plumtree, electrical engineers, trading as Irving and Plumtree, 12, Canal-street, Nottingham, have dissolved partnership. Mr. Irving continues.

BANKRUPTCIES AND LIQUIDATIONS.

A fourth and final dividend (3¾d.) is payable at Bankruptcy-buildings, London, in the failure of B. B. Wake, formerly trading with H. S. Saunders as mica merchants, &c.

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Mr. Anderson, electrical engineer, Tonbridge, appeared for public examination at Tunbridge Wells, on Friday. Debtor who had for partner a Mr. Perkins, received a salary for managing the electrical business, the original idea being to work the business by means of a syndicate. Examination closed.

Claims against G. H. Bentley, electrical engineer, 63, Cross-lane, and 8, Grafton-street (formerly trading at 18, Market-street), Earlestown, Lanca., must be in by 30th inst. to Mr. C. J. Dibb, Byrom-street, Manchester.

J. F. Worthington and G. Nuttall (trading as J. Worthington & Co.), electrical engineers, Foundry-street, Hanley, have been adjudicated bankrupt.

It has been resolved to wind up voluntarily the Southern Electrical Installation and Wiring Co. (Ltd.). Mr. W. J. Larcombe, Hastings, is liquidator.

The South Shields Electrical Engineering Co. (Ltd.) is to be wound up voluntarily, and Mr. M. Stainton, 18, Grainger-street West, Newcastle-on-Tyne, is liquidator.

Claims against the Davy Electrical Construction Co. (Ltd.) should be sent to Mr. G. Frampton, 37, Casselden-road, Harlesden, London, N.W., by Sept. 26.

Electric Lighting Boards (Ltd.)—As announced in our "Legal Intelligence," an order was made on Wednesday by Mr. Justice Swinfen Eady for the appointment of a receiver and manager of the Electric Lighting Boards (British Mfg. Co.), Ltd. We have been asked to state that the company, being in financial difficulties, has decided to go into voluntary liquidation, and that a reconstruction scheme is on foot under which both creditors and shareholders will be protected. The original Electric Lighting Boards Syndicate, who were debenture-holders of the British company, have appointed a receiver to protect the assets and carry on the business in Great Britain for the present. It is further stated that the position of the British company does not affect the foreign concerns working the company's system.

Catalogues and Price Lists Wanted.—In an advertisement Mr. John Denham, electrical engineer to the Cape Government Railways, announces that he requires catalogues and price lists of electrical plant and apparatus, including engines (steam, oil and gas), direct-coupled generating sets and motors (alternating and continuous-current), boilers, feed-heaters, condensers, pumps, &c., electric cranes, cables, wires, electric lamps, fittings, measuring instruments, &c.

Works Premises for Sale.—Messrs. Miller and Abbotts, 30, High-street, Banbury, will sell by auction at the White Lion Hotel, Banbury, on Sept. 3, at 5 p.m., freehold premises with extensive frontage to the Oxford and Birmingham canal. See advertisement.

Plant for Sale.—The Newcastle-upon-Tyne Electric Supply Co. (Ltd.) having recently changed over their system of supply from alternating to direct current, have some plant for disposal, particulars of which are set out in an advertisement. Additional information can be obtained from the general manager, 50, New Bridge-street, Newcastle-on-Tyne.

Northgate Mansions (Ltd.), Gloucester, have for sale a 20 B H.P. gas engine, a dynamo (60 amps. 200 volts), switchboard, belting, &c. See advertisement.

Rock Drill Competition.—On 25th ult. official competing tests were made at Düsseldorf Exhibition between the different rock-boring machines on the market, and we are informed that the Schuckert combined electric compressed air percussion drill was able to show the best results in the competition.

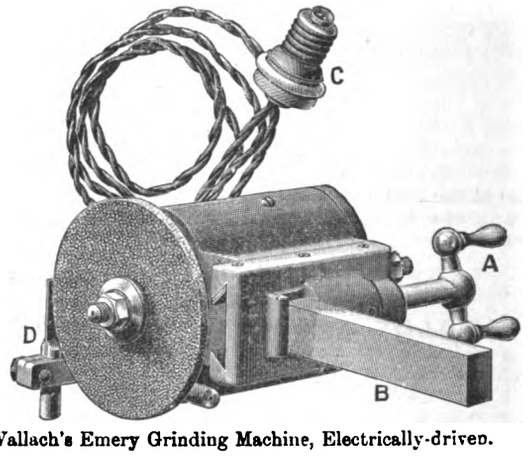
Catalogues.—The Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C., have ready an illustrated description of their special type of continuous-current dynamos (for direct coupling). These machines are built for all outputs and speeds.

A large batch of catalogue sheets is to hand from the General Electric Co. covering the subjects of enamelled steel conduit, electric fans, deadbeat moving coil ammeters and voltmeters, flexible cords, E.C.C. dry batteries, wires and cables, electric bells, switches and switchboards, &c. All the lists are fully illustrated, and go to complete the company's general catalogue.

A list of V-type dynamos and motors (pamphlet No. 1,001) is issued by the Union Electric Co., 151, Queen Victoria-street, London, E.C., in which the advantages of these machines for various and special purposes are set out. Particular stress is laid upon the merits of the enclosed ventilated type of motor supplied by the company, on the ground that by the special method of ventilation adopted the machine can be rated as highly as the open-type motor. Patent adjustable pole-pieces give the brushes a fixed position as regards the machine.

The Sun Fan Co., 4A, Thornton-road, Bradford, have ready two lists, dealing respectively with electrically-driven and belt-driven fans. The first-named list gives a very complete specification for electric fans, with comprehensive tables of speeds, volumes and powers, weights, &c. A double-effect electric fan, specially suitable for high-pressure driving or where a reversible fan is needed, is illustrated in the list, and a self-closing shutter device to prevent back draft when the fan is stopped. Wire guards for fans placed in dangerous positions are also shown.

Messrs. Wallach Bros., 57, Gracechurch, London, E.C. have ready a new list (section K) of hydraulic gauge-testing pumps, drilling machines, tool-grinding and sharpening machines, steam engine indicators, drills, vices, &c. The illustration shows an electrically-driven emery grinding machine for use with direct current at 110



Wallach's Emery Grinding Machine, Electrically-driven.

and 220 volts. A socket and coil is supplied with this machine, and current can be taken from an ordinary incandescent light circuit. A set of wheels of diameters ranging from 4½in. to 8in. can be used with these machines. With machines working on a 220 voltage a speed controller is necessary for starting the motor and regulating the machine to any desired speed.

Messrs. W. F. Dennis & Co., 23, Billiter-street, London, E.C., have ready, for the trade only, the 1902 issue of the "Fredennis" wire gauge table and trade price list.

Pamphlets 130-1-2, issued by the British Thomson-Houston Co., describe and illustrate slow and moderate-speed motors, motor-driven air compressors, and traction motors respectively. With the last-mentioned pamphlet a price list of spare parts, &c., of traction motors is given.

A pocket price list of E.P.S. storage cells for rough calculations is issued by the Electrical Power Storage Co., 4, Great Winchester-street, London, E.C. An imposing list of some of the larger power stations in Great Britain for which E.P.S. batteries have been supplied is listed on a separate sheet, and there is also a list of stations where these batteries are in course of erection. This includes orders for the Underground Electric Railways Co. (the company which is carrying out the electrification of the London underground railways) and for the local authorities at Barking, Barnsley, Birkenhead, Broughty Ferry, Chelsea, Cleckheaton, Hendon, Hornsey, Norwich, Tadcaster and Walsall, and the Midland Light and Power Co. Birkenhead and Tadcaster have each two batteries under construction. Liverpool Corporation electricity works have 12 E.P.S. battery sets installed.

One of the oldest firms engaged in the design and manufacture of electric light fittings of all kinds is Messrs. Benham and Froud, of Chandos-street, London, W.C. This firm have just issued a nicely illustrated list giving a selection from a large number of original designs of which manufactured examples can be seen at the company's showrooms. It is claimed for many of these that they are of the most up-to-date design. The list is particularly strong in fittings suitable for churches and public buildings, and in this class of work Messrs. Benham and Froud have special and unique experience. The complete installation of the electric light in ecclesiastical structures is carried out by this firm, who can claim some of the best work of the kind in the kingdom.

Messrs. L. M. Ericsson & Co., 154-5, Temple-chambers, London, E.C., forward a copy of the 1902 edition of their catalogue of telephones and accessories. The catalogue comes as the forerunner of the establishment by Messrs. Ericsson & Co. of a large factory at Tottenham, London, N., and the catalogue itself is an excellent earnest of the completeness of the company's facilities for filling orders of any magnitude for telephone apparatus and accessories. Telephone subscribers in the United Kingdom have by this time become familiar with the instruments supplied by this firm, who have previously manufactured their goods at the parent factory at Stockholm, or at the factory more recently erected and equipped at St. Petersburg. The catalogue is fully illustrated and is carefully compiled and systematically arranged.

Willard's Storage Battery Co., Cleveland, Ohio, have prepared a new catalogue of Willard batteries illustrating the standard types.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which

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is not separately specified) from Aug. 13 to 19, with the ports of destination :—

Africa—Alexandria, £51 ; Cape Town, £400 ; Durban, £1,605 (including £865 telegraph material). *Argentina*—Buenos Ayres, £405. *Australasia*—Adelaide, £387 ; Auckland, £217 ; Melbourne, £107 ; Perth, £377 ; Sydney, £238. *Belgium*—Ostend, £377. *Brazil*—Rio Janiero, £2,246 (telegraph material). *British Guiana*—Demerara, £365 (telegraph material). *China*—Shanghai, £41. *Denmark*—Copenhagen, £83 (telegraph wire). *Fanning Island*—£350,000 (telegraph cable). *India*—Calcutta, £3,405 (including £2,397 telegraph wire) : Madras £46. *Siam*—Bangkok, £737. *Straits Settlements*—Singapore, £13. *Sweden*—Gothenburg, £183. *West Indies*—St. Lucia, £44 (telegraph wire). Total £361,327 against £11,234 in the corresponding week last year (Aug. 14 to 20).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

June 24, 1902.

14,297. C. F. HEATH. Electric time switches.*
14,319. C. SCHWABE. Liverpool. Incandescent lighting devices.
14,326. O. ZIELINSKI. Switch-holders for incandescent lamps.
14,329. G. C. MARKS. Storage batteries. (Smith Storage Battery Co., U.S.)*
14,334. F. J. W. HATCH. Trolley wheels for electric cars.
14,344. H. BREMER. Arc lamps.

June 25, 1902.

14,348. J. LAIDLAW. Glasgow. Electric centrifugal machines.
14,349. J. FERGUSON and KELVIN AND J. WHITE. Glasgow. Electrostatic apparatus for measuring potentials.
14,373. LANCASHIRE DYNAMO AND MOTOR CO. and R. S. MCLEOD. Liverpool. Regulating charge and discharge of storage batteries.
14,374. NATIONAL RAIL AND TRAMWAY APPLIANCES CO. and P. MCCULLOUGH. Liverpool. Swivelling electrical collector trolley head.
14,384. C. FRANKLIN. Bristol. Apparatus for observing the sparking of plugs without removing them from motors.
14,386 and 14,387. P. L. E. LEDERLIN. Electrolytic manufacture of chlorates and perchlorates. (Date applied for Jan. 8, 1902, date of application in France.)*
14,401. R. B. ROXBY. Incandescent lamps.
14,430. T. H. W. HIGGINS. Type printing telegraphic instruments.

June 30, 1902.

14,464. E. E. MADDOX. Bournemouth. Portable transformers.
14,471. W. THOMSON Baron KELVIN. Glasgow. Regulator for electric instruments.
14,479. A. A. GUEST. Birmingham. Shade or globe holders.
14,482 and 14,498. G. L. ADAMSON, J. ELIAS and E. E. ADAMSON. Manchester. Magnetic separators.
14,487. E. W. COWAN and W. B. DALE. Manchester. Automatic cutouts.
14,489. T. HESKETH. Folkestone. Maximum demand meters.
14,507. J. S. HIGHFIELD. St. Helens. Controlling devices for electric motors.
14,523. A. P. MAXFIELD and C. R. GERRARD. Electric ignition devices for motor cycles and other services.
14,538. A. GRAMMONT. Electro-goniometers. (Date applied for Dec. 20, 1901, date of application in France.)*
14,524. E. R. GILL. Coupling for electric lamps.
14,547. E. WESTON. Electrical measuring instruments.*
14,572. SIEMENS BROS. & CO. Lightning conductor for electrical installations. (Siemens and Halske A.G., Germany.)*
14,573. EDISON AND SWAN UNITED ELECTRIC LIGHT CO., J. SHEPHERD and H. D. GOVER. Switches for electrical glow lamps.*
14,574. G. H. HILL. Controlling apparatus for electric cars.*
14,583. G. E. GAIFFE and G. GALLOT. Electrolytic interrupters.
14,605. EASTON & CO. (LTD.), P. I. UNWIN and J. BJORNSTAD. Starting switches for electric lifts.
14,612. J. H. HEGNER. Incandescent electric lighting.

July 1, 1902.

14,623. J. ATKINSON. Cheshire. Continuous-current dynamos, motors and converters.
14,652. G. WESTINGHOUSE. Arc lamps.
14,667. E. SCHATTNER. Electricity meters.
14,670. H. WALKER. Operating points of electric tramways.
14,676. W. M. BROWN. Electric railways.*
14,680. A. SCHWEHR and P. WAGNER. Arc lamps.
14,683. C. WÜST-KUNZ. Driving mechanism for electric machine tools. (Date applied for July, 20, 1901, date of application in Switzerland.)*
14,715. S. H. SHORT. Electrical starting and regulating mechanism for gas or petroleum engines.
14,716. T. H. JONES. Automatic electric lock and block signalling.

July 2, 1902.

14,728. R. BEATTIE. Manchester. Instrument for measuring or comparing transient currents.
14,732. T. B. MURRAY and N. O. FULTON. Glasgow. Magneto-electric generators.
14,738. T. CHALMERS. Manchester. Lampholders.
14,741. M. MERCIER. Manchester. Electric propulsion of wheeled vehicles and boats.
14,761. J. D. F. ANDREWS and ELECTRICAL PRODUCTIONS LIMITED. Tumbler switch.
14,767. E. R. GILL. Electric lamps and switches.
14,768. E. R. GILL. Portable electric lights.
14,772. SIEMENS BROS. & CO. Liquid starting apparatus for electro-motors. (Siemens and Halske A.G., Germany.)*
14,773. SIEMENS BROS. & CO. Controlling electro-motors from a distance. (Siemens and Halske A.G., Germany.)*
14,774. VICKERS, SONS AND MAXIM, A. D. WILLIAMSON, and C. L. SUMPTER. Electric working of reciprocating tools.
14,780. T. J. HOWELL and A. A. ANDREW. Sawbridgeworth. Creation, multiplication and application of E.M.F.
14,781. B. J. B. MILLS. Subjecting gases to high-tension electrical discharges. (Atmospheric Products Co., U.S.)*
14,788. E. W. SCHNEIDER. Automatic switches for telephones.*
14,790. JOHNSON-LUNDELL ELECTRIC TRACTION CO. Armature windings. (R. Lundell, U.S.)*

July 3, 1902.

14,809. T. HENWOOD. Brighton. High-tension switch.
14,829. E. WILSON. Detectors for space telegraphy.
14,836. K. KISHI. Field magnet cores of dynamo-electric apparatus.
14,851. L. LOHNER and F. PORSCHE. Electric vehicles.
14,855. SIEMENS BROS. & CO. Electrical transformers for mono and polyphase currents. (Siemens and Halske, A. G., Germany).*
14,869. H. H. LAKE. Arc lamps. (H. Cuénod, Switzerland.)
14,878. J. H. HEGNER. Incandescent lamps.
14,883. W. AITKEN. Telephonic intercommunication systems.*

July 4, 1902.

14,884. H. H. LAKE. Electric distribution systems. (General Electric Co., U.S.)
14,887. J. C. BOOTH. Bradford. Electric battery.
14,897. W. HARRIS, H. BRECKNELL, E. M. MUNRO and H. J. ROGERS. Bristol. "Frogs" or points for overhead wire systems.
14,899. E. SCHATTNER. Safety fuses for electric circuits.
14,901. G. ATHERTON. Manchester. Brakes of electric tramcars.
14,910. H. I. JACQUES. Bristol. Electric capstans.
14,947. C. F. BAUDRY. Electric systems. (Date applied for Dec. 14, date of application in France.)*
14,962. A. WAKEFIELD. Conduits.
14,971. M. MARGOWSKI and C. GORICK. Automatic telephone exchange apparatus.

July 5, 1902.

14,977. R. C. HARPUR and L. W. WOODMAN. Dover. Electric reflector glow lamp.
15,029. W. SIMM. Liverpool. Lifeguards for electric vehicles.
15,038. BRITISH THOMSON-HOUSTON CO., A. J. IRELAND and F. SAMUELSON. Arc lamps.
15,039. BRITISH THOMSON-HOUSTON CO. Connecting multiphase electric circuits. (W. S. Moody, U.S.).
15,049. J. B. BIRNBAUM. Telephone switches. (Telephon Fabrik vorm. J. Berliner, Germany)*.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1902.

8,872. BACH. Switches for electric lighting.
8,969. HADDAN (Peck). Dynamo-electric generators.
9,229. OXLADE and RICHARDSON. Audible electric telegraphy.
9,380. RENDER. Fuse head for electric blasting.
9,504. NORDEN. Electric lamp sockets.
9,704. VANDAM and MARSH. Switches, wall plugs and bases for same.
9,720. OFFENBROICH and MAFELI. Automatic electric alarms.
9,788. BROWN. Electric switches and application to electrically-propelled vehicles.
9,789. KEELER. Electric railway crossings and switches.

NEW COMPANIES, STATUTORY RETURNS, &c.

CALVERT'S MOTOR CO. (LTD.)—Reg. Aug. 16, capital £5,000 in £1 shares, to acquire the business of G. Calvert, and to carry on the business of electrical engineers, manufacturers of motors, motor cars, launches and cycles, builders of carriages, rolling stock, &c. The first directors are G. Calvert, W. C. Head (chairman) and A. J. Woolnough. Reg. office : 487, Kingsland-road, N.

FLATHER & CO. (LTD.)—Reg. Aug. 12, capital £3,000 in £1 shares, to acquire the business of electrical engineers carried on at Leeds as Flather & Co., and to carry on the business of electrical engineers, machinists, manufacturers of rolling stock, motors, dynamos, accumulators, cables, wires, &c. The subscribers are J. Camm, electrician, A. Hather, electrician, A. Burton, S. Anderson, L. Flather, electrician, H. Cross, engineer, and G. H. Pedley. J. Camm is sole director. Reg. office : Park Electrical Works, Marshall-street, Leeds.

NEW GUTTA-PERCHA CO. (LTD.)—Reg. July 30, capital £200,000 in £1 shares, to enter into an agreement with H. Woolner, R. S. Jones and S. Bibby, and to manufacture, refine, mix, prepare, grow, import and export and deal in indiarubber, gutta-percha, balata and other gums ; also as

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cable manufacturers, mechanical, electric and consulting engineers, &c. Reg. office: Dashwood House, London, E.C.

SLOUGH AND DATCHET ELECTRIC SUPPLY CO. (LTD.)—Reg. Aug. 12, capital £50,000 in £1 shares, to carry on at Slough and elsewhere the business of an electric light and power company, to generate, distribute and supply electricity, and to carry on the business of manufacturers of and dealers in apparatus and appliances used in connection with the same, electric launch and electric carriage builders and fitters, &c. The subscribers are H. L. Prior, J.P., T. Moseley, J.P., A. A. Somerville, A. H. Thornton, J.P., banker, A. W. Shipley, brewer, and Capt. C. C. Higgins (each with 500 shares), and C. J. Jackaman, C.E., R. de Salis, J.P., and E. Riley (with one share each). The directors are T. Moseley, H. L. Prior, A. A. Somerville, A. H. Thornton, A. W. Shipley, C. J. Jackaman and Capt. C. C. Higgins. Reg. office: 11, Mackenzie-street, Slough, Bucks.

J. THACKRAH & SON (LTD.)—Reg. Aug. 11, capital £6,000 in £1 shares, to acquire and carry on the business of wholesale ironmongers, mill furnishers, electrical and sanitary engineers, carried on at Halifax as J. Thackrah & Son. Reg. office: 3, Fountain-street, Halifax.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24⅛d. per oz. (Aug. 21). Consols (2¾ per cent.) 94⅞—95 for money, 94 15/16—95 1/16 for account; 2½ per cent. 95¼—95¾ (Aug. 21). Consols Pay day, Sept. 1; Stocks and Shares Continuation Days, Aug. 26 and Sept. 9; Ticket Days, Aug. 27 and Sept. 10; Pay Days, Aug. 28 and Sept. 11; Mining Share Carry-over Days, Aug 25 and Sept. 8.

BRITISH INSULATED WIRE CO. (LTD.)—An interim ordinary dividend has been declared for the half-year to June 30 at the rate of 8 per cent. per annum.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)—Dividend warrants for preference and ordinary shares have been posted.

ELECTRICAL LUMINISCRIPTOR CO. (LTD.)—Extraordinary meetings were held yesterday (Thursday) to decide upon the best course to be taken in dealing with the company's affairs, and, if considered necessary, to wind up.

FURNESS RAILWAY CO.—At the meeting on Tuesday the chairman (Sir John Hibbert) said the directors would consider the question of electric traction, and would not be behind others in adopting improvements. They were also experimenting with oil fuel for their locomotives.

GERMAN EAST AFRICA.—A syndicate has been formed at Osnabrück, Germany, to promote a German East African mining and electrical company, with a capital of 800,000m. (£40,000).

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—An interim ordinary dividend at the rate of 12 per cent. per annum for the half-year to June 30 will be paid on Sept. 1, comparing with 10 per cent. last year. The half-year's 4½ per cent. preference dividend will be paid on same date.

IMPERIAL TRAMWAYS CO. (LTD.)—An interim ordinary dividend for the half-year to June 30 is declared at the rate of 10 per cent. per annum, payable 23rd inst.

LONDON ELECTRIC SUPPLY CORPORATION (LTD.)—The interim report for the half-year ended June 30 states that the units sold were 1,971,106, against 1,648,065 in the corresponding period of 1901, an increase of 323,041. The gross revenue was £38,455. 16s., compared with £33,587. 13s. 11d. in 1901, and the net revenue was £16,466. 19s. 7d., against £10,826. 1s. 6d., increases of £4,868. 2s. 1d. and £5,640. 18s. 1d. respectively. After payment of interest, a balance (including £1,489. 19s. brought forward) of £10,816. 2s. 8d. is applicable to reserve and dividends on share capital. The interim 5 per cent. preference dividend, payable Sept, 1, will absorb £6,230.

LONDON GENERAL OMNIBUS CO.—The chairman (Ald. John Pound) announced at the meeting on Wednesday that motor omnibuses were being built for their approval by different firms, and they expected to have one delivered within the next few weeks; but, so far, they had not seen one that fully answered their requirements.

LONDON UNITED TRAMWAYS (1901) (LTD.)—An interim ordinary dividend is declared for the half-year to June 30 at the rate of 8 per cent. per annum, payable 23rd inst.

MATHER AND PLATT (LTD.)—At the meeting on Wednesday, Sir Wm. Mather, M.P., said the results of the business for the past year justified the policy of having several distinct branches of engineering and machine making within one concern instead of depending solely on one branch. The dividend was approved.

MERSEY RAILWAY CO.—In the report for the past year it is stated that the continued decrease in receipts is due to the competition of electric tramways, and that the work for the conversion of the line to electric traction is well advanced.

NORTH-EASTERN RAILWAY CO.—At the half-yearly meeting on Friday, Sir Joseph Pease, Bart., M.P., referred to the "diversion of urban passenger traffic by competing electric tramways," and said that neither he nor the board were alarmed at such competition, as while it drew upon them it ought also to feed them to some extent. It was confined for the present to short-distance traffic, and had not seriously affected their revenue, but they must, of course, protect even their short-distance traffic. They considered the best way to meet new competition affecting some of the lines about Newcastle was by running more frequent trains. They had carefully considered the use of electric traction, and had decided to equip 37 miles in the neighbourhood of Newcastle and Tynemouth for electric working. That step was only in the nature of an experiment, but they believed it would be successful one, and would secure a fuller train service for the public, as well as greater economy.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has ordered the further issue of 10,000 £5 fully-paid shares of the *Calcutta Electric Supply Corporation (Ltd.)*, and 30,000 5 per cent. cumulative preference and 30,000 ordinary shares of £5 each (£3 paid) of the *Urban Electric Supply Co. (Ltd.)* to be quoted. Application has been made to the committee to appoint a special settling day in and to grant a quotation to the further issue of 30,000 £5 shares (£2. 10s. paid) of the *Calcutta Tramways Co. (Ltd.)*, and to allow 100,000 £1 ordinary shares of the *National Electric Wiring Co. (Ltd.)* and £1,000,000 preferred stock (in lieu of the 200,000 preferred £5 shares) of the *National Telephone Co. (Ltd.)* to be quoted.

TYNEMOUTH AND DISTRICT ELECTRIC TRACTION CO. (LTD.)—This company has made an issue of £20,000 4 per cent. debenture stock at par.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	...	...	...	...	...	...
Ayr Corporation	Aug. 16	464	...	13	5,228	...
*Birmingham Tramways.	„ 16	4,743	+ 248	6	29,919	+ 890
*Blackburn Corporation..	...	...	..	...	...	...
Blackpool Corporation...	„ 14	2,523	+ 269	20	20,316	— 779
Blackpool and Fleetwood	„ 16	2,132	+ 412	7	8,649	— 754
Bolton Corporation	„ 17	1,664	+ 70	20	32,612	+ 2,044
Bradford Corporation	„ 10	3,782	+2,465	20	67,531	+46,061
	„ 17	3,441	+2,198			
Brighton Corporation ...	„ 17	1,063	...	38	26,981	...
Brisbane Tramways.....	July 2	2,510	+ 558	1	2,510	+ 558
*Bristol Trams & Carriage	Aug. 15	5,425	+1,780	6	31,690	+ 6,037
*Buenos Ayres & Belgrano	July 20	2,738	+ 165	3	8,697	+ 597
Burnley Corporation ...	Aug. 16	827	+ 419	‡20	14,284	+ 5,325
Calcutta Tramways Co...	„ 16	R25,345	+R4,017	7	R172,410	+R38,183
Cardiff Corporation	„ 16	1,658	...	20	26,764	...
Carlisle Tramways Co....	„ 16	213	+ 12	†33	5,724	+ 399
Central London Railway	„ 16	6,669	+1,364	7	45,100	+ 4,893
City & South London Ry.	„ 17	3,222	+1,35	7	19,496	+ 6,584
Cork Elec. Tramways Co.	„ 14	886	+ 337	§32	17,337	+ 2,209
Devonport & Dist. Trams	„ 8	593	- 46	31½	13,383	+ 398
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	„ 16	311	— 17	20	4,784	— 152
Dublin & Lucan Railway	„ 17	132	— 26	7	937	— 113
Dublin Southern Dist....	„ 15	1,113	+ 45	†7	7,557	— 623
Dublin United	„ 15	4,116	+ 86	†7	26,934	
Dudley—Stourbridge ...	„ 8	1,290	+ 80	31½	23,184	+ 3,139
*Dundee Corporation ...	„ 13	816	+ 152	...	...	...
East Ham Council	„ 16	505	+ 54	8	4,297	+ 663
Gateshead & Dist. Trams	„ 8	899	+ 202	31½	22,542	+ 3,475
Glasgow Corporation ...	„ 16	12,442	— 75	11	130,040	— 1,287
Gravesend	„ 8	294	...	1	294	...
Greenock & Port Glasgow	„ 8	620	+ 419	31½	15,262	+ 9,116
Hartlepool Tramways ..	„ 8	382	+ 51	31½	7,792	+ 879
Hull Corporation	„ 16	1,839	+ 132	20	35,363	+ 1,469
Isle of Thanet Co.	„ 16	1,389	+ 376	7	9,909	— 88
Kidderminster & Dist....	„ 8	285	— 27	31½	3,871	+ 7
Leeds Corporation	„ 16	5,258	+1,224	21	108,787	+18,336
*Liverpool Corporation...	„ 9	11,347	+1,003	32	307,582	+25,734
Liverpool Overhead Rly.	„ 17	1,604	— 130	†7	11,468	— 833
Manchester Corporation	„ 16	5,521	+3,321	61	168,758	...
Merthyr.....	„ 8	254	— 339	31½	6,401	— 1,225
Middleton	„ 8	290	...	19½	6,071	...
Newcastle-on-Tyne Corp	„ 16	2,745	...	...	...	...
Oldham, Ashton & Hyde	„ 8	578	+ 39	31½	16,271	+ 638
Perth (W.A.) Elec. Trams	„ 15	1,080	+ 239	¶32	34,537	+ 5,672
Poole & Dist.....	„ 8	462	— 36	31½	7,719	— 158
*Portsmouth Corporation	...	...	...	...	...	...
Potteries	„ 8	1,890	+ 89	31½	45,910	+ 1,721
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ..	„ 17	4,435	+ 688	7	30,460	+ 3,884
Southampton Corp.	„ 14	1,270	+ 246	...	...	...
Southend Corporation...	„ 13	498	+ 100	19	5,698	...
Southport Tramways ...	„ 8	440	+ 120	31½	7,597	+ 2,605
*S. Staffordshire Trams...	„ 8	990	— 180	31½	24,428	+ 392
Sunderland Corporation	„ 17	1,373	+ 72	20	24,487	+ 2,209
Swansea Trams.....	„ 8	681	— 167	31½	14,669	+ 1,176
Taunton Trams.....	„ 8	119	...	31½	1,934	...
Tynemouth & Dist.	„ 8	589	+ 64	31½	8,718	+ 768
Weston-super-Mare	„ 6	482	...	13½	2,913	...
Wigan Corporation	„ 14	249	...	19	4,586	...
Wolverhampton District	„ 8	493	+ 341	31½	5,414	+ 3,626

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 13.	Price Wednesday, Aug. 20.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 13	
						£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.						
100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ ¼	¾ ¼		...	...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103 106	103 106	4 6 0	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	5 12 0	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref. xd	9½ 10½	9½ 10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101 104	101 104	4 6 7	...	...	...
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord. xd	9½ 9¾	9½ 10⅛	3 16 2	...	9⅞	9⅝
20,000	5	3/6	Do. 7 per Cent. Preference xd	9½ 9¾	9⅝ 10⅛	3 6 8	March and September	9⅞	9⅝
30,000	5	3/6	Calcutta Elec. Supply Ordinary (1 to 30,000)	7½ 8¼	7½ 8¼	3 10 7	...	...	...
10,000	5	...	Do. (30,001 to 40,000)	...	7⅝ 8		...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	106 108	103 108	3 14 8	...	...	...
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000) xd	9 10	8½ 9½	5 5 3	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...	..	..	...
70,000	5	2/3	Do. 4½ per Cent. Preference xd	5⅝ 6	5½ 6⅛	3 18 3	,, ,,	5⅞	5¾
40,000	5	...	Do. City Undertaking 4½% Cum. Pref.	4½ 5	4¾ 5¼	...	...	4⅞	4⅞
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105 107	105 107	3 14 9	...	...	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½ 5¾	5½ 5¾	2 2 2	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109 112	109 112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	8½ 9¼	9 10	5 0 0	February and August	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12⅝	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	101 104	102 105	4 6 4	...	104	102¾
40,000	10	4/0	County of London and Brush Prov. Ordinary xd	8½ 9¼	8½ 9¼	4 4 3	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference xd	12 12¾	12 12¾	4 16 0	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	109 112	109 112	4 1 1	...	...	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5¾ 6¼	5¾ 6¼	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10 11	10½ 11½	4 6 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6¼ 6¾	6¼ 6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105 108	105 108	3 15 0	...	...	...
£111,000	5	...	London Electric Supply Ordinary	1¾ 1¾	1¾ 2⅛		...	...	...
19,380	5	3/0	Do. 6 per Cent. Preference	4¼ 4¾	5 5½	5 9 1	...	5⅜	4¾
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	95 100	96 99	4 1 2	Mar., June, Sept., Dec.	99¼	96½
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000) xd	15½ 16½	15 16	4 7 6	April and October	15⅝	15⅜
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	108 112	108 112	4 0 5	June and December	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99 102	99 102	3 9 2	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary	13¼ 14¼	13¼ 14¼	4 2 9	March	...	...
12,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	97 100	97 100	4 0 0	...	...	...
300,000	1	...	Rand Electric	⅞ ⅞	⅞ ⅞	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70 75	70 75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103 105	103 105	4 7 0	April and October	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15⅛	...
20,000	5	3/6	Do. 7 per Cent. Preference	8¾ 9¼	8¾ 9¼	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97 100	97 100	3 10 0	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1¾ 2¼	1¾ 2¼	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2½ 3	2½ 3	...	...	2⅜	...
110,000	5	5 6	Westminster Electric Supply Ordinary	10½ 11¼	11 12	4 11 8	March and September	1⅜	1⅛
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5¾ 6¼	5¾ 6¼	4 0 0	...	6⅜	6
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4⅛ 4⅜	4⅛ 4⅜	4 11 5	April and October	4⅜	4⅛
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125 130	125 130	4 12 2	...	1 7	...
20,000	10	6/0	Barcelona Tramways Ordinary	9 11	9 11	2 14 7	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	8¾ 9¼	8¾ 9¼	5 5 3	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	93 98	93 98	4 11 9	...	...	...
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½ 14½	13½ 14½	4 9 8	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3⅞ 4⅛	3⅞ 4⅛	...	...	3 15/16	...
75,000	5	2/6	Do. 5% Cum. Pref.	4⅛ 5	4⅛ 5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	102 105	103 106	4 5 0	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd	20½ 21½	20½ 21½	3 14 2	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106 108	106 108	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7 7½	7 7½	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9½ 10	9¼ 10	5 0 0	May and November	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	103⅞ 105⅞	103⅝ 105⅞	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12⅜ 13⅛	12⅜ 13⅛	6 13 4	...	13	12⅞
100,000	10	6/0	Do. 6% Cum. Pref. xd	12⅜ 13	12½ 12⅝	4 14 1	February and August	12⅝	12⅜
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126½	125⅛
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅜ 1⅞	1⅜ 1⅞	...	...	...	...
40,000	5	8/0	Do. 6% "A" Cum. Pref.	4⅞ 5¼	4⅞ 5¼	5 14 3	...	...	...
37,500	5	10/0	Do. "B"	5 5⅛	5 5⅛	5 9 1	...	5⅛	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 9	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	95 98	97 100	5 0 11	...	...	...
70,000	10	6/0	Calcutta Tramways	7 7⅛	7 7⅛	4 0 0	...	7⅛	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107 109	107 109	4 3 1	...	107¾	...
£80,000	1	1/2½	Cape Electric Tramways Shares	2¼ 2⅜	2¼ 2⅜	6 4 6	...	2 1/16	2 1/16
£1,860,014	Stock	4%	Central London Ordinary Stock xd	105 107	103 106	3 15 6	June and December	107¼	104
£494,993	Stock	4%	Do. 4% Preferred Stock xd	106 109	104 107	3 14 9	...	105	105
£494,993	Stock	4%	Do. Deferred Stock	103 106	103 106	3 15 6	...	103½	...
£698,201	100	4%	Do. 4% Deb.	115 118	115 118	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5⅛	5 5⅛	4 10 9	...	5 1/16	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	102	...
£1,330,000	Stock	3%	City and South London Railway Con. Ordinary	71 73	71 73	3 11 11	February and August	73	71½
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	... ...	... ...	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	127 130	127 130	3 17 0	,, ,,	129½	...
£200,000	Stock	5%	Do. (1896)	126 129	126 129	3 17 6	...	...	...
£150,000	Stock	5%	Do. (1901)	121 125	121 125	4 0 0	...	1 5/16	...
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115 118	115 118	3 9 7	May and November	...	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11½ 12½	11½ 12½	4 8 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½ 15½	14½ 15½	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½ 4¾	4½ 4¾	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99 102	99 104	4 18 0	...	...	...
78,000	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	...	8⅛	...
20,000	10	8%	†Imperial Tramways Ordinary	23 24	23 24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½ 13¾	13½ 13¾	4 7 3½	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	108 110	108 110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Lighting 5% Pref.	4½ 5	4½ 5	5 0 0	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary xd	4½ 4¾	4⅝ 4¾	2 4 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference xd	10 10½	9¾ 10½	4 17 7	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	99 1 1	99 10⅛	3 4 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	1 ¾ 11¼	10¾ 11¼	4 8 11	...	11	10⅞
30,999	10	2/3	Do. (£7. 10s. paid)	8 8½	8 8½	4 8 6	...	...	...
£655,341	Stock	¼%	Do. 4% 1st Mortgage Debenture Stock	107 109	108 110	3 12 9	...	109½	103½
£169,659	Stock	18 0	Do. Prov. Certs. (£75 paid)	81 83	81 83	...	...	...	...
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112 117	112 117	4 5 7	...	...	...
£50,000	100	5%	Montreal Str't R'lw'y 8% Str'l'g 6% Mort. Debs. (1908)	106 108	106 108	4 14 5	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	105 107	105 107	4 4 1	...	...	...
24,000	5	4/0	New General Traction Ordinary	⅜ ⅝	2 3	6 13 4	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½ 4½	3½ 4½	6 13 4	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93 98	93 98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100 103	100 103	4 17 5	...	102½	...
13,334	10	8/0	Potteries Electric Traction Ordinary	8½ 9½	8½ 9½	4 4 3	...	...	...
30,000	10	5/0	Do. 5 per Cent. Cumulative Preference xd	10 11	10 11	4 10 11	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108 111	108 111	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	... ...	... ...	...	...	...	...
51,132	1	...	Do. 6% Preference (14/0 paid)	... ...	... ...	...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	... ...	... ...	...	,, ,,	...	...
500,000	Stock	...	Do. 4½% Debenture Stock (70% paid)	... ...	... ...	...	January and July	...	...
£540,000	Stock	8%	Waterloo and City Ordinary xd	92 95	90 93	3 4 6	June and December	92½	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 13.	Price Wednesday, Aug. 20.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Aug. 13. Highest	Lowest
			TELEGRAPHS.						
£67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.).....	98 102	98 102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph.....	3½ 4½	3½ 4½	...	June and December ...	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70 80	70 80	...	...	...	...
£788,840	Stock	15/0	Anglo-American	45 48	47 50	5 17 0	Feb., May, Aug., Nov.	...	...
£3,105,580	Stock	30/0	Do. Preferred.....	89 91	92 94	6 2 4	" "	95⅜	90
£3,105,580	Stock	2/0	Do. Deferred	6⅜ 7½	7½ 8	1 5 0	" "	7⅞	7 15/16
$13,383,300	$100	$1½	Commercial Cable Capital Stock.....	155 165	155 165	4 17 0	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock.....	95 97	95 97	4 2 6	" "	96½	96
16,000	10	4/0	Cuba Submarine Ordinary	5 6	5 6	6 13 4	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½ 13½	12½ 13½	7 8 2	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2½ 3½	2½ 3½	5 14 4	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7½ 8½	7½ 8½	5 17 8	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞ 103⅞	99⅞ 103⅞	4 7 8	January and July	...	...
60,710	20	4/0	Direct United States Cable	10 11	10 11	5 18 2	Jan., Apr., July, Oct.	10⅝	11⅛
£96,200	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	99 102	99 102	4 8 3	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary ... xd & bonus ..[to 1,200) (red.)..	117 127	117 127	5 10 3	Jan., Apr., July, Oct.	121	118½
£1,955,565	Stock	17/6	Do. 8½ per Cent. Preference Stock	87 90	87 90	3 17 8	" "	89½	88
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108 112	108 112	3 12 2	May and November ...	109	108½
300,000	10	2/6	Eastern Extension	11½ 12½	11½ 12½	5 12 0	Jan., Apr., July, Oct.	11⅞	11½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107 112	107 112	3 11 4	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	93 101	98 101	3 19 3	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)...	100% 103%	100% 103%	3 18 3	May and November ...	...	...
150,000	10	5/0	Great Northern of Copenhagen	25 27	25 27	5 11 1	January and July	...	...
£70,000	100	4½%	Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos.	99 102	99 102	4 8 1	June and December ...	...	...
17,000	25	37/6	Indo-European..... [1 to 1,200) (red.	38 42	38 42	5 19 1	May and November ...	...	..
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	102 106	102 106	5 16 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.) ...	94 102	99 102	3 18 5	June and December...	...	...
15,609	10	...	*West African Telegraph Shares	3½ 4½	3½ 4½	...	...	...	...
£139,300	100	5%	Do. 5% Debentures (red.)	... ...	...	...	March and September	...	...
30,008	7½		West Coast of America.....	⅛ ⅜	⅛ ⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97 100	97 100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	¼ ½	¼ ½	...	May and November ...	...	...
34,563	10	£/0	Do. 6 per Cent. 1st Pref.	4½ 5½	4½ 5½	11 8 6	" "	5⅛	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3 4	3 4	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99 102	99 102	4 18 0	January and July	...	...
207,930	10	3/0	Western Telegraph (late Br zil'n Submarine)	11½ 12½	11½ 12½	5 16 4	Mar., June, Oct., Dec.	11⅞	11½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	101 104	101 104	4 16 2	June and December...	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.).....	97 100	97 100	4 0 2	...	98½	...
			TELEPHONES.						
44,000	£5	5 0	Chili Telephone (fully paid)	3½ 4	3½ 4	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	2/6 2/9	2/6 2/9	10 18 2	April and October.....	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½ ⅝	½ ⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	½ 1	½ 1	5 0 0	"	...	...
£983,333	Stock	6%	National Co. Preferred Stock ..... xd	95 99	93 96	6 5 0	...	95	92½
200,000	5	1/8·67	Do. Preferred Shares (£3. 10s. paid) ..... xd	4⅜ 4⅞	4⅜ 4⅞	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock ..... xd	56 60	54 58	7 15 2	...	56½	54
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference xd	12 14	11 13	4 12 4	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference xd	11 13	10 11	5 9 1	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. xd	4⅞ 5⅛	4⅜ 5	5 0 1	" "	...	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.).....	95 98	95 98	3 11 5	June and December ...	97⅞	97
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102 106	102 106	3 15 6	...	103½	...
171,504	1	0/8⅝	Oriental	⅝ 1 1/16	⅝ 1 1/16	5 12 11	April and October.....	...	...
58,000	5	4/6	United River Plate	4½ 5½	4½ 5½	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4½ 5	4½ 5	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101 104	101 104	4 16 2	June and December ...	103⅝	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref. ..... xd	¼ ⅜	¼ ⅜	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛ ¼	⅛ ¼	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	¼ ⅜	¼ ⅜	12 0 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7½ 7⅝	7½ 7⅝	6 9 0	July and February ...	7⅝	...
80,000	5	3/0	Do. 6 per Cent. Preference	5⅝ 5⅞	5⅝ 5⅞	5 4 4	January and July	...	...
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	101 104	101 104	4 6 1	...	102⅞	...
200,000	5	3/0	British Westinghouse 6% Preference.	5⅞ 6⅛	5⅞ 6⅛	4 18 0	...	6 1/16	5 15/16
£500,000	Stock	...	Do. 4 per cent. Mortgage Deb. Stock	...	103 105	...	...	104⅛	104
105,731	1	...	Brush Electrical Engineering	1⅜ 1⅝	1⅜ 1⅝	...	March	1½	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅝ 2	1½ 2	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock....	102 105	102 105	4 7 5	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	93 98	95 98	4 11 6	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15½ 16½	15½ 16½	4 10 11	" "	16	15⅞
40,000	5	3/6	Do. 5 per Cent. Cumulative Preference..	5½ 6	5½ 6	5 0 0	" "	5 15/16	5 13/16
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb.(red.)...	109 113	101 113	3 19 8	November and May ...	...	...
450,000	1	0,9⅞	Castner-Kellner Alkali Co. (fully paid).....	1 1½	1 1½	4 16 0	...	1	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	94 99	94 99	4 11 0	...	...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	9 2 0	March	...	...
85,000	3	1/9⅞	Crompton and Co. (Nos. 1 to 54,000) ..... xd	2½ 3½	2½ 3	6 0 0	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb.(red.) ..	101% 106%	101% 106%	4 14 4	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid) ..	⅜ ⅝	⅜ ⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid).....	1⅜ 2⅛	1½ 2⅛	...	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb.Stock (red.) ..	74 78	74 78	5 3 0	June and December...	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock ..	78 83	78 81	6 2 10	...	...	...
150,000	5	4/0	Edmundson's Electricity Corporation Ord.....	6½ 6⅝	6½ 6⅝	5 3 8	Half-yearly	6⅝	...
30,000	5	3/0	Do. 6% Cumulative Preference	6 6⅛	6 6⅛	4 12 4	...	6⅝	6
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.) ...	106 109	107 110	4 2 1	...	108	107½
112,100	2	1/2½	Electric Construction Co.	1⅜ 2½	1⅜ 2½	5 6 8	January and July	1⅝	1½
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅝ 3	2½ 3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	93 101	98 101	3 19 6	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾ 1½	¾ 1½	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	9½ 10½	9½ 10½	4 17 7	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	99 102	99 102	3 19 5	...	...	...
35,000	5	5/0	Henley's Telegraph Works Ordinary	16 17	16 17	4 8 3	February and August	16⅛	16⅜
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛ 5⅜	5⅛ 5⅜	3 18 3	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb.Stock(red.) ..	114 116	111 116	3 18 3	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	4 13 0	" "	21⅜	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½ 15½	14½ 15½	6 9 0	July	...	...
37,350	12	12/0	Telegraph Construction and Maintnce.	37 40	37 40	5 19 10	March and July	39½	38⅝
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	...	...	5 14 3	...	...	...
50,000	5	2/6	Do. 5 per Cent.Cumulative Preference	...	...	4 3 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	...	...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.....	...	...	...	" "	...	...
			FINANCIAL, INVESTMENT, &c.						
19,900	5	3/0	Electric and General Investment 6% Cum. Pref. ...	5½ 5⅝	5½ 5⅝	5 9 1	...	...	...
180,227	10	4/9	Globe Telegraph and Trust ..... xd	9 10	9 10	5 5 0	Jan., Apr., July, Oct.	9⅜	9 1/16
180,042	10	3/0	Do. 6 per Cent. Preference ..... xd	12½ 13½	12½ 13½	4 8 11	" "	13 1/16	12⅝
11,839	8	4/0	Reuter's.....	6½ 7½	6½ 7½	5 6 8	April and October.....	...	...
8,803	£100 Cert	6%	Submarine Cables Trust.....	110 120	110 120	5 0 0	"	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these

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NOTES.

THE Paper by Prof. R. L. WEIGHTON, which we publish this week, contains two surprises for steam engine builders and users. Experiments which the professor has made at the Durham College of Science lead him to believe that the economies effected by re-heating the steam after it leaves the high-pressure cylinder of a compound engine, and by the employment of high vacua with engines running condensing, are both illusory. In his first series of tests he found that, while his experimental compound engine consumed less steam per indicated horse power when the re-heater was in use, the steam consumption per brake-horse-power was lower when the re-heater was not in use. Although the output of the engine could be increased by using the reheater, its mechanical efficiency was diminished, and this latter accounted for the resultant loss in economy. Some engineers have already regarded the re-heater as of no great importance, and have characterised it merely as a fashion; but the results of Prof. WEIGHTON'S experiments on various degrees of condenser vacuum with a triple expansion engine will command greater attention. Considering only the steam consumption, a higher vacuum is more economical than a lower one, but taking into account that the water from the hot well will be transferred to the boiler at a lower temperature in the former case than in the latter, Prof. WEIGHTON finds that there is no advantage gained by increasing the vacuum above 20in. This, he says, is not entirely due to the lower temperature of the hot well; the aggregate mean pressure in the cylinders does not increase at the same rate as the vacuum increases, and actually more steam enters the high-pressure cylinder per stroke at a high vacuum than at a low vacuum.

THOSE who discussed Prof. WEIGHTON'S Paper at the Institution of Mechanical Engineers, however, did not seem inclined to accept either his explanation (viz., that the cooling effect of the condenser temperature is felt throughout the cylinders, even to the high-pressure admission) or his two main conclusions. The general opinion, especially with regard to the question of vacuum, appears to be that the nature of Prof. WEIGHTON'S results was due to the design of the particular engine employed for the test, and that with an engine properly designed to work condensing, and with a high vacuum, the greater the vacuum the greater will be the economy. The Paper raises two most interesting points, however, and we trust that more will soon be heard on the same subject.

SINCE the year that Dr. JOHN HOPKINSON was killed on the Alps, there has not been a summer with a sadder list of mountaineering accidents than this one. The death of the two brothers FEARON and their guides on the Wetterhorn last week will have been particularly noticed by those interested in electrical science by the fact that the unfortunate mountaineers were undoubtedly killed by a lightning flash. Thunderstorms are, of course, by no means rare among the mountain peaks, and lightning has left its traces on several. Many cases are on record in which climbing parties have found themselves enveloped in or in close proximity to a thundercloud and have observed luminous discharges from their ice-axes and even from their own bodies; but naturally it is a less frequent occurrence, although by no means unknown, that the mountaineers themselves have been injured by lightning flashes either directly or indirectly. Mr. H. C. D. FEARON, one of the unfortunate victims of the Wetterhorn calamity, was known personally to some of our readers, and took considerable interest in matters connected with the electrical industries. He was one of the factory inspectors who spoke at the Institution of Electrical Engineers in the recent discussion on the new Factory Act and the dangers from electric shock.

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In connection with this accident, a correspondent of *The Times*, writing from Grindelwald, asks the very pertinent question, What is one to do and how is he to place himself if surprised by a thunderstorm when on a climbing expedition? Obviously, the danger is greater when the individual is on a mountain, and may constitute an isolated projection, than when he is on comparatively low ground where he is protected by natural and artificial lightning conductors, and is, moreover, at a greater distance from the thundercloud. No one, therefore, surprised by a thunderstorm on a mountain, could be thought pusillanimous if he adopted any precaution that might tend to increase his safety. Some guides, and also the writer of the letter referred to above, suggest that the best precaution is to stand their ice-axe (an implement about 4ft. long) upright and to sit or lie down some distance off. In such a case, however, we should rather advise against the elevation of the ice-axe, as its short height and the high electrical resistance of its temporary earth connection would rather constitute an element of danger from a side flash of lightning than a safeguard. A better plan would be to lay the axe down flat and to lie down at as great a distance from it as practicable. There would also be an element of safety in avoiding, if possible, tall, sharply-projecting rocks during a thunderstorm on a mountain. Probably to lie down on lower ground a hundred feet or so away from a tall projection of this nature would be as good a safeguard as any that could be mentioned. Thin layers of insulation, such as goloshes, which have been suggested, are useless as a protection.

As to thunderstorms in ordinary circumstances, in which the wayfarer is at no great elevation above surrounding country or objects, "experts" have recommended that the safest thing to do is to get wet through and lie down in the middle of a field. We should think it safer, however, for general reasons, to go home and get dry. As a matter of fact, there are more deaths caused by rheumatic fever than by lightning strokes.

Even when the electricity works of the Islington Borough Council were built, seven years ago, it could not have been considered good design to bunch together a number of india-rubber insulated feeders and other cables at the back of a high-pressure switchboard. But to leave such an arrangement still standing in 1902 in a generating station responsible for the whole public and private electric lighting of a large metropolitan borough is inexcusable. It was this neglect, however, that led to the fire and 24 hours' interruption of supply at Islington, of which the details will be found in another column.

New Air ship Journal.—We have received the first number of the *Aeronautical World*, a paper published in Glenville, U.S.A., and devoted to air-ships.

Long-Distance Telephony.—The St. Petersburg correspondent of the *Financial News* states that a movement has been set on foot to establish a direct telephone line between St. Petersburg and Berlin.

The Dunkirk Lighthouse.—The *Standard* states that a new electric revolving light has been installed at the Dunkirk lighthouse, and was used on Monday night for the first time. Its flashes are visible at a distance of 40 miles in a clear atmosphere.

Wireless Telegraphy in Germany.—A Reuter telegram, published in Monday's daily papers, stated that wireless telegraph and telephone messages were exchanged between the stations Sassnitz and Kolberg, which are 170km. apart, and were erected by Messrs. Siemens and Halske for experimental purposes.

The Board of Trade and American Railways.—*The Times* states that Col. H. A. Yorke, senior inspecting officer of railways, has been commissioned by the Board of Trade to proceed to America next month to report to the Board on the working of American railways, including both steam and electric lines.

Underground Telephone Trunk Line.—The *Engineer* states that progress is being made with the underground paper cable which the Post Office authorities are laying between Cardiff and Newport on the main road through St. Mellons. This work was begun last year, and at the present time the workmen are engaged upon the jointing process.

Underground Telegraph Cables.—In answer to a communication from the Glasgow Chamber of Commerce to the late Postmaster-General (Lord Londonderry) urging the necessity of an underground telegraph cable between London and Scotland, Mr. Austen Chamberlain, who has succeeded Lord Londonderry, has assured the Glasgow Chamber of Commerce that he will not lose sight of this important subject.

Erratum.—In the Paper on the "Neptune Bank Power Station," by Mr. W. B. Woodhouse, on p. 702 of *The Electrician* for August 22, 1902, the columns under "Mean total" (Table I.) should read:—

I.H.P.	KW.
364	163
594	331
850	503
1,177	719

Large Motors in America.—The *Electrical Review* of New York states that two electric locomotives ordered by the Baltimore and Ohio Railroad Co. from the General Electric Co. are said to be the two largest electric locomotives in the world. Each machine will weigh 150 tons and be capable of drawing 1,500 tons of freight up the heavy grades of the belt line tunnel, which runs nearly 2 miles under the city. Passenger trains have been drawn through the tunnel by electricity since it was opened in 1895, but the locomotives now in use are not capable of pulling the heavy freight trains. The new machines will be designed to haul a load equal to twice that drawn by the present steam locomotives.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Santa Cruz—Teneriffe	July 7, 1902 ...	—
Puerto Plata—Martinique	July 10, 1902 ...	—
Anjer—Kalianda	Aug. 2, 1902 ...	—
Nagasaki—Fusan	Aug. 5, 1902 ...	Aug. 21, 1902
Guantanamo—Mole St. Nicholas	Aug. 5, 1902 ...	—
Cayenne—Pinheiros	Aug. 13, 1902 ...	—
Cape Town—Mossamedes	Aug. 16, 1902 ...	Aug. 24, 1902
Nagasaki—Fusan	Aug. 27, 1902 ...	—

Dispute over Niagara Power.—An American contemporary states that the Ontario Government has heard a lengthy argument regarding the dispute that has arisen between the Ontario Power Co. and the Canadian Power Co. in regard to the use of the waters of Niagara for power development. The Canadian Company is installing a very large plant, and the Ontario Company wishes to enlarge its first proposal by getting 25,000 H.P. additional from an intake at Dufferin islands. This is 3,000ft. from the Canadian Power Co.'s intake, but its engineers say they are not in a position to state whether or not the Ontario Power Co.'s intake will injure the flow towards their own until they see detailed plans. They accordingly asked the Government to require the production of plans by the Ontario Power Co. of the proposed intake at Dufferin islands.

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Obituary.—We regret to announce the death, on Thursday last week, of Mr. Thomas Nevins, promoter of the Cheltenham and District Light Railway, and chairman of the company which works the line. A few months ago Mr. Nevins' company obtained powers to extend the above line to Leckhampton and Charlton Kings, but an endeavour to obtain a light railway order for some lines of tramways in the Strood Valley, connecting Painswick and Cheltenham, was unsuccessful, owing to the competition such lines would have set up with the main railway lines. Mr. Nevins, who was about 60 years of age, was a native of Ireland, and emigrated to the United States about 40 years ago, where he interested himself with light railway undertakings among other things.

New Electricity Works at Eastbourne.—The Corporation of Eastbourne have just erected new electricity works at a cost of over £50,000. The offices, workshops and stores form a distinct block at one end of the engine room, and the other end consists of only a temporary wall, so that extensions can be made at any time. The engine room is 82ft. long by 35ft. wide and 30ft. high, and the switchboard is on a raised platform at the end of the engine room. Water is obtained from the town supply, and in addition to the pump from the old works there is installed a new pump with a capacity of 3,000 gallons per hour. The new engines and generators consist of two 400kw. Ferranti sets, but in addition to these there will be two sets of 150kw. and 200kw. respectively, which are being removed from the old station. Three boilers from the old works and one new Babcock and Wilcox are also being erected, with two Stirling water-tube boilers, already working, of 550 H.P. each. These latter two work at a pressure of 150lb. per square inch, and each has a heating surface of 2,470 sq. ft. with a grate area of 48½ sq. ft.

Tramcar Lights.—A conference was held on Saturday between representatives of tramway companies and municipal undertakings and officials of the Board of Trade and the Home Office with reference to proposed Board of Trade regulations, especially with regard to carrying a red light on the rear of all cars. Mr. John Young, Glasgow, made the opening statement, and was followed by representatives of Manchester, Newcastle, Liverpool, Cardiff, Hull, Leeds, &c., for the municipal systems, and by Mr. S. Sellon for the companies. It was pointed out that at night electric tramcars present such a blaze of light that a red rear light was unnecessary, and that, owing to the adoption on all large systems of distinctive route colours, with lights at night coloured to correspond, a regulation requiring a red light on the rear of every car would practically abolish the system of distinguishing route colours. Sir Herbert Jekyll explained that since the suggestion had come from the Home Office, and the Board of Trade had no special views on the matter, he would allow Mr. H. Cunynghame, of the Home Office, to deal with it. Mr. Cunynghame said that the Home Office had no desire to fetter or harass electric tramways. Their idea was to have, if possible, all road and street vehicles carrying a red light on the rear. He saw, however, from what had been said, that there might be a difficulty in making such a rule general, and they would now consider whether electric tramcars should be excepted in he event of such a rule being adopted.

The Berlin Tramways.—The following interesting particulars of the traffic on the Berlin tramways have been published in the *Deutsche Bauzeitung*, and were quoted in Wednesday's *Standard*:—

During the year 1901 nearly 82,000,000km. were covered by the tramcars, and 330,000,000 fares were taken. The increase in passenger traffic over the total for 1900 was about 18 per cent. The average number of journeys made per head by the population (2,550,000) of Berlin and the suburbs in the year 1901 was 129. The corresponding totals in other towns of Germany were: Hamburg, population 1,000,000, journeys per head 109; Munich, population 550,000, journeys 95; Leipzig, population 500,000 journeys 127; Dresden, population 500,000, journeys 148; Frankfort-on-Main and suburbs, population 390,000, journeys 110. But it must be taken into consideration that, in the last-mentioned towns, there are no special means of transit other than the tramways, whereas, in Berlin, there are the metropolitan and circular railways, the Wansee line, numerous omnibuses and cabs, and, of late, the electric overhead railway as well.

Of the total passenger traffic in Berlin more than three-fifths is on the tram lines. From 1870 to 1890, the use of the horsed street-cars grew continually. From 1890 to 1895 the growth of traffic was considerably less, for horse traction was gradually reaching the limit of efficiency. With the introduction, however, of electric traction, the carrying capacity of the cars—owing to quicker transit and an increased number of cars—rose considerably. Since 1900 especially, as a result of the introduction of the uniform 10 pfennig tariff, there has been a rapid rise in the number of passengers.

The passenger traffic of Berlin and the suburbs has increased 42-fold since the year 1870; or, including cab and railway traffic, 45-fold. During the same period the use made of the means of traffic, per head of the population, shows an increase of more than 15-fold, whilst the number of residents in Berlin and the suburbs has grown 180 per cent. The total length of the Berlin tramway lines is 864·9 kilometres, which is about the distance fron Berlin to Zurich.

The De Forest Wireless Telegraph System.—The Marconi interests in New York are threatened with competition by the De Forest Wireless Telegraph Co., which has been briefly alluded to from time to time in our columns. The precise details as to this company's system are not yet available, but it appears that they employ for their "responder" an anti-coherer which is a development of the electrolytic anti-coherer action observed by Neugschwender (see *The Electrician*, Vol. XLIII., p. 221). A telephone is used in series with this anti-coherer, the signal being read by the noise of the telephone when the anti-coherer breaks circuit on being subjected to the influence of the Hertzian waves. No tapping back is required; and the transmitter also appears to be different in many respects from that ordinarily employed.——It is stated in a New York contemporary that the De Forest Wireless Telegraph Co. is bringing an action against the Marconi Wireless Telegraph Co., of America, and the firm of E. Rollins, Morse and Brother, its financial agents, to recover $1,000,000 damages, alleged to have been incurred through the publication of an article by the Marconi Company in a New York daily newspaper. The article, it is said, stated in substance that the Marconi Company was bringing an action against the De Forest Company for the infringement of the patent rights in America of the Marconi service, and went on to say that the Marconi system would legally stand against all others, none of the three "foreign" systems having been patented in that country, and the single American company (the De Forest) holding patent rights which would, it said, expire next year. The De Forest Company allege that the article is false, as no action was pending against them, and that the De Forest patents are unimpeachable.

Durability Tests of Secondary Cells for the French Navy.—A recent issue of the *Centralblatt für Accumulatoren und Elementenkunde* contains details of tests carried out by order of the French Minister of the Marine with secondary cells of French manufacture—presumably for use on submarines. The method of testing the durability of the cells was as follows:—The cells submitted by the various manufacturers were connected up in series to form one battery, and were charged and discharged 250 times. A current of 330 amperes was used for the first charging operation for a period of four hours, and subsequent chargings were carried out with the same current for a period equivalent in ampere hours to a 50 per cent. increase on the previous discharge from the battery. The discharge was carried out at 660 amperes, and was continued until the E.M.F. of any cell had fallen to 1·65 volts. Two chargings and dischargings were completed daily, and Sundays were observed as a rest day. The level of liquid in each cell was preserved constant by additions of water or acid during the period of the test. The cells which fell below 1·65 volts in less than half-an-hour from the commencement of any period of discharge were withdrawn from the series, and the plates submitted to a final examination in presence of a representative of the makers. The number of cells entered for the test was 21, these being submitted by 18 manufacturers. The experiment continued from October 10th to March 17th, and on the latter date only five cells were left as survivors of the durability test. The following are the trade names and final E.M.F.'s of these five cells:—Heinz (1·860 volts), Union (1·790 volts), Metaux (1·772 volts), Max (1·714 volts), Fulmen-d'Arsonval (1·650 volts). Of the above five makes of secondary cells, the first four are manufactured exclusively with pasted plates. The maximum weight of accumulators for the French navy is fixed by the Ministry at 225kg. The Heinz cell had a total weight of 181kg., of which 106kg. represented the weight of the plates.

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Tube Railways and the Medical Profession.—The *Lancet*, which may be considered to express the opinions of the medical profession on general subjects, publishes, in its issue of August 23rd, a clear summary of the various "tube" railway schemes which have been brought before Parliament this session, and comments on them in a favourable manner. Our contemporary says :—

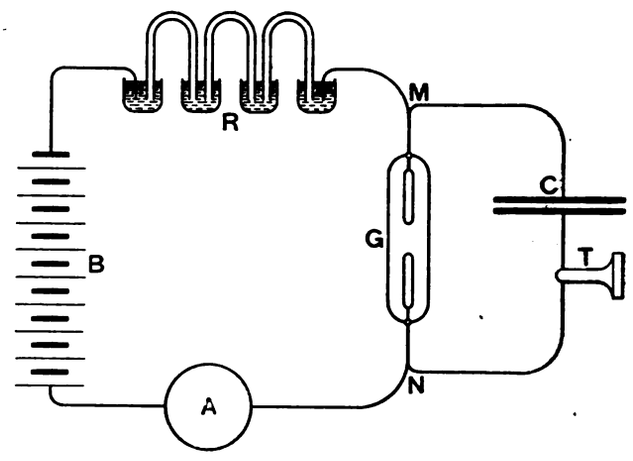
The schemes for the construction of deep-level railways now on paper, or receiving Parliamentary sanction, or actually nearing constructive completion, demand, we think, the general approval, if not the admiration in detail, of all who live in, or work in, or are interested in the welfare and business position of London. . . The danger to health and life and limb in our overcrowded metropolis, with its terribly congested traffic, are very real, and are increasing by leaps and bounds. It has become necessary that means should be provided whereby persons living at a distance from the business centre of the world can reach that centre at the expense of the minimum of time and trouble. . . Overhead railways are subject to the gravest disadvantages. Of underground railways two are possible, the shallow and the deep. There is much to be said for the shallow railways and the London County Council is known to favour them ; but the difficulty of construction is very great, the inconvenience caused during the work is incalculable, and the expense is proportionately high. . . Against deep railways it has been urged that their ventilation is faulty, and that the damage that they do to structures upon their route by altering the drainage and formation of the soil cannot be estimated. We think that this is a pessimistic view based upon conditions which experience will not allow to recur. The ventilation of the new tube railways is to be much more thorough than any previous scheme has provided for, and the promoters of one and all the lines are awake to the gravity of asking the public to pass long spells of time in grossly-vitiated atmosphere. There is evidence that the precautions that are to be taken in the new tube railways for doing away with vibration are also very sound and thorough, while there seems no reason to suppose that any important settlements will take place if the tubes are constructed entirely in the deep-lying clay. . . The wholesale injury to buildings on the route, which has been so generally anticipated, will not occur unless some of the most experienced engineers in the country are wofully out in their calculations. On the whole, we think that we are in a position to assure our readers that the vast network of tube railways soon to be crossing and re-crossing each other in the clay below London will not subject the public health to the strain that has been suggested, while the improved facilities for travelling ought to lessen the overcrowding which is now such a terrible source of disease in many quarters of the metropolis.

Fire at the Islington (London) Electricity Works.—Shortly after 7:30 p.m. on Tuesday a cable became ignited at the back of the switchboard at the electricity works of the Islington Borough Council, owing, it is thought, to the development of a fault. The cable in question was a 19/16 rubber insulated concentric steel-armoured Silvertown cable, and fed the Caledonian-road transformers. Its fuse on the switchboard did not blow, however, and as the various cables at the back of the switchboard from the machines, feeders, &c., were not isolated from each other in any way, the fire naturally spread to them, and a series of dead shorts occurred and fuses commenced to blow. Immediately the fire was discovered, efforts were made by the staff to overcome it by means of sand, but they were not successful. The Fire Brigade were quickly on the scene and soon subdued the flames, but in the meantime all machines were shut down and the whole of the area supplied by the Islington Corporation works was plunged into darkness. Practically every cable behind the switchboard was seriously damaged either by fire or water, but the board itself, curiously enough, escaped injury. Neither Mr. Gay, the engineer and manager, nor Mr. Yeaman, his chief assistant, were in the station at the actual moment of the outbreak, but they arrived within a few minutes, and the work of reconstruction was commenced without delay. The switchboard was taken to pieces, thoroughly cleaned and dried, and erected again. All through the night the staff worked, and did not cease until 6:30 p.m. the next day, when they had the satisfaction of switching the machines on to some of the mains once more. We believe that work was actually in progress whereby each cable would have been isolated from all the others, so that should one become ignited the fire would be prevented from spreading. Unfortunately this accident occurred before the scheme could be consummated. The switchboard gallery consists of fireproof material throughout; this undoubtedly prevented a much more serious conflagration which would have involved the station itself, and Islington would probably have been in darkness for several weeks instead of for a few hours. Fortunately the station lighting was not interrupted owing to a battery being used for this purpose, the leads from which are fireproof throughout their entire length.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Singing Vacuum Tubes.—A. Righi obtains clear musica notes by means of the apparatuss hown in the diagram, where B is a battery of accumulators, A a galvanometer, C a condenser, G a vacuum tube, R a copper sulphate resistance, and T a telephone. The pitch of the note heard in the telephone increases on increasing the number of cells in the battery, or on diminishing the resistance, the capacity, the pressure in the tube, or the distance between its electrodes. By suitably varying these elements, it is possible to pass through the whole range of musical notes, from the lower to the higher limit of audibility, and beyond. The notes are not due to an alternating current, as in the singing arc, but to a varying period of retardation of discharge in one direction. The introduction of a considerable inductance makes the phenomenon much more complicated, and approaches the conditions to those of Duddell's singing arc. As a general rule, an increase of inductance lowers the pitch of the note, but in an irregular manner. At certain points there is a sudden



transition. Thus the gradual introduction of an iron core gives rise to an abrupt succession of notes, sometimes marked by a tremolo at the point of transition. The action of an inductance is being further studied.

[A. Righi, *Nuovo Cimento*, July, 1902.]

Atmospheric Heat and Thunderstorms.—The heating of a column of air in the atmosphere may be due to three causes, the condensation of vapour H_v, the direct absorption of solar heat H_s, and the absorption of other radiant heat H_r. Thus,

$$\triangle T = H_v + H_s + H_r$$

H_v may be calculated from the difference of moisture per kilogramme of air above and below, taking into account that for every gramme of vapour condensed per kilogramme of air the temperature rises by 2·5deg. Now, since the terms H_s and H_r taken together are never negative, we should have

$$\triangle T \geqq H_v$$

unless a portion of the heat were converted into a different form of energy. But a calculation from the data furnished by observations at Säntis-Altstätten (St. Gallen) shows that the quantity $\triangle T - H_v$ becomes negative in the summer months. The following table gives the means of the differences for 1897, 1898, and 1899, the stations having a difference of level of 2,080 metres.

	Diff.	Thunderstorms.		Diff.	Thunderstorms.
January ...	9·7 deg.	 1	July	− 1·8deg.	 44
February...	6·1 „	 3	August ...	− 1·5 „	 45
March	3·3 „	 4	September	0·8 „	 18
April	1·7 „	 19	October ...	5·4 „	 3
May	− 0·03 „	 39	November.	8·8 „	 0
June	− 0·6 „	 43	December.	10·3 „	 0

It will be seen that there is a close correspondence between the sign of the difference mentioned and the frequency of thunderstorms.

[A. Weilenmann, *Mitt. Phys. Ges. Zürich*, No. 2, 1901.]

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Calorimetry of High Temperatures.—R. Ferrini discusses the practical application of the calorimetric method to the measurement of high temperatures. To begin with, he gives a table of the number of kilogramme-calories required to heat a kilogramme of platinum or nickel from freezing point to a certain temperature, as follows :—

Final temperature. Deg.	Calories absorbed by 1kg. of		Final temperature. Deg.	Calories absorbed by 1kg. of platinum.
	Platinum.	Nickel.		
100	3·23	12	1,100	42·13
200	6·58	24	1,200	46·65
300	9·95	37	1,300	51·35
400	13·64	50	1,400	56·14
500	17·35	63·5	1,500	61·05
600	21·18	75	1,600	66·08
700	25·13	90	1,700	71·23
800	29·20	103	1,800	76 50
900	33·39	117·5		
1,000	37·70	134		

Then, if m is the weight of the metal, M that of the water, t_1 the initial, and t_2 the final temperature of the water, c the specific heat of the metal at t_2, and Q the heat required to cool the body from the unknown temperature T down to zero, we have

$$m(Q - ct_2) = M(t_2 - t_1),$$

whence

$$Q = ct_2 + \frac{M}{m}(t_2 - t_1).$$

Having thus found Q, the value of T may be found from the table within 100deg. For more accurate determinations the following equations hold :—

For platinum: $T^2 + 52{\cdot}84T - \frac{Q}{0{\cdot}06} = 0.$

For nickel: $T = \frac{1+Q}{13}.$

The unit interval of temperature is here 100deg. The results calculated are correct between 700°C. and 800°C. At other temperatures the errors are trifling.

[R. Ferrini, *Rendic R. Istit. Lomb.*, 35, 2, 1902.]

Electrical Treatment of Infantile Paralysis.—E. A. Weil describes the clinical treatment of 20 cases of infantile paralysis as carried out in the infantile surgery department of the Trousseau Hospital. In all cases brought in within a few days of the cessation of the fever the only treatment consisted in the application of continuous currents of about 10 milliamperes through an electrode of 100 sq. cm. joined to the positive pole, with the extremity of the afflicted member immersed in a tepid bath connected with the negative pole. The sittings lasted 15 or 20 minutes, and were repeated three times per week. Other cases were treated, in addition, with a few minutes' application of a rhythmically interrupted current. In case the muscles concerned were inexcitable by a faradic current, the treatment consisted in the application of interrupted currents through the square electrode and a pad moved up and down over the atrophied muscles. The author quotes a number of cases, almost all successful. The electrical treatment with proper appliances has a distinct advantage over other methods, such as massage, when the paralysis is of long standing ; but its utility is brought out most strikingly in the treatment of fresh cases.

[E. A. Weil, *Arch. d'Electr. Méd.*, July 15, 1902.]

Tesla Discharges.—K. von Wesendonck criticises the work of Möhlmann on Tesla discharges by ordinary means (see *The Electrician*, July 25, p. 551). He points out that there is a great difference between a static and an oscillatory discharge. In the former there is a greater negative discharge from a point, while in the latter there is a greater positive discharge. This difference cannot be brought out by placing a plate opposite the point, since the side discharges are too important. Even with an apparently pure negative discharge positive electricity streams out from the sides of the conductor. It is, therefore, necessary, in order to get at the total discharge, to surround the point with a hollow conductor. The author describes an experiment with one of Himstedt's Tesla transformers. An Exner electroscope showed nothing but a positive discharge. When the point discharged freely into space a probe or flame collector, mounted on one side, showed no negative electricity, unless an earthed disc was placed pretty close in front of the point at the same time. Here, therefore, the central positive discharge was surrounded by a kind of negative sheath. But a hollow conductor completely surrounding the point only acquired a positive charge, evidently due to an excess of positive electricity.

[K. von Wesendonck, *Physikal. Zeitschr.*, July 15, 1902.]

Luminescence.—From Dewar's and Becquerel's observations it is known that uranium nitrate commences to glow on being immersed in liquid air. The glow only lasts while the cooling is going on, and reappears on heating again, but a repeated change breaks the crystal into small fragments. J. Precht points out that several different processes are at work here. One of them is what Wiedemann has called "triboluminescence" or glow due to friction or disintegration. Another is that of pyro-electric discharge. The former may be eliminated by reducing the substance to a very finely powdered state. It is then seen that the luminescence attains a maximum at a temperature somewhat above that of liquid air, and ceases abruptly as soon as the substance has attained a temperature of −193deg. On withdrawing it from the freezing apparatus, the same process is gone through in the reverse order. The author maintains that if the substance is kept at the temperature of maximum glow, the glow continues indefinitely. Barium platino-cyanide and other substances which are dark at ordinary temperatures may be made to glow by cooling. Ice is vividly triboluminescent. The disturbance of molecular equilibrium due to excessive cooling may give rise to a series of pyro-electric and piezo-electric processes which would explain the phenomena observed.

[J. Precht, *Physikal. Zeitschr.*, July 15, 1902.]

Concentration Cells.—If the free ions in a solution are regarded as a special class of molecules, and there are two solvents, the distribution coefficient must be separately investigated for the undissociated molecules (k), the free positive ions (k^+) and the free negative ions (k^-). Nernst has, by an application of the law of mass, found the following relation between these three coefficients,

$$k^+k^- = \frac{K_1}{K_2}k,$$

where K_1 is the dissociation constant in the first solvent L_1, and K_2 the dissociation constant in the second solvent L_2. Now, E. H. Riesenfeld points out that different species of ions will distribute themselves differently in the two solvents, the number of positive and negative ions might become unequal. But there can be no accumulation of one kind of electricity in the interior of a phase. Therefore a double layer of ions must be formed at the limiting surface between the two solvents. Since it is not at present possible to discover such an interior difference of potential, the author studied concentration cells in which two different electrolytes in the same solvent were separated by a third solution. He found that such cells offer a new means of determining the transference numbers in the second solvent, but that the values show a hitherto unexplained discrepancy as against previous results.

[E. H. Riesenfeld, *Ann. der Physik*, No. 7, 1902.]

Discovering Metallic Veins by Electricity.—A method of discovering underground metallic veins was described in a recent issue of the *Western Electrician*. Wires are run across the land which is to be surveyed, and the resistance between contacts placed at the ends of the wires is measured. A fall of resistance indicates proximity to a metallic vein. An average resistance of 54,000 ohms, it is stated, fell in a particular case to 56 ohms when over a rich copper vein.

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THE WATERSIDE STATION OF THE NEW YORK EDISON CO.

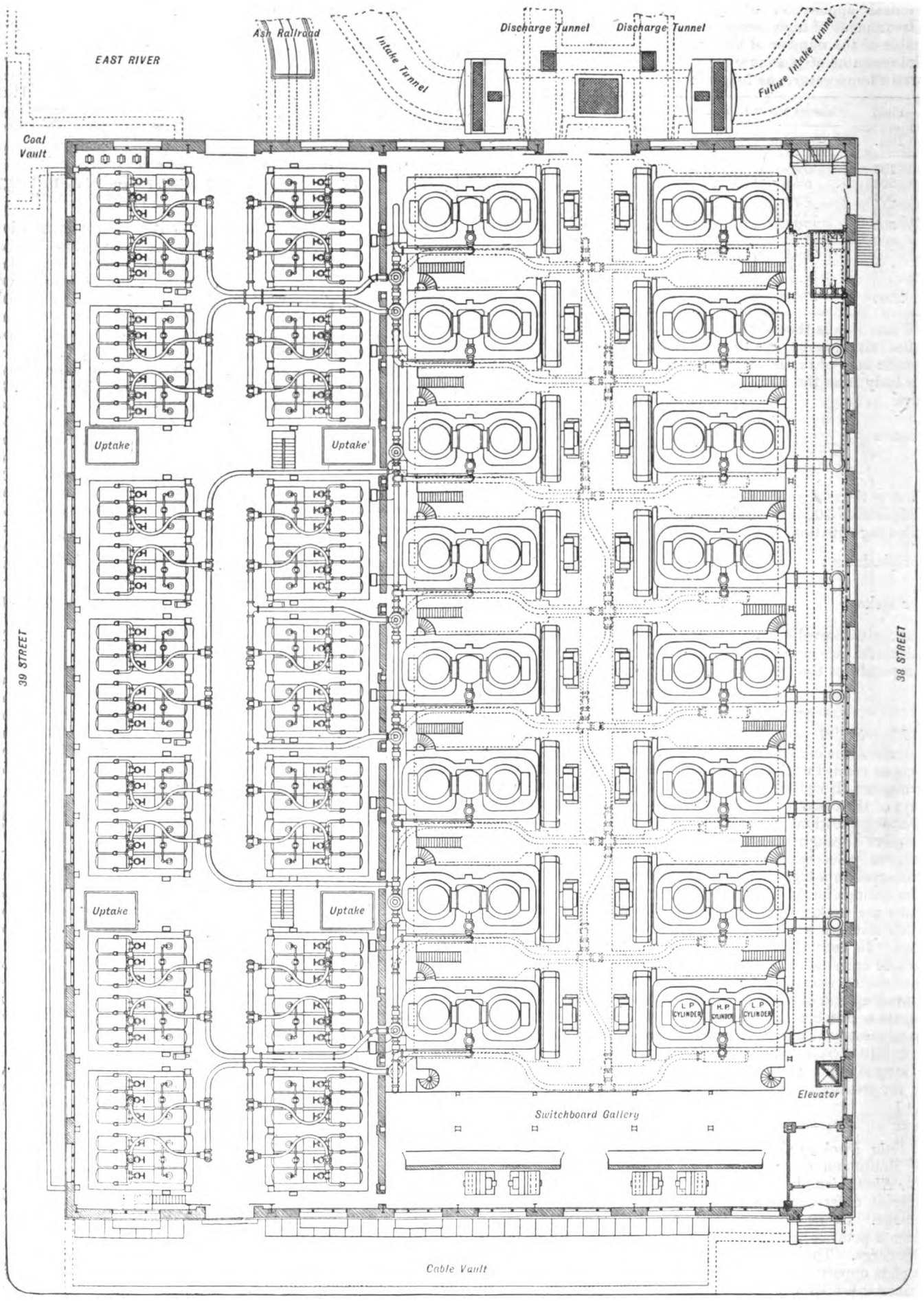

FIG. 1.—PLAN OF THE WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.

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THE WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.*

The problem of furnishing light and power to a large city like New York involves the supplying of the densely populated business and southern district, and also requires that current be transmitted to a large outlying residence district covering many square miles in area, and, in the case of New York, extending north 10 miles from the heart of the city. Numerous small stations distributed through this territory furnish a possible solution of the problem, but such a system lacks the well-known advantages and economy of a large central station. It being impossible to supply such an area with continuous current from a single station, it was decided to use a high-pressure alternating system of generation and transmission. In deciding upon the position of the central station, the general rule that it shall be located as nearly as possible at the centre of gravity of the system is often modified by the cost of land, availability of water supply, coaling facilities and various local considerations. The Waterside station of the New York Edison Co. is admirably situated to satisfy all these requirements, and being equipped with the most modern and economical plant, will generate the bulk of the current used on the system, the larger Edison stations, Duane, Twelfth and Twenty-sixth streets, being used as distributing stations and as supplementary generating stations during the period of heavy load in the winter months. Some of the less important stations, Vandam, Thirty-ninth and Fifty-third streets, equipped with less economical generating apparatus will have their generating equipment removed and will serve as distributing centres. Storage batteries located at all the important distributing centres, in addition to acting as a reserve, will also be used to eliminate the peaks from the local demand, so that the load on the Waterside station will be almost constant during the 24 hours. By utilising the more important generating plants during the months of heavy demand, the larger generating apparatus already installed is used to advantage, additional new investment being saved, which would otherwise be necessary to take care of this capacity.

The Building.—The station is located on First-avenue, covering the block between Thirty-eighth and Thirty-ninth-streets, and running to the East river, an area of 272½ft. by 197½ft.

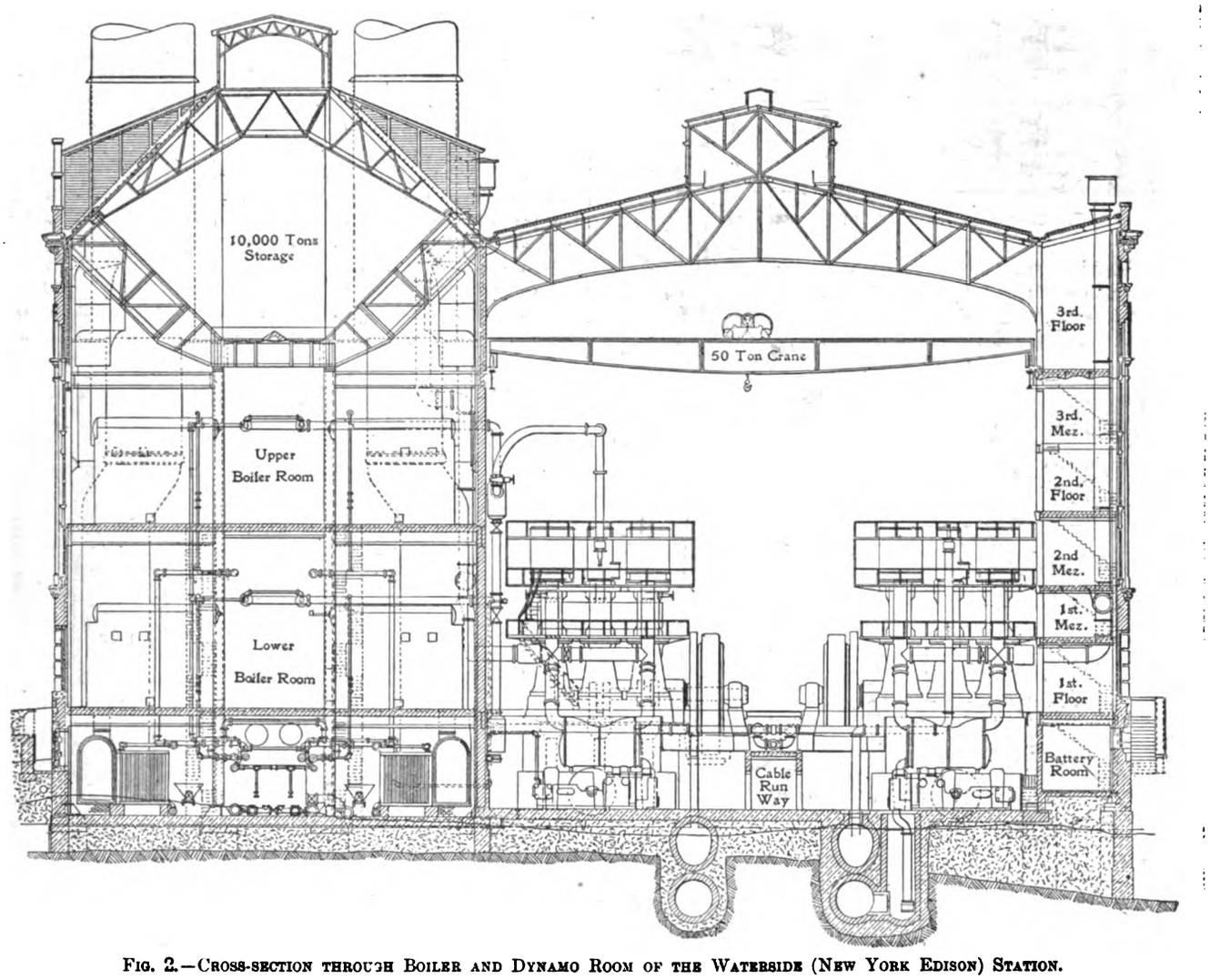

FIG. 2.—CROSS-SECTION THROUGH BOILER AND DYNAMO ROOM OF THE WATERSIDE (NEW YORK EDISON) STATION.

The foundations for both engine and building are of concrete, and rest directly upon bed rock, giving an exceptionally solid construction. The building is of yellow brick trimmed with red sandstone. The inside of the generating room is faced with pressed buff brick, with the exception of a wainscot of enamel-faced brick, 14ft. high, running around the entire room. The floor is of cast-iron plates, and the roof, 116ft. above, has a glass monitor giving abundant light. The general lay-out of the building is shown in Fig. 1. The boiler room is 76ft. by 267ft. 10in., separated by a massive brick wall from the engine room, which is of the same length and no less than 115ft. wide.

Coal-handling Equipment.—The coal will be received at the pier being built out into the river, 150ft. beyond the bulkhead line. On this pier will be located the coal-receiving tower. It carries a bucket with a capacity of 1½ tons, which discharges into the hopper, from which the coal descends into the crusher,

* Abstract from the *Electrical World*, New York.

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passing thence into the bucket conveyor running along the pier and under the marginal street into a receiving vault at the north-east corner of the building. Here it is received into the weighing hoppers, and is then discharged by the auto-

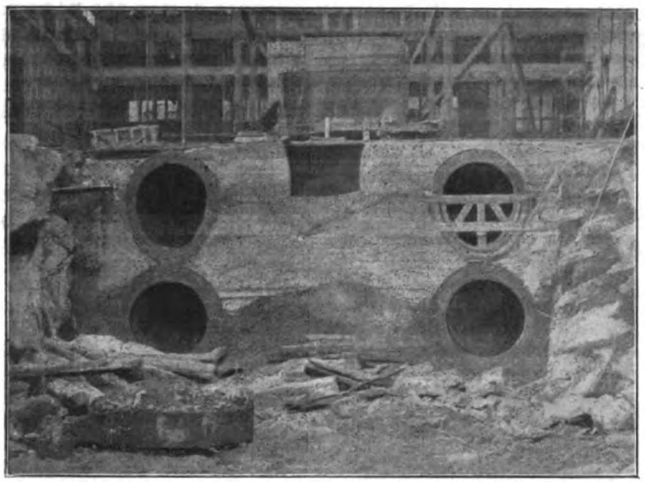

FIG. 3.—CONDENSER TUNNELS AND CABLE GALLERY.

matic fillers into the vertical conveyors which elevate the coal to the monitor, where a horizontal conveyor finally distributes it into the bunker. This bunker, as shown in the sectional view (Fig. 2), is of solid steel construction, and has a capacity of 10,000 tons—sufficient for two weeks' supply. Coal chutes descend from the bunker, each chute feeding the stoker hoppers of two boilers, and each is equipped with a Clarke automatic coal-weighing scale. The bunker is lined with concrete, no coal coming into contact with the iron, and a deflecting ridge along the bottom prevents the lodging of coal in dead pockets where it might take fire from spontaneous combustion.

The Boilers.—The boilers were made by the Aultman and Taylor Mfg. Co., of Mansfield, Ohio. They are arranged in two double-decked rows, one on each side of the boiler room, 14 in each row, 28 on a side, or 56 in all. They are each 18ft. long, with 6,250 sq. ft. of heating surface, and are rated at 650 H.P. each, on a 30lb. basis; but as the engines used will require only about 12lb. of steam per indicated horse-power, the boilers will actually develop about 1,625 H.P. each. When operated with forced draught, they can develop a much greater capacity. The boilers are designed for a working pressure of 225lb., although 175lb. will be the pressure usually carried. They are equipped with Roney stokers and furnaces supplied by Westinghouse, Church, Kerr & Co. Sixteen fan blowers of large capacity furnish the forced draught, so that the maximum capacity may be obtained from the boilers, enabling also the use of steam sizes of anthracite coal in connection with the Roney stokers. It should be added that these stokers have the greatest possible depth of grate in the available space to give the greatest feasible grate area, in view of the desirability of burning anthracite coal. It must be mentioned here also that provision has been made for the installation of superheaters on the boilers, proper fittings having been provided for connecting them, as the engines have been designed with a view to the ultimate use of superheated steam. The furnaces discharge the products of combustion into four steel stacks, each 17ft. in diameter, rising 182ft. above the roof, the tops being plainly visible from a great distance along the river; the total height from the grates of the lower tier of boilers is nearly 200ft. The shell of the stacks is $\frac{5}{8}$in. thick for 44ft., other sections of the same length being made up of $\frac{1}{4}$in. and $\frac{3}{8}$in. plate. The stacks are lined with 8in. of firebrick for one third of their height, the remainder being lined with red brick. The lining is carried upon rings of angle iron in independent sections of 20ft., an air space of 4in. being left between the lining and the stack. The ashes are discharged from the ash hoppers under the boilers into cars, which are to be hauled by small electric locomotives to the dock and the contents dumped into barges.

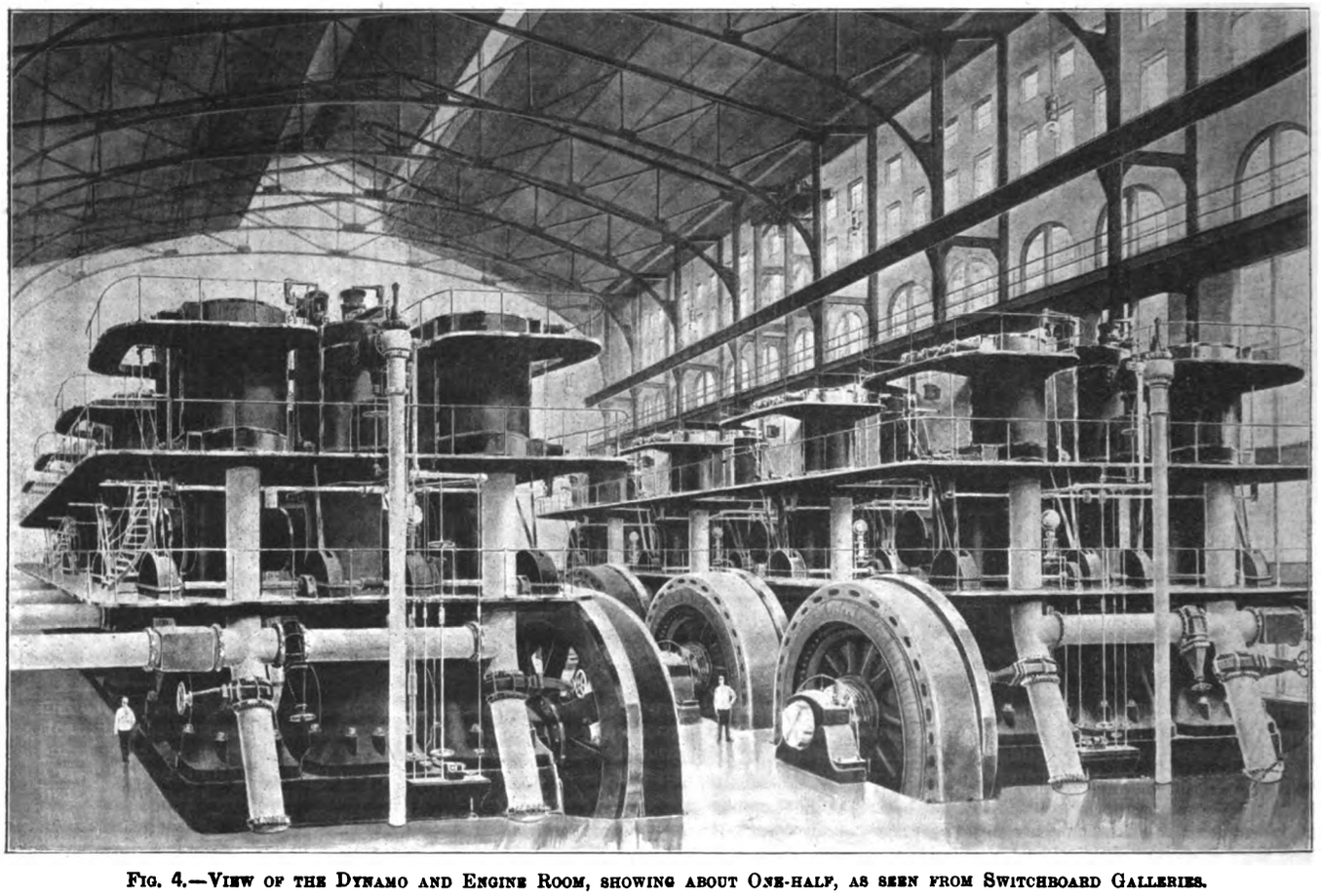

FIG. 4.—VIEW OF THE DYNAMO AND ENGINE ROOM, SHOWING ABOUT ONE-HALF, AS SEEN FROM SWITCHBOARD GALLERIES.

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Space has been provided in the basement for economisers in case it may be deemed desirable to instal these before the completion of the station.

Steam Piping and Heaters.—The steam is delivered from each boiler through a 10in. pipe into a 14in. boiler-room header, of which eight enter the engine-room through openings in the fire wall from each deck of boilers, as indicated in various views herewith. The headers from the upper deck drop into steam separators connected in the main engine-room header, from which steam pipes are taken to the northerly row of engines. Vertical risers drop from the engine room header and receive the steam supply from the headers of the lower tier of boilers, conveying the steam to separators in the basement, from which 14in. mains carry it thence to the throttles of the southerly line of engines. Special fittings are connected to the cross-over pipe to each southerly engine, permitting their connection into a central tie header located under the centre aisle. All joints are ground to a steam tight fit, no gaskets being allowed in any of the high-pressure piping. The pipe, special fittings and flanges are of the maximum thickness specified for the highest class of high-pressure work. The feed water heaters are 50in. diameter, 16ft. long, containing 246 1½in. tubes, giving a total heating surface in each heater of 1,333 sq. ft. These heaters are inserted between the feed pumps and boilers, and receive the exhaust steam from the boiler feed pumps, stoker engines, and other auxiliaries. The feed water will be supplied from the city service in the beginning, although it is expected later to use the condensed steam from the engines as boiler feed after being purified. To this end four special storage and separating tanks have been installed in the basement under the boilers, provision being made in each tank for cartridge filters for removing the greater quantity of oil from the condensed steam. The more complete elimination of suspended oil to be effected in special purifying apparatus. The boiler feed pumps are of the Worthington type, steam driven.

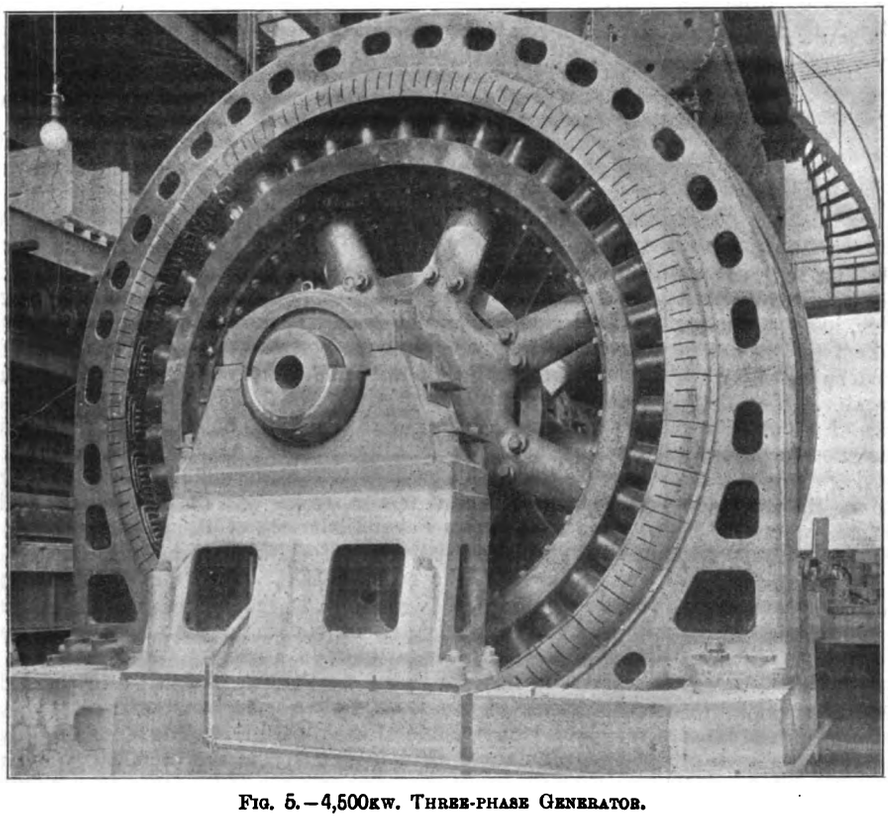

Fig. 5.—4,500kw. Three-phase Generator.

Condensing Water Tunnels.—The condensing water is brought from the river through an intake tunnel built by the General Tunnel Engineering Co., under the Landé patents. This interesting intake tunnel is composed of two ¼in. steel shells, with a space of 15in. between them filled with concrete. It was made in Elizabethport, and when finished was fitted with bow and stern and towed to its present position It extends from the east end of the station 230ft. diagonally under the proposed marginal street along the river front out into the East river. Provision is made for connecting another similar tunnel, should it ever become necessary. Just outside the building the intake tunnel enters the screen wells and divides into two parts, circular in section and 7ft. in diameter, one running under each row of engines. The discharge water from the condenser is returned to the river through two tunnels of an oval section 8ft. high, running out on a higher level (Fig. 3).

The Engines.—The engines, 16 in number, are the product of the Westinghouse Machine Co. They are of the marine type, vertical, three crank, with one high and two low-pressure cylinders, direct connected to 16 General Electric three-phase generaters. The high-pressure cylinder is 48½in. in diameter, and each low-pressure cylinder 75½in. in diameter, with a stroke of 5ft. The low-pressure cylinders only are jacketed, and are provided with liners, the contemplated use of superheated steam rendering jackets for the high-pressure cylinder unnecessary. With 175lb. steam pressure at the throttle and 27in. vacuum, and while running at the normal speed of 75 revs. per min., the engines are to indicate 5,200–5,500 H.P. at most economical load, but will be capable of a sustained load of 8,000 H.P., with an ultimate capacity at maximum cut-off (five-eighths of stroke) of over 10,000H.P. The engine is guaranteed to develop its most economical load, 5,200–5,500 H.P., at a steam consumption not to exceed 12½lb. of dry steam per indicated horse-power per hour, including the steam used in re-heater and jackets. The bed-plate is made in three pieces with an extension for supporting the outboard bearing. The engine frames are of the A type, of strong and massive yet graceful design, with a substantial bearing on the bed-plate. The crank shaft is built up in three section, with a 10in. hole extending from end to end. The 26in. shaft is supported in four bearings, the three main bearings each 60in. long and the outbound bearing 48in. long. The engine, having three cranks, set at the angles 101deg., 133deg., 126deg., so as to give a uniform turning moment, does not require a heavy flywheel, a weight of 90,000lb. in the rim with an outside diameter of 28ft. being sufficient to give the required steadiness of motion for parallel operating and avoid any evidence of "beat" or pulsation in the electrical system.

The high pressure cylinder is fitted with poppet valves, following European practice on engines of similar types using superheated steam. The low-pressure cylinders have valves of the double-ported Corliss type. The valves are driven by eccentrics from a lay shaft receiving motion from the main engine shaft by means of helical gears, European practice again being followed in this respect also, although quite unfamiliar in America. The governor is driven from the lay shaft, and controls both the high and low-pressure valves, the latter being also detachable so as to be adjusted by hand. The engine speed can be controlled by mechanical adjustment of the governor weights while in motion. To facilitate synchronising, the speed of the engine can also be varied from the electrical gallery by a pilot switch operating an electric motor which shifts the weight on the governor arm. An emergency steam-operated throttle is provided enabling steam to be shut off instantly, and this is connected to a centrifugal device in one of the crank cheeks, which, in case the engine speed exceeds a certain limit, engages a pawl admitting steam to

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the emergency throttle automatically, and cutting off steam. In passing from the high-pressure to the low-pressure cylinder the steam travels through the re-heater, whose capacity is of 220 cubic ft.

A complete oiling system is provided, the main bearings being fed with a gravity-pressure system, and the cylinders, cross-heads, &c., are lubricated from sight feed manifolds having pressure pumps driven from the valve motion. The oil is circulated by a special force pump, with a system of tanks for its filtration.

Each engine has an independent air and circulating pump driven by a separate engine with Corliss valve gear. The surface condensers are of the Worthington type, with a cooling surface of 9,200 sq. ft. Each engine is provided with an automatic relief valve in the exhaust line, admitting to the 80in. atmospheric exhaust riser, extending from each engine to the roof, where the riser is capped by an exhaust head.

Very complete platforms at three different heights are provided, giving ready access to all the working parts of the engine; and the two upper platforms have walkovers from engine to engine, facilitating efficient and economical supervision and oiling. These details will be gathered from the general view of the engine-room in Fig. 4. A flying bridge, which can be moved by the cranes, will span the aisle between the north and south row of engines. The engineer can thus be carried from one end of the long hall to the other, with instantaneous access to any generating unit in either row. At the same time, when not in use, the flying bridge does not interfere in any way with the normal operation and employment of the cranes.

The Generators.—The 16 General Electric 4,500kw. three-phase generators deliver 25-cycle alternating current at 6,600 volts. They are of the revolving field direct-connected type, and, as they run at 75 revs. per min., have 40 poles. The revolving field is keyed to the engine shaft and bolted to the hub of the flywheel, which is extended so as to form a heavy flange on the side toward the generator. The field-magnet cores are bolted to the outer surface of an iron ring, which is made in two semi-circular pieces fastened together by I links. This ring is supported by a spider having eight spokes, through each of which pass two bolts, securing the revolving element to the flywheel hub. The fields are wound with copper ribbon set on edge, and give full excitation at 220 volts, thus making it possible to take the exciting current either from the low-tension board or storage battery in case of failure of the exciter sets. The exciting current passes to the revolving field through two iron collector rings. Iron rings were used because of their superior wearing qualities. Four carbon brushes on the 1½in. face of each ring give ample current-carrying capacity. The armature is built of laminated steel of the highest magnetic quality. The coils are secured by dovetailed wedges in slots 4½in. deep and 1½in. wide, and the ends of the coils are so formed as to leave a space of at least an inch between adjacent windings. There are 240 slots, two per phase per pole. The revolving field weighs 130,000lb., the armature 125,000lb., and the foundation plates 20,000lb., making the total weight of each generator 275,000lb.

The complete generator is shown in Fig. 5. The design is such that all necessary repairs to field and armature windings may be made without removing the upper half of the armature. By taking out the two bolts, securing it to the yoke, any field spool may be removed, and by withdrawing two poles the armature coils may be removed and replaced. The armature coils will carry a non-inductive load of 250 amperes per phase for 24 hours without the temperature of any part exceeding that of the air by more than 30°C. A non-inductive load of 400 amperes per phase carried for three hours causes a temperature rise of less than 50°C. In making the heating tests the resistance method of calculating the temperature was used in addition to thermometer readings. In all cases where the latter gave the higher reading the results as indicated by that method were used. The armatures are designed to withstand a test of 15,000 volts alternating, applied for half an hour, and a puncture test of 25,000 volts alternating for one minute. The insulation between the field coils, collector rings and generator frame is such as to withstand 25,000 volts continuously. The efficiency at full load and one-quarter overload is 97 per cent.; at three-quarter load, 96 per cent.; at one-half load, 95 per cent.; and one-quarter load, 91 per cent. The regulation is such that, with the sudden throwing off of full load, the rise in voltage does not, with constant excitation, exceed 8 per cent.

Motor-generator Exciter Sets.—There are three exciter sets installed, each consisting of a 225 H.P., 6,600 volt, three-phase induction motor, direct-connected to a 150kw., direct-current, four-pole generator, giving a potential of 200–280 volts. These exciter sets can be run continuously at full load with a rise of temperature not to exceed 40°C. above the surrounding air, and will carry 33⅓ per cent. overload for three hours without injury.

In order to ensure absolute continuity of current for exciting the fields of the generators a storage battery was installed having capacity sufficient to excite the fields of 16 generators for one hour. This battery is of the Chloride type, and similar to those used in all the annex stations, to be referred to again later.

(To be continued.)

NOTES ON CALCIUM CARBIDE MANUFACTURE IN ITALY.

BY CESARE PIO.

In Italy the calcium carbide industry is rapidly progressing, and the number of furnaces operated with continuous or polyphase current is increasing every day. A large number of patents relating to improvements of this industry are also being applied for in Italy. In the early days a great deal of cheap but faulty apparatus was placed on the market, and the unfortunate result was that many accidents and explosions occurred, and the calcium carbide industry suffered considerably. It is only since last year that the business in this line in Italy has become profitable. Since 1896, however, the commercial use of acetylene has been general in Italy. After the construction of the factory of Pont Saint Martin, near Ivrea (Piedmont), which utilises water power, many other companies were formed, and electric furnaces were installed where it was possible to obtain power from waterfalls. In 1897 the Società Italiana dei Forni Elettricci, of Rome, built a factory at Narny; a little later the Società Italiana pel Carburo di Cacio, Gas Acetilene ed Altri Gas, with 3,000,000fr. capital, put down a 3,000 H.P. plant near the Marmore falls (Terni). In the month of August of the same year a company was formed in Turin, and electric furnaces were installed in S. Marcello d'Aosta in the north-west of Italy, and there the water power of the Dora Baltea river was utilised.* This last plant, which is one of the most interesting of its kind, has just been enlarged in consideration of the increasing demand for carbide.

A great field now open to the Italian calcium carbide industry is the application on the railways for train lighting. A few years ago the use of acetylene was limited to small villages, but at present the number of big centres lighted with this modern system is continually increasing. Moreover, the possible application of acetylene is larger since it was discovered that this gas, mixed with a certain quantity of acetone, may be easily transported without danger of explosion. Another field of application is the acetylene gas motor for small industries. This class of motor, however, has not yet been sufficiently improved to tempt many experiments with it on a commercial scale.

The price of calcium carbide has been lately raised to 437.50fr. per ton, as against a price of 250fr. per ton last year. This seems to be the result of a syndicate recently constituted on the Continent, which is trying to keep up the price of this product. In a recent publication by Mr. Riccardo Memmo, who is an authority on all questions regarding manufacture of calcium carbide, the conditions of this industry in Italy are considered, and it is stated that, in order to render the industry really remunerative in Italy the conditions must be as follows:—

1. The price of the plant, per horse-power installed, including

* See *The Electrician*, Vol. XLIII., p. 637.

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machinery, furnaces and all the necessary supplies, must be not higher than 500fr.

2. A certain ratio between the number of tons of carbide produced and the number of effective horse-power produced must exist. The price of calcium carbide, including general expenses, must be not greater than 120fr. the ton.

4. The capital expended must be amortised in 10 years. This corresponds to a sinking fund of 40fr. per ton produced.

5. The selling price of the carbide must be 250fr. the ton, so that, including freight, loss, profits, &c., the price to customers does not exceed 800fr. per ton.

6. At least 6 per cent. must be paid on the capital invested.

These conditions at present are not entirely fulfilled in the majority of existing plants, but with the continual development which is taking place in this industry in Italy, and also in consideration of the great amount of water power available there, not only should these conditions be fulfilled, but the price of the product should be reduced also.

MODERN MACHINE METHODS.*

BY H. F. L. ORCUTT.

(*Concluded from p. 725.*)

Erecting Department.—Probably in no department of mechanical work are the contrasts between old and new methods more striking than in erecting or assembling. In the new method machining is done accurately to dimensions; in the old, machine and tools are mainly used for removing metal, and reliance is placed on the fitter for proper working fits. In the new, accuracy and interchangeability of dimensions are maintained by a suitable equipment of gauges and the establishment of limits; in the old there is a variety of sizes depending upon the skill and judgment of individuals. In the new the time necessary for "setting up" a particular piece of work or "lots" of work is reduced 25, 50, 100 per cent., and even more, below that taken in the old shop. In the new the number of fitters is strikingly small compared with the abundance of this class of helpers necessary in works running on old lines. The model erecting department, therefore, is one in which fitters' work is reduced to a minimum and where the least possible amount of time is occupied in assembling. These results are, of course, only possible when the best methods of machining are practised, when jigs and fixtures are used as much as possible, when a proper equipment of gauges is installed and a system of inspection is amplified.

Testing and Analysing Material.—In view of the fast machine operations, the increasing demand for accuracy and the exacting requirements in respect to material under which the engineer often has to work, it is wonderful how little the ordinary manufacturer really knows about the structure, composition and capabilities of the material which he is continually buying, manipulating and selling. A testing machine here and there (crude enough, as a rule), a few laboratories connected with schools and scientific public institutions; the rest is guesswork. A change of foundry foreman or the transfer of patronage to another steel maker often demoralises a whole establishment, results in the ruin of expensive machines and tools and in the scrapping of costly finished product.

The advantages of possessing a well-equipped laboratory and testing department are many and far-reaching compared with the sole disadvantage—expense—and they bring quick returns for a small outlay. In the first place, raw material, pig-iron, scrap, coke, steel, copper, brass, &c., should be bought to specification. The result would be emancipation from the slavery of "branda." This is in itself a considerable advantage to the buyer. A control of cupola mixtures can also be undertaken which will give definite results in castings. Steel, iron and other materials can be selected independently of the recommendations of the maker, who too often answers a complaint with the assurance that more expensive material must be purchased when, perhaps, cheaper would be better. Not alone in the purchase of material, but in the manipulation as well, is the analysing and testing engineer of value. Castings must be properly treated, and be of the right mixtures to allow rapid and accurate machining. Recently a case came under the author's observation where the product of a milling machine was increased 30 per cent. simply by improvement in the quality of material. Many concerns are using *hard* material, which is necessary for certain parts, but uncalled for in other cases, because they have no definite knowledge to enable them to vary cupola mixtures. If they had they would increase the speeds of machining in a large percentage of their work. Materials should be studied with a view to selecting that which is most suitable for the purpose, which, being most suitable, can be most rapidly machined, and which, fulfilling all conditions, is the cheapest. This cannot be accomplished with the haphazard methods commonly employed. The establishment of laboratories is confidently put forward as a suggestion worth the serious consideration of mechanical engineers. It will pay, in nearly all cases, for those employing 1,500 hands, in a majority of cases for those employing 1,000, and in some where under 1,000 are employed.

Where the size of a shop does not warrant the expenditure necessary to support its own department several manufacturers can easily combine and contribute to the support of a fully-equipped laboratory. Where the last course only is feasible petty jealousies and nonsensical isolation, which are so prevalent amongst manufacturers, will probably stand in the way for some time to come. There is, however, no practical reason why every mechanical engineering establishment in the United Kingdom should not have a testing institution at its command which could be constantly made use of. The realisation of this state of affairs would be of incalculable benefit to the industries and commerce of Great Britain. The following Table III. of chemical specifications is one suitable for a large variety of light machinery castings, which can be rapidly machined, are close-grained, have good wearing qualities, and take a good finish.

Table III.—*Chemical Composition of Light Castings (Iron).*

—	A. Mixture for thin castings under §in. thickness.		B. Mixture for castings of an average thickness of ⅞in.		C. Mixture for castings 1¼in. to 2in. thick.	
	Limits allowed.	Analyses desired.	Limits allowed.	Analyses desired.	Limits allowed.	Analyses desired.
Silicon.....	2·45 to 2·65	2·55	2·30 to 2·50	2·40	2·15 to 2·35	2·25
Sulphur ...	0·07 to 0·10	0·08	0·07 to 0·10	0·09	0·08 to 0·12	0·10
Manganese	0·30 to 0·70	0·40	0·30 to 0·70	0·40	0·30 to 0·70	0·40
Phosphorus	0·70 to 1·00	0·90	0·50 to 0·90	0·70	0·40 to 0·80	0·60
Cm. Carbon	0·30 to 0·50	0·40	0·30 to 0·50	0·40	0·30 to 0·50	0·40
Graphite...	2·90 to 3·20	3·10	2·90 to 3·20	3·10	2·90 to 3·20	3·00

For very heavy castings a mixture containing about 2·00 silicon should be used, other elements same as mixture C.

Shop Fittings.—Good fittings play a not unimportant part in shop economics. They are too often looked upon as articles of luxury only, to be made use of by faddists instead of as possessing a practical value as means of saving time and maintaining order and cleanliness. Among the more important are included well-designed work benches, shop stands for workmen who are machine attendants, cans and buckets for waste and rubbish, properly-designed racks for holding parts, carefully-arranged receptacles for tools and gauges, and racks for holding rough material. Stores for rough materials, partly finished work and finished product, should be most carefully studied. Simple and easy methods of fastening countershafts and main shaft hangers should be devised. Means of transportation—whether cranes, railways, or trucks—should, of course, receive special attention. Machine shop floors deserve far more thought than they usually receive. Means of heating and ventilating are, as well as floors, absolutely essential to the modern shop, for without them it is impossible to properly keep fine machines, tools and gauges in good condition. Comforts and conveniences for workmen are fast becoming necessities in the modern shop, as they help in attracting and retaining the best and most intelligent workpeople.

Extensive Application of Modern Methods Possible.—There is a widely-spread and erroneous idea, particularly amongst European manufacturers who would emulate American manufacturers, that the latest methods cannot be economically adopted except where work is thoroughly standardised, specialised and made in large quantities. Advantage of every method which has been mentioned, with the exception, perhaps, of jig and fixture work, can be taken where none of the above conditions exist, not even excepting that which practically amounts to interchangeability. One hole is more cheaply bored in a chucking machine than in a lathe. It is more easily made to a limit gauge than when the skill of a workman in setting his calipers has to be trusted. One spindle is more cheaply finished in the grinding machine than in the lathe, quality duly considered, and, again, is more easily finished to a limit gauge than to calipers, with the employment of less skilful labour. With the quickly-adjusted, easily-manipulated milling machine any amount of work can be more cheaply milled than planed, even where only a few pieces are to be worked. Inspection, good equipment of gauges, tool stores, the latest machines and small tools are necessary, whether one piece or 1,000 are in question. The idea that big quantities and standard work are necessary before modern equipment begins to play an important part in the economics of manufacturing is the delusion of those who have grasped but a small part of the problem.

Apprenticeship Question.—Unquestionably one of the most serious obstructions to the introduction and successful working of new machines and methods is the lack of knowledge and understanding of modern machine methods on the part of workmen. This is not due so much, as is commonly supposed, to the restrictions and regula-

* Paper read before the Institution of Mechanical Engineers. Slightly abridged.

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tions of trade unions as to the ignorance, bad management and want of foresight on the part of the masters. The fact is, that men in a great many shops accomplish wonders, considering the opportunities given them to learn and the appliances with which they are expected to work. Within a comparatively short time methods of manufacturing, machines and tools have undergone an almost revolutionary change. This change has been so great and rapid that men who served as apprentices under the old *régime* are ignorant of new methods and have not the necessary training to manipulate successfully and supervise the most economical working machinery. Many of them are as much at home in a really modern shop as "Alice in Wonderland." It is not at all surprising that they shake their heads at strange new machines and doubt the tales of the American "Mad Hatter." It is well to ask the masters who grumble if they themselves are familiar with the latest methods of machine work; if they are familiar with the advantages of the subdivision of labour and departmental work; if they know the value of skilful, intelligent tool makers, and are familiar with the best machines and appliances. These are items which must be studied by the masters and, side by side, should be considered—how shall they instruct and train men in the proper use and care of machines and tools? In other words, systems of apprenticeship must be inaugurated and maintained which teach men how to work in modern ways. Do not work apprentices on old-fashioned machines with out-of-date tools, letting them take years to learn to perform certain operations which a man from the street with three weeks' practice can do better and quicker on a modern labour-saving tool. Many shops are having endless trouble from trying to work new machines by men trained on the old lines, neither masters nor men comprehending their duties. It is the duty of masters to establish modern systems of apprenticeship arranged in accordance with new methods. It is the duty of men to try to adapt themselves to these new systems. It is wasteful and foolish for all to insist that a man must serve from four to five years before he can become a proficient turner, when we know that in a few weeks a labourer can learn to operate two grinding machines and produce cylindrical surfaces that it is impossible for the most skilful turner to duplicate, either in regard to quality or cheapness. This is not saying that it is unnecessary to train men to become good turners; it is, however, unnecessary to train them to perform many operations which are superseded by new methods of working. The same comparison can be made between the screw machine and the lathe and the milling machine and the planer. Chuck and jig work supersede boring and drilling. Men must realise that the new ways have come to stay. Masters will wait in vain if they think the technical school can ever take the place of rational training in that best of all schools—the shop itself. Many employers are beginning to realise that there is but one way to get good men—that is, to make them. A modern system of apprenticeship naturally divides itself into three broad classes—(1) Training of men who wish to become skilful in special operations, like turning, planing, &c.; (2) training of men who wish to become merely machine operators; (3) training of men who are necessary for supervising and keeping plant in a high state of efficiency. By the old methods men are largely trained to become skilful in turning out a certain product. By the new methods the highest skill is employed as supervisor of labour-saving machinery which turns out the product in a practically finished state. This calls for a radical change in the systems of apprenticeship.

Politicians and writers are raving over the technical schools of Germany. Speaking as one who has for years been in contact with the product of the German technical school, the author has no enthusiasm nor admiration for their methods, at least as far as mechanical progress is concerned. Technical education as taught to-day is useless, except to a very small percentage of our mechanical workers. There is an immense amount of talk about scrapping old machinery, buying new plant and planning new shops, whilst the most important factor of all—men—is left to shift for itself. Yet all are asking the question, Where can I get good men? Train them, is the answer. The means for doing this are in the hands of every manufacturer. In your own shops, on your own machines, with your own instructors, in your own time; neither municipalities nor governments can do it for you. Manufacturers must establish systems of apprenticeship which include workshop experience under educational guidance.

EXPERIMENTS WITH THE "SPARKLET" FUSE.

Messrs. Elliott Bros. have sent us particulars of some interesting experiments with Mr. Partridge's "Sparklet" fuse which were recently carried out at the Deptford station of the London Electric Supply Corporation. This ingenious device, it will be remembered, was fully described and illustrated in *The Electrician* of July 4th last.

A 1,000kw. 10,000-volt generator was specially run for the purpose. Fig. 1 shows the effect of breaking a 10,000-volt 1,000kw. circuit at a horizontal 30in. fuse without the aid of any extinguishing device. A small sparklet fuse was put in series with this arc, but kept short-circuited by means of a plug switch. When the large

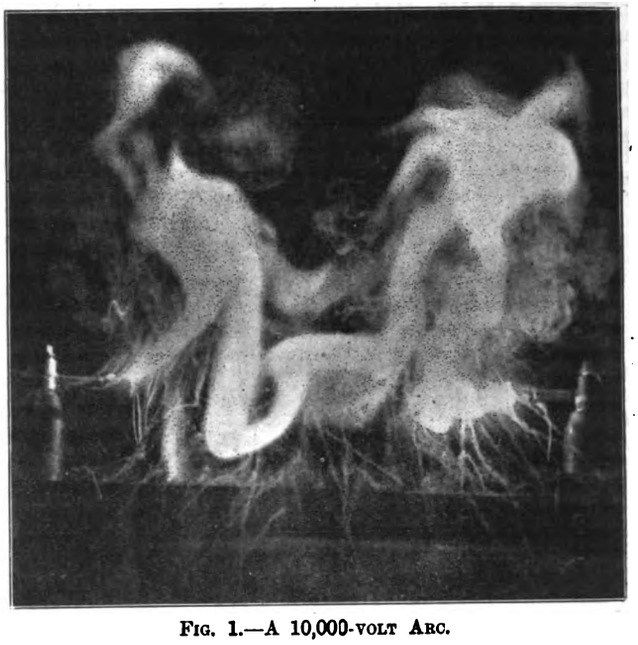

FIG. 1.—A 10,000-VOLT ARC.

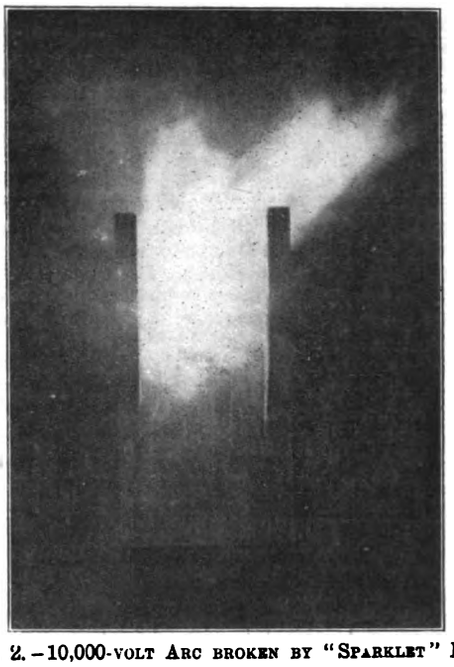

FIG. 2.—10,000-VOLT ARC BROKEN BY "SPARKLET" FUSE.

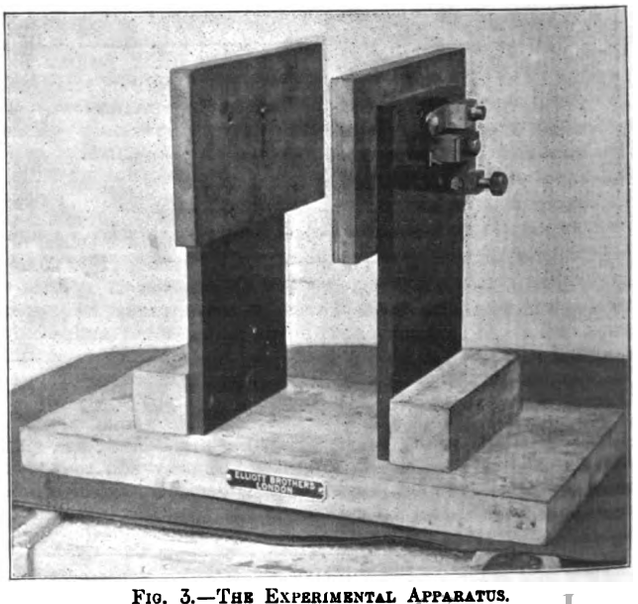

FIG. 3.—THE EXPERIMENTAL APPARATUS.

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arc, which made a tremendous roar, had been examined with darkened glasses and generally admired by those present, the sparklet fuse was brought into action, and the circuit was broken instantaneously. Another experiment was made with a view of simply showing in how short a distance currents at high pressures could be broken, and is illustrated in Fig. 2. In this case the fuse went between two terminals fixed on the back of two insulating slabs, placed 4½in. apart only. The power and pressure remained the same as in the foregoing experiment, but the fuse broke the circuit instantly with the sparklet device, and the photograph shows how the arc is confined to a very small space in this case. Fig. 3 shows the experimental apparatus which was used for the trial with the 4½in. break.

SOME EXPERIMENTS ON STEAM-ENGINE ECONOMY.*

BY PROF. R. L. WEIGHTON.

The object of this Paper is to record the results of two separate and distinct sets of experiments bearing upon the economical performance of the steam-engine. The first constitutes a series of experiments, made with a view to determine the economical effect of re-heating the steam passing through the receiver of a double expansion, or compound, engine. The second forms a series of experiments, made with a view to determine the influence upon economy, of degree of vacuum in the condenser of a triple-expansion engine. Both sets of experiments were made upon the experimental engines in the engineering laboratory at the Durham College of Science, Newcastle-upon-Tyne, and form part of a systematic course of research work upon the steam engine, which is being carried out there.

I. Economical Effect of Receiver Re-heating.

Method of Making the Trials.—The cylinders used for these trials were 7in. and 15½in. diameter, with a stroke of 18in. The boiler pressure was maintained constant throughout the trials at 200lb. per square inch above the atmosphere. The re-heater, which was specially fitted to the engines for the purpose of these trials, was kindly lent by Messrs. Richardsons, Westgarth & Co., of Hartlepool engine works, and was fitted to the engines as shown in Fig. 1. The heating surface consisted of a double coil of copper piping arranged inside a cast-iron chamber, and amounted to 30 sq. ft. The piping was 1¼in. external diameter and 1·06in. internal diameter. The receiver steam was compelled to pass through the heater by the blocking up of the middle cylinder and ports as indicated in the drawing. Steam of boiler pressure was admitted to the inside of the heater coils. The water condensed in these coils passed to a trap at a lower level, in which it was carefully measured, and from which it was periodically drained off, thus keeping the coils absolutely clear of water. The receiver condensation was similarly dealt with.

In order to test the effect of the reheating at different loads, the power of the engines was varied, and a progressive series of results was obtained. The power variation was brought about by variation in the cut-off in the high-pressure cylinder, the low-pressure cut-off remaining constant throughout at 7in.

The engines are normally fitted with Meyer's expansion valves, but it so happened that prior to these trials, and for other purposes, the high-pressure cylinder had been fitted with a shifting eccentric, in imitation of the action of an automatic expansion governor. This eccentric was retained for the re-heating trials, and was shifted by hand to give the variation in power. There was no governor attached to the engines. To preserve as great a uniformity of conditions as possible, the experiments were made in pairs, the only change between the two trials of each pair being, that in the one the steam was shut off from the re-heater coils, while in the other the steam was admitted to the coils. Sufficient intervals were allowed to elapse between the trials to permit of the attainment of thermodynamic stability under the changed conditions. In this way only has the author found it possible to obtain consistent results, in any series of experiments where the differences in effect due to given changes in conditions are small.

The dynamometer was adjusted to give as nearly as possible 133 revs. per min. for the first trial of a pair, the steam being shut off from the heater coils, and the receiver steam passing through the heater on its way to the low-pressure cylinder. Under these conditions a trial was run, and the observations and measurements recorded. Immediately on finishing, steam was admitted to the re-heater coils, and the engines allowed to run till they adjusted themselves to the new conditions, no other change whatever being made as compared with the trial just completed. The vacuum was kept as nearly as possible constant throughout all the trials.

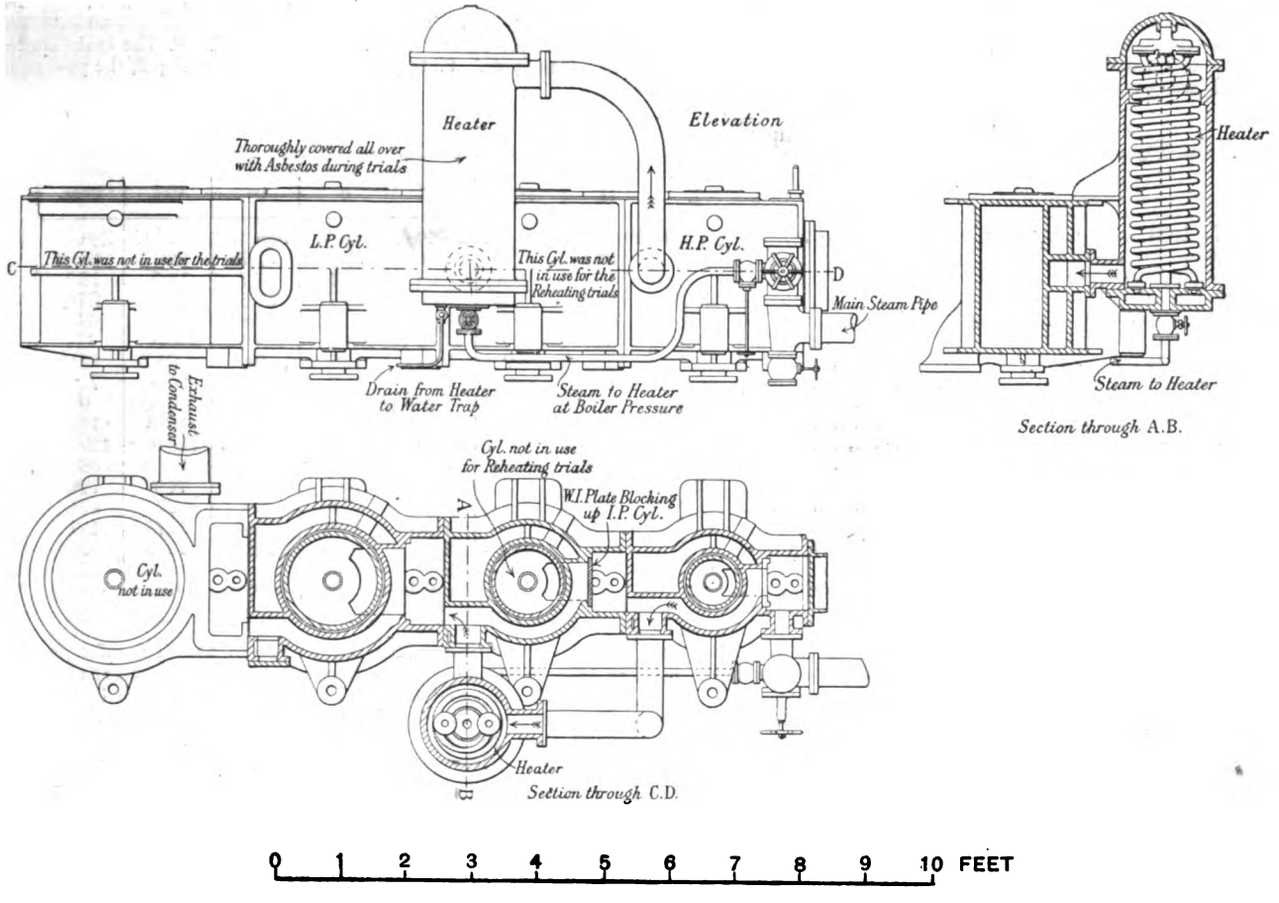
Heater
Elevation
Thoroughly covered all over with Asbestos during trials
This Cyl. was not in use for the trials
L.P. Cyl.
This Cyl. was not in use for the Reheating trials
H.P. Cyl.
C
D
Main Steam Pipe
Drain from Heater to Water Trap
Steam to Heater at Boiler Pressure
Exhaust to Condenser
Heater
Steam to Heater
Section through A.B.
Cyl. not in use for Reheating trials
W.I. Plate Blocking up I.P. Cyl.
A
Cyl. not in use
Heater
Section through C.D.
0 1 2 3 4 5 6 7 8 9 10 FEET

Fig. 1.—Arrangement of Receiver Re-heater.
Heating Surface of Heater = 30 sq. ft. Copper Tubing, 1¼in. external diam.

* Paper read before the Institution of Mechanical Engineers.

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Table I.—*Results of Receiver Re-heating Trials.*

Cylinders 7in. and 15½in./18in. Boiler pressure 200lb. (above atm.). Jacket steam off. Cut-off in L.P. cylinder 7in. Power varied by shifting H.P. eccentric. Condensing water adjusted for an approximate vacuum of 24·4in.

No. of trial	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Date of trial. 1900	May 4.	May 4.	April 27.	April 27.	May 11.	May 11.	May 18.	May 18.	May 25.	May 25.
Reheater steam ....off or on	off	on	off	on	off	on	off	on	off	on
Shift of H.P. eccentric .... inches	⅛	⅛	¼	¼	⅜	⅜	½	½	⅝	⅝
Pressure in H.P. steam chest ....lbs. above atm.	195·5	194	197	196	198	197	199	198	198	198
Pressure in reheater coils .... „ „	0	193	0	194	0	194	0	195	0	195
Pressure in receiver .... „ „	50	54·3	43	47·5	31	36	16·7	21	1·0	4
Barometer ....inches of mercury	29·4	29·4	30	30	29·8	29 8	29·9	29·9	29·75	29·75
Vacuum .... „ „	23·12	23	24·4	24·37	24·4	24·5	24·42	24·45	24·2	24·4
Mean pres., reduced to L.P. cylinder...lbs. per sq. in.	58·1	60·4	54	55·6	44	46·5	30 8	32·7	12·36	13·78
Revolutions per minute	133·4	136·1	130·2	134·4	132·8	137·6	133·9	137·5	136·4	143·2
Condensation in receiver ....lbs. per hour	95	49·5	not taken	not taken	81·78	43·96	55·8	32·6	would not drain	would not drain
Condensation in coils of re-heater ... „ „	0	110	0	106	0	88	0	68	0	22
Total water used ....lbs. per hour, W	2298	2454	2050	2216	1725	1896	1270·6	1378·6	599·5	686
Steam shown by indicator cards at L.P. cut-off in percentage of total water	72	76·7	68·4	75	68·3	77·2	60	70	60·4	71
Indicated horse-power....	131	138·8	118·7	126·2	98·7	107·6	69 7	75	28·5	33·3
Brake horse-power	120·3	126·1	112·6	117·1	94·1	99·5	63·5	67·7	24·3	27·32
Mechanical efficiency	0·918	0·908	0·948	0·928	0·953	0·925	0·911	0·902	0·854	0·820
Pounds water ....per I.H.P. hour	17·54	17·61	17·2	17·5	17·5	17·62	18·23	18·38	21·06	20·59
Pounds water .... „ B.H.P. „	19·1	19·46	18·2	18·92	18·33	19·06	20	20·36	24·67	25·11

NOTES.—1. Trials were made in *pairs*—steam *off* and steam *on* re-heater—the one after the other with a sufficient interval. 2. The brake sluices were adjusted for the first of each pair, and were not altered for the second trial of the pair. 3. In plotting the results on Fig. 2, the powers in Nos. I. and II. are brought up to the average vacuum of the others—viz., 24·4in.

Table II.—*Results of Variable Vacuum Trials.*

Cylinders 7in.–10½in.–15½in./18in. Jacket steam off. Receivers drained continuously. Cut-off in each cylinder 10½in. Brake sluices shut 1in.

No. of Trial	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Date of trial. 1902	Mar. 14.	Feb. 28.	Feb. 28.	Feb. 28.	Mar. 7.	Feb. 21.	Feb. 21.	Feb. 21.	Feb. 21.
Vacuum—inches of mercury ...	0	11·53	16·70	19·69	20·40	21·79	24·07	25·72	28·18
Condensing water/feed water ...	...	5·7	7·0	8·4	8·3	8·7	11·2	15·3	43·7
Barometer	29·7	29·15	29·15	29·15	29·7	29·85	29·85	29·85	29·85
Pressure in H.P. steam chest (above atm.)	147	146	147	148	147	151	150	148	149
Revolutions per minute. (R)	109	118·6	122·6	124·5	124·3	125·4	126·6	127	127
Indicated horse-power	54·7	70·2	76·9	78·7	78·5	81	83	82·2	83·4
Brake horse-power	48·3	60·3	64·9	67·4	66·9	69·1	70·6	71·1	71·5
Mechanical efficiency	0·882	0·859	0·844	0·856	0·852	0·853	0·850	0·865	0·857
Total water used per hour in pounds. (W)	1048	1141·5	1189·5	1210	1218	1217	1235	1246	1247
Hot-well temperature °Fahr. (t_H)	212	193	177	164·5	164·3	157	142 8	129 2	88·8
Mean pressure reduced to low-pressure cylinder (M)	29·75	35·06	37·13	37·41	37·33	38·22	38·85	38·32	38·85
I.H.P. at 120 revolutions. (I)	60·3	71	75·2	75·8	75·7	77·5	78·7	77·6	78·8
B.H.P. at 120 revolutions. (E)	53·2	61	63·5	65	64·6	66·1	67	67·2	67·6
Water per hour at 120 revolutions. $(W_1)=120\ W/R$	1154	1155	1164	1166	1175	1164	1170	1177	1178
Heat units per hour at 120 revolutions* $(W_H)=W_1(T_1-t_H)/T_1$ ..	954	973	996	1008	1016	1015	1033	1053	1092

* T_1 = total heat—above zero Fahr.—per pound of boiler pressure. (W_H) = Heat units reduced to pounds of water for comparison.

Results of the Trials.—The results are given in Table I., and are recorded graphically in Fig. 2. Attention is directed to the following points in these results:—

1. The amount of condensation per hour in the heater coils seems to be independent of the difference of temperature between the heating and the heated steam, and would appear to depend chiefly upon the quantity of heated steam (exhaust from high-pressure cylinder) passing through the heater in unit time. It will be noticed from the table that as the power diminishes so does the quantity condensed in the coils diminish, and this in spite of the fact that the temperature-difference increases as the power grows less.

2. The influence of the re-heater is very marked in respect of the following—viz.,

(*a*) Reducing the amount of condensation in the receiver.
(*b*) Raising the receiver pressure.
(*c*) Raising the mean pressure throughout the engines.
(*d*) Increasing the speed of revolution of the engines.
(*e*) Increasing the dryness of the steam acting in the low-pressure cylinder.

These may be ranked as effects which are in themselves favourable to the attainment of economy.

3. The influence of the re-heater is, however, equally marked in effects which are detrimental to economy—viz,

(*a*) Lowering the mechanical efficiency of the engines.
(*b*) Increasing the steam consumption per horse-power developed.

From the last two columns of Table I., it is seen that at all powers there is a slight loss attendant on the use of the re-heater, with the single exception of "water per indicated horse-power," Trial X.

The consumption per brake horse-power is in all cases consistently greater when the heater is in use, the average increase being 2·6 per cent. against the heater. The economic effect of the heater in terms of water per indicated horse-power is exceedingly small, an average of 0·18 per cent. against the heater. The smallness here, however, is entirely due to Trial X. already referred to. The effect, at any rate in terms of brake horse-power, is appreciable and definite, and this effect—as compared with that in terms of indicated horse-power—is almost entirely due to the detrimental influence of the re-heater upon mechanical efficiency. It will be noticed from the table that in every case a lessened mechanical efficiency is associated with the use of the re-heater, the average adverse effect being 2·2 per cent. The cause of this very undesirable effect is doubtless to be found in the greater dryness of the working steam after passing through the re-heater, when steam is in the coils. The result here obtained shows the necessity for stating steam-engine efficiency in terms of brake horse-power, instead of indicated horse-power, especially in those cases in which steam-drying arrangements or devices are employed—*e.g.*, steam jackets, superheaters, &c.

II. Economical Effect of Degree of Vacuum.

Method of Making the Trials—For these trials the cylinders were arranged as triple-expansion, having diameters of 7in., 10½in. and 15½in. with 18in. stroke. The boiler pressure employed was 150lb. above the atmosphere, and the cut-off in each cylinder was retained throughout at 10½in. The brake adjustment was unchanged during the trials, so that any variation in speed of revolution of the engines was entirely due to variation in the vacuum. The degree of vacuum was the one and only condition which was varied throughout the trials, this variation being brought about by variation in the quantity of condensing water. Any degree of vacuum up to the maximum was obtainable by this means. In the case of no vacuum at all, the air pump was disconnected, and the feed-water simply allowed to run out into the measuring tanks, sufficient condensing water being supplied in this case to just prevent the pressure in the condenser from rising above that of the atmosphere. The receivers were kept clear of water by drainage at intervals into the hot well, and it is owing to this drainage that the hot-well temperature was slightly in excess of the temperature corresponding to the condenser vacuum.

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Results of the Trials.—The general results are given in Table II., and are recorded, after reduction, in Fig. 3. All the results on this diagram are plotted to a base of degree of vacuum. It is, therefore, necessary they should first be reduced to some constant speed of revolution. The revolutions chosen for this purpose are 120 per minute.

Curve W_1 gives the pounds of water (that is, steam) used per hour (as measured) on this basis.

Curve W_H gives this water expressed in terms of British thermal units expended between the high-pressure steam-chest and the hot well.

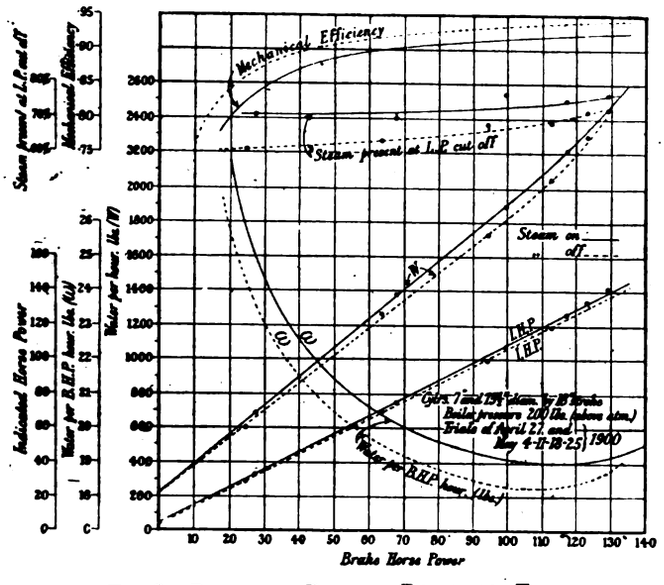

FIG. 2.—RESULTS OF RECEIVER RE-HEATING TRIALS.

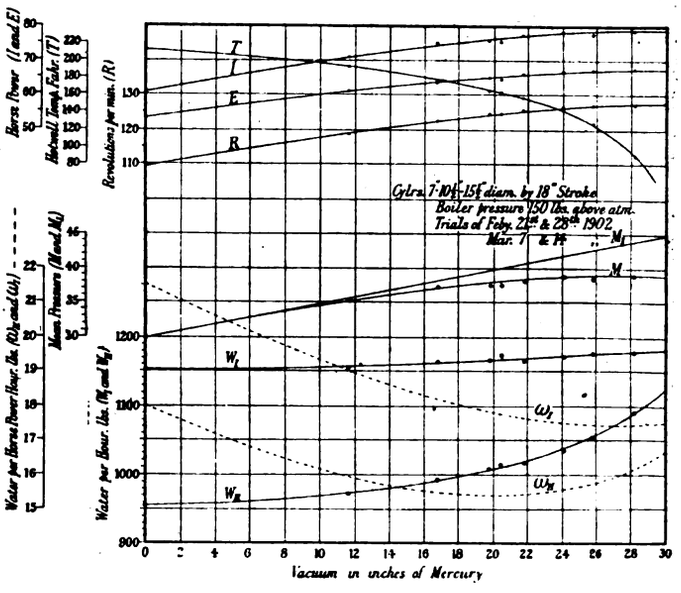
Cylrs. 7·104-15¼ diam. by 18" Stroke
Boiler pressure 150 lbs. above atm.
Trials of Feby. 21st & 25th 1902
Mar. 1 & 7
Vacuum in inches of Mercury

FIG. 3.—RESULTS OF VACUUM TRIALS.

Curves I and E show respectively the indicated horse-power and the brake horse-power, both reduced to the basis of 120 revs.

Curve M indicates the mean pressure referred to the low-pressure cylinder, as given by the indicator cards.

Curve R shows the variation of revolutions per minute due to variation in vacuum.

If the variation in hot-well temperature be disregarded, curve W_1 gives the steam consumption, and the ordinates of this curve, divided by the corresponding ordinates of curves I and E, will give the pounds of water used per indicated (curve ω_1) and per brake horse-power per hour. These curves both attain their lowest point at from 26in. to 28in. of vacuum. Looked at in this way, therefore, the highest vacuum is practically also the most economical vacuum, although it does not appear that there is any gain by going higher than 26in. vacuum. This, however, does not give the true economy of the engines, because the feed-water in the case of the lower vacua would carry away from the engines—and presumably to the boilers—a greater quantity of heat per pound than would be the case with the higher vacua. Hence the need for curve W_H, the ordinates of which, divided by those of curve E, result in curve ω_H, which curve represents the true economical performance—namely, heat-units expended per brake horse-power developed, expressed in pounds of water for convenience in comparison. It will be noted that curve ω_H attains its lowest point at or about 20in. of vacuum. So far as degree of vacuum affects economy, therefore, it follows that these engines were working with the minimum expenditure of heat units—or, to put it otherwise, coal—per useful horse-power developed, when the vacuum carried amounted to 20in.

It is not by any means an uncommon opinion amongst engineers that the highest economy is associated with the highest possible vacuum. This opinion is probably based upon two suppositions—first, that the aggregate mean pressure in the cylinders rises and falls—other things equal—in proportion as the vacuum rises and falls; and, second, that the steam consumption per revolution is—other things equal—not affected by the vacuum. On these suppositions any addition to the vacuum would mean the same addition to the mean-pressure, without any addition to the steam consumption. How far the first supposition is from the truth will be seen by comparing curves M and M_1. M_1 is a straight line passing through the point representing mean-pressure at zero vacuum, which from the table is seen to be 29·75. The ordinates to M_1 simply are 29·75 + vacuum in pounds per square inch; and this line would represent the mean pressure if the lower condenser temperatures associated with the higher vacua had no condensing effect on the steam acting in the cylinders. Curve M represents the actual mean-pressure realised; and the vertical distance between M and M_1 at any vacuum shows the loss due to cooling effect of the condenser at that vacuum. It is seen that the loss grows as the vacuum rises.

How far the second supposition is from the truth is indicated by the upward inclination of curve W_1. This curve virtually represents the water used per revolution at the various vacua, because it repre-

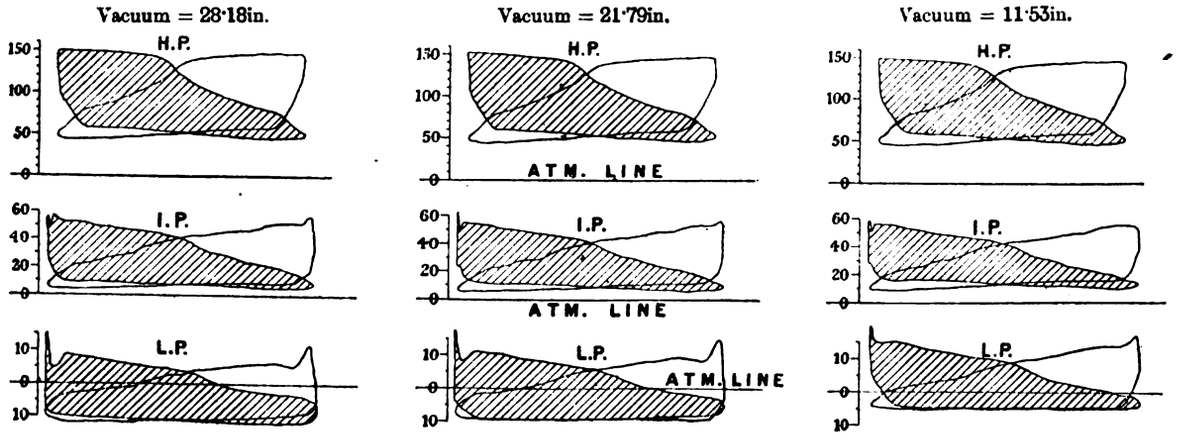

FIG. 4.—SAMPLES OF INDICATOR CARDS AT THREE DIFFERENT DEGREES OF VACUUM.
Cylinders, 7in., 10½in, 15½in; Stroke, 18in.; Cut-off, 10½in. in each cylinder. (Nothing changed except vacuum.)

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sents it at constant revolutions, and the fact that it inclines upwards shows that more steam enters the high-pressure cylinder per stroke at a high vacuum than at a low vacuum. This can only mean that the cooling or condensing effect of the condenser temperature is felt throughout the cylinders, even as far as the high-pressure admission. Had the vacuum no effect upon the weight of steam admitted per stroke into the high-pressure cylinder, curve W_1 would simply be a horizontal straight line.

The indicator cards, as well as the recorded receiver pressures, show this fact in another way. Specimen indicator cards are given in Fig. 4, from which it will be seen how the high-pressure exhaust "sympathises" with that of the low-pressure, and how the steam line, as well as the exhaust line of the intermediate cards, follow suit. In connection with all this, it is to be borne in mind that no adjustment or condition about the engines was altered during the trials, with the single exception of the amount of condensing water. All the variation in results must, therefore, be due to this single cause. Mechanical efficiency does not appear to be materially affected by degree of vacuum. Partly for this reason, and partly in order to avoid confusion in the diagram, the curve of water used per indicated horse-power in terms of W_H has not been drawn. It is to all intents and purposes parallel with that for brake horse-power, but occupying a lower position on the diagram.

These experiments have been made on triple-expansion engines. The question naturally arises, Would similar results follow from experiments on double and quadruple expansion? A thoroughly conclusive answer to such a question can only be obtained by direct tests, and such will probably be carried out later on with these engines. Certain predictions from the foregoing results may, however, fairly be hazarded. The fewer the number of cylinders intervening between the steam pipe and the condenser the greater would be the general effect of the condenser temperature upon the working steam in the cylinders; and vice versa, the greater the number of cylinders the less would be the condenser effect upon this steam. It may, therefore, be expected that, in a two-cylinder compound engine, the vacuum associated with maximum economy will be somewhat less than 20in., while in the case of a four-cylinder quadruple-expansion engine, the corresponding vacuum will be somewhat higher than 20in. During the whole of these trials steam was shut off from the cylinder jackets. How far the results may be modified—if at all—by the use of jackets will be subject of future tests.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Electric Traction." Six lectures delivered in March, 1902, at the Civil Engineering College, Sibpur. By J. W. Meares. (Calcutta: Bengal Secretariat Press). 2s. 3d.

"Proceedings of the Royal Society." No. 465. Vol. LXX. (London: Harrison & Sons.) 2s.

"Text Book of Electro-chemistry." By Svante Arrhenius. Translated by J. McCrae, Ph.D. (London: Longmans, Green & Co.) 9s. 6d. net.

"Science Abstracts." August, 1902. (London: The Feilden Publishing Co.) 2s.

"Transactions of the North-East Coast Institution of Engineers and Shipbuilders." Parts 5, 6 and 7. Session 1901–2. (London and Newcastle: Andrew Reid & Co.)

"Journal of the Institution of Electrical Engineers." Part 6, Vol. XXXI. Edited by W. G. Macmillan. (London: E. & F. N. Spon, Ltd.) 2s.

"Board of Trade (Labour Department) Report on Changes in Rates of Wages and Hours of Labour in the United Kingdom in 1901." 8½d.

ELECTRICITY WORKS ACCOUNTS.

Manchester Municipal Electric Supply Works.

Again we are enabled to record a material reduction in the costs of working of this undertaking. All the chief items of expenditure except management salaries show lower figures than in 1900–1. The most creditable are the works costs, and particularly the generating expenses, although repairs, both at the station and outside, are still somewhat high. However, they are well set off by the low item of wages at the station. The weak part of the costs column continues to be the management and property charges. It is true that they have been reduced by 0·05d. per unit sold, but, considering the output and load-factor on which they are based, they should work out at not more than 0·4d. instead of 0·535d.

It will be noticed that there was a substantial fall in the revenue. This is attributable to the traction supply, which amounted to nearly 19 per cent. of the total output, and was sold at the average price of 1·25d. per unit. The average price of the supply for private consumers shows a rise from 3·13d. to 3·48d.

In relation to the output the mean capital stands at a fair average figure considering the order of the output and the load-factor. Were it not that the price of coal was, during the period, still above the mean price we should be inclined to say that the working profit had been cut down to rather a fine figure by the tariff in force prior to September. The City Council advanced the price by ¼d., taking effect from September 30, 1901. Hence the rise recorded in the average price of supply to private consumers.

The average load-factor of the lighting demand (including public lighting and motors), as distinct from the traction demand, was 12·3 per cent.

In the Bloom-street station the first 3,500 H.P. generator was started on October 28th, the second set on February 12th, and the third on April 2nd. The fourth was expected to be ready in July. At the Stuart-street station the first 2,500 H.P. generator was started on May 27th. This represented the first instalment of a total of 15,000 H.P. to be put down at that station under Dr. Kennedy's scheme. Buildings and machinery are in progress of instalment for a further 12,000 H.P., under Mr. Metzger's scheme, at Stuart-street, to meet the demand for power for electric traction over the whole of the tramway system.

Oldham Municipal Electric Supply Works.

The Oldham undertaking is another which, like that of Manchester, has had a large increase last year in its output by the addition of a traction load. It is interesting to note, however, that the total output sold at Oldham is just about a tenth of that at Manchester. A splendid reduction of the expenses of production is recorded in the Oldham accounts. Here, again, a general diminution of the value of the several items has been effected with the same exception of the items of repairs in and outside of the station. At Oldham, however, the collective item of management and property charges has fallen remarkably and to a figure considerably below what was to be expected. With a load, especially a traction load, growing so rapidly as it has at Oldham, the average load factor is more than usually a meaningless factor. In 1900-1 the lighting demand load factor was 10·7, and in 1901-2 11·65 per cent. Owing to the slightly lower capital expenditure in relation to the output, in the present accounts there is little to choose between the financial results at Oldham and at Manchester, even after allowing for the slightly higher revenue per unit at the former place. Perhaps the advantage is slightly with Oldham.

REMARKS.

MANCHESTER.—*a* Including 672 motors aggregating 2,774 H.P. and 2,316, the equivalent of arcs. *b* Over-expended. *c* £282 for electricity and £115 maintenance of lamps for lighting of station. *d* Buildings £585, machinery £5,666. *e* £80,550 on land. *f* Of meters £94, of mains and fuses £7,200, of tools £752, of machinery at district stations £561. *g* Chief assistant engineers £963, mains engineers £473, clerical staff, meter readers, &c., £1,572, various assistants, draughtsmen, &c., £1,247, secretary's department £1,965. *h* £28 insurance, £143 bank commission, £181 thrift fund, £495 commission on loans, £159 clothing. *i* Paid to the city fund. *j* With option of charge at 1½d. per unit plus £1. 15s. per quarter per unit of demand. *k* With option of charge at 2½d. per unit, except where all motors run for 48 hours per week, when fixed charge of £1. 15s. as charged for lighting is remitted and current charged at 1½d per unit. *l* Lighting and power 7,930kw., for traction 1,210kw. The supply (for traction) demanded for six routes as and when opened—average 979kw. *m* Including 774 motors aggregating 2,806 H.P., and 2,453 the equivalent of the arcs. *n* £83,248 on land. *o* Includes £29,936 on land, buildings and machinery of distributing stations. *p* Lighting of station £287, sundries £636. *q* Buildings £1,092, machinery £6,849. *r* Machinery, &c., at distributing stations £1,844, mains, fuses, &c., £8,947, meters £122, tools £160. *s* Engineer's department £3,858, secretary's department £5,320. *t* Law and Parliamentary charges £1,179, insurance £139, commission on loans £805, thrift fund £234. *u* Up to 8ept. 30 same in all respects as in 1900-1, but from October to March—for lighting 5½d., or 1⅞d. per unit plus £1. 15s. per quarter per kw. of demand; for motors, as for lighting, or 3d., except where all motors are kept running for 48 hours per week, when fixed charge is remitted and current supplied at 1⅞d. per unit.

OLDHAM.—*a* Over-expended. *b* Buildings £119, machinery £356. *c* Of mains £309 on consumers' premises £84. *d* Engineer £248, clerical staff £144. *e* Auditing £6, costs of opposing Power Bill £191, insurance £36. *f* Maximum demand system two-hour scale. *g* Traction supply started Dec., 1900. *h* The maximum demand for lighting (exclusive of traction demand) was 713kw. in 1900-1 and 765kw. on Jan. 10, 1902, in 1901-2, and for traction 60kw. in 1900-1 and 425kw. in 1901-2. *i* Buildings £219, machinery £585. *j* Of mains £560, on consumers' premises £144. *k* Engineer £273, clerical staff £141. *l* Auditing £6, insurance £35.

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	MANCHESTER.		OLDHAM.	
Undertaking Worked by	Manchester Corporation.		Oldham Corporation.	
Date of Commencement of Supply	August, 1893. [rotary converters.		March 20, 1894.[g]	
System of Supply	Con.-cur. 5 & 3-w. and 3-phase alternating with		3-wire continuous-current.	
Chief Engineer	G. F. Metzger.		S. Wilmott Newington.	
YEAR ENDED	MAR. 31, **1901.**	MAR. 31, **1902.**	MAR. 25, **1901.**	MAR. 25, **1902.**
QUANTITIES—				
Units generated	9,639,973	12,697,590	796,884	1,242,570
„ **SOLD (TOTAL)**	**7,794,098**	**10,502,299**	**679,724**	**1,042,055**
„ sold to consumers	7,750,548	8,512,189	650,854	709,127
„ sold for public lighting, &c.	43,550	38,120	18,391	19,960
„ sold for traction	nil	1,951,990	10,479	312,968
„ used on works	150,442	1,016,641	24,463	97,371
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**38·0**	**28·4**	**17·8**	**23·3**
Actual maximum supply demanded	6,876 kilowatts	9,140 kilowatts[i]	773 kilowatts[h]	990 kilowatts[h]
Load factor	12·95%	13·1%	10·0%	12·0%
Number of public lamps	29 arc	29 arc	28 arc	25 arc
Number of consumers	3,790	4,030	511	558
Connections to mains in 8-c.p. lamps at end of year	346,876[a]	414,597	40,553	45,389
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	**7,250**	**16,450**	**1,332**	**1,532**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	**£884,011** / **£122**	**£2,171,121** / **£132**	**£88,000** / **£66·0**	**£244,510** / **£160**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	884,011 / 122	2,171,121 / 132	88,000 / 66·0	244,510 / 160
RECEIVED (TOTAL)	**790,111** / **109**	**1,113,301** / **67·6**	**75,649** / **56·8**	**101,468** / **66·2**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	790,111 / 109	1,113,301 / 67·6	75,649 / 56·8	101,468 / 66·2
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**93,900** / **13·0**	**1,057,820** / **64·3**	**12,351** / **9·27**	**143,042** / **93·4**
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	93,900 / 13·0	1,057,820 / 64·3	12,351 / 9·27	143,042 / 93·4
REPAID (TOTAL)	**67,838** / **9·36**	**92,857** / **5·64**	**4,300** / **3·23**	**5,300** / **3·46**
RESERVE OR SINKING FUND	nil / —	nil / —	3,299 / 2·48	4,641 / 3·03
DEPRECIATION FUND	**13,172** / **1·82**	**16,341** / **0·993**	**4,597** / **3·45**	**4,778** / **3·12**
EXPENDED (TOTAL)	**863,293** / **119**	**1,164,307** / **70·8**	**80,173** / **60·2**	**108,209** / **70·7**
Lands and buildings	165,441[e] / 22·8	234,616[n] / 14·3	— / —	— / —
Plant	214,081 / 29·5	325,760[o] / 19·8	— / —	— / —
Mains	482,332 / 66·5	596,056 / 36·2	— / —	— / —
Miscellaneous	1,439 / 0·198	7,876 / 0·479	— / —	— / —
BALANCE OF CAPITAL ACCOUNT	**−73,182**[b] / **−10·1**	**−51,006**[b] / **−3·10**	**−4,523**[a] / **−3·39**	**−6,840**[a] / **−4·46**
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	**£101,481** / **3·122d.**	**£134,289** / **3·070d.**	**£9,969** / **3·520d.**	**£13,474** / **3·103d.**
Revenue from supply	100,888 / 3·106d.	123,514 / 2·820d.	9,233 / 3·260d.	10,196 / 2·349d.
„ meters, &c.	231 / 0·007d.	290 / 0·007d.	332 / 0·117d.	381 / 0·088d.
„ public lighting	363 / 0·011d.	318 / 0·007d.	192 / 0·068d.	208 / 0·048d.
„ supply for traction	nil / —	10,167 / 0·232d.	144 / 0·051d.	2,642 / 0·608d.
„ miscellaneous sources	— / —	— / —	68 / 0·024d.	47 / 0·011d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£59,138** / **1·821d.**	**£73,879** / **1·688d.**	**£6,500** / **2·295d.**	**£7,599** / **1·750d.**
TOTAL WORKS COSTS	**40,094** / **1·234d.**	**50,449** / **1·153d.**	**4,549** / **1·607d.**	**5,823** / **1·341d.**
Generation of electricity	*28,652*[c] / *0·882d.*	*36,192*[p] / *0·827d.*	*4,123* / *1·455d.*	*5,074* / *1·169d.*
Fuel (including cartage, &c.)	14,315 / 0·440d.	18,093 / 0·414d.	2,596 / 0·916d.	3,064 / 0·706d.
Oil, waste, water, stores	2,867 / 0·088d.	3,920 / 0·090d.	76 / 0·027d.	97 / 0·022d.
Wages at station	4,138 / 0·127d.	5,267 / 0·120d.	976 / 0·345d.	1,110 / 0·256d.
Repairs and maintenance at station	6,251[d] / 0·192d.	7,941[q] / 0·181d.	476[b] / 0·168d.	803[i] / 0·185d.
Distribution of electricity	*11,442* / *0·352d.*	*14,257* / *0·326d.*	*426* / *0·151d.*	*749* / *0·172d.*
Wages, &c.	2,223 / 0·068d.	2,500 / 0·057d.	33 / 0·012d.	45 / 0·010d.
Repairs, renewals of mains, &c.	8,607[f] / 0·265d.	11,757[r] / 0·269d.	393[c] / 0·139d.	704[j] / 0·162d.
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	**19,044** / **0·586d.**	**23,430** / **0·535d.**	**1,951** / **0·689d.**	**1,776** / **0·409d.**
Net rents	*946* / *0·029d.*	*1,208* / *0·028d.*	*313* / *0·111d.*	*323* / *0·074d.*
Rates and taxes	*5,938* / *0·183d.*	*6,423* / *0·147d.*	*554* / *0·196d.*	*522* / *0·120d.*
Management	*12,160* / *0·374d.*	*15,799* / *0·361d.*	*1,084* / *0·383d.*	*931* / *0·214d.*
Salaries	6,220[g] / 0·191d.	9,179[s] / 0·210d.	392[d] / 0·138d.	414[k] / 0·095d.
Stationery, &c.	984 / 0·030d.	1,977 / 0·045d.	154 / 0·054d.	222 / 0·051d.
Establishment charges	1,751 / 0·054d.	1,906 / 0·044d.	243 / 0·086d.	176 / 0·041d.
Law charges &c.	3,205[h] / 0·099d.	2,737[t] / 0·063d.	295[e] / 0·104d.	119[l] / 0·027d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	**£42,343** / **5·63%**	**£60,408** / **5·68%**	**£3,468** / **4·73%**	**£5,876** / **6·24%**
Sum carried to Depreciation Fund	−135 / −0·018%	7,635 / 0·718%	703 / 0·959%	nil / —
Sum carried to Reserve Fund	18,605 / 2·47%	25,019 / 2·37%	1,426 / 1·95%	2,113 / 2·24%
Net interest on loans (incl. Debenture charges)	19,873 / 2·64%	27,754 / 2·61%	2,512 / 3·43%	2,865 / 3·04%
Net profit for the year	4,000 / 0·532%	nil / —	−1,173 / 1·60%	+898 / 0·953%
BALANCE FROM LAST ACCOUNT	— / —	— / —	1,109 / 1·52%	−65 / −0·069%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	4,000[i] / 0·532%	— / —	— / —	832 / 0·883%
Deficit	— / —	— / —	*65* / *0·089%*	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	58·3%	55·0%	65·2%	56·4%
Expenditure per mean kilowatt capacity	£9. 0s. 2d.	£6. 4s. 7d.	£5. 6s. 7d.	£5. 6s. 0d.
REVENUE PER MEAN KILOWATT CAPACITY	**£15. 9s. 0d.**	**£11. 6s. 7d.**	**£8. 3s. 7d.**	**£9. 8s. 2d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**6s. 4d.**	**7s. 1d.**	**5s. 5½d.**	**6s. 3d.**
Price charged for lighting, per unit	5d.[j]	5½d.[u]	4d. to 2d.[f]	4d. to 2d.[f]
Price charged for power, per unit	5d.[k]	3d. to 1¾d.		
Price charged for public lighting	2d. per unit.	—	2½d. per unit	—
Receipts per unit for private supply	3·13d.	3·48d.	3·26d.	2·35d.
„ „ public lighting	2·00d.	2·00d.	2·51d.	2·50d.
„ „ traction	—	1·25d.	3·30d.	2·03d.

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COAL CUTTING BY MACHINERY.

It is clear that there is an increasing interest being taken by mechanical and mining engineers in the problem of the useful application of machinery to coal getting. Is this renewed interest a by-product of that spirit and policy of mining labour which has also called the "stop-day" into being? We advisedly allude or refer back to the *spirit* of the movement, for the stop-day policy of the colliers is only a more evident expression and manifestation of that theory which is also responsible for the "ca-canny" device in other callings. The immediate aims of these two expedients of labour towards its betterment are ostensibly quite different, but the premises of the theories on which they are based appear to be identical.

In thus surmising as to the nature of the hidden stimulus which is pressing engineers to seek in the more extended use of coal-cutting machinery a solution to the situation in the coal trade, we do not mean to imply that such a solution would be injurious to miners as a labouring class. It is almost needless to say that, in the light of past experience in the use of machinery, such a conclusion is inadmissible, and it is opposed also to considerations peculiar to the particular conditions of coal mining. There is another interesting and allied relation to be discerned in this development of coal-cutting machinery. Probably unconsciously, mechanical engineers in their singular persistence of attack at the coal-cutting problem are really defending a position rather than actually prosecuting an attack. Not only has manufacturing labour become more and more insistent in its demands, and foreign competition more keen, but, lately, on the whole, fuel—the very life blood of the mechanical engineering industry—tends to become almost prohibitive in price.

The gain that would accrue from lower coal prices to that industry as to others dependent on fuel, in enabling them to meet competition, is well indicated in the useful little Paper read by Mr. R. H. WAINFORD before the Institution of Mechanical Engineers, an abstract of which we publish on another page. Mr. WAINFORD makes out a good case for coal cutting by machinery, in seams under a certain thickness. In common with other writers on the subject, however, he fails to insist on the great saving which might be anticipated from the more *rapid* working of a colliery taking, which a properly organised system of mechanical coal cutting would make possible. From what has been done already in this way, it would seem that the output of a colliery, developing a not too faulty taking and a seam not over 3ft. in thickness, might be doubled at least by the substitution for manual labour of an organised system of coal winning by machinery. The vital importance of this element of rapidity of working of a coal face will be evident on a consideration of what may be called the standing charges of a colliery. In collieries these standing charges are sometimes exceedingly heavy, notably where there is a good deal of pumping to be done, and also where the seam is at such a

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depth that the pressure entails constant re-timbering and relaying of the roads owing to their "heaving." A few more of these charges may be called to mind, such as—dividend and repayment charges on capital, dead rents on mineral takings secured but unwrought, constant ventilating costs, and repairs, maintenance and attendance in respect of most of the boiler plant at bank.

Besides these charges, which go on merrily whatever the output of the place, there are certain running charges that, while not usually entering into calculations of the actual difference of the cost of cutting coal by hand and by machine, are reduced by the increased rapidity of the working of a coal face. Amongst the phenomena forced on one's notice underground is the viscid or fluid nature of the ground or strata. The subsidence of the overlying strata is gradual after the coal has been removed. Therefore the timber used at the face (in long-wall working more especially), and which represents so large a cost item, may be largely reduced in quantity or a much larger proportion of it may be recovered for re-use if the face working is accelerated. The importance of these standing and quasi-standing charges have been drawn attention to above at some length because they form such a large part of the total cost of coal delivered to the consumer.

Mr. WAINFORD holds the balance very evenly between electric and compressed air machines. If anything, he inclines, perhaps, and justly so, we think, to the former, and, it will be noticed, records his belief that they hold the record for holing. In those thin seams which are so particularly the field for machines, the electric system has the advantage of lightness and flexibility afforded by the use of cable instead of pipe mains, while maintaining at the same time equal, and even greater, efficiency of power transmission underground. Mr. WAINFORD'S Paper must be read with due attention to the fact that the author does not claim to give an exhaustive description of makes of machines. He does not mention the Jeffrey machines, which have been popular in America, and are, in one design, particularly applicable to "pillar and stall" and heading work. The Stanley heading machine also deserves some notice in a Paper bearing such a wide title as "Mechanical Appliances in Mines."

Returning to some more general considerations again—what strikes one forcibly in the history of machines for coal cutting is the great share which, in England, the Midland and especially the Northern and Scottish coal fields have taken from the earliest time in the development of mechanical coal-cutting methods. South Wales has done comparatively little or nothing, and yet, as a coal field, it is, perhaps, pre-eminent. The writers on the subject, therefore, naturally also hail from the North, and their writings bear evidence of the assumption that holing in or under the coal is generally the *raison d'être* of the collier. The most important output of the South Wales coal field is steam coal or, more generally, a coal won under conditions calling for a different class of skill and labour in getting the coal. In many seams of this district the conditions are such that there is little, and often no, holing to be done preparatory to filling the coal into the tubs, owing to its free-working nature and the pressure of gas and superincumbent strata. Under these conditions there is no place for machine work, unless, indeed, it be a power-driven boring-drill. On the other hand, there are in South Wales many seams—more particularly of house coal—where there would seem to be a great field for the application of machinery to the actual cutting of coal. There are thin hard seams of 2ft. and under in thickness which could only be economically worked by coal cutting machinery of the bar or disc type; but, unfortunately, here again a difficulty is met in the very faulty nature of the South Wales district—a condition militating seriously against machine work on an economical system.

Hitherto, no doubt, the greatest deterrent to the use of machinery in England is the attitude of misguided labour. It is unnecessary to repeat what has already been said as to the effect of the use of coal-cutting machinery on the fortunes of the miner in respect to his wage-earning capacity. There is, however, another consideration not to be lost sight of. There is now not the slightest doubt that the introduction of holing machines greatly reduces the loss of life in collieries—especially the death rate of the workers at the faces of the mine. The periodical explosion has that sensational element in it which at once secures widespread interest and sympathy. Statistics show, however, that the daily mortality amongst miners from accidents chiefly at the coal face far exceeds that due to explosions, and this points to the reasons of the greater safety of working by machinery. Owing to the more rapid working away of the face of the coal, there is a much larger output per man engaged at or near the face, and the miner is relieved of the necessity or temptation to get partly under the unsupported coal in his endeavour to reach to a far undercut. Undoubtedly the extended application of coal-cutting machinery, while benefiting others, would also be to the ultimate betterment of the miner's lot. No words are strong enough to condemn the stupid and short-sighted prejudice of the miners—fostered we regret to say by their leaders, who should have broader minds and greater intelligence—against the introduction of mechanical appliances in mines. The same phase has been gone through in other industries in which the element of dangerous and unhealthy conditions of working under the old régime have been far less than in coal mining; and in all cases the workmen have been the ultimate gainers by the adoption of modern labour-saving devices.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

Die Gleichstrommaschine. By Prof. E. ARNOLD. Vol. I.: Theory. (Berlin: Julius Springer.) 1902. 16m.

This is the first part of Prof. Arnold's treatise on continuous-current dynamos, the second part of which (dealing with the construction, calculation, testing and working of such machines) may be expected to appear before long. The whole treatise, when complete, is to take the place of the fourth edition of the same author's standard work on (continuous current) "Armature Windings and Constructions," and, in addition, by completing the study of this class of machine, the work is meant to be a standard treatise on the subject. The volume now under review gives the whole of the theory of the continuous-current dynamo and motor in a very complete, clear and practical manner. It covers the theory of closed and open coil armature windings, of equalising connections for various armature types, of commutation, of the magnetic circuit and of characteristic curves, as well as the fundamental theory of the continuous-current machines. In addition, the question of the losses is very carefully treated, leading up to two excellent chapters (containing much original matter of considerable practical value), on the subject of the predetermination of the efficiency, temperature rise, &c.

Quite early in the book the reader is given a clear idea of the various classes of armature winding, together with their laws. The author was the first, we believe, to point out (many years ago) that the properties of all classes of closed coil windings could be fully described, and such windings properly classified, by means of simple algebraical expressions, from which the winding schemes could be drawn out, or the winding tables prepared. In these first chapters these rules are developed for two-pole and multipolar machines, and for

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the different classes of parallel, series, and series-parallel windings. This last class of winding is very fully considered by the author, which is not surprising, for he was the first to show how such windings could be commercially carried out, and to state their laws and advantages. It is noteworthy that Continental constructors have realised more fully than those in the United States or in this country how solid these advantages are for multipolar machines with drum armatures—the modern case. For such machines bar windings are frequently an absolute necessity, and always desirable. With a given number of field poles and of armature conductors, and with a parallel winding (where there are $2p$ circuits), it will often happen that the current per circuit is too small and the number of conductors is too great for bars to be employed, while, on the other hand, with a series winding (where there are but two circuits) the current per circuit may be too large or the number of commutator bars too small. It is for such cases that the Arnold series-parallel winding (in which the number of circuits is greater than two, but less than $2p$) is of real service. The number of circuits is independent of the number of poles, and in all cases a section of conductor can be used best suited to the design of the machine. Such windings well merit the detailed consideration given to them by the author, although the other classes of winding are by no means neglected by him; even disc armatures are fully considered, although the inherent disadvantages of this class are sufficiently great to exclude their use nowadays, except in special cases. In considering wave windings for drum armatures (which are much more difficult to study than ring or lap windings) the author introduces a novelty which will undoubtedly prove of service to designers of multipolar machines; he shows that all such windings may be reduced to the basis of a ring winding, which is precisely equivalent to it as far as the winding scheme is concerned. The "reduced winding scheme" is easy to make for any given case, and certainly simplifies matters very greatly, especially for the case of multiple closed windings; in such cases the equivalent ring windings are not re-entrant, but divided up into parts which are individually closed, so that they are still "multiple closed windings," but in another sense.

The theory of equalising connections is very fully discussed by the author—we believe for the first time. It is only during the last few years that such connections have been employed, although they were certainly used with the old multipolar Brush-Victoria dynamos, which had parallel armature windings. Equalising connections are very necessary with multipolar machines with parallel armature windings, and desirable even for machines having series-parallel armatures, when the number of poles is very large. In both cases they fulfil the same object—namely, to assist commutation by equalising the amounts of current collected by the various sets of brushes, which would otherwise be unequal if there was any want of symmetry in the machine, such as unequal strengths of pole, unequal air-gaps, unequal spacing of brush rods, &c. Obviously, parallel-wound armatures are likely to suffer most from such want of symmetry, while symmetrical wave windings will not suffer at all; series-parallel windings will be affected more or less, according to prevailing conditions, but are always liable to be, insomuch as there are circuits in parallel which are not simultaneously acted on by the same poles. Prof. Arnold gives the complete theory of such equalisers, including the question of the losses in them, but more particularly with reference to his series-parallel windings. More detailed reference to the case of parallel windings should, we think, have been made, for, as indicated above, this is the more important case. The author certainly lays too much stress on the novelty of such equalisers. They have been used by designers for some time now, especially with large slow-speed railway generators of American origin, and the author's work merely serves to place the subject on a scientific basis, and to fix ideas.

Chapter XIV., dealing with the calculations for the magnetic circuit, is excellent—in particular, the author's figuring of the leakage coefficients under various conditions should be of considerable use to designers. Another point of interest is the treatment of the calculation of the ampere-turns for the teeth of slotted armatures. With the exceedingly high saturations employed nowadays (the reason for which follows at once from the author's theory of commutation, given in other chapters) this is not an easy matter, and hence the curves and reasoning given, which are after Parshall and Hobart, but more complete, will be of much use to designers.

The author's theory of commutation, including the whole question of armature reaction, of compounding, and of the conditions and calculations for sparkless operation, is by far the most complete and scientific discussion of the matter that has yet been published. The value of the author's work will not be found, for the most part, in its originality (although there is much that is new), but in his methods of treatment, and in the systematic arrangement of the modern ideas on the subject, together with the clear deductions which are drawn, or can be drawn, from such detailed treatment. While it is certainly true that few designers will have time to study this section of the book as it undoubtedly deserves, still it is so well arranged that certain portions can be passed over without rendering the remainder useless. As the author rightly says, however, the theory of commutation is not only an interesting mathematical study, but nowadays a working knowledge of this theory on the part of the constructor is a necessity, in order that his materials may produce the best result with a minimum of cost. Certain it is that, in this matter, the designer, who is perfectly clear on the theory of the subject, and who can combine such theory with his own experiences, will build a lighter (and, therefore, cheaper) machine to fulfil given conditions than the engineer working with rule-of-thumb methods and empirical formulæ and constants. Not only this, but the former's machine will probably be better, while, when new conditions arise, outside the latter's experience, there is no doubt as to who will be in the better position for solving the problem at minimum cost.

Regarding the author's treatment of the actual theory of commutation, it must suffice here to say that the full calculations for the reactance of the short-circuited coils are given, and, in addition, for their mutual influence on one another—that is, the calculation for L and M. A very complete discussion is given of the resistances in the circuit of the short-circuited coils, including the whole question of the brush resistance and the importance of the part played by it. This leads up to the calculation of the difference of (electric) pressure between the heel or toe of the brush and the commutator, and to its experimental measurement, the author showing that, from the curve of difference of pressure between brush and commutator over the whole breadth of the brush, the "short-circuit current curve" can be readily found, which discloses any errors of commutation, and indicates how these can be removed. Finally, the methods of producing the commutating pressure, the different pole-shoe constructions (special and normal), the question of special pole-horns and the discussion of compensating windings, including that of Sayers, are given in detail. Regarding the latter, the author rightly observes that their day is over, as equally good or better results can be obtained by the correct designing of standard machines.

The last chapters on efficiency, losses and heating, contain much original matter, and the results of many researches on the part of the author and his assistants; if any one part of these chapters is more excellent than the rest, it is that dealing with the commutator losses, which is a subject that has been carefully studied by but few up to the present.

The requirements and conditions of specialised forms of direct-current machinery have been, on the whole, neglected by the author, whose treatise certainly deals with standard machinery alone. The working theory of traction motors, boosters and balancers, all of which operate under special conditions, follows immediately from what has been said with regard to dynamos and motors generally, but nevertheless it would have been an advantage if certain questions connected with them (such as best windings, commutation, &c.) had been specifically dealt with.

In conclusion, we may say that Prof. Arnold has produced an excellent work, far ahead of any other that has yet appeared on the subject; if the second volume is as good as the first, his treatise will certainly be *the* standard work in the future.

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It is what we should expect from a gentleman who is head of the electrical side of one of the first German technical universities, who has been formerly the chief constructor of one of the largest European firms, and who is now the valued consultant of several of them. For the sake of the industry in general of this country, it is to be hoped that the complete work, when ready, will be translated into English.

Injectors: Their Theory, Construction and Working. By W. W. F. PULLEN, Wh.Sc. (Manchester: The Technical Publishing Co., Ltd.) 1900. 2nd edition. 3s. 6d. net.

This little book deals very completely with a subject concerning which there has been a singular dearth of information available. The theory of the injector is first exhaustively treated, and this is followed by a practical description of typical examples of English-made injectors. The author rather curiously excuses the comparative lack of American types noticed by the difficulty of obtaining information about them and the impossibility of consulting any American patent records. Not only are steam injectors for lifting and boiler feeding dealt with, but so also are ejector condensers and air injectors, and ejectors as applied respectively for blowing furnaces and for exhausting railway vacuum brakes. An innovation introduced is that of deferring the historical chapter to the end. This historical summary appropriately includes references to miscellaneous applications of the injector and ejector.

THE CAPABILITIES OF THE MILAMMETER AND THE GALVANOMETER IN GENERAL AND SUBMARINE CABLE TESTING.

BY C. W. SCHAEFER.

(*Continued from p. 709.*)

To Determine the Resistance of Leakage in a Battery and its Resultant Position.—Let E be the E.M.F. (volts) and l the resultant leak (megohms) situated at a point in the battery such that e_1 and e_2 are the E.M.F.s on either side of it.

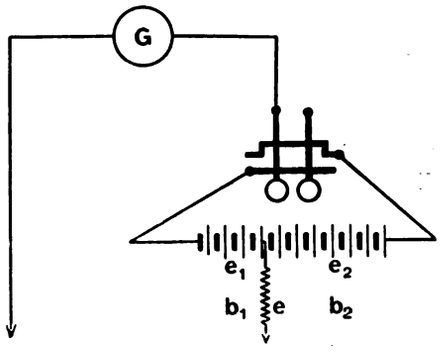

FIG. 3.

By depressing the left-hand lever of the key (see Fig. 3), the galvanometer deflection will represent the leakage current (microamperes) due to the effect of e_1, and when raised, that due to e_2.

Also let c_1 and c_2 represent these currents respectively.

Then,
$$c_1 = \frac{e_1}{b_1 + G + l} \quad \ldots\ldots\ldots \quad (34)$$

and
$$c_2 = \frac{e_2}{b_2 + G + l} \quad \ldots\ldots\ldots \quad (35)$$

But generally G as well as the internal resistance of the battery b_1 and b_2 are negligible in comparison with the leak l, therefore

$$c_1 = \left(\frac{e_1}{l}\right) \quad \ldots\ldots\ldots \quad (34A)$$

and
$$c_2 = \left(\frac{e_2}{l}\right) \quad \ldots\ldots\ldots \quad (35A)$$

Calling $c_1 + c_2 = C$, we have

$$C = \frac{e_1 + e_2}{l}, \quad \text{or} \quad \frac{E}{l},$$

from which
$$l = \frac{E}{C}. \quad \ldots\ldots\ldots \quad (36)$$

Example.—A battery consisting of 10 dry cells, having an E.M.F. of approximately 14·8 volts, was joined up as above, having a leak of 1Ω placed at the carbon of the third cell.

The current-constant of the galvanometer was 0 06446 microampere per division.

Leakage deflection observed through negative terminal of battery, 70 divisions... = 4·5 microamperes.
Leakage deflection observed through positive terminal of battery, 160 divisions... = 10·3 do.

$$\therefore \quad c_1 + c_2 = C \quad \ldots\ldots = 14{\cdot}8 \quad \text{do.}$$

$$\therefore \quad l = \frac{14{\cdot}8 \text{ volts}}{14{\cdot}8 \text{ microamperes}} = 1 \text{ megohm.}$$

The position of the leak, being proportional to the deflections, is found thus: $10\left(\frac{70}{70+160}\right) = 3{\cdot}04$; that is to say, at the carbon of the *third* cell.

It must be understood, however, that leakage is not to be tolerated under any circumstances in a battery for insulation tests, or localising purposes, more especially for loop testing; but the above method will be found useful in tracing any leakage that might occur. Should the deflection be too large, it may be reduced by the insertion of an extra resistance in the galvanometer circuit, which must be allowed for in computing l.

The evolution of the formulæ for determining the "constant" of a galvanometer lead us to a highly interesting matter, more particularly in the province of submarine cable electricians, to whom the just appreciation of the minute currents dealt with forms a most important item in their daily curriculum, and where increased accuracy in this respect will more perfectly establish the practicability of certain simultaneous methods of fault localisation upon which these delicate measurements depend, and which are beyond the scope of any pivoted instrument controlled by differential springs. The idea of using a proportional deflection galvanometer suitably shunted as a milammeter is by no means new, but the practical solution of the problem has remained in abeyance and impeded progress in this particular direction.

How to Use an Ordinary Proportional Deflection Galvanometer as a Milammeter.—1. When a milammeter is available for calibration. 2. When a milammeter is not available for calibration.

1. It is easily seen from equation (31) that if we know the current-constant a_m of a galvanometer G, then, when the latter is shunted by s, the current c_1 which will be measurable per unit deflection will be

$$c_1 = \frac{a_m(G+s)}{s} = a_m\left(\frac{G}{s} + 1\right), \quad \ldots\ldots \quad (37)$$

and if G is very large in comparison with s,

$$c_1 = \frac{a_m G}{s} = \frac{v_m}{s}, \quad \ldots\ldots\ldots \quad (37A)$$

where the numerator v_m is a constant for any particular temperature, representing the microvolts at the galvanometer terminals per unit deflection.

The abridged formula (37A) should not be used indiscriminately, because it can be shown that the calculated currents will fall short of their true values by $100\left(\frac{s}{G}\right)$ per cent.

Practically, if the galvanometer resistance is not less than 500 times the resistance of the shunt, the error will never exceed 0·2 per cent., and in such cases, except for very refined work, equation (37A) suffices. In any case, the percentage correction is easily determined and applied if necessary, or, if preferred, use equation (37).

2. *Example.*—Supposing that we wish to utilise a galvanometer as a milammeter, but have no direct-reading milammeter at hand by which a_m may be determined in the manner already

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described, the process would be as follows:—Find the E.M.F. of a battery, which, in the absence of a potentiometer or Varley's slides, had better be determined by condenser method, using a universal shunt if necessary; and then take a "constant" in the usual manner, except that for the latter the galvanometer should be unshunted.

Suppose E = 10·67 volts (10,670,000 microvolts), G = 876ω corrected, H.R. = 752,000ω corrected and $b = 50\omega$; whilst the deflection under these circumstances was 360 divisions.

Then $\frac{10,670,000}{360\,(752,000+876+50)} = 0{\cdot}03936$ microamperes per division. Supposing that we intend to use a shunt $s = 0{\cdot}2\,\omega$, from equation (37) we have $c_1 = \frac{0{\cdot}03936(876+0{\cdot}2)}{0{\cdot}2} = 172{\cdot}43$ microamperes per division, and, therefore, on a scale of 700 divisions, the maximum current measureable would be 120,700 microamperes, or 120·7 milliamperes. Similarly, with a shunt of 1ω, c_1 would $0{\cdot}03936\ (876+1) = 34{\cdot}52$ microamperes. If we had used the abridged formula in the above examples, and provided the shunt were not more than 1ω, the maximum error would only be $\frac{100\times 1}{876} = 0{\cdot}114$ per cent., and for all practical purposes, under the circumstances, the longer formula is an unnecessary refinement. The microvolts per division $v_m = 0{\cdot}03936 \times 876 = 34{\cdot}48$ have merely to be divided by the resistance of the shunts to get the "microamperes per division." Since each deflection has to be multiplied by the coefficient c_1, it would be advisable to add a resistance, R_g, in the galvanometer circuit (see Fig. 2) of such value that c_1 is made some more suitable coefficient, such as 50, 100 or 200 microamperes, and so on.

Evidently, from equation (37) it follows that when R_g is in circuit with the galvanometer

$$C = a_m\left(\frac{G+s+R_g}{s}\right). \quad . \quad . \quad . \quad . \quad . \quad (37B)$$

whence

$$R_g = \frac{cs}{a_m} - (G+s). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (38)$$

With the above galvanometer shunted by 1ω, let us, for example, decide upon 100 microamperes as the value for c,

$$\therefore \quad R_g = \frac{100}{0{\cdot}03936} - (876+1) = 1{,}664\omega.$$

thus, by adding 1,664ω in the galvanometer circuit, each division of deflection corresponds to 0·1 milliampere, whilst, if s were made 0·1ω and R_g about $2{,}541 - 876 = 1{,}665\omega$, the deflections would read directly in milliamperes.

If, instead of 100 we had fixed upon 50 as the value for c, R_g would have been $1{,}270{\cdot}5 - 877 = 393{\cdot}5$, and with the shunt of 1ω across the galvanometer system, each division of deflection would be equivalent to 0·05 or $\frac{1}{20}$th of a milliampere.

Fortunately, however, to those conversant with elementary slide-rule work, the coefficients are so readily applied that any extra resistance in the galvanometer circuit would never be resorted to except as a means of increasing the range of the improvised milammeter for higher currents when the shunt s cannot be reduced sufficiently.

This forms a means of checking the calibration of a Weston or other direct-reading milammeter.

It is essential that in making these calculations the galvanometer resistance should be known accurately at its actual temperature, for it is obvious that the error on the current c_1 will be equal in percentage to any error on G.

In any case resistance tables should accompany each coil of a galvanometer, and these values checked as opportunity offers. For this purpose Thomson's method will be found most convenient unless circumstances allow of its being taken by ordinary bridge method.

In thus using a galvanometer, it is highly important that if s be an adjustable resistance, such as an ordinary subdivided ohm, the plugs, sockets and terminals should be kept scrupulously clean, and care should be taken that the connections are made as shown in Fig. 4 and *not* as in Fig. 5.

If joined up as in the latter figure, the wires, ω_1 and ω_2, although short, introduce an extra fractional resistance into the shunt circuit which gives a false value for the calculated currents.

Finely-divided pumice powder forms an excellent cleansing substance for plugs as well as sockets, and should be applied to the latter by means of a cylindrical piece of soft wood. This cleanliness of bridge plugs and sockets as also the removal of moisture or dirt from the ebonite between the plug pieces is unfortunately too little appreciated in ordinary practical work, except by those upon whom localisation or other accurate work depends.

Reference has already been made concerning the fallacious results to which standard cells are liable, although their E.M.F. may remain perfectly constant.

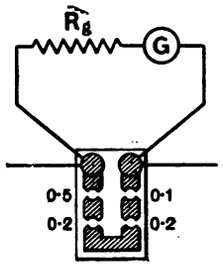

FIG. 4.

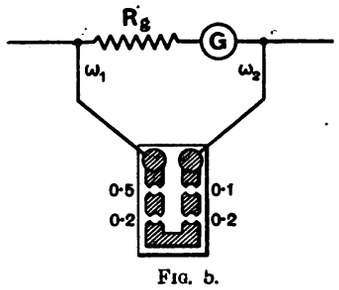

FIG. 5.

Since in practice these cells are frequently used through high resistances, it is a matter of great moment that their internal resistance should be tested periodically, as well as the comparison of their E.M.F.'s.

I prefer adopting the following system:—

Internal Resistance of Standard Cells.—Join up the standard cell through a resistance of 2,000ω (including the resistance of the milammeter itself) and find the current value of the deflection. The result is then worked out by equation (15)—viz., $b = \frac{E}{c} - 2{,}000$.

Example.—A galvanometer having a current-constant of 0·0646 microampere, and a resistance of 635ω had a shunt of 20ω placed across its terminals so that the coefficient was

$$0{\cdot}0646\left(\frac{635+20}{20}\right) = 2{\cdot}116 \text{ microamperes per division.}$$

Practically, therefore, the resistance of this "microammeter" is 20ω, so that by adding 1,980ω we have $(R+m) = 2{,}000\omega$. Two Clark's cells were tested, their temperature being 26°C., and E.M.F. consequently 1,442 B.A. millivolts per cell.

Cell.	Deflection observed. D (divisions).	Milliamperes. $\frac{D\times 2{\cdot}116}{1{,}000}$.	$\frac{E}{c}$.	Resistance of cell. $\frac{E}{c} - 2{,}000$.
A	309	0·6538	2,205ω	205ω
B	28	0·0592	24,360ω	22,360ω

The cell B, although differing from A in E.M.F. by only 1·5 parts in 1,000, had increased to over 22,000ω, owing to "creeping" of the zinc sulphate solution through a leak in the cork and marine glue. The main reason for selecting 2,000ω as the resistance through whichthe cell is to be circuited is because with smaller current outputs the appreciation suffers, and any high resistance in the cell is more masked by its correspondingly higher internal resistance. With the Muirhead pattern of Clark's cell the resistance, when in good condition, will range between 150ω and 300ω, or even higher when the current output is about 0·7 to 0·6 milliampere. The effective resistance when the output is about 0·015 milliampere may be in the order of 2,000ω or 3,000ω roughly.

Since the actual time necessary for observing the current deflection need never exceed 10 seconds at most, whatever little polarisation takes place in the cell is practically negligible, and the E.M.F. is, therefore, not appreciably vitiated for more than a minute afterwards.

This fact has been very lucidly demonstrated by Mr. W. Clark Fisher, whose standard cell recovery curves are very interesting and instructive. In view of the importance and utility of the milammeter, whether it be of the direct-reading type or the more refined suspended coil instrument adapted for the measurement of extremely small currents, it is a *sine quâ non* that, to ensure

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practicability, temperature corrections should be eliminated. The key to the solution of this interesting problem is given in equation (37), from which it is evident that, by constructing the galvanometer or milammeter circuit G and its shunt s of similar proportions and quality of wire, having exactly similar temperature coefficients, and provided also that G and s are kept at equal temperatures $\left(\frac{G}{s}+1\right)$ is a constant, and compensation becomes automatic. The same reasoning applies to the resistance R should it be required in simple circuit with the milammeter G.

This fact is partly taken advantage of in the Weston instrument, the compensation of which, although remarkably good, is not quite perfect, mainly, if not entirely, because of the lower temperature coefficient of the differential controlling springs, which have the effect of making the actual readings slightly too large, with an increase of temperature and vice versa.

(To be concluded.)

MECHANICAL APPLIANCES IN MINES—COAL CUTTING AND DRILLING.*

BY R. H. WAINFORD.

By reason of its bearing upon other great industries, besides being in itself the most important industry of this country, there is no question which should demand more serious consideration than the cost of obtaining coal. It is true that up to the present time the iron and steel industries have suffered more from outside competition than the coal trade is probably ever likely to do; but it is equally true these trades would not have been so seriously affected had the fuel they required been produced on the most economical lines, and, therefore, put on to the market at lower prices than prevails, for it must be remembered that it takes 2½ to 3 tons of coal to produce a ton of finished iron or steel, and from 3½ to 9 tons for every ton of engineers' work completed. A saving, therefore, in the initial stage of operations in the cost of coals is a boon, not only to the mine, but to those who are, as indicated, dependent upon its produce; if the steel maker could buy fuel at, say, 1s. a ton less cost, he would accordingly produce a finished bar or plate at 2s. 6d. to 3s. less cost per ton. It is the idea of this Paper to draw particular attention to work which may be and is done at the coal face by drills and coal cutters.

From reports, it is gathered mechanical drills and coal cutters are pretty generally used in America—it is said the Ingersoll Company have about 3,000 coal cutters operating; in Belgium, France and Germany power drills are used a good deal, but coal cutters are not so much applied as in England and Scotland. The author recently visited several collieries on the Continent, and here, witnessing some five or six different types of coal getters operating, these are described, but it may be incidentally remarked it is not his wish to specialise them, as there are many machines in the market equally as good; they are given because operations have been witnessed; the results are from actual practice. Some of our collieries could not show a gain by using drills and cutters, others might be able to adopt one or the other; but it is extremely likely that at least 60 per cent. of the mines could adopt both to advantage—to advantages ranging from 6d. to 4s. 6d. per ton of coal produced.

It may here be mentioned the advantages gained by mechanical means do not end in the simple reduction in cost of getting—there is also a substantial gain in having a coal of enhanced value due to there being a greater percentage of round coal (not so much slack made); by there being a less number of men actually working at the coal face—the most dangerous point in a mine—and, consequently, a reduction in the number of claims for compensation; and another important factor, that of houses for workmen; in fact, this latter, taken in a broad sense, is capable of repaying capital outlay for plant. From this it is not to be assumed all the men taken from the face are thrown out of work, but, rather, the output of each pit is so much increased that work of a less dangerous nature will be available for them in the pit, and an outlet will also be found in the iron and steel works, which it is to be assumed would have increased business, to the detriment of the imports of iron and steel, and, in fact, of general engineering work. Thus it will be gathered the introduction of mechanical appliances at the coal face does not necessarily mean paying off men, but it does suggest largely increased output, both in the mines and kindred trades. It may be urged still further—it is due to the ironworks and engineers—improved conditions in coal winning should be vigorously pushed forward. The idea of curtailing the output of coal in order that high prices may be maintained is diametrically opposed to the above suggestion—which idea represents one of the many disadvantages of piece-work, and when considering mechanical methods it should be prosecuted with the ultimate intention of paying wages by the day or hour and not on tonnage.

Advantages of Curving or Holing by Mechanical Methods over Hand Labour.—Generally the machines do this work under the coal, whereas the miner holes in the coal, and from a commercial point of view a distinct gain in favour of machine practice is established, there being a reduction in the amount of slack made. Something like 90 per cent. of the coal got by machines will pass over a ⅞ screen mesh, as against 60 per cent. by the hand method. For the purpose of ascertaining the difference in selling values, an exhaustive trial was made at a Lancashire colliery with these results:—

*Hand labour—3 tons coal at 11s. per ton	£1	13	0
1 ton slack at 7s. 3d. per ton	0	7	3
Value per ton, average	£0	10	0¾
By machine—8 tons coal at 11s. per ton	£4	8	0
1 ton slack at 7s. 3d. per ton	0	7	3
Value per ton, average	£0	10	7

An increase of 6¼d. per ton in value.

The foregoing figures are the result of work performed some time ago by a Winstanley disc coal cutter; similar results are maintained at the present time, and whereas a miner produces 3 tons of coal to one of slack, a machine will get 8 tons of coal to one of slack. This advantage is somewhat discounted by the fact of slack being nearly as valuable as coal for coking purposes; a better quality of coke is, however, made from disintegrated coal than from slack, as it is free from dirt—an element not entirely overcome by washing. If the coal is house or steam coal, then the advantage is fully maintained.

Therefore, if 6¼d. can be realised in this manner, the amount may reasonably be placed to the credit of mechanical appliances, and then more than one-half of the shilling suggested as the possible saving is established. It is not proposed to set anything down definitely as to compensation claims, although experience has shown that accidents occur very much less frequently where machines are in use. Mr. Garforth, of Normanton, instances this in a concise manner. He says "four accidents occurred in getting 1,100,000 tons of coal by machines, as against a similar number of accidents in getting 315,000 tons by the old pick method." If Mr. Garforth's experience could be taken as representing average conditions, then somewhere about 0·375d. per ton is saved in this direction, which is, however, a minor consideration compared with the increased safety of the pit; but the third item, houses for workmen, should prove important; whether the gain is established by maintaining a constant output with fewer men, or the output is increased with the same number of men employed—preferably the latter—the costs will have diminished, say, by 1d. per ton. There is now left, if that amount is allowed, 4¾d. to be made by the mechanical appliances themselves, coal cutters and drills at the coal face. For the purpose of making direct comparison as to the work of machines *v.* hand labour it is advisable to fix upon normal conditions, and to do this a 3ft. seam may be reasonably and fairly regarded as the average. Coal can be holed by machines in this thickness to advantage; as they get thicker the saving is decreased, and as they become thinner they increase; the machine may cease to show a gain when the thickness exceeds 5ft.; on the other hand, the best results have been attained in seams under 2ft. thick. A good miner will hole, curve, get and fill 3 tons a day of eight hours in a 3ft. seam under normal conditions, and in so doing will have earned, say, 7s. 6d.; the cost for "holing or curving," getting and filling is, therefore, 2s. 6d. per ton. There is little doubt as to this figure—viz., 2s. 6d. per ton—being below the average on the total output of Great Britain, so the rate may be accepted.

The capital outlay for a complete coal-cutting plant is here considered, with allowances made for interest on capital, depreciation, repairs, cost of running, stores, &c., and a figure arrived at to stand against the machine.

The estimated cost of a single coal-cutting machine plant:—For one machine complete with all fixings and power plant, exclusive of boiler, engine-house and foundations, £1,000; the standing charges are as follows:—

For interest and depreciation at 15 per cent. per annum of 300 working shifts	£150
For repairs and stores	75
For power (fuel)	60
£285 ÷ 300 shifts = 19s. per shift.	£285

The specification of a single machine installation complete, as estimated above, includes engine and dynamo, electric standard type coal cutter and all accessories and connections from the generator to the machine at a face ½ mile from the shaft, erecting the plant and running it for 10 days. No account is taken for attendance at the generating station. It may be here suggested that, when the cutters

* Abstract of a Paper read before the Institution of Mechanical Engineers.

* These figures are taken from the recently published book by Sydney F Walker, "Coal Cutting by Machinery in the United Kingdom."

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are worked on the night turn, which is usual, the fuel account would hardly be appreciable, as the steam in this case will be drawn from boilers that are not in use, although in steam. This is for an electric installation; the compressed air plant may be taken over all to be about equal in cost. Some slight differences occur in the prices for the Hurd, Clarke-Stephenson and Diamond; the sum £1,000 is not exceeded, however, in any case.

The coal cutter will hole or curve to a depth varying from 3½ft. to 6ft.; the average working depth is 4½ft, and in eight hours will travel across a face 70yds. under normal conditions, holing or curving through a distance on the face, which, when got and filled, equals

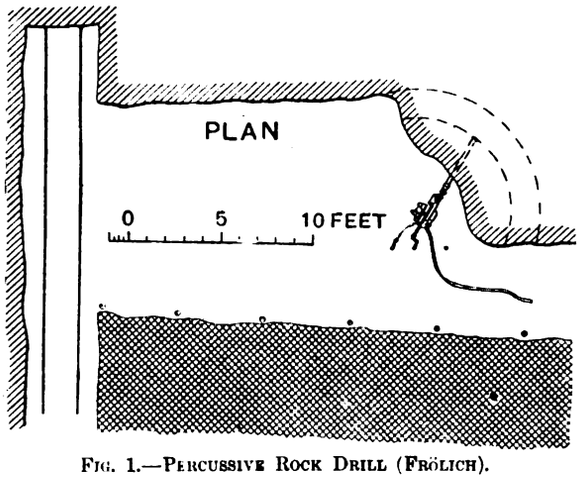

Fig. 1.—Percussive Rock Drill (Frölich).

100 tons; the same falling off and increase in the make applies here, so the average may be taken as stated. Sometimes two men only are required to look after the machine, and never more than three; if these men are paid at the same rate as the miner, the holing through 70yds. will then cost 7s. 6d. × 3 = 22s. 6d., less if anything, because two men may be enough to do the work.

The Hurd machine at a colliery in North Staffordshire has holed over a period of 12 months an average of 100yds., 4ft. deep in hard fireclay below the coal—the machine making its own pavement; the cost by hand was 2s. 1d., and the machine showed a saving of over 6½d. per ton, after allowing for all charges, the gross difference at the face being 10d. per ton. At a colliery in Yorkshire a medium-sized machine holed 3,600yds., 4ft. under in a seven weeks' trial, working single shifts daily—the Saturday being a six hours' shift; the saving effected was 1s. on a 3s. 6d. rate—the holing in this instance being in a hard black band. Another case to be mentioned effected a clear saving of 1s. 3d. per ton; this is in the Midlands district, and it is interesting to note that the first machine was put in over a year ago and no repairs have been required, though the holing is very hard and the temperature in the pit is 80°F. The Diamond coal-cutters at a colliery in South Yorkshire, hole from 700 to 800 tons per day in a 4ft. seam. The holing is made in the bottom dirt and inferior coal, which contains a large quantity of pyrites. The output by hand was 3½ tons per man, which has been increased, by means of the deep under-cut introduced by the makers of this machine, to 6 tons by the machines; the price was 2s. 1½d. per ton by hand, and is reduced to 1s. 3½d by the coal cutters, a difference of 10d. per ton at the face, from which must be deducted interest on capital, &c.; an average of 80yds. per machine per shift of eight hours is maintained, the depth of holing being 5½ft. To a mining engineer 80yds. 5½ft. under not only represents a large superficial area of coal, but implies better coal, less shots, road-making, timbering and an all-round reduction in getting price. At another colliery where the seam lies at an angle of 25deg., the holing is made to the rise; the getting price was formerly 2s. 3d. per ton by hand as compared with 1s. 4½d. per ton by machines. At a colliery in Durham a saving of 2s. per ton in a 2ft. seam is made, and at another place in Yorkshire, in a seam 19in. thick, a saving of nearly 4s. per ton has been established, thus showing as previously stated, as the seams get thinner the saving increases. The Clarke-Stephenson (Messrs. Ernest Scott and Mountain) is installed in a large number of collieries in Yorkshire and district, similar in design to the drawing, Fig. 5, and in every case, without exception, savings have been effected, bearing out my remarks as to the all-round reduction in the cost of producing coals. It may suffice to quote one instance: this is in a 3ft. seam in the Barnsley district; the contract price for

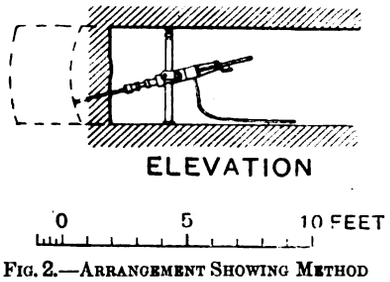

Fig. 2.—Arrangement Showing Method of Using Machine for Heading

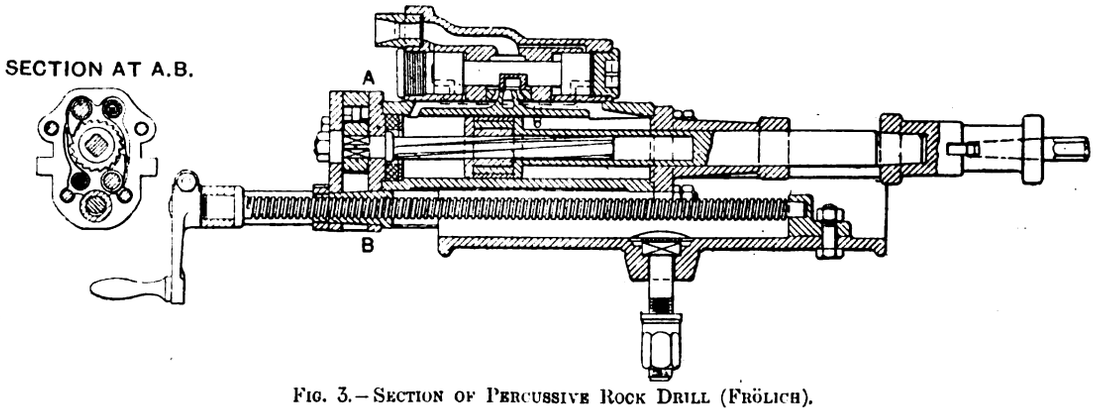

Fig. 3.—Section of Percussive Rock Drill (Frölich).

For getting down and filling (11d. per ton standard* + 57½ per cent.) cost per ton = 1s. 6·46d., and the total for holing or curving, getting and filling, 100 tons is:—

For special machine men (holing)	£1	2	6	or 0s	2·7d.	per ton.
For getting and filling	7	13	10	or 1	6·46	„
For holing, getting and filling	8	16	4	or 1	9·16	„

Bringing forward the amount estimated as the standing charge per shift against a single machine plant, we have the following results:—

For holing, getting and filling 100 tons	£8	16	4	or 1s	9·16d.	per ton
For standing charges, interest, &c., 100 tons	0	19	0	or 0	2·28	„
	9	15	4	or 1	11·44	„

The reduction, therefore, is 6·56d. on the 2s. 6d. rate in favour of the machine, and, together with the amount previously estimated as savings due to increased selling value, &c., of 7·25d. = 13·81d. The unfavourable points in the foregoing estimates are found in the fact that, whereas a single-machine plant is put down at £1,000, a two-machine plant costs £1,575, a three-machine plant £2,125 and a four-machine plant £2,950 approximately.

The following results obtained by the Hurd bar-type machine, and the two disc-machines of the Diamond Coal-Cutter Co., and the Clarke-Stephenson will to a great extent verify the above figures.

* This low figure is taken from a colliery in South Yorkshire worked by the Diamond cutters, and is attributable to the deep under-cut, which gives the men a good buttock to work at. (See detailed labour bill in Appendix II.)

cutting is 3½d. per yard producing 15cwt of coal, and the filling price is 1s. 3d. = 1s. 6½d. all told.

The price of hand-labour in this seam was 3s. per ton. The total amount of yardage cut by the coal-cutting machine is about 4,000 per week, the total output of the pit being 3,000 tons; the depth of undercut is 3ft. 6in., and apart from the saving in connection with the coal-cutting plant is the fact that the coal produced is worth at least 1s. 6d. per ton more on the average, due to the great reduction in amount of small made. Formerly this seam could not be worked by hand except at a loss.

The cutters instanced are, of course, longwall machines; for pillar and stall and general holing work a machine made by Frölich and Klupfel, Unter-Barmen, is doing excellent work in Germany. Figs. 1, 2 and 3 show the system, and the undermentioned figures give an idea of holing operations:—

Trial with the Frölich Machine at the Reden Pit, Saarbrücken.

Date. 1901.	Seam.	Time cutting. Min.	Depth of cut. Metre.	Width of cut. Metre.	Area. Sq. metre.
June 12	Landsweiler / Hauptbasck	90	...	...	3·06*
„ 13	11 Tiefban / Heiligenwalden	55	1·60	2·00	3·20
„ 14	„	54	1·80	1·65	2·98†
„ 15	Kallenberg	75	2·25	2·15	4·80

* Two drills broken. † 20 minutes' stoppage for adjustments.

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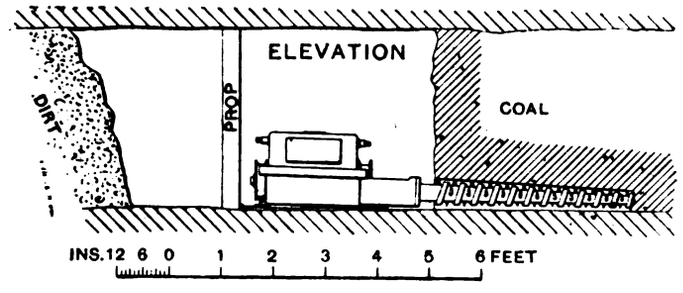
Trial with the Frölich Machine at the Heinitz Pit, Saarbrücken.

Date. 1901.	Seam.	Time cutting. Min.	Depth of cut. Metre.	Width of cut. Metre.	Area. Sq. metre.
July 23	Wrangel Sohle III.	135	2·00	2·80	5·60
,, 24	,,	105	2·15	2·55	5·48
,, 25	,,	105	1·80	2·55	4·59*
,, 26	,,	120	2·00	2·60	5·20†
,, 27	,,	120	2·00	2·60	5·20

* Three knives broken. † One knife broken.

These are authentic results of cutting in hard coal :—Three men look after two machines, and, accordingly, the average cost for holing, taken from the above figures and assuming the seam to be 3ft. thick and the rate of wages at 7s. 6d. per day as before, we get the following :—In a working shift of eight hours, two machines will hole across a face 122·8ft., 6·3ft. under, which is equivalent to 50 tons of coal, the rate per ton for wages being 5·4d., or exactly double the amount of that upon the bar and disc machines noticed ; the capital outlay is, however, very much below the previously estimated



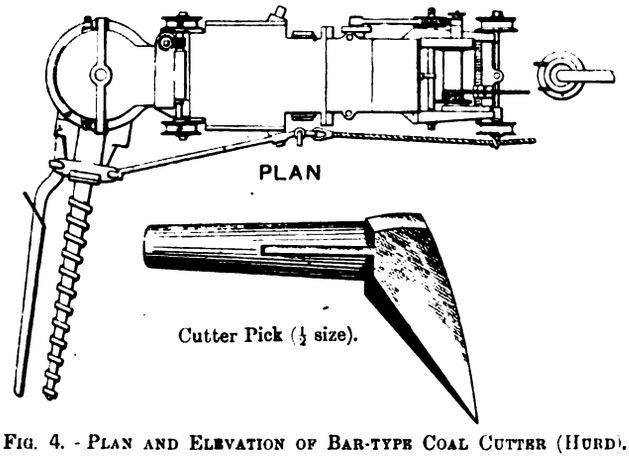


Fig. 4. - Plan and Elevation of Bar-type Coal Cutter (Hurd).

machines, and consequently the charges for interest, depreciation, &c., works out about the same on every ton of coal produced, and so the cost of holing may be put down at 2·7d. above them ; by the Frölich system the rate per ton will then show a saving of 3·86d. as against 6·56d. by the bar-type machine and the two-disc type machines mentioned ; but the Frölich machine has special advantages which discount the gain in favour of other types, as shown. Four machines are better than one, they are easier to handle, it taking about five minutes to fix up for work ; no rails are required, and, an important consideration, existing conditions at the mine need not be interfered with. Thus, where longwall or pillar and stall is worked the machine applies ; heading work and cross-cuts are dealt with as readily, and the fact of less space being occupied is a good feature.

When coal-cutting by machinery is efficiently carried out the working face is kept straight and clean. Under-cutting to greater depths than possible by hand renders timbering required less frequent and, therefore, less costly, and also a reduction in the number of shots to be fired is found from experience to be considerable. By keeping a straight line the coal breaks away more easily, especially when aided by increased depth of hole. At a mine in Yorkshire 40 shots were fired per day when the holing was made by hand ; the machine method reduced the number of shots necessary to seven.* Another good feature in the new method to be noted is, that work can be carried on regularly ; to keep a face moving forward at a set

* This result is due to deep under-cutting by machines at Messrs. Pope and Pearson's, Normanton.

speed, varying conditions are minimised, and so the work becomes easier to cope with and less hazardous.

From the practical point of view some objections to machine practice occur ; they present themselves differently in each mining district, discussion may indicate them variously. One of the chief objections to the system is the difficulty in finding men to attend the machines possessing sufficient mechanical skill and pit experience to enable them to cope with contingencies at the face as they are met ; but this hardly reflects discredit upon the mechanical methods directly. Miners can readily apply themselves if dealt with with tact and encouraged in the work. At some places machine methods have recorded a failure, traceable very often to the plant being either

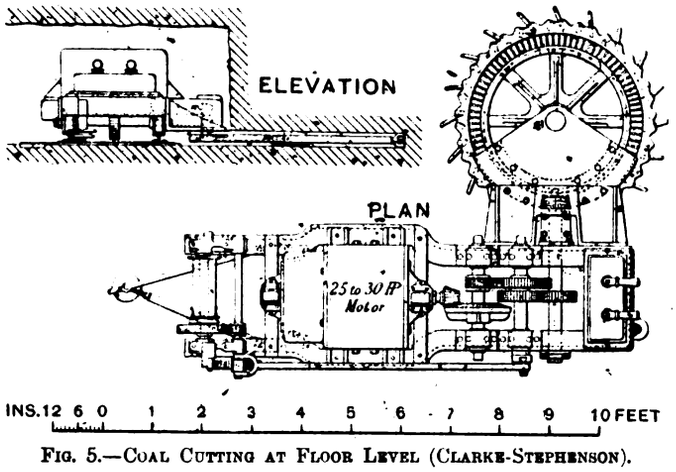


Fig. 5.—Coal Cutting at Floor Level (Clarke-Stephenson).

badly designed or lacking the necessary power, but most often to the system being taken up in a desultory manner, for it seldom happens that a new idea does not meet serious difficulties, due to prejudice, either on the part of the management or the men, or both.

Percussive Rock Drills.—The introduction of a driller into the category of coal-cutting appliances will, no doubt, cause a little surprise ; the arrangement for swinging the tool whilst operating shows, however, that holing under or in coal can be performed, and under certain conditions exceedingly good holing, for instance, in

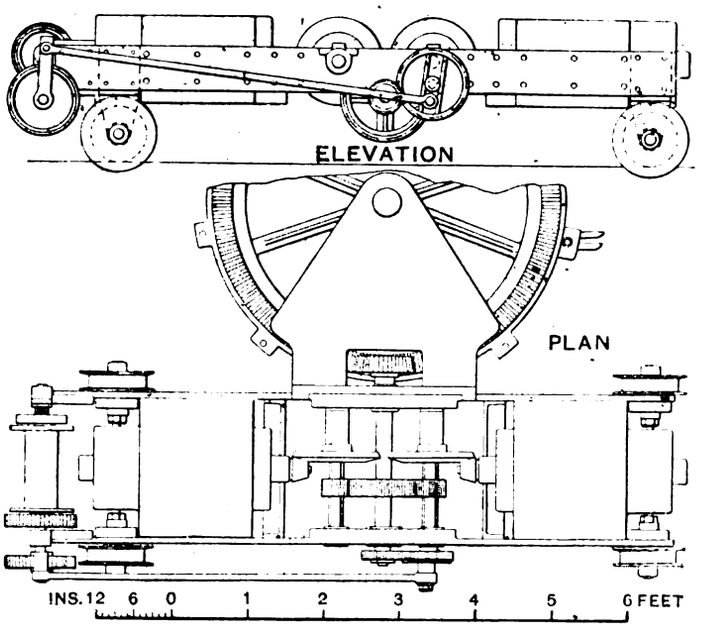


Fig. 6.—Plan and Elevation of Undercut Electric Coal Cutter (Diamond Co.).

places where a conglomerate is met which cannot by a rotating action be dealt with, the percussion rock drill does the work satisfactorily ; in fact, a percussion machine often does well when other types completely fail. The swinging device allows the tool to be worked at varying angles from the horizontal to a vertical position, so it can hole under and shear, and therefore applies to many conditions of a coal-cutter proper. The Frölich machine (Figs. 1, 2 and 3) is more serviceable for heading purposes and drilling. Various sizes are made ; the one for general work is as follows :—Cylinder 3in. diameter, varying stroke from 6in. to 8½in., working pressure 2½ to 4 atmospheres, number of strokes per minute 300 to

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400, weight 180lb. A hydraulic column is used mostly, which arrangement gives a much firmer hold to the work than an ordinary screw. It is said two and three machines are fitted on to one column, but this could not be in a coal mine; in sinking operation the machine is fitted on a tripod.

The Frölich drill is made in four sizes as follows :—

No.	Diam. of piston. mm.	Maximum stroke. mm.	Weight. kg.	Pressure in atmospheres.	Approx. horse-power required per machine
1	80	220	130	2½ to 4	8 to 13
2	75	220	90	2½ to 4	7 to 12
3	70	190	85	2½ to 4	6 to 10
4	60	170	70	2½ to 4	5 to 8

There are many power drills to be seen working on the Continent and in this country, notably the Daw rock drill, made by the Hardy Patent Pick Co., which firm probably have had more experience in this direction than anyone ; they also make a power rotary machine for general drilling work in coal and ironstone ; it is in reality the well-known Elliott drill with an electric motor and outfit attached—a handy tool, very light.

Mr. Morison, of Cramlington, has recently invented a double-cylinder percussion drilling machine which has very remarkable features. He proposes to use this tool for holing purposes as well as drilling ; a drill may be seen working at Cramlington.

*Bar-type Coal-Cutter (Hurd).**—This machine is a little less costly to instal, and it is said less power is required and it occupies less space as compared with disc machines ; all things considered, there is no material gain by this type over the disc machines when account is taken of work performed. Like the disc cutters, these are designed to work on the floor-level and at varying heights above the floor. Fig. 4 illustrates an under and over type machine, which shows it to be a compact and altogether a sound mechanical engineering job. Doubt as to the ability of the bar standing up against heavy work may be dispelled, as it seldom if ever happens that this part gives

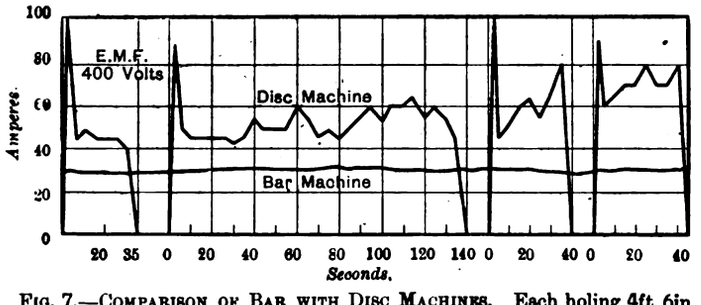

FIG. 7.—COMPARISON OF BAR WITH DISC MACHINES. Each holing 4ft. 6in. (under) in the same seam of hard fireclay at 18in. per minute.

way ; the cutting tool is rathar a difficult thing to shape, but by the use of proper forging dies this work can readily be performed at an ordinary blacksmith's hearth. The following table shows the principal dimensions and other interesting details.

No.	Length.	Width.	Height.	Weight.	Weight of bar.	Under-cut.	Power.	Continuous current.	Gauge of rails.	Weight of rails.
				cwt.	cwt.		B.H.P.	volts		lb. per yd.
A	6·6	2·6	1·1	19	1½	2·6 to 3·6	12	400	1·6 to 2·3	22
B	9·3	2·8	1·4	30	2½	3·0 to 4·6	18	400	1·9 to 2·4	25
C	9·6	2·8	1·10	45	3	4·0 to 6·0	26	400	2·0 to 2·4	28

The cutting tools are all one side—i.e. one size from one end of bar to the other ; they weigh ½lb. each ; picks are fitted at intervals between the screw, and the bar rotates at about 400 revs. per min. ; in the cutter head-piece there is a toggle arrangement which gives the bar a reciprocating action. This backward and forward action, together with the rotary motion, gives a shearing and chipping action on the coal, which reduces the strain on the bar and effectively cleans out cuttings from the tools themselves. The cutter head-piece has special advantages in the ready way of varying angle of the holing bar. The bar may be tilted to any angle. The small size A is applicable to low seams, owing to its light weight and the space it occupies. A diagram showing the comparison between bar and disc machines holing hard fireclay is shown in Fig. 7.

Disc-type Coal-cutter (Clarke-Stephenson).—Generally, the disc machines are larger than the bar machine described ; they are heavier, and occupy a little more space, but against the apparent disadvantages there is the question of stiffness to be considered, and a greater output. The Clarke-Stephenson is doing work equally as good as any other coal-cutting machine ; the disc is made of cast-steel to undercut from 3·6 to 6ft. ; cutter tools are fitted to the periphery of the disc about 12in. apart into a square socket set to a suitable angle, and there is also provided sockets to opposite hand, thereby allowing the machine to hole across a face in either direction by the simple readjustment of the tools and reversing the engine and hauling tackle. The disc has teeth grid-fashion cast on the internal part of the rim into which is geared a pinion. A single motor (continuous-current) is fitted and with intermediate gearing the speed is reduced. The disc revolves at varying speeds to suit the work to be done—from 20 to 50 revs. per min. ; the motor, which is capable of developing 25 effective horse-power, runs about 900 revs. per min. The Clarke-Stephenson machine is fitted with the Scott and Mountan totally enclosed electric motor.

Disc-type Coal-cutter (Diamond Co.).—These coal-cutters are made to work electrically and by compressed air. They have many points in common with other machines of the disc type, but the cutting disc is arranged to work from a central point, and where it is advisable to hole across the face and back alternately this seems the better form. The machine is always in perfect balance, and naturally greater depths of under-cutting can be obtained without the risk of the trouble of getting off the road. The disc is provided with loose or separate tool-holders fitted to lugs projecting from the rim—a very good feature, as it simplifies the disc casting, and the tools can more readily be reversed : a bolt is withdrawn and the tool-box reversed.

The electric appliance does not seem as simple as the one previouly noticed, there being two motors fitted in series, but probably less heating at the armatures is found owing to the cooling area being greater. In many other respects the two disc machines compare.

The compressed air machine is probably the best in use at present of its class ; the central position of disc most likely found its origin in the compressed-air type. It applies perfectly both to the engines and gearing required, two cylinders being placed one at either end of the framing driving on to a central shaft. The application of compressed air as against electricity has advantages, the speed of the engines being more suitable to the working speed of the tools, thus reducing gear is almost done away with—in fact, the crankshaft may be coupled direct to the disc through a single purchase. As to the question of safety, this is somewhat exaggerated. Electric appliances of the present day for mines are quite safe, the motors are so well covered that a spark cannot possibly be emitted, the only source of danger being the possibility of a cable being dislocated : there are many such incidental possibilities in a mine, very remote. Fig. 6 shows the machine as it is now made. An electric machine of the type possibly holds the records for holing—this being at a pit in Durham, where 140 yds., nearly 6ft. deep, is cut per shift, representing 2,500 superficial feet average.

APPENDIX I.—HEADING WORK RECORDS BY THE FRÖLICH DRILL.

Driving a heading at the "Mansfeld'schen Kupferschiefer bauende Gewerkschaft Shaft 81 Lichtloch," near Klostermansfeld.

Four drills in use.

Time required to complete the work—From October 19 to December 16, 1899.

Length of heading done	393ft.
Section of heading	8ft. wide by 7½ft. high.
Character of rock	Magnesia limestone and lower new red sandstone.
Number of working days	134.
Do. attacks	713.
Do. drills in	4.
Do. hydraulic columns in use	2.
Do. miners per shift	8.
Do. drivers do.	9.
Average number of bore-holes per attack	9.
Do. depth of bore-holes	3ft. 7in.
Do. time for drilling the bore-holes	1 hour 46 min.
Do. do. blasting and carting	2 hours 28 min.
Gelatine dynamite used per attack	25lb.
Do. do. linear foot of heading	8lb.
Average progress per attack	3ft.
Do. do. 24 hours	15ft. 10in.

Driving a heading of the "Kirchbergtunnel" near Schiltach (Schwarzwald).

One drill in use.

Time required to complete the work—From December 29, 1891, to February 3, 1892.

Length of heading done	127ft.
Section of heading	6½ft. wide by 7½ft. high.
Character of rock	Hard granite.
Number of working days	28.
Do. attacks	40.
Do. drills in use	1.
Do. columns in use	1.
Do. miners per shift	2.
Do. drivers do.	3.

* [See also *The Electrician* of May 23, 1902, p. 178.—ED. *E.*]

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Average number of bore-holes per attack	11.
Do. depth of bore-holes	3ft. 5in.
Do. time for drilling the bore-holes	11 hours 45 min.
Do. do. blasting and carting	5 hours 25 min.
Gelatine dynamite used per attack	20lb.
Do. do. linear foot of heading	6½lb.
Average progress per attack	3ft. 2in.
Do. do. 24 hours	4ft. 7in.

Driving a heading at the Coal Mine "Deutschland" near Hasslinghausen.

Two drills in use.

Time required to complete the work—From October 26, 1894, to June 26, 1895.

Length of heading done	1,590ft.
Section of heading	8ft. wide by 7ft. high.
Character of rock	Hard sandstone and slate rock.
Number of working days	199.
Do. attacks	342.
Do. drills in use	2.
Do. hydraulic columns in use	2.
Do. miners per shift	4.
Do. drivers do.	2.
Average number of bore-holes per attack	17.
Do. depth of bore-holes	5ft. 1in.
Do. time for drilling the bore-holes	6 hours 30 min.
Do. do. blasting and carting	7 hours.
Gelatine dynamite used per attack	42lb.
Do. do. linear foot of heading	9lb.
Average progress per attack	4ft. 8in.
Do. do. 24 hours	8ft.

APPENDIX II.—Cost of Getting Coal in a South Yorkshire Colliery.

Total *underground cost of working* a seam 3ft. 3in. at a depth of over 500yds. in a Yorkshire colliery by means of the "Diamond" deep undercutting machine, holing to a depth of 5½ft. in stiff fireclay.

	Cost per ton. s.	d.
Coal getting (11d. per ton standard price, including 57½ district per centage)	1	6·46
Coal-cutter men, paid by day	0	4·82
Cleaning up, ripping (9ft. roads), horse-keepers, hurrying and hanging-on, main roads, bye work and superintending, including deputies, shot-firers, &c.	1	1·91
	3	1·19

Approximate output from seam, 4,500 tons per week.
Average tonnage for fillers, 6½ tons per shift.

TUBE RAILWAYS AND STREET TRAFFIC IN LONDON.

In the September issue of the *Chamber of Commerce Journal* will appear an article on this subject by Mr. Reginald E. Middleton, in which, although it deals with a matter that has been very fully discussed already in these columns, some new ground is broken. The main objective of the tube railway, as at present constructed, is to transport large numbers of passengers only, but the author fails to see where any relief to general traffic congestion can follow upon this. Tube railways cannot serve as connecting links between the main lines of railways by reason of the impossibility of passing ordinary standard rolling stock through the small tunnels hitherto adopted. We believe that the Great Northern and City Railway is a solitary instance of meeting this criticism. As an example of the futility of such railways as a means of decreasing vehicular passenger-carrying traffic on the surface, attention is drawn to the return of a large number of omnibuses running from Bayswater to the Bank, on the Oxford-street and Holborn route, which had been taken off at the time of the opening of the Central London Railway. That congestion of traffic is not due to any one form of transit—say, omnibuses—however, is at once admitted by Mr. Middleton, and from this very reason he foresees that either the whole system of underground railways must be reconstructed, or an entirely new system must be provided for intercommunication between railways and for the carriage of goods if any better state of affairs is to be arrived at with respect to street traffic of all descriptions.

Dealing, however, with the design of tube railways for passenger traffic pure and simple, he inclines to the use of the 13ft. 6in. tunnel which has been recommended by the Board of Trade, and which will probably be recognised as the standard for future schemes. He also supports the opinion of the Joint Committee of 1900 that all junctions should be eliminated, and that lines laid in the direction of the main roads would secure the bulk of the traffic to and from the City. But the vibration trouble, and the liability for damage of almost any kind during a definite period, makes it probable, in the writer's opinion, that it may be advantageous to lay out future railways in straight lines from point to point, whereby many curves would be avoided, the speed of the trains increased and the discharge from, and the influx of passengers to, the stations would be removed from the main arteries of traffic.

The difficulty of carrying out the London County Council's idea of shallow tramways in preference to deep level railways is deemed well-nigh insurmountable in London as it exists. If London were to be entirely destroyed by fire, and another city built on entirely new lines, it might possibly be well to lay out a comprehensive system of subways for tramway and other purposes, but the difficulties in the way would even then be considerable. At present very few streets in London exceed 60ft. in width, whilst many main thoroughfares in some parts are even less than 30ft. Under present conditions it would be absolutely necessary to underpin all buildings along the route of such shallow tunnels, a matter of danger, difficulty and expense, and it was an open question whether the vibration would be greater or less than that which had hitherto attended the running of tube railways.

Treating the matter from the point of view of deep level tube railways versus shallow tramway subways, the author distinctly prefers the former, one of his chief arguments being the non-disturbance of subterranean water—as the tubes would be in the London clay—and, consequently, no endangered building foundations. A subway, on the other hand, he says, must, almost of necessity, be constructed in the water-bearing strata, wherever these exist, some of the water must be removed and foundations be endangered. Subways for the reception of water, gas and electrical mains would have been constructed long ere this, if the difficulties and dangers connected with them had not been so great as to cause hesitancy as to their use, notwithstanding that the perpetual breaking up of the streets is a constant and increasing annoyance and expense. When tunnels are excavated entirely in the clay it is probable that the use of brick as a lining is to be preferred to cast iron as being less noisy than the latter material, and transmitting less vibrating motion to the surrounding clay, both on account of the material itself, and of the greater surface exposed to the clay, due to the greater thickness of the brickwork.

On the questions of ventilation, train lighting and multiple unit working, the views of the Board of Trade are advocated; but it is safe to assume that in the schemes sanctioned this year, and those already authorised but not constructed, the recommendations of the Board of Trade in these and other respects will be followed, the promoters having pledged themselves so to do. These recommendations will be found set out in *The Electrician* for April 18th, p. 1027, and May 16th, p. 151, in the evidence given by Lieut.-Col. Yorke before Lord Windsor's Committee.

Some details of cost and working expenses are given. It has already been stated that, for a purely passenger service, tunnels 13ft. 6in. in diameter are sufficient, but we are reminded by the author that however desirable it may be to use a still larger tunnel, the cost of construction increases approximately as the square of the diameter, and that a railway with tunnels 13ft. 6in. in diameter will, with land, stations and other accessories, cost on a cash basis, about £450,000 a mile. If the working expenses be taken at the not unusual figure of £55 per cent., in a line 8 miles in length, the gross earnings must amount to £320,000 a year, in order to pay the not exorbitant dividend of 4 per cent. To collect £320,000 a year means the receipt of 76,800,000 pence, or, considering that workmen are carried during certain hours at half fare, the carriage of some 70,000,000 passengers in a year, or about 190,000 a day. The Central London Railway pays 4 per cent., with a traffic of about 40,000,000 passengers a year, but in this case the fare is 2d., and the cost of collection is reduced to a minimum. If, as is proposed by the Morgan group of railways, the fare for a little more than 4 miles is 1d., the number of passengers carried must be greatly increased, in order to earn the same dividend, and the collection of tickets is likely to increase the cost of working. Moreover, the railways dealt with by Parliament this session have been placed under very serious obligations as to compensation for structural damage and interference by vibration or otherwise, as well as in respect of fares, and it is doubtful if new lines will be constructed or worked so economically as old ones, which are not subjected to the same obligation, or will be able to earn the same return per mile, in which case they will not even pay 4 per cent. on the outlay. The aim of the municipalities and the public seems to be, the article continues, to put these railways to the greatest possible expense, by demanding from them the construction of subways, the widening of streets, and compensation for interference, without consideration of the obvious fact that these expenses must eventually be defrayed by the travelling public, or by the railway, to the loss of interest to the shareholders, who invest their money in the faith that they will receive a fair return thereon. Should the tube railways fail to make a fair return on the capital invested no more such railways will be constructed, certainly on the like conditions, the difficulties of transport will increase, and the municipalities will have to widen the streets at the cost of the ratepayers, or to leave them unwidened.

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In summing up, at the conclusion of his article, Mr. Middleton states that the problem to be solved is twofold—viz, the transport of workers from their houses to their places of business and back, and the removal of congested traffic from the streets. The two objects are not identical, nor are they to be obtained by the same means. All the railways, with the exception, perhaps, of the Great Northern and City line, have been designed to secure the first-named object, but have done little, if anything, to relieve the congestion of the streets, which must be obtained by other means. If the time for the construction of railways to deal with the carriage of foodstuffs and the necessaries of life has not yet arrived, much may be done by fostering the introduction of properly-constructed motor cars and the regulation of traffic, so that all vehicles should travel at one rate of speed, neither too fast nor too slow.

If the cost of underground railways is enhanced by legislative enactment, and by the action of municipalities, and their earning power curtailed until they cannot pay a reasonable interest on the capital invested in them, they will not be constructed, and the working man, whether labourer, artisan, clerk, merchant, or professional man, who desires, in order to reduce his rent, or for other reason, to live at a distance from his work, will have to travel by other conveyance, and pay a remunerative price for his transport.

To secure the best system of underground railways it is suggested that this momentous question should be referred to a committee composed of the engineers and general managers of all the metropolitan railways, assisted by experts whom the committee might employ, and presided over by a statesman of the capacity of, say, Lord Balfour of Burleigh.

Attached to the article is a map of tube railways in London, as well as a list of them. *The Electrician* for June 6th last contained very full details of the result of the Parliamentary procedure this year, as well as a complete map of all the lines, and to these we would refer our readers.

ON ELECTROMOTIVE WAVE ACCOMPANYING MECHANICAL DISTURBANCE IN METALS IN CONTACT WITH ELECTROLYTE.*

BY PROF. J. CHUNDER BOSE, M A., D.SC.

Take a rod of metal and connect the two points A and B with a galvanometer by means of non-polarisable electrodes (Fig. 1, *a*). If the point O is struck a wave of molecular disturbance will reach A and B. It will be shown that this is attended by a wave of electric disturbance. The mechanical and the attendant electrical disturbance will reach a maximum and then gradually subside. The resultant effect on the galvanometer will be due to $E_A - E_B$ where E_A and E_B are the electric variations produced at A and B. The electric changes at A and B will continuously balance each other, and the resultant effect on the galvanometer will be zero, (1) if the mechanical disturbance reaches A and B at the same time and with the same intensity, (2) when the molecular condition is similar at the two points, and (3) when the rate of rise and subsidence of disturbance is the same at the two points. In order that a resultant effect may be exhibited in the galvanometer, matters have to be so arranged that (1) the disturbance may reach one point, say A and not B, and vice versa. This may be accomplished by the method of block. Again, a resultant differential action may be obtained even when the disturbance reaches both A and B, if the electrical excitability of one point is relatively exalted or depressed by physical or chemical means; we thus have two other means of obtaining a resultant effect, (2) by the method of relative exaltation, (3) by the method of relative depression.

Method of Block.—The electromotive effect described below may be obtained with all metals. A piece of "tin" wire (an alloy of tin and lead used as electric fuse) will be found to give very good results. A specimen of wire 1mm. in diameter, 10cm. in length, is mounted in the apparatus. (Fig. 1, *b*.) Two strips of cloth moistened with water or dilute salt solution are securely tied round two points A and B. They hang loose from EE' (non-polarising electrodes—Zn in $ZnSO_4$ solution), so that there is no pull on the wire. Special precautions are taken so that there is no variation of contact. If a sharp tap be given to the side A, a transitory electrical current in response to the disturbance will flow round the circuit, which under normal conditions will be found to flow *in the wire* towards the more excited end A. Disturbance of B will give rise to a reverse current. For quantitative measurement it is necessary to have the intensity of stimulus maintained uniform or increased or decreased in a definite manner. Instead of a tap, the stimulus of torsional vibration is more satisfactory. By maintaining the amplitude of vibration constant or increasing or decreasing the amplitude, we may either keep the stimulus constant or increase it or decrease it in a definite manner. I shall first describe some of the typical results which may be obtained with the simple "straight wire form" of the apparatus. If worked with care it will give consistent and satisfactory results. For quantitative measurements requiring the greatest exactitude the "cell form," to be presently described, will be found preferable.

Recording Apparatus.—The galvanometer used is a sensitive dead-beat D'Arsonval; the period of complete vibration of suspended coil under experimental conditions is 11 seconds. The records are taken by means of a cylindrical modification of the response recorder described in my previous Paper,* or by means of photography. In the latter method, a clockwork moves the photographic plate at a uniform rate, and a curve is traced on the plate by the moving galvanometer spot of light. The disturbance of molecular equilibrium caused by the stimulus is attended by an electromotive variation, which gradually disappears on the restoration of the molecules to equilibrium. The rising portion of the response curve shows the electromotive effect, due to stimulus, and the falling portion the recovery. The ordinate represents the electromotive variation, and the abscissa the time.

Experiments to Exhibit the Balancing Effect.—If the wire has been carefully annealed, the molecular conditions of different portions are approximately the same. Every portion of the surface will be found nearly iso-electric. If the wire be held near the middle by the clamp, and a vibration through an amplitude of, say, 90deg. be given to the end A, an upward deflection will be produced; if a vibration of 90deg. be given to B, there will be produced an equal downward deflection. (Fig. 1, *c*.) If both the ends are simultaneously vibrated,

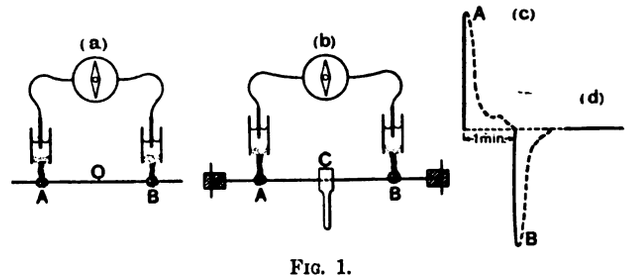

FIG. 1.

In (*a*) mechanical disturbance applied at O produces similar electrical disturbances at A and B; there is no resultant effect. In (*b*) owing to a clamp, disturbance applied at A cannot reach B. A tap or vibration imparted to the end A produces responsive current which flows in the wire from the unexcited B to the excited end A. Disturbance of B gives rise to a current in the opposite direction. (*c*) gives the record of the response to equal stimuli applied to A and B. The ascending part of the curve shows the effect of stimulus, the falling part shows recovery. (*d*) Simultaneous stimulation of A and B gives no resultant response. (In the records dotted lines represent recovery.)

the electromotive variation at the two ends will continuously balance each other, and the galvanometer spot will remain quiescent. (Fig. 1, *d*.) The clamp may even be removed, and the wire vibrated as a whole; the stimulation of A and B being the same, there will be no resultant deflection. Having found the balancing point for the clamp (which is at or near the middle), if the clamp be now shifted to the left, on simultaneous vibration of A and B, the A effect will be relatively stronger (inasmuch as the angular vibration of A is increased and that of B decreased), and there will be produced a resultant upward deflection. Thus keeping the rest of the circuit untouched, by merely moving the clamp from tne left, past the balancing position to the right we get either a positive or zero or a negative resultant effect. This can be repeated any number of times. The experiment shows, further, that when the amplitude of vibration is kept constant, the intensity of electromotive effect is increased by shortening the wire. A thick wire produces a stronger response. The direction of the current of response in the wire is in the majority of metals under normal condition, from the relatively less to the relatively more excited point.

The form of the response curve, stimulus remaining constant, is modified by the molecular condition of the wire. A wire in a sluggish condition shows feeble response; the recovery is also slow. The same wire after it has been vibrated for a time exhibits stronger response. The period of recovery may also then be hastened. Longer time is required for recovery from the effects of a stronger stimulus.

Comparison of Electric Excitability of Two Points by the Method of Balance.—As has already been said, when the clamp is put at the balancing position, alternate equal stimulations of A and B produce equal and opposite electromotive effects, and when the two ends are stimulated simultaneously there is no resultant effect.

Increased Excitability Produced by Preliminary Vibration.—If now one-half of the wire, say the A half, be vibrated for a time, the electric excitability of that half will be found to be more or less permanently augmented, presumably by increased molecular mobility conferred by vibration. The response of A would now be found to

* A preliminary account of this investigation was given in a Paper "On Response in Organic Substances," read before the Society, June 6, 1901.

* Paper read before the Royal Society. See "On the Continuity of Effect of Light and Electric Radiation on Matter," Roy. Soc. *Proc.*, Vol. LXX., p. 159.

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be very much enhanced, as compared with its previous response, the response of B remaining the same as before. If now both the ends are simultaneously vibrated, the balance which previously existed will be found to be disturbed, the resultant showing that A has been rendered the more excitable.

If B be now vibrated for a time, the former approximate balance will be re-established by the enhanced responsiveness of B. Thus, in the following experiment with the clamp at the approximate balancing point—

—	Response of A.	Response of B.	Resultant response.
Approximate balance ...	+ 5 divisions	- 4·5 divisions	+0·5 divisions
After the end A has been vibrated	+10·5 „	- 4·5 „	+6 0 „
After the end B has been vibrated for an equal length of time.....	+10·5 „	-9·5 „	+1·0 „

Effect of Chemical Reagents.—It will be shown that keeping the electrolyte by which contact is made constant, the electric excitability of the wire depends on the molecular condition of the wire. Certain electrolytes, such as dilute solution of NaCl, dilute solution of bichromate of potash, &c., are normal in their action; that is to say, with such contacts the response to stimulation is practically the same as with distilled water contact. Contact made with dilute NaCl solution may, therefore, be regarded as the normal contact. There are again certain chemical reagents which enhance the electrical excitability; others, on the contrary, produce great depression, or abolition of excitability.

Electric Comparator.—We may compare the relative electric excitability conferred by chemical reagents by the method of balance. Having previously obtained a balance (with water or dilute NaCl solution contacts at A and B), one contact, say A, is touched with a few drops of Na_2CO_3, which is an exciting agent. The electric excitability of A will now be found to be greater than that of B; on simultaneous vibration of A and B there will be a disturbance of balance, giving rise to an upward deflection (current of response towards the more excitable A).

—	Response of A.	Response of B.	Resultant response.
Both contacts of normal saline	+12	-12	0
Contact A touched with Na_2CO_3 solution..	+32	-12	+20

Similarly, when A is depressed by a trace of oxalic acid the electric excitability of B is less than that of A, the resultant deflection being now downwards (current of response towards the relatively more responsive B). It is to be remembered that in all cases *the resultant current of response in the wire is towards the more excitable point.*

An interesting line of investigation rendered possible by a modification of method of balance described above, is to compare the

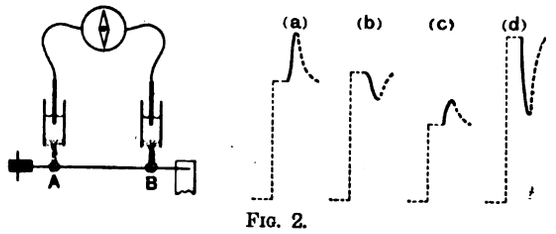

FIG. 2.

(*a*) Response when A is treated with sodium carbonate—an apparent positive variation. (*b*) Response when A is treated with oxalic acid—an apparent negative variation. (*c*) Response when A is treated with very dilute potash—positive variation. (*d*) Response when A is treated with strong potash—negative variation. This response is up when A is more excitable and down when B is more excitable. Lines thus ····· indicate direction of permanent current.

relative excitability induced by various chemical reagents, the influence of the same reagent of different strengths, and the modification of the effect caused by the duration of application. We may thus compare the effect of the reagent in relation to the normal effect of water or dilute NaCl solution. There is, again, an extremely delicate method of comparison of the relative effects of a series of compounds like Na_2CO_3, K_2CO_3, &c. Balance having been previously obtained between the normal sensitiveness of A and B, the two different solutions are now applied at the two points; the slightest difference in their relative action is at once exhibited by the upsetting of the balance during stimulation, the direction of the resultant deflection indicating the more exciting reagent.

Resultant Response by Method of Relative Depression or Exaltation.—From what has been said, it will be seen that by rendering A and B unequally excitable, a resultant response may be obtained. The block may be abolished, and the wire may be vibrated as a whole; the response will now be due to the differential effect at A and B. To produce difference in excitability we may subject one point, say A, to a preliminary vibration, or apply at the point a suitable chemical reagent. By the application of the latter there will be a small P.D. between A and B: this will simply produce a displacement of the zero. (By means of a potentiometer the galvanometer spot may be brought back to the original position.) The shifting of the zero will not affect the general result. The direction of this more or less permanent current, due to the small P.D., gives no indication of the direction of current of response; the direction of the latter is determined by the rule that the responsive current flows towards the more excitable point. The effect of the mechanical stimulus is to produce a transient E.M.F. which is algebraically superposed on the existing P.D. The deflection will take place from the modified zero, to which the spot returns during recovery. I give four records (Fig. 2): in (*a*) A is touched with Na_2CO_3 (which is an excitant); a permanent current flows from B to A; response to stimulus is in the same direction as the permanent current (positive variation); in (*b*) A is touched with a trace of oxalic acid (which depresses the excitability), the permanent current is in the same direction as before, but the current of response is in the opposite direction (negative variation); in (*c*) A is touched with dilute KHO (three parts in 1,000), the response is exhibited by a positive variation; in (*d*) A is touched with stronger KHO (three parts in 100), the response is now exhibited by a negative variation. The last two apparently anomalous results are due to the fact (which will be demonstrated later) that KHO in minute quantities is an excitant, while in larger quantities it is a depressant.

—	Permanent current.	Current of response.
A treated with sodium carbonate	←	←
„ „ „ oxalic acid	←	→
„ „ „ very dilute potash.....	←	←
„ „ „ strong potash.....	←	→

Current of response is always towards the more excitable point.

Detection of Traces of Physico-chemical Change.—I will now describe an experiment which will show in a striking manner how exceedingly delicate is the method of electric response to stimulation, and how by its means we can detect and measure traces of physico-

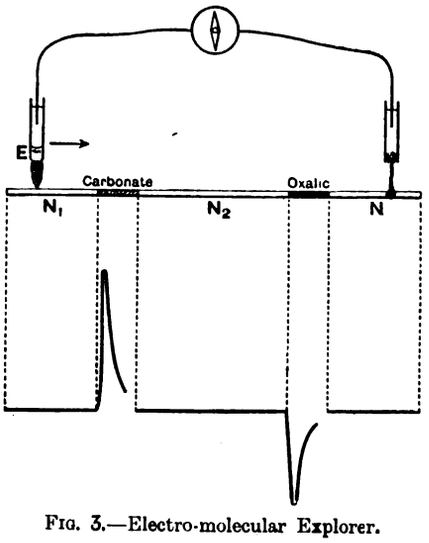

FIG. 3.—Electro-molecular Explorer.

chemical changes in different parts of the same solid. Take a wire and touch two points, one with Na_2CO_3 solution, the other with oxalic acid. Wash the wire. There is no trace left of the previous treatment. Let one contact be permanently made at a normal or previously unacted point N. Let the other exploring contact be moved along from the other end towards N, the wire being mechanically stimulated during the test. The galvanometer spot remains quiescent as long as the exploring contact is over normal areas. But as soon as it touches the zone on which is impressed the invisible image of physico-chemical change, the differential effect of stimulus at once reveals it by producing a vigorous movement of the galvanometer spot. At N_1 there was no movement, but there was an upward movement of response when the explorer came over "Carbonate." As the explorer passed on to N_2 there was a cessation of movement, but when it reached the area marked "Oxalic" there was a vigorous movement downwards (Fig. 3).

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Interference Effects.—I have already described a case of interference in the galvanometric effect when the two points A and B in similar molecular conditions are simultaneously acted on by the same mechanical stimulus. Under these conditions the electric variation at the two points *continuously* balance each other, and there is no resultant effect. When one point is acted on by a chemical reagent, not only is its electric excitability changed, but its time relations—its latent period, the time-rate of its acquiring the maximum electric variation, and the recovery from the effect of stimulus—will also be modified. Using the block method, we may place a drop of excitant Na_2CO_3 on A and depressant KBr on B. On simultaneous vibration of A and B, the A effect being relatively much stronger than B effect, the resultant would be an upward deflection. But on shifting the balancing clamp away from A (thus decreasing the stimulation intensity of A and increasing that of B) we may find a point where the A effect is equal and opposite to the B effect. But owing to change of time relations, simultaneous vibration of A and B will no longer give a continuous balance ; instead, we obtain a diphasic variation. The diphasic curve thus obtained is exactly the same as the resultant curve deduced from the algebraic summation of the A and B curves obtained separately.

Continuous Transformation from Positive to Negative through an Intermediate Diphasic. Response.—In the following record, Fig. 4, I succeeded in obtaining a continuous transformation from positive to negative phase by continuous change in the relative sensitiveness of the two contracts. I found that traces of after effect due to application of Na_2CO_3, even after it is washed off, remain for a time, the increased sensitiveness conferred disappearing gradually. Again, if we apply Na_2CO_3 solution to a fresh point, the sensitiveness

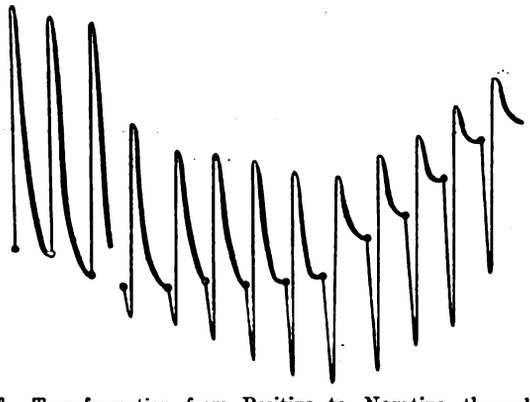

Fig. 4.—Transformation from Positive to Negative through Intermediate Diphasic Variation. Thick dots represent times of application of stimulus.

gradually increases. There is another interesting point—viz., that the beginning of response is earlier when the application of Na_2CO_3 is fresh. In the experiment whose record is given, the wire is held at one end, and successive uniform vibrations imparted to the wire as a whole at intervals of one minute by means of a torsion head at the other end. (See Fig. 2.) Owing to after effects of previous applications of Na_2CO_3, the sensitiveness of A is at the beginning great, hence the resultant response is at the beginning positive or upward. Dilute solution of Na_2CO_3 is next applied to B. The response of B (down) begins earlier, and continues to grow stronger and stronger. Hence, after this application, the response shows a preliminary negative twitch of B followed by positive variation of A. The negative grows continuously. At the fifth response, the two phases, negative and positive, of the double response become equal ; after that the negative becomes very prominent, the positive dwindling into a feeble after vibration.

Modification of the Apparatus into "Cell Form."—The series in Fig. 5 explains the transformation from the "straight wire" to "cell" form. The wires A and B, cut from the same piece, are clamped separately below ; vibration of A (the amplitude of which is measured by a graduated circle) gives rise to a responsive current in one direction, vibration of B gives rise to a current in an opposite direction. Every experiment may thus be verified by corroborative and reversal effects. The electromotive effect varies with the substance, and is sometimes considerable ; for example, with "tin," a single vibration may give rise to as high a value as 0·4 volt or more. The intensity of response does not depend on the chemical activity of the substance, for the electromotive variation in the relatively inactive tin is greater than in zinc. Again, the sign of response, positive or negative, is sometimes modified by the molecular condition of the wire (see below). In the modified form of apparatus the wires in the cell are immersed to a definite depth in the electrolyte ; there is thus a perfect and invariable contact between the wire and the electrolyte. The wire in the cell is clamped below, and torsional vibration gives rise to a strong electrical response. If the wire be now carefully unclamped, and the vibration repeated as before, there will now be found no electrical effect. As all the rest of the circuit was kept absolutely the same in the two different sets of experiments, these results conclusively prove that the responsive electromotive variation is solely due to the mechanical stimulation of the acted wire. The excitatory effect due to the disturbance persists for a time. This may be shown by keeping the galvanometer circuit open during the application of vibration, and completing it at various short intervals after the cessation, when a persisting electrical effect diminishing rapidly with time will be observed. When the wire is brought to the normal condition, successive responses to uniform stimuli are, in the case of metals which, like tin, show no fatigue, exactly the same. I usually interpose a high external resistance, varying from 1 to 5 megohms, so that the galvanometer deflections may be proportional to the electromotive variations ; the internal resistance of

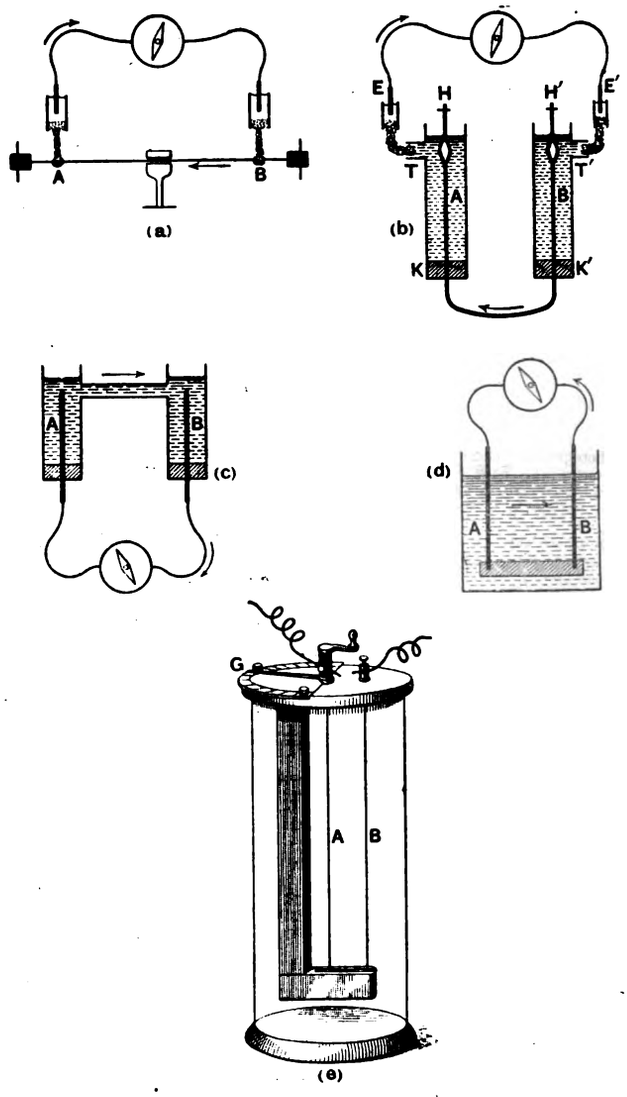

Fig. 5.

Successive modifications of the "straight wire" ending in "cell form." (*b*) shows how the ends of A and B of the wire may be vibrated by ebonite clip-holders, H and H'. When A is excited, current of response *in the wire*, normally speaking, is from the unexcited B to the excited A. The stimulated wire becomes zincoid. Note that though the current of response is constant in direction, the galvanometer deflection in (*d*) will be opposite in direction to (*b*). In (*e*) is shown one of the two graduated circles by which the amplitude of vibration is measured.

the cell and the variation of that resistance by the addition of chemical reagents being thereby rendered quite negligible. Ordinarily, I use tap-water as the electrolyte. The responses obtained with tap-water is practically the same as that obtained with distilled water. Zinc wires in $ZnSO_4$ solution give responses similar in character to those given by, for example, Pt or Sn in water.

Character and Intensity of Response Dependent on Molecular Condition.—The following experiments show how intimately the response phenomena is connected with the molecular condition of the acted wire :—

Effect of Annealing.—The following photographic record, Fig. 6, shows the equal and opposite responses in A and B wires to a succession of uniform stimuli. Hot water was now substituted for the cold water (too high a temperature temporarily reduces the response);

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the cell was then allowed to cool to its old temperature, when a second series of responses were taken, the stimulus intensity being the same as before. It will be seen how the responses are enhanced by annealing.

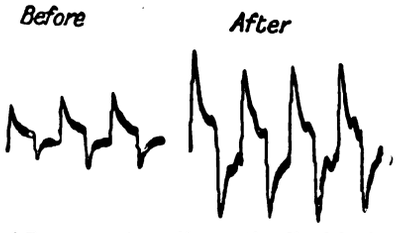

FIG. 6.—Series of Responses, to uniform stimuli, of both A and B wires, before and after annealing.

Effect of Previous Vibration.—The increased sensitiveness conferred by previous vibration has already been referred to before. I give below a record (Fig. 7) obtained with platinum (I have obtained similar records with other metals), which clearly shows how the response is enhanced after preliminary vibration.

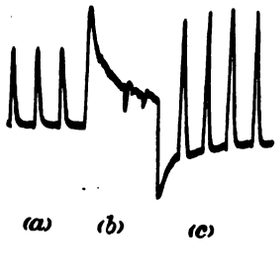

FIG. 7.

Photographic record showing the effect of continuous stimulation in enhancing response (Pt). Each curve shows response (followed by recovery), the stimulus being kept constant throughout. The series of responses (*a*), enhanced to series (*c*) after continuous vibration (*b*).

Sometimes the wire gets into a very sluggish condition, when the response almost disappears; in other words, owing to some molecular modification, responsiveness is reduced from the normal positive value (by positive is meant that the acted wire becomes zinc-like or is zincoid) to zero. In these cases annealing or preliminary vibration are usually effective in transforming the sensitiveness from zero to a positive value.

(To be concluded.)

BRITISH ASSOCIATION.

Last Friday's *Times* publishes its forecast of the coming meeting of the British Association, which begins on September 10th next, at Belfast, under the presidency of Prof. Dewar. It is stated that the general programme of section A (Mathematical and Physical Science), the president of which is Prof. John Purser, has not yet been definitely arranged. Prof. Purser's address will be in the main biographical, giving an account of the Irish school of mathematicians and physicists in the last century (not living). Lord Rayleigh will probably raise the question of the conservation of weight in chemical reaction; Prof. Trouton may be able to show his experiments on the magnetic field due to the motion of a charged condenser; Prof. Martin will communicate some results in electrical oscillation and some experimental work done by students under his direction; while Dr. Larmor will have something to say on the temperature of radiant energy. Mr. Petavel has promised a Paper on radiation experiments with a view to the construction of a more trustworthy standard of light. Section B (Chemistry) will be presided over by Prof. Edward Divers, the subject of whose address will be "The Atomic Theory: What it has become in the course of a Century." Dr. Cannan will preside over section F (Economic Science and Statistics). The staple of his address, our contemporary learns, will probably be the thesis that economic theory is useful in regard to practical questions such as protection, housing and other municipal enterprises (especially those connected with locomotion), the Post Office and various means of raising revenue. As in other sections, the general work of the branch will largely deal with Irish subjects. The Right Hon. Horace Plunkett will discuss technical instruction and industrial development. The effect of factory legislation is the subject of the work of a committee which will make a lengthy interim report. Other Papers are on miscellaneous subjects, including "Municipal Trading," by the Hon. R. Porter (director of the U.S.A. 11th Census), the "Position of Economics and the Applied Sciences" in the University training of men intended for a commercial life, which will be discussed by Dr. W. R. Scott, and a Paper by Mr. P. Ashley on "Municipal Policy and State Control." Prof. John Perry, who presides over section G (Engineering) will, says *The Times*, have something very incisive to say in his address on the training of engineers. He does not think that German methods are at all suited for English boys, and he affirms, moreover, that such methods are unpractical. Being of opinion that the great technical colleges of England suffer because their pupils have had no good general education, he will urge that an endeavour should be made to instil into all boys—whatever profession they intend to enter—(1) A knowledge of English, as distinct from classical, subjects; (2) the power to compute—to achieve this the present methods employed in the teaching of mathematics must be completely revised; (3) a knowledge of the methods of study in experimental science. Prof. Perry will contend that the average boy is not stupid, and that what is needed is a radical change in our educational systems. The great technical colleges themselves need reforming; for one thing every teacher at an engineering college, whatever his subject, ought to have engineering experience, and many more and better paid teachers are required. Among other points that will come under discussion are whether workshop experience ought to come before, or after, or during an engineering college course, and the reforms due to foreign competition going on in engineering shop management and methods. In the general work of the section Prof. Hele-Shaw is expected to present an important report embodying the result of the deliberations of the Road Traction committee, while the report of the Screw Gauge committee is likely to conclude a prolonged discussion of an important point of detail in small mechanisms. Among the Papers that have been promised are the following:—"The Combustion of Bituminous Coal," by Mr. W. H. Boots; "Water Power in Ireland," by Mr. F. J. Dick; "Exhibition of Electrical Apparatus," by Mr. M. B. Field; "Recent Progress in Large Gas Engines," by Mr. H. A. Humphrey; and "The Importance of Minor Details in Engineering Work," by Mr. L. Holroyd-Smith, and Papers on other electrical subjects have been promised by Mr. P. V. McMahon and Mr. F. Holden and Mr. J. E. Kingsbury. Prof. H. E. Armstrong, F.R.S., who is president of section L (Educational Science), and to whose efforts the formation of this new section is largely due, will devote his address largely to a discussion of the educational outlook. He will consider the deficiencies of the present curriculum and the directions in which it needs reform, and will also deal with the question of the training of teachers. Following the practice of last year, a definite programme has been arranged for the section, so that a number of important subjects may be debated. The first two days will be mainly devoted to the discussion of Irish educational problems. In a debate on technical instruction in relation to industrial development in Ireland, the Right Hon. Horace Plunkett, Vice-President of the Board of Agriculture and Technical Instruction, has promised to take part. More general debates later in the meeting will be on the training of teachers, about which Prof. Withers and Miss Walter will have something to say. Dr. Kimmins will discuss the subjects to be taught as "science" and the order in which they should be taken, and Papers on educational experiments have also been promised. Reports will be presented on the teaching of mathematics, the teaching of science in elementary schools, and on examinations. For the Tuesday afternoon a joint discussion with section G on the training of engineers has been arranged. The Friday evening discourse will be by Prof. J. J. Thomson, F.R.S., on Becquerel rays and radioactivity, but that on Monday evening and the lecture to working men on Saturday evening will not be on electrical or engineering subjects.——The programme of the Belfast meeting is now obtainable from the secretary at Burlington House

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(London, W.), or at the local offices, 2, Wellington-place, Belfast. The following are among the works which members are invited to visit during the week:—The harbour works at Lough, the electric generating station, the telephone exchange, Messrs. Workman, Clark & Co.'s shipbuilding and engineering works, and Messrs. Harland and Wolff's shipbuilding and engineering works.

CORRESPONDENCE.

ELECTRICAL TRAMWAYS AND OMNIBUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I fear from his last letter that Mr. Charles Bright is in something of a fog as to the effect of overtaking powers of cycles. The calculations I gave in your issue of 15th inst. were of the carrying capacity of a certain width of roadway as to cycles all travelling at 8 miles per hour. At a constant speed the overtaking power does not exist. Moreover, it stands to reason that with the same average speed a road will accommodate many more cycles if the speeds are all the same than if different. Therefore, if this overtaking power enables the cycles to run at various speeds, with an average of 10 miles per hour, instead of a level rate of 8 miles an hour, as I assumed, the carrying capacity of the road will certainly not be increased in the ratio 8 to 10, or anything like as much.

It seems to me that the assistance of the overtaking power of a cycle or omnibus in raising the absolute carrying capacity of a road has been greatly overrated. Certainly, with fairly open roads it enables faster vehicles to pass slower ones, and in that respect is highly advantageous. But directly the road becomes crowded to any degree the possibility of passing a slower vehicle is greatly lessened. A cycle possesses overtaking powers to a much greater extent than any other vehicle, owing to its slimness and easy guiding. But if Mr. Bright will attempt to negotiate his cycle in the most crowded of the City streets during the busy hours of the day, I think he will find his speed very little greater than that of other vehicles there.—Yours, &c., EDWARD V. CLARKE.

Manchester, Aug. 27.

LEGAL INTELLIGENCE.

Re British Power, Traction and Lighting Co. (Ltd.).

In the Vacation Court, on Wednesday, Mr. Justice Swinfen Eady heard a motion on behalf of the Halifax Bank for the appointment of a receiver and manager of this company. Mr. Bramwell Davis, K.C., for applicants, said there was great danger in respect to the assets, and they asked that a Mr. Watkin be appointed. This appointment was assented to on behalf of the company. His lordship made the order asked for.

Bright's Light and Power Co. (Ltd.) v. Wingfield.

This case came before Mr. Justice Eady in the Vacation Court on Wednesday, on a motion asking that the name of the company be struck out, but after hearing arguments of counsel his lordship directed the case to stand till Wednesday next week.

Tramcar Bye-Laws.

The Leeds stipendiary magistrate (Mr. C. M. Atkinson) gave his decision on Tuesday in the case in which a tramcar conductor was summoned for overloading his car. He said the powers possessed by the Corporation for licensing and regulating hackney carriages, omnibuses, &c., extended also to tramways. In 1875, when the tramways were in the hands of a company, a bye-law prohibited a conductor from allowing any person beyond the licensed number "to enter or mount or remain in or upon any part of a carriage." The Corporation subsequently purchased the undertaking and became invested with all the rights, powers and authorities of the original promoters, and if the bye-law was enforceable against a conductor in the service of the company it would be enforceable against the present defendant. It was suggested that, as the Corporation had not enacted a bye-law in relation to tramways similar to that relating to hackney carriages and omnibuses, they did not possess, and never had possessed, the right to impose a limitation on the number of passengers carried, and therefore that the bye-law under which the information was laid was useless and unenforceable. Even if that view were adopted it did not follow that bye-law 17 was not valid, because quite apart from any powers conferred on the local authority, the tramway company had power under the Act of 1870 to make bye-laws for regulating travelling in or upon any carriage belonging to them. Why should not the company themselves prescribe as the maximum number to be carried such number as the local authority had already determined by the terms of the licence to be a proper number, and as such, required to be exhibited by public notice in the vehicle itself. Holding that view, he should convict defendant, subject to its being proved that he did allow more than the licensed number to remain on the car, but as the man acted under express instructions, and the present action was only a test one, he should impose only a nominal penalty of 5s. He consented to grant a case.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Preston Corporation require a resident electrical engineer capable of designing and superintending the construction and working of electric tramways. An advertisement contains further particulars. Applications to the town clerk (Mr. H. Hamer), Town Hall, Preston, by noon Sept. 8.

A large shipbuilding firm require a mechanical draughtsman experienced in, and fully capable of, preparing general arrangements and detail drawings of foundations, steam, exhaust, condensing pipe and all mechanical details of large electricity station; also an electrical draughtsman similarly qualified in designing the electrical equipment in station and outside work. See advertisement.

Hoylake and West Kirby Urban District Council require a resident electrical engineer at a salary of £250 per annum. Applications (addressed chairman, Electric Supply committee) will be considered on Sept. 2. See advertisement.

An assistant lecturer in mathematics and a demonstrator in engineering are required for the Municipal Technical College, Sunderland. Applications to the secretary by Sept. 8. See advertisement.

A junior assistant is wanted for the Bury (Lancs.) Corporation electricity works. Applications to the engineer and manager, Mr. S. J. Watson. See advertisement.

Maidenhead Corporation have vacancy for a pupil at their electricity works. Applications to resident electrical engineer (Mr. C. O. Milton), Guildhall, Maidenhead, by Sept. 20. See advertisement.

A meter reader and tester is required at Sunderland Corporation electricity works. Applications to chief electrical and tramways engineer (Mr. John F. C. Snell), Town Hall, Sunderland. See advertisement.

Rochdale Corporation have a vacancy for a shift engineer. Salary £65 per annum. Applications to the borough electrical engineer (Mr. C. Claremont Atchison), Electricity Works, Rochdale, by noon, Sept. 8. See also advertisement.

The Visitors committee of the County Asylum, Thorpe, Norwich, require a working engineer. Applications to Mr. P. E. Hansell, The Close, Norwich, by Sept. 2.

Mr. Wm. Thomson, of Paisley, has been appointed manager of the electricity and gas works at Kendal at £225 per annum.

Mr. George Conaty, manager of the South Staffordshire Tramways, has been appointed manager of the City of Birmingham Tramways Co.

Mr. E. I. Hiss, assistant to Prof. Silvanus P. Thompson at Finsbury Technical College, has been appointed teacher of electric lighting and electric wiring at Hornsey Technical School.

EDUCATIONAL NOTICES.

Merchant Venturers' Technical College.—The calendar for the forty-seventh session (1902–1903) is just issued, and contains a large quantity of interesting matter concerning the courses of instruction at this college. Numerous full-page illustrations of the principal laboratories, workrooms, engineers' shops, &c., are given, and show the very complete equipment of these important sections of educational work at Bristol.

University College, Bristol.—The session 1902-3 begins on Oct. 7, and lectures in inorganic, organic and advanced chemistry will be delivered during the session. Some particulars of the course of instruction are given elsewhere. Prospectuses from the registrar and secretary.

Aberdeen.—The accounts of the electricity department for the year to July 31 were issued on Monday, and show a total income of £23,139. 18s. 5d., and an expenditure of £10,499. 10s., leaving £12,139 8s. 5d. Interest came to £4,767. 2s., depreciation on buildings and plant to £3,226, and sinking fund to £2,290, leaving £2,699 to be carried to reserve, which now stands at £7,664. Sinking fund stands at £9,182. Borrowings amount to £173,572 7s. 6d. 1,859,812 units had been generated, compared with 1,389,385 in the previous year. The quantity consumed was—Public lamps 186,058, traction 381,495, private consumers 979,016, compared with 793,176 last year, the total sold being 1,546,569. The quantity used in the works was 91,901. The charge for current for private lighting has been revised, and in future the figures will be: 6d. for the first hour's maximum demand and 2½d. after, against 6d. and 3d. in 1901-2.

The electric tramway system is to be extended to Ferryhill and Torry.

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Alleged Forgery and Theft —At East Riding petty sessions, on Wednesday, Arthur Wilson, electrician, Leeds, was charged with uttering a forged cheque and with stealing a travelling bag. It was alleged that the prisoner told the prosecutor (a public-house proprietor) that he was an electrician employed by Messrs. Drake and Gorham, Manchester, but Mr. W. J. C. Budd, manager for Messrs. Drake and Gorham, said prisoner was not in their employed, and had no authority to sign cheques for the firm. On this charge and that preferred by the London and North-Western Railway Co., prisoner was committed for trial, bail being refused.

Asuncion (Paraguay).—An American company has secured a contract for the lighting of this town by electricity.

Barnsley (Yorks)—The Council have applied for sanction to a loan of £4,500 to provide generating plant to give a supply of electrical energy to Barnsley and District Light Railway.

Brighton.—At the Council meeting last week some discussion arose as to orders given by the electricity department to the Reason Mfg. Co. Mr. Tozer objected to these orders being given on the ground that Mr. Arthur Wright, the Corporation's consulting engineer, was interested in the company. The mayor answered that, even if that were true, it did not matter so long as they got the best goods at market prices. Mr. Wright was not the Council's servant; he was their consulting engineer. Mr. Wright's position in the company was that the Mutual Electrical Trust Co. were shareholders in the Reason Mfg. Co., and Mr. Wright was holder of about one-third of the shares in the Mutual Company. The matter then dropped.

Bristol.—The chief constable is preparing a report on the most suitable system of fire alarms for Bristol.

Burnley.—Three additional electric tramway routes are to be constructed, completing the original tramway scheme of the Corporation.

Burton-on-Trent.—An inquiry was held on Wednesday into the application of the Council to borrow £15,630 for additional generating plant for the tramways, and for carrying out extensions of the electric lighting mains. £11,000 is for generating plant, and £4,630 for mains. For the tramway service the Corporation intend to provide 20 cars, and the overhead trolley system of traction has been decided upon. There was no opposition.

Bury (Lancs.).—The Tramways committee offer to construct an electric tramway to Whitfield, giving Whitfield Council the option of purchasing track and equipment at the end of 25 years.

Caerphilly.—The Council is making inquiry as to terms for reporting on an electric lighting scheme.

Chile.—There were recently invited by the Chilian Government tenders for the construction and laying of a submarine telegraph cable between Talcahuano and Puenta Arenas, and a committee was appointed to consider the tenders submitted. Consideration of these offers did not commend them to the committee, who declined to accept any tender sent in. The Government have now decided to have fresh soundings made between the two points, and will shortly issue fresh invitations for tenders for the cable.

Cleckheaton.—An inquiry was held on Friday into the application of the Council to borrow £6,000 for additional electricity generating plant. It was stated that the original loan of £16,650 had been expended in buildings and machinery, and it was now proposed to put in two additional boilers and a dynamo, and to erect a cooling tower at the station, so as to supply electrical energy for working the tramways of the British Electric Traction Co., who had covenanted with the Council to take a minimum supply of 400,000 units per annum. There was no opposition.

Cromer.—An inquiry will be held here next Friday into the application of the Council to borrow £25,000 for electricity supply works.

Dungannon (Ireland).—The Board of Works have approved the proposed electricity supply scheme of the Council.

Ebbw Vale.—The Council have accepted the terms of the South Wales Electrical Power Distribution Co. for the supply of electricity in bulk.

Electric Tramways in Bucks.—The Buckinghamshire County Council will not oppose the application of the London United Tramways (Ltd.) to extend its system to Slough and Maidenhead, with branches to Datchet and Langley Station.

Electric Tramways in Russia.—The question of the construction of electric tramways in St. Petersburg and Moscow has advanced a stage. The Imperial commission appointed some time ago to examine and report on the various schemes submitted for the concession for building the lines has decided that the project proposed by an American banking house and a M. Balinski should have the preference, as these persons undertake to form a connection between the Russian and Finnish railway systems, and to construct a railway bridge over the Neva. The capital expenditure is estimated at 120,000,000 roubles for St. Petersburg and 150,000,000 roubles for Moscow. The duration of the concession is 81 years, the right of purchase by the municipal authorities being reserved at 25 years. The electric lines are to be completed within five years from the granting of the concession.

Electric Tramways in Sussex—Shoreham and Southwick Councils have sealed agreements with the British Electric Traction Co. in connection with the proposal to construct electric tramways in the district.

Before consenting to the scheme of the British Electric Traction Co. for the construction of electric tramways between Worthing and Littlehampton, the Steyning Council require further particulars.

Finchley.—Sanction to a loan of £35,000 for electric lighting has been obtained by the Council.

Frimley.—The proposal to establish electricity supply has been discussed by the Council, and a special meeting is called for Sept. 22, when Mr. Brown will move that a provisional order be applied for. Meanwhile the War Office is to be approached to ascertain whether the Department is disposed to adopt electric lighting at the Royal Military College. Messrs. Medhurst and Lloyd are consulting engineers to the Council.

Garston.—The electric tramway service was inaugurated yesterday.

Glasgow.—At the Corporation meeting last week, Bailie Alexander, replying to a question, referred to the subject of tramcar accidents, and said that the Tramways committee were at their wits' end to know how these might be prevented. The Board of Trade had recommended a particular form of guard which they believed to be the best, and the Glasgow cars were to be equipped with it. Already 400 had been fitted, and an order had been placed for another 200. 22 fatal accidents had taken place between June last year and May of the present year. The tramway time-tables were regulated to give an average speed of 6½ miles per hour. In no city was the average speed less. The committee had no information with regard to the number of accidents in other cities. The department were spending £20,000 in order to fit their cars with Newell brakes.

The accounts of the electricity department, abstracted in our issue of 15th inst., were approved.

Gorton.—A proposal to establish electricity supply and refuse destructor works was discussed at Wednesday's meeting of the Council, and the matter has been referred to a joint committee of members of the Electricity, Health and Destructor committees with a view to formulating an electric lighting scheme and to ascertain the best terms on which the Manchester Corporation would accept a lease and pay all expenses of the Council obtaining an electric lighting order.

Guiseley.—A syndicate, for whom Messrs. Le Maitre and Parker are consulting engineers, will apply for powers to construct electric tramways between Leeds, Guiseley, Horsforth and Yeadon.

Hastings.—An inquiry was recently held into the application of the Council to borrow, among other sums, £644 for extensions of the electric lighting mains. There was no opposition.

Heckmondwike.—Owing to the heavy premium demanded by the tariff offices, the Council have decided not to insure the plant at the electricity works against breakdown or accident.

Hornsey (Middlesex).—Last week the Electric Light committee submitted a report from the consulting engineer (Mr. Robert Hammond) as to extensions to the generating plant and mains necessary to meet increasing demand for current. This supplemental scheme entails an expenditure of £47,400. Consideration of the matter was postponed.

Hucknall Huthwaite.—The Council recently received proposals from the Derbyshire and Nottinghamshire Electric Power Co. for the supply of electricity in bulk by the company. In the event of the Council obtaining a provisional order the company offer to give a supply at 2d. per unit for from 50,000 to 100,000 units per annum, the Council to erect a transformer station and put down mains to cost about £1,500. The site of the company's local generating station has not been definitely settled. The company's offer is under consideration.

Huddersfield.—The Corporation are applying for a loan of £5,000 for the purchase of electric motors and fittings to be let out on hire.

The tramway system of the district is to be extended. Huddersfield Corporation, Mirfield District Council and the British Electric Traction Co. are negotiating as to an extension to Mirfield.

Imports into Natal.—Included in the imports into Natal for the first six months of 1902 were electrical fittings to the value of £24,000. This compares with £31,000 for the same period in 1901.

Keighley.—The Council have applied for a loan of £6,000 for extensions of the electric light mains, &c. £750 is for services, £400 for meters, £1,200 for motors, £60 for arc lamps, and £3,280 for extension of mains. Of £3,280 for extension of mains, £2,087 has been expended in excess of the previously-acquired borrowing powers, which amount to £34,600, and other items bring the total expenditure up to £37,392.

King's Norton.—The Council have decided to lease to the City of Birmingham Tramways Co. the proposed tramway line from the

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city boundary to Cotteridge, and the junction with the Bristol-road route to Pershore-road.

Levenshulme.—Manchester electricity department will be able to give supply of electricity for public and private lighting in Levenshulme about Sept. 7.

Light Railways.—The Surrey County and Hambledon Rural Councils will oppose the Surrey and Sussex light railway scheme.

Kent County Council will oppose the Maidstone light railway scheme, as the promoters decline to make provision for the widening of thoroughfares, but the Crystal Palace light railway will proceed without opposition.

Manchester.—A report on the first year's working of the municipal tramways has been issued. At present the Corporation have 50 miles of lines in operation, and by the end of April, 1903, there will be nearly 150 miles under Corporation control, including lines leased from other local authorities. Borrowing powers amount to £1,750,000, of which over £800,000 has already been expended, and after paying £32,000 for interest and repayment of debt, £20,000 was appropriated to relief of rates. The average earnings per car was 1s. per mile, the average operating expenses 8d. The conveyance of parcels between city and suburbs and the establishment of through traffic between Manchester, Oldham, Ashton and other towns are questions under consideration.

Melbourne.—The engineer-in-chief of Victorian railways (Mr. F. Rennick) has prepared a scheme for the construction of electric tramways in Melbourne and suburbs. The present street tramways, which consist of 44 miles of cable and 4 miles of horse lines, were constructed from 12 to 15 years ago, at a cost, exclusive of cars and car sheds, of about £1,700,000, and Mr. Rennick considers that the time has come for an extension of the system, and for the introduction of electric traction on the existing lines. Thirteen new routes, aggregating 50 miles, are scheduled, and these are to be constructed on the overhead trolley system at a total cost (including equipment and track construction) of about £500,000. Mr. Rennick considers the best method of working the tramways would be to operate them in conjunction with the suburban railways, which, it is essential, should be converted from steam to electric traction in the early future, and any tramways constructed now should be dealt with as part of a general electric scheme for suburban railway and tramway working. Before the proposed tramways are constructed the question of electric power installation for working them and the suburban railways should be exhaustively investigated. Mr. Rennick has no doubt that the working of the suburban railways could be greatly improved if the trains were operated electrically. The size of trains might be halved, and the number doubled, giving a much quicker service. Before any large outlay is incurred the Government should obtain the best expert professional advice as to the conversion of the suburban railways. A committee of the Victorian Legislative Council, which made an exhaustive inquiry into the question of converting the present steam railway service into electric, had recommended the equipment of the Melbourne-St. Kilda line as an experiment. The report is before the Minister of Railways.

Municipal Telephony.—Sheffield Electric Light committee have resolved to apply for a licence to establish a municipal telephone service for an area which includes Sheffield, Rotherham, Mexborough, Penistone, Stocksbridge, Woodhouse, Eckington, Dronfield, and Hathersage, and a population of about 500,000. At present the area contains 3,300 telephone lines, and the Corporation propose to provide for 5,000. The annual revenue is estimated at £17,169, working expenses at £12,322.

Norwich.—In accordance with the agreement between the City Council and the Norwich Electricity Co., the Council are recommended to sanction the expenditure of £7,363 by the company as follows:—Balance of machinery and boilers purchased in 1901 (£1,157), water tank, &c. (£300), new mains, services, meters and wiring for new consumers (£5,000), extension to engine-room (£800), shaping machinery (£106).

Patent Application (Opposition).—The Comptroller of Patents (London) heard, on the 19th inst., a petition of the Electric Lighting Boards (British Mfg. Co.), Ltd., opposing the grant of letters patent to the Walsall Electrical Co., Ltd., upon Brown's English application No. 3,894 (1902). Mr. Brown's invention (as set out in the application) is for a method of connecting electric incandescent lamps to electric conductors for the purpose of temporary illumination, using electric incandescent lamps of ordinary construction, such as are used generally in permanent electrical illumination. The petition of the opposing company urged that the invention had been patented before, and giving particulars of six prior patents. The Comptroller, after a lengthy hearing, decided to issue letters patent to the Walsall Co., holding that Mr. Brown's invention had not been previously patented in any of the prior patents submitted by the opposing company.

St. Helens (Isle of Wight).—The Isle of Wight Electric Light and Power Co. offer to undertake the public lighting on a five years' contract at 50s. per 32 c.p. lamp per annum.

Telegraphs in Asia.—5s. 8d. per word has been fixed as the charge for messages between this country and the telegraph offices established at Port Arthur, Dalny and Talien-wan. Offices at these places were opened on the 14th inst.

Through Tramway Traffic in Yorkshire.—An informal meeting of officials of the municipal electric tramways of Leeds, Bradford, and Halifax was recently held to discuss proposals for improving the traffic arrangements on the three systems so as to render a through journey over these systems comparatively easy. It is hoped that by next spring a working arrangement will be in operation. A suggestion is that there should be through fares from Leeds to Hebden Bridge. As the gauge varies, a change of cars would be necessary.

Torquay.—A complete municipal electric tramway scheme is to be prepared, the work to be executed in sections.

The Council have authorised the erection of a second electricity generating station at a cost of £10,500, owing to inability to extend the present station.

Tramway Provisional Orders.—The report of the Board of Trade of their proceedings under the Tramways Act, 1870, during the 1902 session is issued. Of the 18 applications (particulars of which were given in our issue of Jan. 3 last) powers to construct new or extension tramways were applied for in all cases, and only the *West Riding* (Knottingley extension) order was promoted by a company. The aggregate length of the proposed tramways was 22 miles 9 chains double line and 34 miles 35 chains single line, and the estimated expenditure was £666,192.

Todmorden and *Walker* applications were not proceeded with, and local inquiries were held in the *Aberdare* and *Mountain Ash* orders, with the result that both schemes, to which there was considerable opposition, were rejected. A local inquiry was ordered also into the *Chiswick* application, but at the opening of the inquiry it was announced that the promoters had made arrangements with certain objecting parties involving the withdrawal of the application. In the cases of *Bournemouth* and *Pontypridd* applications, the Board decided against the Bournemouth order, while the Pontypridd order was approved with certain modifications.

Twelve applications were granted, and provisional orders issued by the Board of Trade and submitted to Parliament for confirmation. The orders were included in two confirmation bills, which were introduced into the House of Lords on May 5. The orders in No. 1 Bill were not opposed in either house, and the bill received Royal assent on Aug. 8.

The following orders in No. 2 Bill were petitioned against in the House of Lords, viz.:—Heywood (by L. and Y. Railway Co.), Leeds (by L. and N.W. Railway Co.), Pontypridd (by Taff Vale Railway Co. and frontagers) and West Riding (by L. and Y. Railway Co.), The petition against the Heywood order was withdrawn, subject to the insertion of an agreed clause, and the other objections were not upheld.

In the House of Commons petitions were lodged against the Leeds, Pontypridd and the West Riding orders. The Select Committee to whom the orders were referred reported, however, in favour of confirmation subject to amendments in the Pontypridd and West Riding orders. The bill received Royal Assent on Aug. 8.

Since 1870 the number of orders applied for has reached 580, of which 439 were granted and 420 confirmed by Parliament.

Tynemouth.—An inquiry was held here on Tuesday into the application of the Corporation to borrow £31,000 for electric lighting. The town clerk said that originally the Corporation borrowed £34,850, and up to the present £53,976 had been spent, or £19,126 in excess of that loan. The Corporation were supplying current to the Tynemouth and District Electric Traction Co. under agreement, and also for public and private lighting, the demand being greater than was anticipated. They had undertaken to supply current to the Tyneside Tramways and Tramroads Co. for the portion of that company's lines within the borough of Tynemouth.

United States Parcel Post.—To a small extent the arrangement announced as having been come to between H.M. Postmaster-General and the American Express Co. brings the United States into line with all other civilised countries, although the new service is so edged round with charges and exceptions that those who use the new service will need to take careful heed of the restrictions, &c., which are placed upon it. From Sept. 1 there will be established a parcels post between this country and the United States by vessels of the Cunard and White Star lines steaming from Liverpool. The limits of weight and dimensions of parcels are the same as those prevailing for the British inland parcels post. The charges are similar to those prevailing between this country and the colonies. On parcels for New York City, Brooklyn, Jersey City and Hoboken the charge for 3lb. and under is 1s., over 3lb. and under 7lb. 2s., over 7lb. and under 11lb. 3s. For any other part of the States 2s., 3s. and 4s. respectively. There is, further, a fixed charge on every parcel of 1s. for U.S. customs clearance and formalities, and a further 1s. levied by the U.S. Government under the title of "Sample Office Fee" or "Storage Fee," so that each parcel bears a fixed charge of 2s. without any regard to the postal and delivery charges. There is, in addition of course, the customs duty leviable according to the customs tariff of the United States, which is fairly compre-

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hensive. All charges may be prepaid by arrangement. Parcels can also be forwarded in bond by arrangement, and in places where parcels are not delivered by the Express Co. to the house of the addressee they are delivered to the nearest Express office of the company, and a notification of their arrival is sent to the addressee. The prohibited articles are numerous, but do not affect the electrical trades. A system of insurance has been arranged securing compensation from £12 to £120 for fees varying from 6d. to 5s. Parcel post mails are made up in London on Tuesday and Friday evenings, and in Liverpool and Dublin on Wednesdays and Saturdays. The first mail will be made up in London on the night of Sept. 2, and in Liverpool and Dublin on Sept. 3. A list of the ports of entry in the States, and other particulars, can be obtained at any post office.

Winsford.—The Board of Trade have deferred the question of the revocation of the provisional electric lighting order till January.

Workhouse Lighting.—Wakefield Guardians have decided to substitute electric for gas lighting at their workhouse, and application has been made for a loan of £1,850.

Wrexham.—It was reported to the Council on Tuesday, in regard to the relaying of certain electric lighting mains by the St. Helens Cable Co., that the work was now in progress, but the company reserved the right to go to arbitration, as they were sure that, for the most part, they were not to blame for the mishaps that had occurred. The date for commencing supply of electric energy to Wrexham and District Electric Tramways Co. is Feb. 1 next.

Wrexham and District Electric Tramways (Ltd.) are constructing an electric tramway to Rhos, and the Brymbo and Coedpoeth Parish Council are endeavouring to get the system extended to their district.

Marriage.—Mr. Tom Hawkins, director of the General Electric Co. (1900), Ltd., was married at St. Peter's Church, Bedford, on Aug. 19, to Miss Dorothy Attenborough, daughter of Mr. W. A. Attenborough, of Bedford.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

West Ham Corporation invite tenders for steam exhaust, feed water and drain piping, water softener, steam traps and separators; also circulating and air pump, discharge piping, water purifier and vapour pipes. Specifications, &c., from the borough electrical engineer (Mr. James K. Bock), and tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, Stratford, by 4 p.m. Sept. 4. An advertisement contains further particulars.

Bristol Guardians invite tenders for supply of boilers, heating apparatus, laundry and kitchen machinery and general engineering plant and for electric wiring and fittings, &c., for their new infirmary at Stapleton. Forms of tender of the clerk (Mr. J. J. Simpson), St. Peter's Hospital, Bristol, where bills of quantities (prepared by Messrs. Dolby and Williamson) can be obtained. Further particulars in an advertisement. Specifications can be inspected at the office of the architect (Mr. H. Percy Adams). 28, Woburn-place, Russell-square, London, W. Tenders to Mr. Simpson by noon Sept. 10.

Reading Corporation invite tenders for the supply, delivery, drawing in and connecting up of all feeder cables, rail return cables, test wires, &c., with joint boxes and jointing, and the carrying out of tests; also the supply, delivery, erection and connecting up of all poles, brackets, wires, cables, insulators, switch-boxes and other fittings, and the carrying out of tests, for their electric tramways department. Specifications, &c., from the engineers (Messrs. J. Bowen and I. E. Winslow), Town Hall, Reading, and specifications and drawings may be seen at, but not obtained from, the office of Mr. I. E. Winslow, 35, Parliament-street, Westminster, S.W. Tenders to Chairman of Tramways committee by noon, Sept. 18. An advertisement contains further particulars.

Limerick Corporation invite proposals for wiring consumers' premises on hire-purchase or other system. Particulars are given in an advertisement, and additional information can be obtained from the consulting engineer, Mr. J. Enright, 202, Holland-road, London, W. Proposals to town clerk (Mr. W. M. Nolan) by Sept. 1.

Bedford Electricity committee invite tenders for the supply and delivery of two boiler feed pumps. Specifications, &c., from the borough electrical engineer (Mr. R. W. L. Phillips), and tenders (addressed chairman of committee, Electricity Works, Cauldwell-road, Bedford), by Sept. 15. See advertisement.

Tenders are invited on behalf of a public institution for an electrically-propelled brougham and omnibus. Specifications, &c., from Mr. C. H. Wordingham, M.Inst.C.E, 19, Brasenose-street, Manchester. See advertisement.

Aston Manor Urban District Council invite tenders for steel coal bunkers and a coal conveyor for their electricity generating station. Specifications, &c., from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, London, S.W., and tenders (addressed chairman of Electric Lighting and Tramways committee), Council House, Aston Manor, by noon Sept. 19. See advertisement.

By command of the *Postmaster-General* tenders will be received until 10 a.m. of Sept. 29 for the supply of Swedish, Norwegian or Finland red fir telegraph poles, and for creosoting same. Forms of tender and particulars of Mr. S. C. Hooley, controller of stores, G.P.O., London, E.C.

Leicester Tramways committee require tramway track material, feeder cables, telephone and test wires, overhead electrical equipment and copper bonds, steam-raising plant, engines, generators, batteries, boosters, switchboard, overhead travelling crane, electric tramcars, &c., &c. Tenders by noon Sept. 3.

The directors of the *North-Eastern Railway Co.* invite tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders to secretary, York, by noon Oct. 7.

King's Norton and Northfield Urban District Council are prepared to lease their powers under their electric lighting order of 1898. Offers to Mr. E. Docker, 10, Newhall-street, Birmingham, by Sept. 18.

Kirkcaldy Corporation invite tenders for electricity meters. Tenders to Mr. Wm. L. Macindoe by Sept. 8.

West Riding of Yorks. County Council require tenders for wiring and fittings for the Registry of Deeds Office, Wakefield. Tenders by Sept. 1.

St. Petersburg (Russia) Town Council require tenders for the reconstruction of the existing three horse-drawn tramways in the city to electric traction, and for the construction and equipment of an electric power station. Conditions of tender, &c., can be obtained (by post or telegraph) from the Stadt-Amt., St. Petersburg, where projects have to be lodged and tenders sent by the 1st (14th) Nov.

Tenders are invited until Sept. 9, by the *French Colonial Ministry* for the supply of 50 tons of annealed galvanised iron wire, 5mm. diameter, for the post and telegraph authorities in Tonkin, and 100 tons ditto for Cochin China.

The municipal authorities of *Cabeza del Buly* (Badajoz, Spain) invite tenders until Sept. 19 for electric lighting concession for 25 years.

The Minister of the Interior, *Madrid* (representing the Director-General of Postal Telegraphs), is authorised to purchase, without formality of tender, 17,000 telegraph posts, 12,500 7 metres in length, 3,500 8 metres and 1,000 9 metres, at prices fixed for the last supplies of the goods. Particulars are given in the Madrid *Gazette* for Aug. 19 (which can be seen *by appointment* at *The Electrician* offices).

TENDERS RECEIVED AND ACCEPTED.

The Hyde, Stalybridge, Mossley and Dukinfield Tramways and Electricity Board have accepted the tender of Messrs. Underwood and Brother for the construction of tramway permanent way in Stalybridge and Mossley, and that of Messrs. Dick, Kerr & Co. for permanent way in Dukinfield and Hyde.

Swindon Corporation have accepted the tender of the Tudor Accumulator Co. for a storage battery of 252 cells and accessories at £1,102.

Wrexham Town Council have accepted the tender of the Lancashire Dynamo and Motor Co. for supply of a steam dynamo at £3,974 and of a switchboard at £484.

Peterborough Corporation have decided to instal 250 H.P. of Willans engines direct-coupled to Crompton multipolar traction generators for supplying power to the local tramways of the British Electric Traction Co.

Sunderland Corporation have accepted the tender of Messrs. Dick, Kerr & Co. for the construction of the permanent way for tramway extensions, and that of Messrs. Siemens Bros. & Co. for overhead equipment, &c.

An order has been placed with Messrs. Pritchetts and Gold, Feltham, for supply and erection of a storage battery of 1,600 ampere-hours capacity for Messrs. Willans and Robinson's new power house at the Rugby works.

Ferranti Limited have secured an order for standard switch gear for the Orange River colony. Bloemfontein Corporation has ordered a complete central station switchboard to Mr. Robert Hammond's specification, and Messrs. Ferranti are supplying their cellular-pattern gear. The system at Bloemfontein is three-phase, at 2,200 volts.

Messrs. Willans and Robinson are supplying to Victoria (Argentina) two 100 H.P. standard compound engines to be coupled to machines made by the General Electric Co. of New York. The plant is to be used for both traction and lighting purposes.

The Corlett Electrical Engineering Co. have secured a contract for the installation of plant for lighting the works and driving the machinery at the extensive foundry of Messrs. Daniel Owen & Sons, Monton, Lancs.

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BUSINESS NOTICES.

Messrs. C. A. Vandervell & Co., accumulator manufacturers and manufacturing electricians, have removed to larger premises at Chapter Works, Chapter-road, Willesden Green, London, N.W.

Messrs. C. W. Webster, A. L. Rhodes and S. W. England (trading as Rhodes and Webster), electrical engineers, City Electrical Works, Paradise-street, Bradford, have dissolved partnership. Debts by Messrs. Rhodes and England.

The partnership hitherto evisting between Messrs. L. N. Burt and E. E. Prestwich, trading as Prestwich and Burt, electrical engineers, Kingston-on-Thames, has expired. Debts by Mr. Prestwich, who continues.

Messrs. J. A. Bauer and L. E. Schramm (trading as the Electrical and General Engineering Co.) have dissolved partnership. Debts by Mr. Bauer, who continues.

Messrs. James Willats & Son, electrical engineers, &c., 19, Gray's Inn-road, London, W.C., have taken additional premises at 29, Gillingham-street, S.W.

BANKRUPTCIES AND LIQUIDATIONS.

W. Morton and W. T. Sampson, lately trading as Morton and Sampson, electrical and mechanical engineers, Trinity-buildings, Corporation-street, Warrington, have been adjudicated bankrupt.

The General Tramways Construction Syndicate (Ltd.) is to be wound up voluntarily Mr. C. R. O'Flaherty is liquidator.

Claims against the Coley Electric Works (Ltd.) must be sent by Sept. 22 to Mr. S, W. Oakley, 4, King-street, London, E.C.

Plant for Sale.—The Newcastle-upon-Tyne Electric Supply Co. (Ltd.) having recently changed over their system of supply from alternating to direct current, have some plant for disposal, particulars of which are set out in an advertisement. Additional information can be obtained from the general manager, 50, New Bridge-street, Newcastle-on-Tyne.

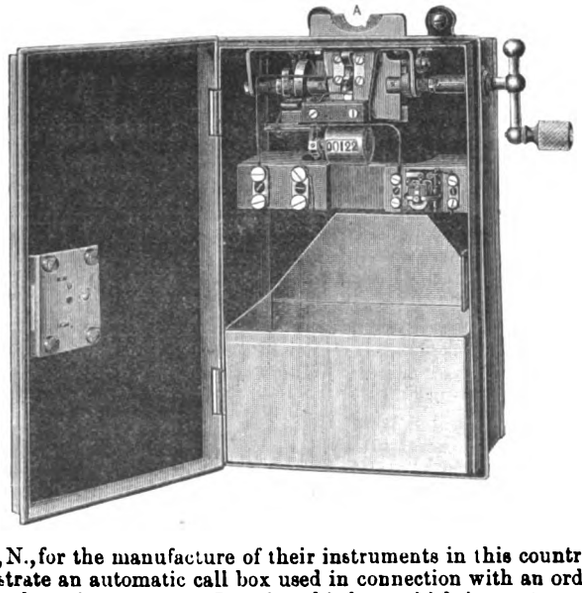
Northgate Mansions (Ltd.), Gloucester, have for sale a 20 B.H.P. gas engine, a dynamo (60 amps. 200 volts), switchboard, belting, &c. See advertisement.

Particulars of some electric lighting plant for sale are given in an advertisement. The plant includes two Crossley 16 H P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold Battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Southend-on-Sea Corporation invite tenders for electricity generating plant recently used in connection with their pier undertaking. Some particulars are given in an advertisement, and the plant may be inspected at the pier. Tenders to the town clerk (Mr. Wm. H. Snow) by 10 a.m. Sept. 4.

Mr. Thomas Johnson, Prescott-street, Wigan, has for sale three electric generating sets, each set giving 400 to 600 H.P. See advertisement.

Call Office Telephone Apparatus.—We referred recently to an exhaustive catalogue of telephone apparatus issued by Messrs. L. M. Ericsson & Co., who are erecting works at Broad-lane, Tottenham,



London, N., for the manufacture of their instruments in this country. We illustrate an automatic call box used in connection with an ordinary telephone instrument. In using this box, which is constructed for pennies only (these are inserted in the slit A), the exchange is called in the ordinary way from the subscriber's instrument, and the operator completes the connection as usual, and then requests the subscriber to pay whatever sum is required for the call. The coin or coins having been inserted and the crank turned half a revolution, a buzzer in the call box is put into action and gives a distinct signal to the operator at the exchange that payment has been made. Connection is then completed, and the conversation proceeds. The instrument is fitted with a connection counter for checking receipts, and with a good-sized cash box. The weight of the apparatus is 2·80lb. Precautions are taken to prevent fraud of every description. A similar call box in cast-iron is also made, which is provided with a vibrating spring instead of a buzzer to indicate the payment of the call money.

Gilbert Arc Lamps.—The Gilbert Arc Lamp Co., of Chingford, Essex, notify us that amongst the contracts in hand are the supply of Gilbert arcs to Eastbourne (second contract), Eccles, Kingston, Grimsby (second contract), Mansfield, and Salisbury station of the London and South-Western Railway (about 100 lamps). The second contract for lamps at Eastbourne is for alternating arcs in series and moving coil transformers, which will be placed in pits by the circuits, as arranged by the Gilbert Company at Harrogate, Newport (I.W.), &c. The company are also carrying out some contract work with yellow arcs.

Electric Pumping.—An electric hauling and pumping plant has been put down at the Manor Haigh Moor Collieries, Wakefield. Current is supplied by a 50kw. steam dynamo and a 60 H.P. motor. A large hauling gear and a set of three-throw ram pumps driven direct by motors have also been put in by the contractors, Messrs. A. Hirst & Son, of Dewsbury.

Messrs. E. Scott and Mountain (Ltd.) recently supplied an electric pumping plant to a Rhodesian mining company. Current is supplied by a 72kw. steam dynamo (Robey engine), and the installation includes motors, pumps, switchboard, &c. The first set is estimated to deliver 330 gallons of water per minute against a head of 80ft. through 6,000ft. of 6in. piping. The diameter of each ram is 10in., length of stroke 12in, and speed 35 revs. per min. The second set of pumps is designed to deliver 85 gallons against a head of 500ft. through 1,000ft. of piping at a speed of 40 revs. per min.

Exhibition.—On Tuesday Sir Wm. Preece, president of the Royal Cornwall Polytechnic Society, opened an exhibition at Falmouth, which has been inaugurated under the auspices of the Society. A large space at the exhibition is devoted to a fine display of electrical plant, machinery, apparatus and material. Sir Wm. Preece was supported by a large gathering of local notabilities, and in formally declaring the exhibition open asserted his belief that such displays were strong incentives to the encouragement of education. Such exhibitions were evidence of the skill and industry of the people, and tended to inspire emulation. Commenting upon the complaint that the Great Exhibition of 1851 was instrumental in showing to the foreigner what we were doing in this country and how we were doing it, Sir William held that that exhibition opened the eyes of English manufacturers to the fact that other countries were treading upon our heels and thus had driven us to the introduction of automatic machinery and the adoption of economical methods in our processes of manufacture. Exhibitions had called special attention to the necessity for standardisation not only in our system of measurement, but in the dimensions of our machinery. There was still great absence of this standardisation in railway and other great public works, and any exhibition that would bring about a more general system of standardisation, and ultimately the universal adoption of the metric system, would prove a benefit to commerce. It was James Watt who in 1785 advocated the metrical system, but failed to induce his fellow countrymen to adopt it, although he was successful in inducing the French to substitute it for the system then in use in that country. Exhibitions encouraged observation, skill, industry and art, and led to discrimination and judgment—the highest ends of education. He tendered the thanks of the Society to Mr. F. H. Headley for his great assistance in the electrical section of the exhibition. In the electrical section Mr. P. Storey, borough electrical engineer, Torquay, was judge, and silver medals were awarded to Tangyes (Ltd.), (gas engine). Reavell & Co. (combined electric lighting set), and Mr. F. H. Headley (patent switches); bronze medals to Mr. Headley (electrical appliances of own manufacture), Electric Lighting Boards (Ltd.) (wiring system), Johnson and Phillips (arc lamps), Drake and Gorham (dining table lighting and method of wiring), and the Bastian Meter Co. (electrolytic meter); and certificates of merit to Ashmore, Benson, Pease & Co. (accumulators), Mr. James Hendry (laminated leather work), F. and C. Osler (electroliers), India Rubber Co. (motors, &c.), American Circular Loom Co. (conduits for interior wiring), D. P. Battery Co. (accumulators), Callender's Co. (cables and cable boxes), and Simplex Steel Conduit Co. (conduits). Among the exhibitors are the Postmaster-General and Sir William Preeee, the former exhibiting a number of telegraph and telephone instruments and the latter sending a choice collection of interesting relics of early telegraph and telephone working. On Wednesday Mr. C. A. Baker, M.I.E.E., read a paper at the exhibition on "The Cornwall Electric Power Co.'s Undertaking," and this was followed later by a paper on "Cornwall—the Nursery of the Steam Engine," read by Mr. H. Davey, M.I.C.E.

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Automobile Exhibition.—An exhibition of motor vehicles was held at Berlin from May 15 to 26 last, and while the public took very little interest in the show, 103 German firms contributed to the exhibits, including all the well-known makers of automobiles in the German empire. Steam-driven vehicles were not represented, and only very few electrical vehicles were on show, the bulk of the exhibits being provided with gasoline or alcohol motors. Five-sixths of the exhibits were of the usual type of racing machines, and several of the heavier freight-carrying vehicles were on show. The chief feature of interest in connection with motor vehicles was a device invented by Prof. Klingenberg, whose invention was exhibited by the Motorfabrik Pasig-Munich. In this vehicle the motor is enclosed in a dustproof case, is geared direct to the rear axle of the carriage, thus eliminating the use of chains, cogs and belts. But it was generally agreed that no epoch-making development in the motor car industry is represented by this invention, although the device is an ingenious and useful one. A large variety of electrical ignition devices for gas and spirit motors was on show, and for many of these an effective and reliable spark with a minimum consumption of current was claimed. Some of these devices were run off storage batteries, and others by a Ruhmkorff coil or small dynamo.

The Journal.—Part No. 158 of the *Journal* of the Institution of Electrical Engineers is now ready, price 2s. Particulars of contents are given in an advertisement.

Catalogues.—The Electric and Ordnance Accessories Co. have ready a catalogue (sec. C) of main switches. Copies of this list, which is fully illustrated, can be obtained by the trade on request.

In the General Electric Co.'s pamphlet No. 41, the "Adephi" D.P. motor switch for circuits up to 500 volts is listed and illustrated, and sheets sent out with the pamphlet show Wood's patent improved combined water cart, rail cleaner and snow sweeper for electric tramways.

Messrs. Johnson and Phillips have ready three new price lists dealing with (1) hot wire, (2) iron-cased permanent magnet moving coils, and (3) iron-cased electromagnetic ammeters and voltmeters. These lists are marked "H.W.," "P.M." and "E.M.," respectively, The "H.W." list illustrates and describes a large assortment of hot-wire instruments, of which some excellent photographic illustrations are given.

Messrs. T. and T. Vicars have ready a fully-illustrated catalogue of their well-known automatic smokeless mechanical stokers. The illustrations include a number of installations of these stokers at many of the principal electricity stations of the kingdom. Messrs. Vicars are supplying a number of these machines, an order being now just completing for 20 machines for the Great Northern and City Railway.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material but not including electrical machinery, which is not separately specified) from Aug. 20 to 26, with the ports of destination :—

Aden, £173 (telegraph material). *Africa*—Alexandria, £113; Cape Town, £1,150 (telegraph wire); Chinde, £21; Durban, £1,274 (including £1,152 telegraph material); Larache, £101; Port Elizabeth, £154. *Argentina*—Buenos Ayres, £46. *Australasia*— Auckland, £67; Melbourne, £66; Sydney, £57; Wellington, £310. *Belgium*—Antwerp, £375; Ghent, £35. *British Guiana*—Demerara, £40. *Ceylon*—Colombo, £83 (including £30 telegraph material). *Channel Islands*—Jersey and Guernsey, £50. *Denmark*—Copenhagen, £494. *Gibraltar*—£152 (including £132 telegraph instruments). *Holland*—Amsterdam, £98. *India*—Bombay, £485 (including £220 telegraph wire); Calcutta, £1,024 (including £78 telegraph wire): Madras £23. *Japan*—Yokohama, £339. *Straits Settlements*—Singapore, £73 (telegraph cable). *Sweden*—Stockholm, £302. *U.S.A.*—New York, £155. Total £7,260, against £605,636 in the corresponding week last year (Aug. 21 to 27).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 7, 1902.

15,095. F. CONRAD. Instruments indicating the phase and frequency relations of alternating-current circuits. (Date applied for July 12, 1901, date of application in U.S.)*

15,103. G. C. FRICKER. Thermo-electric maximum demand indicators.

15,113. BRITISH THOMSON-HOUSTON Co. and F. HOLDEN. Apparatus for testing magnetic qualities of materials.

15,119. G. G. M. HARDINGHAM. Providing copper conductors with solid ends (Felten and Guilleaume Carlswerke A.G., Germany.)

15,124. N. ARTEMIEFF. Wearing apparel for protection from high-voltage currents.*

15,128. A. G. BLOXAM. Electrolytically coating sheet metal with zinc. (Columbus Electricitäts Gesellschaft m. b. H., Germany.)

15,142. A. VANDAM and T. H. MARSH. Lamp holders.

July 8, 1902.

15,226. A. P. S. MACQUISTEN. Electrically controlling mechanical motion.

15,244. W. P. THOMPSON. Transformers. (Louis and H. Loewenstein, Germany.)

15,245. B. PETSCH. Electro-semaphore.

15,251. C. A. KELLER. Electric smelting and refining.*

July 9, 1902.

15,299. S. B. HARDCASTLE. Coventry. Contact breakers.

15,310. A. WILSON. Glasgow. Telephone receiver.

15,311. L. S. ANDERSSON. Glasgow. Arc lamps.

15,312. L. A. GÉNARD. Glasgow. Accumulators.*

15,324. J. KROPFENSTEIN. Device for employing low-tension lamps of high amperage on circuits of any voltage.

15,325. L. MORNAT. Controlling electric current in theatres.

15,334. J. F. CUMMINGS. Conduits.

15,346. H. H. LAKE. Magnetic clutches. (General Electric Co. U.S.)

15,347. H. H. LAKE. Arc lamps. (General Electric Co., U.S.)

15,350. W. P. THOMPSON. Liverpool. Arc lamps. (C. J. Toerring, U.S.)

July 10, 1902.

15,373. R. F. HALL. Birmingham. Covers of dynamos and motors.

15,374. R. F. HALL. Birmingham. Dynamo-suspension gear for electric lighting of railway carriages.

15,378. H. W. COX. Nottingham. Switches.

15,381. J. T. DAWES. Liverpool. Magnetic separators.

15,397. L. MARSTON and R. H. JONES. Birmingham. Telephone receivers.

15,413. W. J. DAVY. Arc lamps.

15,417. G. L. HOGAN. Multiplex telegraphy.

15,431. Hon. C. A. PARSONS. Regulating device for electrical machines driven by steam motors. (C. E. L. Brown, Switzerland.)

15,435. H. H. LAKE. Secondary batteries. (Consolidated Batteries Co., U.S.)*

July 11, 1902.

15,454 and 15,455. T. H. HALL and C. HALL. Birmingham. Switches.

15,456. ELECTRIC AND ORDNANCE ACCESSORIES Co. and R. F. HALL. Birmingham. Brush gear.

15,458. A. H. HICKLEY. Liverpool. Mounting brushes of switches, dynamos, motors, &c.

15,463. C. T. A. HENSHAW. Edinburgh. Pendants.

15,465. J. MCKAY. Manchester. Life-guard.

15,470. C. HOLGATE and P. G. COMMIN. Manchester. Clip for lamp shades.

15,488. OTIS ELEVATOR Co. Controlling devices for motors for elevator and like work. (Otis Elevator Co. (Incorporated), U.S.)

15,511. E. WIGLEY. Measuring instruments.

15,527. A. BLONDEL. Wireless telephony.

July 12, 1902.

15,555. R. ELSON. Manchester. Joint boxes.

15,591. J. H. DOWSING. Electric stoves.

July 14, 1902.

15,618. J. RAMSEY. Leeds. Splicing ears for trolley wires.

15,651. B. J. B. MILLS. Trolley. (Léon Chapius et Cie., France.)

15,674. A. B. HOLSON. Electric motors. (Date applied for, July 5, 1901, date of application in U.S.)*

15,677. A. H. JOHNSON. Bonding wheels having a non-conducting body.

15,696. J. BONNEAU. Electric furnaces.

July 15, 1902.

15,714. C. D. BURNET. Liverpool. Fuse boxes or cutouts.

15,715 and 15,716. C. D. BURNET. Liverpool. Conductor junction box.

15,735. J. BAILEY. Birmingham. Electro-plating.

15,747. M. SUTHERLAND and E. MARCUSON. Storage batteries.

15,753. BRITISH THOMSON-HOUSTON Co. and F. HOLDEN. Electricity meters.

15,764. J. S. STEVENS, C. G. MAJOR, E. C. STEVENS and P. H. STEVENS. Control of electric lifts.

15,772. A. L. SHEPARD. Electric batteries.

15,777. F. D. GOLBY. Telephone instruments.

15,784. C. B. THWING. Thermo-electric couples and generators.*

15,795. A. BEER. Transmitting electricity to vehicles on electric railways.

15,807. C. D. SEDNEFF. Electric accumulators.

July 16, 1902.

5,618A. J. CERVERA. Baviera. Interrupters for induction coils. (Date claimed, March 6, 1902.)*

5,618B. J. CERVERA. Baviera. Switches for wireless telegraphy. (Date claimed, March 6, 1902.)*

15,813. E. BUNTING and WILSON AND BENNETT, LIMITED. Manchester. Safety device for electric tramcars.

15,814. R. F. HALL. Birmingham. Dynamos and electro-motors.

15,815. ELECTRIC AND ORDNANCE ACCESSORIES Co. and R. F. HALL. Birmingham. Fuse boxes.

15,821. K. QUANCY. Stafford. Electro-pneumatic system of temperature finding.

15,823. G. H. NISBETT. Liverpool. Fuse boxes or cut-outs.

15,824 and 15,825. G. H. NISBETT. Liverpool. Rail bonds.

15,832. H. L. P. BOOT and H. J. DAWES. Tunbridge Wells. Automatic prepayment calling apparatus.

15,842. J. C. ETCHELLS. Manchester. Switches for electric hoists.

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

7,617. J. VAUGHAN-SHERIN. Electric meters.
12,023. KIELPINSKI. Alarm apparatus.
12,350. RONAN. Revolving electric igniters for internal combustion engines.
13,033. SIEMENS BROS. & Co. (LTD.) and LYDALE. Polyphase electric motor.
13,662. RASCHEN and UNITED ALKALI Co. Electrolytic cells.
13,738. HEYLAND. Preventing sparking.
14,551. BARWELL, BARWELL, KIMBERLEY and SMITH. Suspension fittings.
15,154. HIRST and HOLLAND. Adjustable holders for incandescent electric lamps.
15,448. PELENC. Recorders for use in submarine telegraphy.
15,460. WISE (A. G. "Magneta," Elektrische Uhren ohne Batterie und ohne Contacte). Electric clocks.
15,463. KUETTNER. Secondary battery plates.
15,475A. JUSTICE. (Rowland Telegraphic Co.) Synchronising dynamo-electric machines. (Date claimed July 30, 1901.)
15,514. ASHTON. Electrical primers, vent sealing tubes and the like.
15,659. WESTINGHOUSE. Electric lighting of railway tunnels.
16,340. RIGGS. Electrically-operating railway switches.
16,762. FARRELL. Switches.
16,814. WILSON. Prevention of danger from falling telephone, telegraph, or other wires.

NEW COMPANIES, STATUTORY RETURNS, &c.

IDDON BROS. (LTD.)—Reg. Aug. 18, capital £25,000 in £1 shares, to carry on the business of iron and brass founders, electrical and mechanical engineers, machinists, manufacturers of electric cables, indiarubber goods, &c. The first director is Mr. J. Iddon. Reg. office: Brookfield Ironworks, Leyland, Lancs.

JOHN JONES & SONS, ST. GEORGE'S IRONWORKS (LTD.)—Reg. Aug. 19, capital £50,000 in £10 shares, to acquire the business of John Jones & Sons, and to carry on the business of shipbuilders, builders of torpedo boats, submarine and other vessels, electricians and electrical engineers, and to establish and maintain telegraph and telephone systems, &c. Mr. C. J. Jones is first manager.

WORCESTER ELECTRIC TRACTION CO. (LTD.)—Reg. Aug. 22, capital £120,000 in £5 shares, to carry on in the United Kingdom or elsewhere the business of electrical engineers, electricians, carriers of passengers and goods, &c. Reg. office: Donington House, Norfolk-street, London, W.C.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 1/16d. per oz. (Aug. 28). Consols (2¾ per cent.) 94 1/16—94 3/16 for money, 94 1/16—94 3/16 for account; 2½ per cent. 95—95¼ (Aug. 28). Consols Pay day, Sept. 1; Stocks and Shares Continuation Days, Sept. 9 and 24; Ticket Days, Sept. 10 and 25; Pay Day, Sept. 11; Mining Share Carry-over Days, Sept. 8 and 23.

ACCUMULATOREN UND ELEKTRICITATSWERKE ACTIENGESELLSCHAFT VORMALS W. A. BOESE & CO.—At the annual meeting at Berlin recently, some details were given as to the financial outlook for the accumulator industry in Germany and Austria. The Austrian branch of the company's business was reported to be suffering, not only from the industrial depression, but from over-taxation. The combination of manufacturers, formed to regulate prices and sales, was reported to be still in existence, but its operations were nullified by the action of one large firm. The introduction of the Stone system of electric lighting in railway carriages was being pushed by the firm, and was stated to be making headway in both Germany and Austria. The orders for accumulators on the company's books were said to be £20,000 better than in the previous year. The profits for the year allowed of a 4 per cent. dividend.

ACCUMULATORENWERKE OBERSPREE AKTIENGESELLSCHAFT.—In the years 1899 (the year of its incorporation) and 1900 no dividend was paid by this company, although in 1900 a small profit of 9,707m. was made. The year 1901 closed with a loss of 671,855m. The majority of the shares in this company are held by the Accumulatoren Fabrik Aktiengesellschaft Berlin-Hagen, and the Oberspree works are now shut down.

BLACKPOOL AND FLEETWOOD TRAMROAD CO.—At the meeting last week the chairman (Mr. G. Richardson) said the receipts showed a slight decrease on account of bad weather. A new accumulator house had been erected which would effect a great saving in operating expenses. A dividend of 4 per cent. was declared.

BRITISH POWER, TRACTION AND LIGHTING CO. (LTD.)—A meeting was held at York on Monday to which reporters were refused admittance.

CARBON FACTORY IN SPAIN.—The Compania Fabril de Carbones Electricas has been formed in Barcelona, with a capital of £80,000, to carry on electric carbon manufacturing works at San Vicente de Castellet.

COMPAGNIA NORWEGA-MEXICANA.—A company has recently been formed at Mexico City to import into the country telephone instruments, apparatus and accessories from Norway, and for exporting Mexican produce, &c., into Norway. It is stated that the company has recently succeeded in securing a large order for telephonic apparatus and materials for installation in Mexico.

THE FINANCE OF ALUMINIUM.—According to the *Elektrochemische Zeitschrift* the Aluminium Industrie Aktien Gesellschaft, of Neuhausen, has earned profits sufficient to pay a dividend of 13 per cent. on its ordinary share capital for 1901. The total surplus on the year's working was 2,036,617fr., and after placing 66,345fr. to reserve, 50,000fr. to bonus and similar funds, and paying the above dividend, a balance of 78,569fr. is carried forward. The directors' report contains a reference to the conference of aluminium producers held in 1901, and to the ratification in November of the decisions of this conference. The object of an agreement between aluminium producing firms is to "sustain prices." The Aluminium Industrie Aktien Gesellschaft produce calcium carbide and other electro-metallurgical products, in addition to aluminium, and the company's three factories at Neuhausen, Rheinfelden and Lend-Gastein in Austria are exceptionally well situated for supplying central Europe with these products.

WIRRAL RAILWAY CO.—At the meeting on Monday the chairman (Mr. T. H. Jackson), speaking as to tramway extensions in the district, said that, although the Wirral Company might expect competition from the tramways, it would, no doubt, be the means of increasing the prosperity of the district, and in that the company would share. There were in the air certain schemes affecting their interests, but these were not sufficiently ripe to put before the shareholders.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	AGGREGATE. No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Aug. 16	1,155	+ 218	11	12,729	+ 3,057
Ayr Corporation	„ 23	420	...	14	5,648	...
*Birmingham Tramways.	„ 23	4,709	- 159	7	34,623	+ 731
*Blackburn Corporation..	„ 22	794	- 69	22	18,315	+ 3,365
Blackpool Corporation...	„ 21	2,535	- 190	21	22,852	— 969
Blackpool and Fleetwood	„ 23	1,912	- 509	8	11,824	- 1,263
Bolton Corporation	„ 24	1,953	- 80	21	34,564	+ 1,963
Bradford Corporation ...	„ 24	3,688	+2,327	21	71,220	+48,388
Brighton Corporation ...	„ 24	1,065	...	39	28,046	...
Brisbane Tramways.....	July 9	2,348	+ 592	2	4,858	+ 1,150
*Bristol Trams & Carriage	Aug. 22	4,995	+ 872	7	36,685	+ 6,909
*Buenos Ayres & Belgrano	July 27	2,571	+ 19	4	11,268	+ 616
Burnley Corporation ...	Aug. 23	696	+ 246	‡21	14,980	+ 5,571
Calcutta Tramways Co...	„ 23	R25,321	+R4,966	8	R197,731	+R31,452
Cardiff Corporation	„ 23	1,634	...	21	28,399	...
Carlisle Tramways Co....	„ 23	212	- 16	†34	5,936	+ 383
Central London Railway	„ 23	5,482	+ 73	8	51,582	+ 4,966
Chatham & Dist. Lt. Rys	„ 21	523	...	¶9	5,016	...
City & South London Ry.	„ 21	2,645	+ 948	8	22,141	+ 7,532
Cork Elec. Tramways Co.	„ 21	1,016	+ 439	§33	18,364	+ 2,648
Devonport & Dist. Trams	„ 15	516	+ 92	32½	13,898	+ 490
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	„ 23	320	- 14	21	5,105	— 167
Dublin & Lucan Railway	„ 24	172	+ 34	8	1,110	- 78
Dublin Southern Dist....	„ 22	1,036	- 151	†8	8,593	- 1,025
Dublin United	„ 22	3,909	- 210	†8	30,903	
Dudley—Stourbridge ...	„ 15	829	+ 106	32½	24,013	+ 3,236
*Dundee Corporation ...	„ 20	764	+ 67	...	...	...
East Ham Council	„ 23	491	- 12	9	4,788	+ 557
Gateshead & Dist. Trams	„ 15	836	+ 205	32½	23,378	+ 3,680
Glasgow Corporation ...	„ 23	11,686	- 1,739	12	141,726	- 3,026
Gravesend	„ 15	219	...	2	513	...
Greenock & Port Glasgow	„ 15	709	+ 528	32½	15,971	+ 9,643
Hartlepool Tramways ..	„ 15	383	+ 118	32½	8,175	+ 997
Hull Corporation	„ 23	1,726	...	21	37,090	+ 1,469
Isle of Thanet Co.	„ 23	1,905	+ 110	8	11,814	+ 22
Kidderminster & Dist....	„ 15	150	+ 9	32½	4,021	+ 16
Leeds Corporation	„ 23	5,119	+ 271	22	113,906	+18,781
*Liverpool Corporation...	„ 16	10,091	+ 734	33	317,673	+26,468
Liverpool Overhead Rly.	„ 24	1,670	- 108	‡8	13,138	— 946
Manchester Corporation	„ 23	5,164	+2,815	62	173,922	...
Merthyr.....	„ 15	208	- 35	32½	6,609	- 1,258
Middleton	„ 15	336	...	20½	6,407	...
Newcastle-on-Tyne Corp	„ 23	2,794	...	...	...	—
Oldham, Ashton & Hyde.	„ 15	628	+ 50	32½	16,899	+ 688
Perth (W.A.) Elec. Trams	„ 22	944	+ 172	¶33	35,531	+ 5,844
Poole & Dist.....	„ 15	389	+ 42	32½	8,108	- 115
*Portsmouth Corporation	„ 16	2,960	+1,803	...	...	...
	„ 23	2,581	+1,181			
Potteries	„ 15	1,389	+ 134	32½	47,299	+ 1,855
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ...	„ 24	4,268	+ 285	8	34,728	+ 9,169
Southampton Corp.	„ 21	1,191	+ 37	...	...	...
Southend Corporation...	„ 20	455	+ 68	20	6,154	...
Southport Tramways ...	„ 15	423	+ 173	32½	8,020	+ 2,779
*S. Staffordshire Trams...	„ 15	698	- 78	32½	25,126	+ 315
Sunderland Corporation.	„ 24	1,386	- 176	21	25,873	+ 2,033
Swansea Trams.....	„ 15	555	- 13	32½	15,224	+ 1,163
Taunton Trams.....	„ 15	160	...	32½	2,143	—
Tynemouth & Dist.	„ 15	505	+ 118	32½	9,223	+ 886
Weston-super-Mare	„ 13	357	...	14½	3,271	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 15	274	+ 177	32½	5,688	+ 3,803

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

PRESENT AMOUNT.	AMOUNT OF SHARE.	LAST DIVIDEND.	NAME.	PREVIOUS WEEK'S PRICE, AUG. 20.	PRICE WEDNESDAY, AUG. 27.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS DONE DURING WEEK ENDING AUG. 27.
			ELECTRICITY SUPPLY.			£ s. d.		Highest / Lowest
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ ⅞	¾ ⅞			
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103 106	103 106	4 6 0		
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11½ 12½	11½ 12½	5 12 0		
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½ 10½	9½ 10½	4 5 9		
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101 104	101 104	4 6 7		
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord	9½ 10⅛	9⅛ 10	4 0 0		
20,000	5	3/6	Do. 7 per Cent. Preference	9⅛ 10½	9⅛ 10	3 10 0	March and September	9⅝
30,000	5	3/6	Calcutta Elec. Supply Ordinary (1 to 30,000)	7½ 8⅛	7⅝ 8⅛	3 10 7		
10,000	5	...	Do. (30,001 to 40,000)	7 8	7 8			
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	108 108	106 108	3 14 8		
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	8½ 9⅛	9 9¼	5 5 3	February and August	9⅜ 9 7/16
20,000	5	...	Do. (50,001 to 70,000)	8 9	8 9	...		
70,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5⅝	5⅝ 5¾	3 18 3	" "	5 9/16
40,000	5	..	Do. City Undertaking 4½% Cum. Pref.	4⅝ 5¼	4⅝ 5¼	...		
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105 107	105 107	3 14 9		106
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5¼ 5⅝	5½ 5⅝	2 12 2	March	5⅝ 5⅝
£150,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	109 112	109 112	4 0 6	June and December	
70,595	10	10/0	City of London Electric Lighting Ord.	9 10	9 10	5 0 0	February and August	9½
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12 13	12 13	4 12 4	January and July	12⅝ 12⅝
£400,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December	
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	102 105	103 106	4 5 10		105 103
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½ 9¼	8½ 9⅛	4 4 3		
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12 12½	11½ 12⅛	4 16 0	March and September	12 1/16 11 15/16
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	109 112	109 112	4 1 1		111
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5⅝ 6½	5⅝ 6½	3 12 0		
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102 105	102 105	...		
11,000	5	4/6	Hove Electric Lighting Ordinary	7 8	7 8	5 0 0		
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10½ 11½	10½ 11⅝	4 6 11		
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6½ 6⅝	6½ 6⅝	4 8 11	January and July	
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101 104	101 104	3 16 11		
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105 108	105 108	3 15 0		
£111,000	3	..	London Electric Supply Ordinary	1⅝ 2⅛	1⅝ 2⅛			2 1 1/16
42,840	5	3/0	Do. 6 per Cent. Preference	5 5⅛	4⅝ 5¼	5 14 3		5 5/16 5
£350,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	96 99	96 99	4 1 2	Mar., June, Sept., Dec.	97
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15 16	15 16	4 7 6	April and October	15⅝ 15⅝
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	108 112	108 112	4 0 5	June and December	
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99 102	99 102	3 9 2		
10,852	10	6/0	Notting Hill Electric Ordinary	13⅛ 14⅛	13⅛ 14⅛	4 2 9	March	14⅛ 13⅝
12,194	5	5/0	Oxford Electric Ordinary	5 6	5 6	4 3 4	"	
£50,000	Stock	4%	Do. 4% Debenture Stock	97 100	97 100	4 0 0		
300,000	1	...	Rand Electric	⅞ 1	⅞ 1	...		
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70 75	70 75	...	January and July	
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103 105	103 105	4 7 0	April and October	
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	15
20,000	5	3/6	Do. 7 per Cent. Preference	8⅝ 9⅛	8⅝ 9⅛	3 13 8	" "	9½
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97 100	97 100	3 10 0		
12,000	5	..	Smithfield Markets Electric Supply Ordinary	1⅝ 2⅛	1⅝ 2⅛			
£50,000	Stock	4%	Do. 4% Debentures	80 90	80 90	4 8 11		
65,000	5	...	South London Electric Supply Ordinary	2½ 3	2⅞ 3	...		2 1/16 2 1/16
30,000	5	..	Urban Electric Supply Ord. (£3 paid)	...	2⅞ 3⅛	...		3 2 1/16
30,000	5	..	Do. 5% Cum. Pref.	...	2⅞ 3⅛	...		3 ...
110,000	1	5 6	Westminster Electric Supply Ordinary	11 12	11 12	4 11 8	March and September	11⅝ 11 7/16
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5⅝ 6⅛	5⅝ 6⅛	4 0 0		
			ELECTRIC RAILWAYS, TRAMWAYS, &c.					
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4⅛ 4⅜	4⅛ 4⅜	4 11 5	April and October	4⅜ 4 5/16
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125 130	125 130	4 12 2		1 8
20,000	10	6/0	Barcelona Tramways Ordinary	9 11	9 11	2 14 7		
10,000	10	5/0	Do. 5% Cumulative Preference	8⅛ 9⅛	8⅛ 9⅛	5 5 3		
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	93 98	95 100	4 10 2		
15,000	10	9/0	Blackpool and Fleetwood Tramways	13½ 14½	13½ 14½	4 9 8		
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3¾ 4½	4¾ 5¼	...		3⅜
75,000	5	2/6	Do. 5% Cum. Pref.	4¼ 5	4¼ 5	5 0 0		4⅜
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	103 106	103 106	4 5 0		105½
50,000	10	8%	Bristol Tramways and Carriage Ordinary	20½ 21½	20½ 21⅜	3 14 2	February and August	
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0		
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106 108	106 108	3 14 9½	February and August	
20,000	10	4/0	British Columbia Electric Railway Ordinary	7 7⅛	7 7⅛	2 13 4		7 1/16 7⅛
20,000	10	5/0	Do. 5% Preference	9½ 10	9⅜ 9⅝	5 2 7	May and November	
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	103⅝ 105⅞	103⅞ 105⅞	4 6 5		
100,000	10	12/0	British Electric Traction Ordinary	12⅜ 13⅛	12⅜ 13⅜	6 13 4		13 12⅝
100,000	10	6/0	Do. 6% Cum. Pref.	12½ 12⅝	12⅜ 13	4 12 4	February and August	12 13/16 12 11/16
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9		125⅝ 125
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅜ 1⅝	1⅜ 1⅝	...		
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅜ 5⅛	4⅜ 5⅛	5 14 3		5⅛
27,500	5	10/0	Do. "B"	5 5⅛	5 5⅛	5 9 1		5 7/16 5 7/16
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 9		
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 11		
70,000	10	6/0	Calcutta Tramways	7 7⅛	7 7⅛	4 0 0		7
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107 109	107 109	4 3 1		107½
480,000	1	1/2⅞	Cape Electric Tramways Shares	2⅛ 2⅜	2⅛ 2⅜	6 4 6		2⅜
£1,860,014	Stock	4%	Central London Ordinary Stock	103 106	103 106	3 15 6	June and December	105½ 105
£494,993	Stock	4%	Do. 4% Preferred Stock	104 107	104 107	3 14 9		106
£494,993	Stock	4%	Do. Deferred Stock	103 106	103 106	3 15 6		106½ 105
£698,201	100	4%	Do. 4% Deb.	115 118	115 118	3 7 8		117½
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5½	5 5⅛	4 10 9		
£800,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11		
£1,330,000	Stock	3%	City and South London Railway Gen. Ordinary	71 73	72 74	3 11 7	February and August	73½ 72⅝
37,500	10	1/0⅛	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	" "	
10,000	10	0/11⅛	Do. (60,001 to 70,000)	.. ...	... ...	...		
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	127 130	127 130	3 17 0	" "	
£200,000	Stock	5%	Do. (1896)	126 129	126 129	3 17 6		
£150,000	Stock	5%	Do. (1901)	121 125	121 125	4 0 0		
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115 118	115 118	3 9 7	May and November	
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅜ 12⅛	11⅛ 12⅜	4 8 0		
52,987	10	6/0	Do. 6 per Cent. Preference	14⅜ 15⅜	14⅛ 15⅛	3 17 5		
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8		
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½ 4⅝	4 4⅛	6 13 4		
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99 102	99 102	4 18 0		
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8		
20,000	10	8%	†Imperial Tramways Ordinary xd	23 24	23 24	2 17 2	March and September	
10,000	10	6%	† Do. 6 per Cent. Preference	13½ 13⅝	13½ 13⅝	4 7 3½	" "	
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	108 110	108 110	4 1 9	January and July	
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4½ 5	4½ 5	5 0 0		
37,500	10	1%	Liverpool Overhead Railway Ordinary xd	4⅝ 4¾	4⅝ 4¾	2 4 5	February and August	
10,000	10	5%	Do. 5 per Cent. Preference xd	9⅞ 10⅛	9½ 10½	4 17 7	" "	
£135,000	Stock	4%	Do. 4 per Cent. Debenture	99 101	99 101	3 19 3	January and July	
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	10⅜ 11⅛	10⅜ 11⅛	4 8 11		11⅛ 10 15/16
30,999	10	2/3	Do. (£7. 10s. paid)	8 8⅛	8 8⅛	4 8 6		
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	108 110	108 110	3 12 9		109 108⅝
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	81 83	81 83	...		
$3,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds.	112 117	112 117	4 5 7		
£60,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908)	106 108	106 108	4 14 5		
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	105 107	106 108	4 3 6		107
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 13 4		
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½ 4½	3½ 4½	6 13 4	May	
£181,800	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93 98	93 98	5 2 0		
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100 103	100 103	4 17 5		
6,334	10	8/0	Potteries Electric Traction Ordinary	8½ 9⅜	8½ 9⅜	4 4 3		
10,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	February and August	
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108 111	108 111	4 1 10		
£50,000	1	...	South Lancashire Electric Traction & Power Ord.	...	...	...		
[illegible]	1	...	Do. 6% Preference (£4/0 paid)	...	...	...	April and October	

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 20.	Price Wednesday, Aug. 27.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Aug. 27. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)...	98 102	98 102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph.....	3½ 4½	3½ 4½	...	June and December ..	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70 80	70 80	..	...	...	...
£788,840	Stock	15/0	Anglo-American	47 50	47 50	5 17 0	Feb., May, Aug., Nov.	...	...
£3,105,580	Stock	30/0	Do. Preferred.....	92 94	92 94	6 2 4	" "	93½	92½
£3,105,580	Stock	2/0	Do. Deferred	7½ 8	7½ 7½	1 5 10	" "	7½	...
£13,333,300	£100	£1½	Commercial Cable Capital Stock.....	155 165	160 170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock.....	95 97	95 97	4 2 6	" "	96½	95½
16,000	10	4/0	Cuba Submarine Ordinary	5 6	5 6	6 13 4	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	12½ 13½	13 14	7 2 6	" "	13½	13½
13,000	5	2/0	Direct Spanish Ordinary	2½ 3½	2½ 3½	5 14 4	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7½ 8½	7 8	6 5 10	" "	7⅛	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99% 103%	97% 103%	4 7 8	January and July	...	...
80,710	20	4/0	Direct United States Cable	10 11	10 11	5 18 2	Jan., Apr., July, Oct.	...	...
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos.	99 102	99 102	4 8 8	June and December ...	...	...
£4,000,000	Stock	65/0	Eastern Ordinary ... xd & bonus ..[to 1,200) (red.)..	117 127	118 128	5 9 8	Jan., Apr., July, Oct.	122½	119
£1,955,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	87 90	88 91	3 17 4	" "	89½	88
£1,584,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108 112	108 112	3 12 2	May and November ...	108½	108
300,000	10	2/6	Eastern Extension	11½ 12½	11½ 12½	5 12 0	Jan., Apr., July, Oct.	11½	11⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107 112	107 112	3 11 4	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1900	98 101	98 101	3 19 3	February and August	...	...
£300,000	20	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)..	100% 103½	100% 103½	3 18 3	May and November ...	...	...
150,000	10	5/0	Great Northern of Copenhagen	25 27	25 27	5 11 1	January and July	...	...
£70,000	100	4½	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(with no Nos	99 102	99 102	4 8 1	June and December ...	...	...
17,000	25	37/6	Indo-European.....[1 to 1,200) (red.	38 42	38 42	5 19 1	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	102 106	102 106	5 16 7	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.) ...	99 102	99 102	3 16 5	June and December...	...	...
76,609	10	...	*West African Telegraph Shares	3½ 4½	3½ 4½	...	...	...	...
£139,300	100	5%	Do. 5% Debentures.(red.)	... ...	... ...	...	March and September	...	...
30,008	2½		West Coast of America.....	½ ⅝	½ ⅝	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97 100	97 100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	¼ ½	¼ ½	...	May and November ...	...	...
34,563	10	£/0	Do. 6 per Cent. 1st Pref.	4½ 5½	4½ 5½	11 8 6	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3 4	3 4	...	" "	...	...
£30,000	100	5%	* Do. 5 per Cent. Debentures	99 102	99 102	4 18 0	January and July	...	...
207,980	10	3/0	Western Telegraph (late Brazilian Submarine)	11½ 12½	11½ 12½	5 16 4	Mar., June, Oct., Dec.	11⅝	11⅛
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1866)	101 104	101 104	4 16 2	June and December...	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)...	97 100	97 100	4 0 2	...	97½	...
			TELEPHONES.						
44,000	£5	5/0	Chili Telephone (fully paid)	3½ 4	3½ 4	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	2/6 2/9	1/0 2/0	15 0 0	April and October.....	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½ ⅝	½ ⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾ 1	1	5 0 0	"	...	...
£963,333	Stock	6%	National Co. Preferred Stock	92 96	92 96	6 5 0	...	94½	92½
200,000	5	1/8·67	Do. Preferred Shares	4½ 4¾	...	6 4 6	...	...	...
£1,966,667	Stock	4½%	Do. Deferred Stock	54 58	54 58	7 15 2	...	56½	55
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	11 13	11 13	4 12 4	February and August	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	10 11	10 12	5 0 0	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4½ 5	4½ 5½	5 0 1	" "	...	...
£3,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)...	95 98	96 99	3 10 10	June and December ..	...	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102 106	102 106	3 15 6	...	...	...
171,504	1	0/6½	Oriental	1⅛ 1⅛	1⅛ 1⅛	5 12 11	April and October.....	1⅛	...
58,000	5	4/6	United River Plate	4½ 5½	4½ 5½	6 13 4	July	5½	5⅛
40,000	5	2/6	Do. 5% Cumulative Pref.	4½ 5	4½ 5	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101 104	101 104	4 16 2	June and December ...	...	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½ ⅝	½ ⅝	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	½ ⅝	½ ⅝	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	½ ⅝	½ ⅝	12 0 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary	7½ 7¾	7½ 7¾	6 9 0	July and February ...	...	...
80,000	5	3/0	Do. 6 per Cent. Preference	5½ 5¾	5½ 6	5 0 0	January and July	...	...
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	101 104	101 104	4 6 1	...	...	...
200,000	...	3/0	British Westinghouse 6% Preference.....	5⅞ 6½	5⅞ 6½	4 18 0	...	6⅛	6
£500,000	Stock	14/0	Do. 4 per cent. Mortgage Deb. Stock	98 105	103 105	...	...	...	...
105,721	5	...	Brush Electrical Engineering	1½ 1⅝	1½ 1⅝	..	March	...	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1½ 2	1½ 2	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock ...	102 105	102 105	4 7 5	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	93 98	93 98	4 11 6	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15½ 16½	15½ 16½	4 10 11	" "	16½	15½
40,000	5	3/6	Do. 5 per Cent. Cumulative Preference..	5⅞ 6	5⅞ 6⅛	4 0 0	" "	6⅛	5⅞
£90,000	Stock	4½	Do. 4½ per Cent. 1st Mortgage Deb.(red.)...	103 113	109 113	3 19 8	November and May ...	...	...
450,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid).....	1 1½	⅞ 1½	5 6 8	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	54 99	94 99	4 11 0	...	...	...
60,000	1	1/0	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	9 2 0	March	...	...
85,000	3	1/9½	Crompton and Co. (Nos. 1 to 54,000)	2½ 3	2½ 3	6 0 0	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb.(red.) ...	101% 106%	101% 106%	4 14 4	...	...	...
99,361	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅞ 1	⅞ 1	...	February and August	...	...
17,139	5	...	Do. (£5 paid).....	1½ 2⅛	1½ 2⅛	...	" "	...	...
£344,028	Stock	4%	Do. 4 per Cent. Mortgage Deb.Stock(red.)	74 78	74 78	5 3 0	June and December ...	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	78 83	78 83	6 2 10	...	...	...
550,000	5	4/0	Edmundson's Electricity Corporation Ord.....	6½ 6¾	6½ 6¾	5 3 3	Half-yearly	6¾	6½
80,000	5	3/0	Do. 6% Cumulative Preference	6 6⅛	6 6⅛	4 12 4	...	6⅛	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.) ...	107 110	107 110	4 2 1	...	108	...
112,100	2	1/3½	Electric Construction Co.	1⅝ 2½	1⅝ 2½	5 6 8	January and July	1⅝	...
31,390	2	2/3½	Do. 7 per Cent. Cumulative Preference	2½ 3	2⅝ 3	4 13 4	July	2⅛	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	98 101	99 102	3 19 1	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾ 1½	¾ 1½	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	9½ 10½	9½ 10½	4 17 7	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	99 102	99 102	3 19 5	...	...	...
35,000	5	5/0	Henley's Telegraph Works Ordinary	16 17	16 17	4 8 3	February and August	16½	...
35,000	5	3/3	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	" "	5¾	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb.Stock(red.) .	111 115	111 115	3 18 3	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	4 12 0	" "	20⅞	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½ 15½	14½ 15½	6 9 0	July	...	...
37,250	12	1½/0	Telegraph Construction and Maintnce.	37 40	38 41	5 17 0	March and July	39½	38½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
25,000	5	3/0	Do. Manufacturing Ordinary	... ...	... ...	5 14 3	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	... ...	... ...	4 3 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	... ...	... ...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.....	... ...	... ...	...	" "	...	...
			FINANCIAL, INVESTMENT, &c.						
19,980	5	3/0	Electric and General Investment 6% Cum. Pref. ...	5½ 5¾	5½ 5¾	5 9 1	...	...	...
199,237	10	4/9	Globe Telegraph and Trust	9 10	9 10	5 5 0	Jan., Apr., July, Oct.	9½	9½
199,943	10	3/0	Do. 6 per Cent. Preference	12½ 13½	13 14	4 5 9	" "	13½	12⅝
11,250	5	4/0	Reuter's.....	6½ 7½	6½ 7½	5 6 8	April and October.....	7⅝	...
2,208	£100 Cert	6%	Submarine Cables Trust	110 120	110 120	5 0 0	"	112½	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee have refused to quote these

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NOTES.

The possibilities of the electric furnace as a rival of the blast furnace, for the smelting of iron ores, are now being tested at several places in Europe. At Darfo, in northern Italy, the Stassano process is under trial, and a plant of 1,500 H.P. capacity has been erected at this place. Dr. Goldschmidt, of Essen, after inspecting the furnaces in operation about a year ago, reported favourably on the prospects of the undertaking. The capital available for these experimental trials has, however, been exhausted, and it was announced in January that the company owning the plant at Darfo was in liquidation. From figures published by those financially interested in the Stassano process in 1899, it would appear that 2·7 E.H.P. hours were expected to yield 1kg. steel in the electric furnace, and that a saving of 28s. per ton of steel was estimated as compared with the cost by the ordinary smelting process in Italy. Whether the liquidation of the company owning the experimental plant at Darfo is due to the failure of the Stassano process to attain these results, or is simply due to a shortness of working capital, is not yet revealed. It is interesting to note, however, that similar trials of the electric furnace for the reduction of iron ores are being conducted at Prague in Austria, at Le Praz in France, and at Güsingen in Sweden, and that at the latter place 1,200kg. steel are said to be produced per day by the Kjellin process. If steel of good quality can be produced in a single operation by the electric furnace from iron ores of average composition, it is possible that these new processes of ore-reduction may have an important future. In countries possessed of extensive coal fields and cheap fuel, the blast furnace is, however, likely to retain its position for many years, and its displacement will only occur when the present stores of easily worked coal have been exhausted.

If an electrical engineer unknown to fame set out seriously to prove that two-wire distribution was preferable to three-wire distribution on a large urban network, he would probably be severely ignored. When, however, such views are put forward by a man of the ability of Mr. John F. C. Snell (who, it may be mentioned, designed the interesting station at Sunderland which is described in this issue) they command careful and critical attention. In a leading article last month, criticising Mr. Snell's recent Paper before the Municipal Electrical Association, we maintained that, assuming the same consumers and the same maximum percentage drop in volts, there was no doubt that the three wire system would be less expensive than the two-wire system. Mr. Snell contributes a letter to our correspondence columns this week in which he grants this, but will not allow that the comparison should be made in this manner. He is greatly impressed with the danger of electrolysis, but yet is unable, apparently, to give us any specific information on this head. We asked him to name half-a-dozen networks in which the negative wire leakage, due to osmosis, is serious enough to cause electrolysis, and to point to a single network originally designed for a 2 × 220-volt three-wire system in which such is the case. Mr. Snell merely replies with another challenge, which, perhaps, some of our readers will like to take up.

Mr. Trotter's remarks as to electrolysis have been, we fear, quite misinterpreted by Mr. Snell. Mr. Trotter, in showing his samples of lead—which, by the way, were marked by electrolysis but could not be described as "pitted"—merely desired to demonstrate the interesting scientific fact that such a thing as alternate current electrolysis was possible at small current densities. Absolutely no quantitative results as to the amount of lead removed were given, and if Mr. Snell wishes to prove anything in this direction he must produce actual figures.

Mr. James Swinburne has contributed an interesting lightly-written article to the current number of *Page's Magazine*, in which he discusses the proposed alterations in

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the patent law of this country. It is not quite clear what is Mr. SWINBURNE's own opinion on the new proposals. He concludes his article by saying :—

Examination without guarantee of validity and without power of rejection, such as proposed in the new Bill, is an unnecessary expense to the Patent Office ; but if it is carried out by reducing the surplus now paid to the Treasury, [instead of by raising fees, it certainly would be a great benefit to inventors.

The whole tendency of what precedes this final summing up, however, is to show that the examination of patent applications by the Patent Office, in order to test the originality of their subject matter, would be practically useless, alike to the skilled specialist and the general public, and that it is only the ignorant or lazy would-be inventor who would really profit by it. The skilled specialist, Mr. SWINBURNE points out, probably knows more about the previous work in his own special subject than the patent examiner, and would profit little by the official examination of his patent. On the other hand, the man who proposes to re-patent an old invention through ignorance, or laziness in not acquainting himself thoroughly with the work of his predecessors, would be assisted by the Patent Office if the present Government proposals are carried. In the latter case the examination which the Patent Office would undertake, free of charge, would as often as not show that the patent applied for is either anticipated or useless, and as in that case the patent would not be granted, the patent fee would not be forthcoming to remunerate the Patent Office for this work.

THE surplus revenue over expenses of the work of the Patent Office is apparently handed over to the Treasury at present. If the new Patent Bill becomes law, probably this surplus will disappear, owing to the decrease in revenue due to the fewer number of patents granted, and the extra expense to which the Patent Office will be put in making the searches. Thus, the unsuccessful inventor will be subsidised by the successful one through the medium of the Patent Office. We had sooner see the surplus applied either to a reduction of fees, or, if it could be made possible, to the institution of some departmental machinery which would lessen the cost of a successful patent action, especially when the defendant is the successful party.

IT may not be out of place to quote the following paragraph from a recent issue of *Electricity* of New York :—

Thomas A. Edison, John D. Rockfeller, George Westinghouse and a number of other inventors, or men interested in inventions, will be invited in a short time to interest themselves in helping to establish the first home in America for indigent inventors—men who have been overcome by the weight of years and by poverty at the same time. The home will be established on Canal-street, West Medford, Mass., unless present plans fail. A large dwelling, known to history as the "Old Mansion House," has been practically transferred to a company headed by J. Dana Bickford, a well-known inventor of Vermont and New Hampshire. Mr. Bickford says that the work of establishing the home will be pushed ahead with all possible speed, and that approximately $20,000 in reality has been turned over to his company already. Copies of a circular letter to America's captains of industry will be sent throughout the country. This letter will outline the plan and contain a request for cash endowments. "We shall have," Mr. Bickford said, "in connection with this home a workshop or laboratory, where the inmates may spend their time developing their ideas. If it should happen that something of value is devised, the company in charge of the home would immediately put it upon the market, and the profits would go in part to the company, but largely to the home."

"If it should happen" is delightful. We suggest a similar scheme to MR. SWINBURNE as an excellent alternative to the objectionable parts in the new Patent Bill.

THE *Fortnightly Review* for the present month contains an article by Mr. P. T. MCGRATH on "Our Defenceless Cables," dealing exclusively with the Atlantic cables, ten or a dozen of which, he says, are landed on or near the Grand Banks of Newfoundland with no effective protection nearer than Halifax and Bermuda. The facts with which Mr. MCGRATH supports his contention are both instructive and interesting. His remedy is to re-establish the abandoned fortifications of the harbour of St. John's, which he would convert into a naval station. But if it be true that the whole value of the Canadian Pacific Railway as a British highway to the Far East may be destroyed at any moment "by a few Frenchmen in a wheezy tug steaming across the Grand Banks with a grapnel," it is equally true that the fortifying of St. John's would not prevent it. One or more fast cruisers in that quarter of the world would be more effective ; and, it may be thought, will not be wanting when the emergency threatens. Naval tacticians are all against land fortifications nowadays. In the same number of the *Fortnightly* there is a vivid account of "Mont Pelée in its Might," by Prof. HEILPRIN of Philadelphia, with some observations on certain electrical phenomena connected with the eruption. The "Possibilities of Wireless Telegraphy," and, incidentally, its impossibilities, are dilated upon in the current *Monthly Review* by Mr. CHARLES BRIGHT.

NEARLY 100 years have elapsed since HUMPHRY DAVY succeeded in decomposing potassium hydrate by aid of the electric current, and showed that what had up to that time been regarded as an elementary body was in reality the hydroxide of an undiscovered metal, which he named potassium. Since the year 1807 the list of elements has been enormously increased, and the electric current now occupies a prominent place amongst the methods by which the chemist analyses and sorts out the materials supplied to him by a bountiful mother earth. Silicon is the latest element which is reported to have succumbed to the attack of the electric current. If the results obtained by TH. GROSS from experiments described in the *Elektrochemische Zeitschrift* for August are confirmed by other investigators, two or more elements are contained in the state of oxide in the silica which is such a common constituent of the earth's crust. The experiments which have led GROSS to this opinion consisted in submitting pure silica dissolved in pure potassium hydrate to the action of an electric current for a lengthened period, and in removing by chemical methods the unaltered silica, after the completion of the electrolysis. The weight of silica recovered in each case was considerably less than that with which the experiment was commenced, and the deficiency was supplied by a material found in the residual solutions, which, after separating, fusing, and reducing in hydrogen gas, left a residue possessing metallic characteristics and resembling selenium. Until these results have been confirmed by other observers it will be well, however, to suspend judgment in this matter. As most chemists are aware, silica when once in the soluble form is

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difficult to recover completely, and the new compound obtained by Gross may simply be some combination of silicon which has resisted his efforts to bring it back to the insoluble state.

Mr. Albert Gay, the Islington borough electrical engineer, has called upon us to explain the recent unfortunate fire at the Islington electricity works. It was thought at first that the fire was caused by a short circuit on a feeder, and the failure of the fuse to blow before the cable was overheated, and this explanation was given us at Mr. Gay's own offices. Mr. Gay is now convinced, however, that the fire originated through some external agency, such as the ignition of cotton waste near the place where the cables were bunched together. He considers that our note was unduly harsh in saying that to have a number of india-rubber-covered cables bunched behind the switchboard at the present time was inexcusable, and he considers that the bunching of the cables in this manner could hardly even be called bad practice. We are glad to learn, nevertheless, that each of the cables at the back of the board will now be run in separate fireproof casing, a work which was being too leisurely proceeded with before the accident, as events have shown.

Tramcar Lights.—As the result of the recent conference in London with representatives of corporations and companies owning tramways, it is stated that the Home Office has dropped the proposal, so far as Scotland is concerned, to have a red light on the rear of every tramcar.

Explosion on a Submarine.—It appears that a somewhat serious explosion has occurred on board the French submarine torpedo boat, "Le Francais," owing to inefficient ventilation while the accumulators were being charged. It is thought that a spark from a switch ignited the liberated gases.

Personal.—Mr. Reginald R. Todd has resigned his position as chief engineer of the Metropolitan Electric Supply Co., and will terminate his engagement next spring. As will be seen in our advertisement columns, the directors of the company are open to receive applications for the vacancy from properly-qualified engineers.

Telephones on Trains.—A train telephone has been installed on the "Overland, Limited" train on the Chicago and North-Western Railway, which runs from Chicago to San Francisco in 2 days 21hrs., 25min., and is said to be the fastest long-distance train in the world. The telephone is connected to the exchange at each town at which the train stops by means of a cable attached to a tripod on the roof.

The Partridge "Sparklet" Fuse.—In our article on the Partridge "Sparklet" fuse on page 746 of our last issue, we referred to Fig. 1 as the effect of breaking a 10,000-volt 1,000kw. arc at a horizontal 30in. fuse. This should more properly have been described as the effect of not being able to break the arc in question. Although the arc would not extinguish itself even when between terminals 30in. apart, the 10,000-volt 1,000kw. arc between terminals 4½in. apart was broken at once when the "Sparklet" fuse was employed.

The Alnwick Electricity Supply Station.—On August 28th electricity supply was commenced at Alnwick (N.B.) The undertaking is the property of the Northern Counties Electricity Supply Co., and the provisional order was obtained in 1901. The system is three-wire, with 460 volts between the outers, and there are altogether 4 miles of mains. Callender's single cables are laid solid in wood troughs. The plant has a total capacity of 5,000 8 c.p. lamps, the necessary steam being raised by means of two Babcock and Wilcox boilers, each with an evaporative capacity of 6,000lb. per hour. There are two Crompton generators coupled to two 240 H.P. Ruston and Proctor high-speed engines. The battery consists of 250 Chloride cells, each having a capacity of 250 ampere-hours, and the station also possesses a balancer.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
St. Lucia—St. Vincent	May 9, 1902 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Santa Cruz—Teneriffe	July 7, 1902 ...	—
Puerto Plata—Martinique	July 10, 1902 ...	—
Anjer—Kalianda	Aug. 2, 1902 ...	—
Guantanamo—Mole St. Nicholas	Aug. 5, 1902 ...	—
Cayenne—Pinheiros	Aug. 13, 1902 ...	—
Nagasaki—Fusan	Aug. 27, 1902 ...	Aug. 28, 1902

Wireless Telegraphy in the American Navy.—It appears that Lieut. Hudgins of the American Navy was sent to Europe in order to find a suitable system of wireless telegraphy, owing to the failure of negotiations between Admiral Bradford and the Marconi Co., who declined to supply instruments except on annual rentals with a royalty of $500 a year. The lieutenant has now returned to the States with no less than eight sets of instruments, from which the authorities hope to evolve a system entirely independent of any other, and which, moreover, must be quite unaffected by the discharge of large guns. Prof. Fessenden is to be allowed an opportunity to perfect his system for warships so that it will comply with the regulations laid down.

Thunderstorms.—On Thursday last week a severe thunderstorm passed over Sheffield, and during its progress a flagstaff on Heeley Church tower was shattered by a lightning stroke, 20ft. of the pole being torn completely away. At Churwell, near Leeds, two houses were struck on the previous day, the occupants narrowly escaping injury. In one of the houses a quantity of gas piping was melted. Exceptionally heavy rainstorms, accompanied by thunder and lightning, were experienced in the neighbourhood of South Notts on the evening of the 28th ult., when much damage was done to crops. During one of these storms Wentworth Church was struck, and a gas pipe being fractured, the gas became ignited, but was, fortunately, extinguished by some workmen before much damage was done.

The Kendal Electricity Works.—The Kendal electricity works, opened last month, is chiefly interesting by the fact that it was originally proposed to make it a water-power station in connection with the water supply to Kendal. In 1898 Messrs. Handcock and Dykes reported on the prospects of a municipal electric lighting scheme, and then advised the utilisation of the water power, in the pipe line between Fisher Tarn and the low reservoir by means of turbines driving dynamos, assisted by an auxiliary plant with storage batteries in the town. Their estimate for this work was £17,818, and a sliding scale of charges was recommended. In 1899 the engineers further reported that the water-power scheme was not feasible, and that by reducing the area of supply the estimate would only reach £15,015 for a plant having a capacity of 5,000 8 c.p. lamps. It was however, decided to instal a plant equivalent to 2,500 8 c.p. lamps at a cost of £8,160, and instructions were given to Messrs. Handcock and Dykes to prepare plans and specifications. The provisional order was obtained in 1900, and in due course tenders were received and contracts let to Messrs. Johnson and Phillips for the whole of the station plant at £4,975, and to the British Insulated Wire Co. for mains, meters and services at £3,000. On the opening night the total number of motors, arcs and incandescent lamps connected were equivalent to 2,496 8 c.p. lamps, and steps are being taken to increase the plant immediately. The engine room is 49ft. long by 28ft. wide, and contains, in addition to a balancing booster, two Willans 50 B.H.P. high-speed engines, direct-coupled to Johnson and Phillips 6-pole shunt wound generators. In the boiler house are two Fraser single-flue dry-back boilers, each capable of evaporating 2,500lb. of water per hour. At the base of the chimney, which is only 50ft. in height, there is fixed a Sturtevant induced draught fan, driven by an enclosed steam engine. The battery consists of 240 Tudor cells in glass boxes, each having a capacity of 210 ampere-hours. The mains are three-core paper-insulated lead-covered, laid solid in wooden troughs, with 440 volts across the outers, and there are five disconnecting pillars at various parts of the town.

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Lightning in Chicago.—It is stated, says the *Electrical World* of New York, from Chicago that since June 1st over 500 buildings in that city have been struck by lightning. Of these, over 400 were struck in July. The electrical storm, which began July 7th, struck 68 buildings, 28 on the evening of the 7th, and 40 after midnight. This, however was far surpassed by the storm of July 17th, when 127 strokes were reported. That these figures do not accurately measure the number of lightning strokes in Chicago during July is shown by the fact that they are taken from the record of adjusted insurance losses reported to the fire insurance companies. For weeks the insurance companies have been complaining of the number and size of the lightning losses they were being called on to pay. Up to July 31st, 415 lightning losses had been reported, with an aggregate loss to the companies of $31,782.

Trolley Cars Without Rails.—Experiments have recently been made in Saxony with electric cars similar in many respects to the overhead system of tramways, but minus the rails. The cars are built for the accommodation of 16 persons—12 sitting and four standing, and their weight with passengers is not expected to exceed 4 tons. The car is supplied with two motors and a controller, and is fed by means of a small motor suspended between two trolley wires 12in. apart. The trolley motor is fed from the car motors, and thus runs at a proportional speed, always keeping slightly ahead so as to keep the flexible lead taut. Alternating current at 10,000 volts three-phase is transformed down by rotary converters to 550 volts for the line. There are three sub-stations, one in the middle and one at each end of the system. The estimated cost of 20km. of line in course of construction at Marseilles, including all sub-stations, 12 cars, and all other material for the working of the line, will not exceed £40,000.

Electric Haulage on Canals.—The *Financier and Bullionist* gives some interesting figures in connection with the electrical system of canal haulage on the Brussels and Charleroi canal, which, it seems, is no small success. The canal is 50 miles in length, and conductors are fitted along its side for supplying current to vehicles drawing the boats. Three-phase transmission at 6,000 volts is adopted, and step-down transformers are placed every 3 miles, which bring the voltage down to 600 for use on the 5 H.P. motors, with which the tractors are equipped Each tractor is capable of hauling five boats, each laden with 70 tons, but up to the present only one boat is allowed to be towed by each tractor. There are 60 tractors, 45 of which are in constant use, and they are driven by boys. The charge is, roughly, 0·1d. per ton per mile. Goods are carried from Brussels to Charleroi in one-half the time that was formerly occupied when the work was done by horses. The company supplies current all along the line to villages for power and lighting purposes at 220 volts, the charge for lighting being 5½d. per unit and for power 2·5d. to 1·8d. per unit.

The St. Louis International Exhibition.—The preparations for the forthcoming St. Louis Exhibition are proceeding apace. Transmission lines will be carried from the generating station to the switchboard in a subway 7ft. in width and depth and 1 mile in length. Low-tension conductors will lead out to all buildings wherever electrical energy is required for lighting or power. There are over 100 miles of conduits, in course of delivery, to carry these conductors. The total energy available will exceed 20,000 H.P., in addition to which about 2,000 H.P. will be obtained from engines exhibited. The Electricity Palace is to cover an area of over 350,000 sq. ft., and steam or gas will be supplied to all direct-coupled units which form part of working exhibits; and should the capacity of the electric generators be at any time in excess of the requirements of the working exhibits with which they are connected, arrangements advantageous to the exhibitors will be possible for the utilisation of all or part of the surplus energy. No charge for space is to be made to exhibitors, and everything will be done to facilitate the working of operative exhibits at the smallest possible expense.

Great Britain and Japan.—In the second number of a new publication, the *Anglo-Japanese Gazette*, the situation between Great Britain and Japan is discussed from an industrial and economic point of view, and a warning given to the former country. Our contemporary calls attention to the fact that Japan stands in a favourable condition, geographically, to this country as compared with America, but that this state of affairs will be changed when the Isthmus canal is completed. It is unfortunately a fact that America can transport goods to Japan, via London, at a cheaper rate than British goods can be sent from London to the same place in Japan. At present, we send far more to Japan than does America, and America takes more Japanese produce than Great Britain does. The following figures show, however, that America has increased her exports with Japan, during the last few years, much more rapidly than Great Britain:—

	United Kingdom		United States	
	Imports into.	Exports from.	Imports into.	Exports from.
1890.....	£916,300	£4,325,587	£3,220,900	£1,117,150
1895.....	788,300	4,517,200	5,402,900	927,600
1896.....	901,200	6,039,800	3,179,700	1,692,800
1897.....	848,800	6,678,200	5,362,500	2,784,200
1898.....	778,400	6,432,500	4,787,200	4,087,100
1899.....	1,127,100	4,593,000	6,422,900	3,920,900
1901.....	1,148,250	5,057,578	7,230,936	4,276,943

New Edison Storage Battery Patents.—Of four patents issued to Thomas A. Edison on July 8th, and abstracted in an American contemporary, three have the same title, "Reversible Galvanic Battery," and cover different compositions of active materials. No. 704,803 describes a battery with an alkaline zincate as the electrolyte, and an "oxygen-storing" element, which comprises an intimate mixture of finely divided oxide of mercury and flake graphite. A magnesium plate receives the deposited zinc. The parts of the battery described in patent No. 704,804 comprise an alkaline electrolyte and two conducting supports, one of which carries finely-divided oxidisable iron and the other an oxide of cobalt intimately mixed with flake graphite. This oxide of cobalt, it is explained, should have more oxygen than the black oxide of cobalt (Co_2O_3). Finely-divided copper, mixed with flake graphite, forms the material carried by one conducting support in the battery described in patent No. 704,806, and an electrolytically oxide of nickel or suitable magnetic material other than iron is carried on the second support. No. 704,805 relates to an "Electrode for Batteries," consisting of a support carrying a number of pockets or receptacles in which the active material is placed. These pockets are arranged in substantially the same plane, each pocket being made of elastic material with corrugated walls.

Liquid Fuel.—At the Newcastle meeting of the Institution of Mechanical Engineers, Mr. Edwin L. Orde read a Paper on "Liquid Fuel for Steamships." The hydrocarbon methane ($CnH2n+2$) was given a short consideration, some of its characteristics described, and refinement, by two distinct processes of distillation—viz., the "cracking" process and the effect of steam on distillation—was gone into in detail. The first effect of the furnace heat on the petroleum spray is to liberate hydrocarbon vapours, and to ignite them on the outer surface of the jet. The ignition raises the temperature of the whole of the jet, and probably dissociates some at least of the hydrocarbon vapours into carbon monoxide and hydrogen. In what form the undissociated vapours burn it is difficult to conjecture, but the appearance of the flames suggests that acetylene is present. When the conditions are satisfactory, the flames are opaque and dazzling white in colour for a distance of some 6in. from the nozzle of the burner, becoming semi-transparent and almost violet in colour at the middle of their length, and shade into red at the end. In burning oil mixed with water the combustion is incomplete; the violet colour never appears, and the end of the flame is dark red and fringed with smoke. The "burners" may be divided into three types—viz., (1) mechanical spray, in which the liquid fuel is forced under pressure through nozzles, made of such a form as to break it up into fine spray; (2) spray burners, where the liquid fuel is held in suspension and driven into the furnace by means of a jet of steam and compressed air; (3) vapour burners, in which liquid fuel is volatilised and the vapour admitted to the furnace. Those burners in the second category are considered by Mr. Orde to be greatly superior to any others at present in existence.

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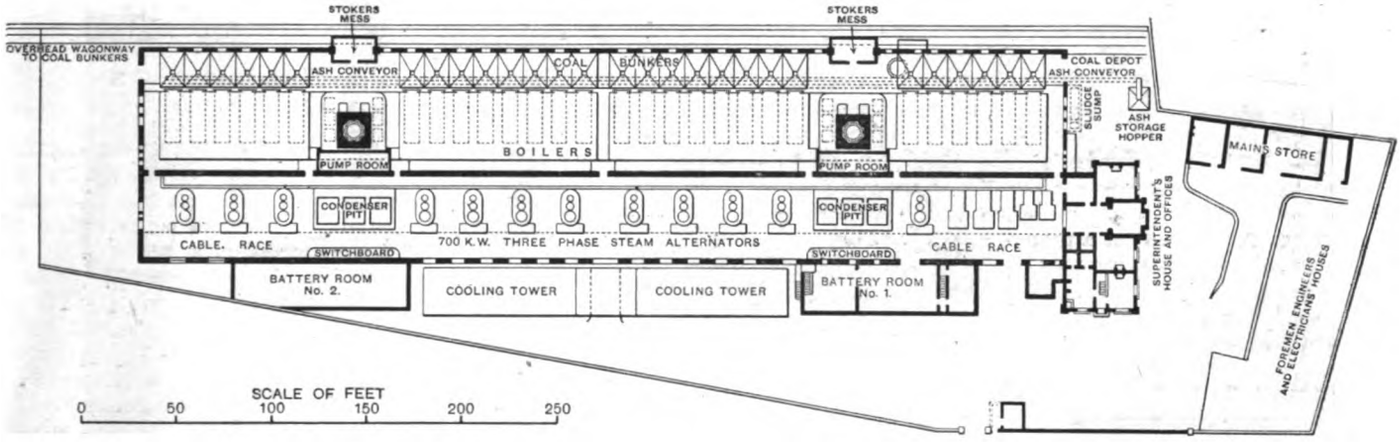
SUNDERLAND CORPORATION ELECTRICITY WORKS.

The site of the pioneer Dunning-street station having been filled up, the Corporation of Sunderland acquired a new site of 3 acres in extent at Hylton-road, upon which a station for 20,000 H.P. will be ultimately erected. The site obtained is peculiarly suitable in the way of levels for the easy delivery of coal from the colliery, with which the Corporation has made an agreement for the supply of coal at advantageous terms. The ground also has the advantage of good foundations, consisting of stiff boulder clay overlying the magnesian limestone.



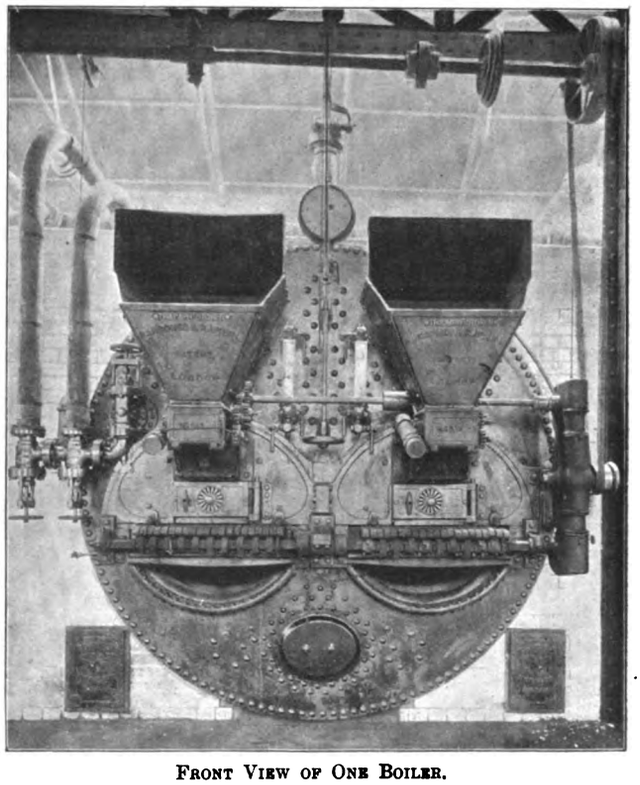
PLAN OF NEW SUNDERLAND ELECTRICITY WORKS.

A further advantage is an existing deep well, the shaft of which is 80ft. deep and 6ft. in diameter. A new 11½in. borehole has been sunk into the Permian sands to a depth of 120ft., and a good supply of fresh water is pumped by means of an Isler's deep well pump, driven by a Marshall horizontal engine of 8 H.P. The pump is designed to deliver 5,000 gallons per hour into the overhead tanks and cooling pond, and room is also provided for a second borehole and pump.

Buildings.—The first instalment of buildings consisted of an engine room 169ft. by 48ft., a boiler house 169ft. by 63ft., a battery room 71ft. by 24ft., and a fitting shop, joiner's shop, spare gear room, mess room, lavatories, &c. This portion of the building is designed to hold machines having a total capacity of 5,000 H.P. The chimney is 120ft. high by 8ft. diameter, built square to the plinth and octagonally beyond. It is lined with fire-brick to a height of 90ft., and its foundations were taken down to the limestone at a depth of 20ft. from the datum level.

In the boiler house is the pump room, at the back of the chimney; symmetrical to the right and left are batteries of boilers, and opposite this (in the engine room) is the condenser and hot-well pit. The flues are so arranged that the gases from each (or both) of the ranges of boilers may pass through either, or both, of the two economisers flanking the chimney, or through the by-pass into the chimney. Provision has been made for coupling induced-draught fans at the base of the chimney, between the economisers and the by-pass. An ash tunnel will be arranged for when the number of boilers has increased, so as to require the mechanical removal of the ashes. Overhead self-trimming, steel plate bunkers, fed from the coal viaduct on the west side of the building, are carried by a steel structure as shown in the plan of the station. The boiler blow-down pipes are taken outside the boiler house to a sump of ample capacity arranged in two compartments, so as to enable the water to be cooled before running off into the sewer. Lavatory, bath room and mess room for the stokers are also provided.

Boiler-house Equipment.—In the boiler house provision has been made for eight Lancashire boilers, 28ft. by 8ft. 6in. diameter, of which five are at present installed. These boilers were constructed by Messrs. Clayton, Son & Co., and work at a pressure of 160lb. They are fitted with Deighton's corrugated flues (as shown in the sectional illustration), and "Triumph" mechanical stokers. They are seated on Poulton's seating blocks, and are covered in a somewhat unusual manner: the partition wall between each pair of boilers is carried up above the top of the boiler shell, and the top covered flat with chequer plates, laid on light tee frames; the stand pipes on the boilers are made additionally long to permit of this covering. On the boiler shells are laid blue asbestos mats, and these, together with the air space between them and the chequer plate tops, form an exceedingly efficient and neat boiler covering. There



FRONT VIEW OF ONE BOILER.

is space for two economisers, one of which by Messrs. E. Green & Sons, consisting of 360 tubes, has already been fixed.

Mechanical stokers of the "Triumph" type are used, and appear to give very satisfactory results. We give a front and side view illustrating the mechanism. The power is taken

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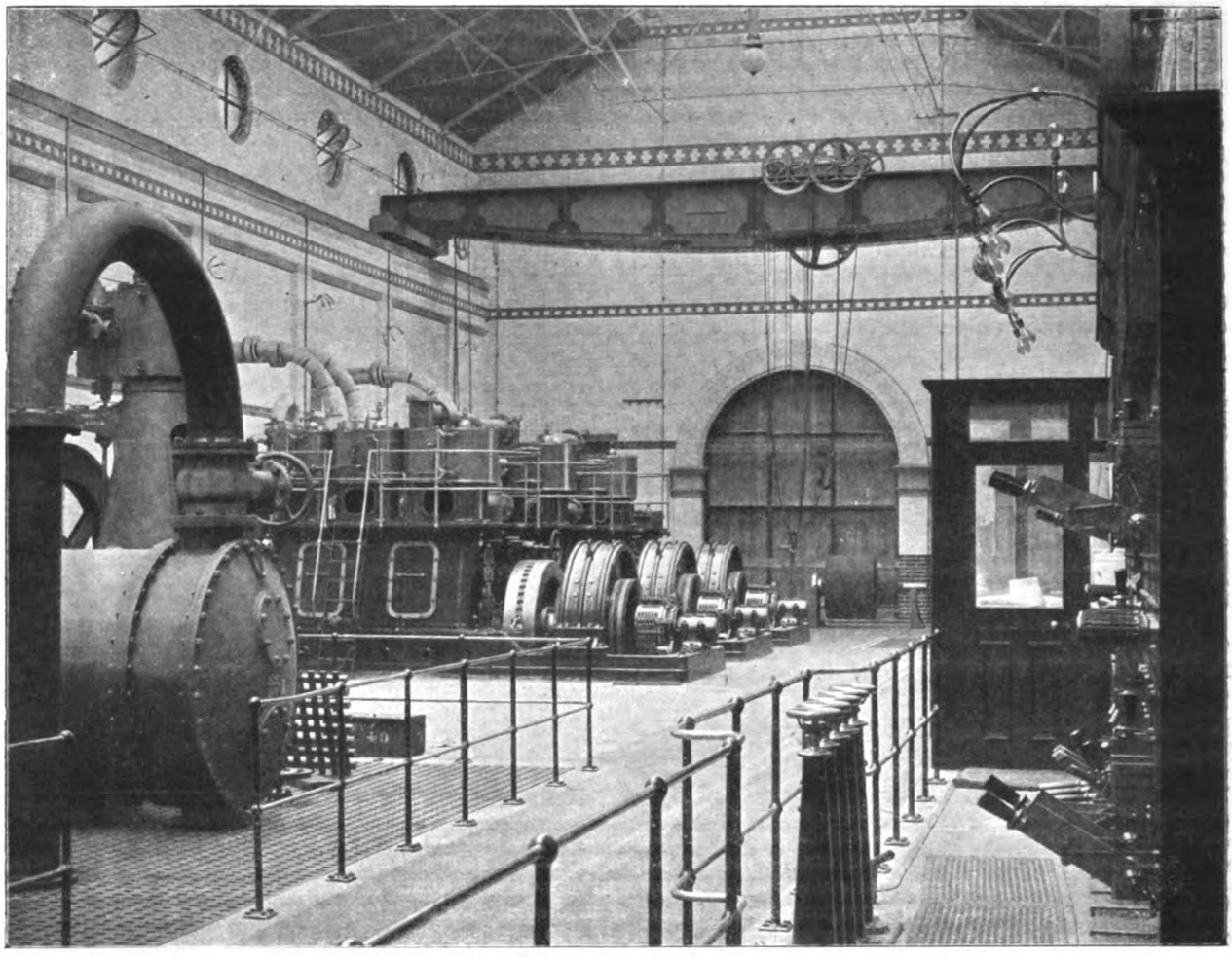
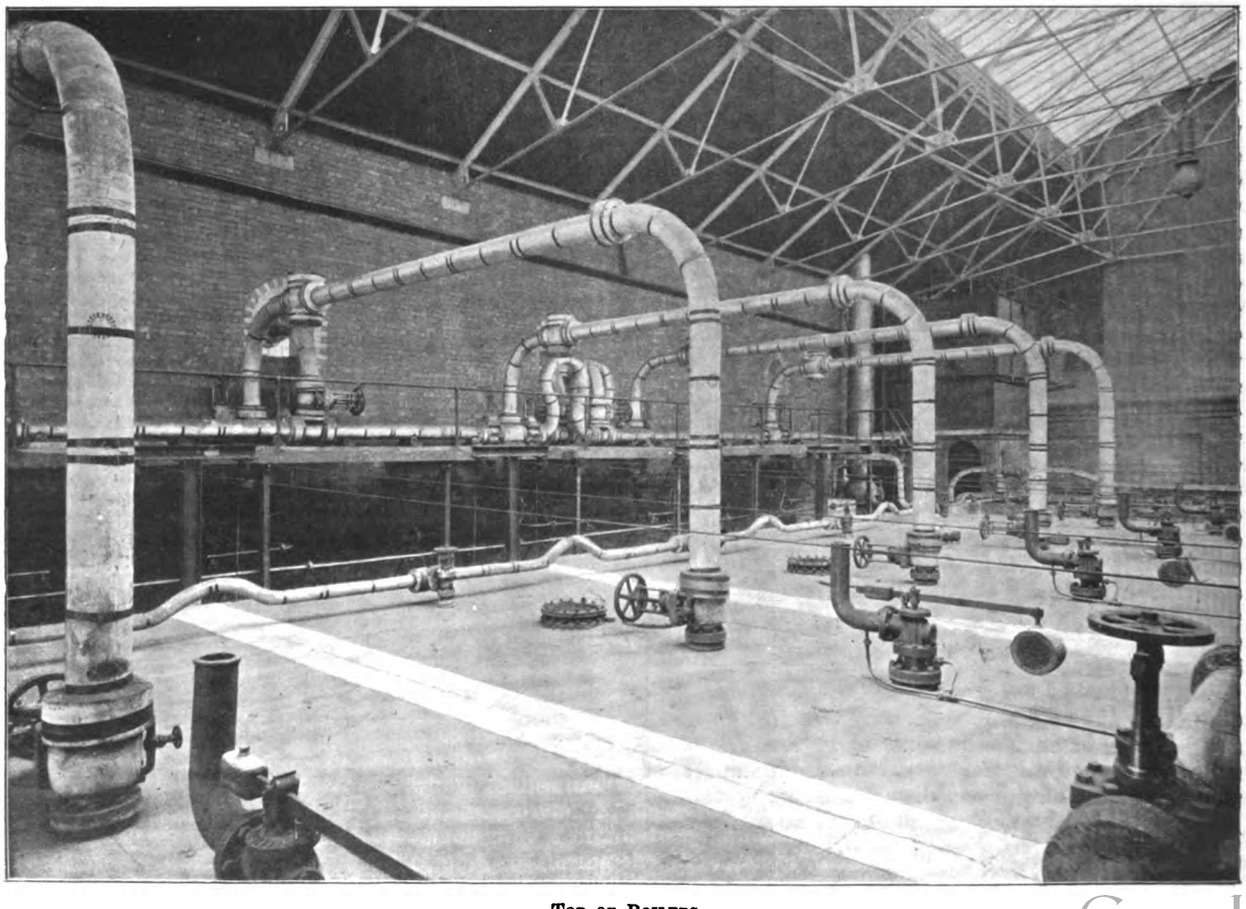


ENGINE ROOM.



TOP OF BOILERS

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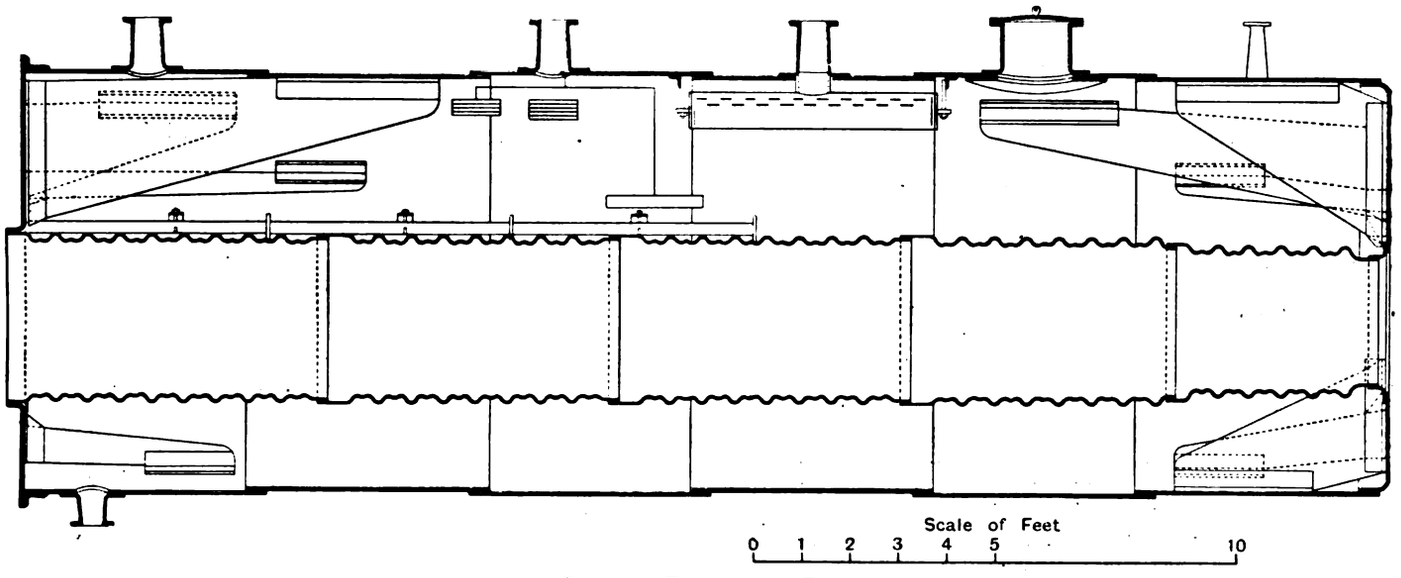
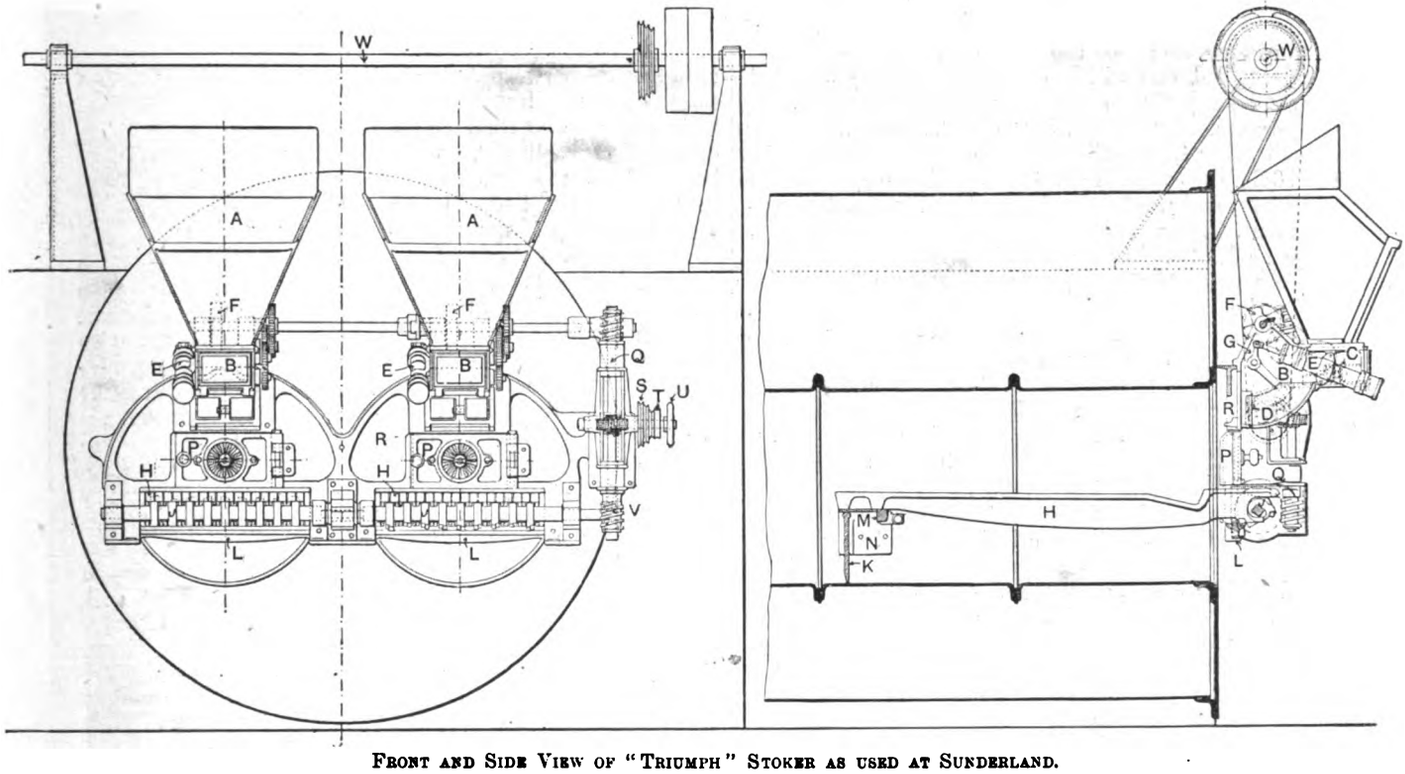
from the countershaft W, driven by an electric motor, and provided with fast and loose pulleys. By means of a three-grooved cone and rope, this shaft works a similar cone, S, whose bearing, Q, is bolted to a prolongation of the boiler front R. This pulley, S, gives a slow rotary motion through a vertical shaft and worm gearing to two horizontal shafts, V and X, placed on opposite sides of the flues. It is thus seen



SECTIONAL ELEVATION OF BOILER.

that the stoker is arranged to work at three speeds. The wheel U allows the machine to be turned by hand. The coal descends from the hoppers A into a box containing an adjusable slide, C, and it receives a rectilinear reciprocating movement by means of a crank worked through gearing from the upper shaft X. At regular intervals this slide allows coal to fall on the shovel D, hinged by steel side-arms to an axle pin, which carries the trigger G, placed in the field of action of a four-armed cam, F, keyed to the shaft X. This trigger is also attached by a crank to a powerful recoil spring, E, which it compresses during the movement given by the cam. At the moment of release this spring drives the shovel smartly forward, after which the shovel returns to its back position, and the slide C again charges it with a definite quantity of fuel. In order to distribute the fuel uniformly on the grate, the cam has four arms of unequal lengths, which successively, more or less, compress the spring, and consequently vary the throw of the shovel. The come-and-go motion of the fire bars is obtained by the cams J, threaded on a square bearing on the lower longitudinal shaft V, which rotates very slowly by means of its worm gearing. Each of these cams has two projections in different vertical planes; the one draws forward two bars at once by about 2in. by engaging in recesses formed in the top of their ends, and the other, after a slight pause, pushes them back by projecting heels formed below. The



FRONT AND SIDE VIEW OF "TRIUMPH" STOKER AS USED AT SUNDERLAND.

result of these continued movements is that the clinkers and ashes travel towards the back, and finally, at the extremity of the bars fall into the ashpit, whence they are removed from time to time by the door K.

These bars rest freely in front on the bearer L, which completes a guide frame formed by the boiler front, and at the

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back on the bearer M, carried by two supports N, bolted to the sides of the interior flue, and which carry the door, K, of the ashpit.

In order to maintain the moving parts as far as possible from the high temperature of the flues, the principal shaft, X, is placed high above the flues. None of the parts of this stoker project into the combustion chamber; all are bolted to the cast-iron boiler front, R. In the centre of the latter is the door, P, in which a butterfly-register serves to regulate the admission of air to the furnace.

The two side-arms of the shovel fasten it solidly to a strong pivot running from side to side of the feed box and turning in long bearings, between which is keyed the trigger; by reason of its axial position, the latter imparts equal forces to the arms of the shovel, which consequently works quite parallel to its axis and throws the coal straight in front of it. The four-armed cam of the shovel is keyed separately on its shaft so as to lend itself easily to detachment and renewal. The mechanical stokers and economiser scraper gear are driven by a 4-H.P. Lundell motor.

The following figures were obtained by the borough electrical engineer in connection with a test of the "Triumph" stoker made at the old works at Sunderland on January 25, 1901 :—

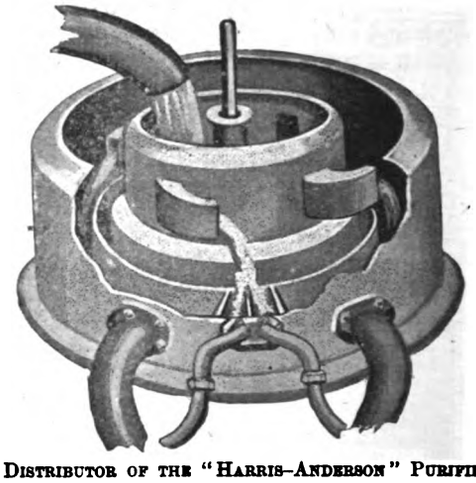
Galloway Boiler, 28ft. by 8ft. 6in.

Duration of test	12 hours.
Heating surface	1,140 sq. ft.
Total grate area	47 sq. ft.
Average evaporation per hour	972·25 gallons.
Evaporation per pound fuel, actual	8·45lb.
Evaporation per pound fuel, from and at 212°F.	8·91b.
Quality of coal	South Hetton unscreened bean small.
Fuel consumed per hour	1,150lb.
Fuel consumed per square foot grate per hour	24·5lb.
Percentage of ashes	8·9 per cent.
Average steam pressure	122·3lb.
Average temperature, feed water at check valve	204·1°F.
Temperature of cold feed to economiser	80deg.
Average draught at induced fan	0·81 water.
Average temperature, gases in flues	868deg.
Average temperature, gases entering economiser	868deg.
Average temperature, gases leaving economiser	348deg.
Theoretical power of fan	1·6 H.P.
Ratio of fan power to total horse-power	about ½ per cent.

An electrical locomotive by the British Thomson-Houston Co. is being supplied, and will be driven by a trolley wire fed from the tramways system for shunting the coal waggons.

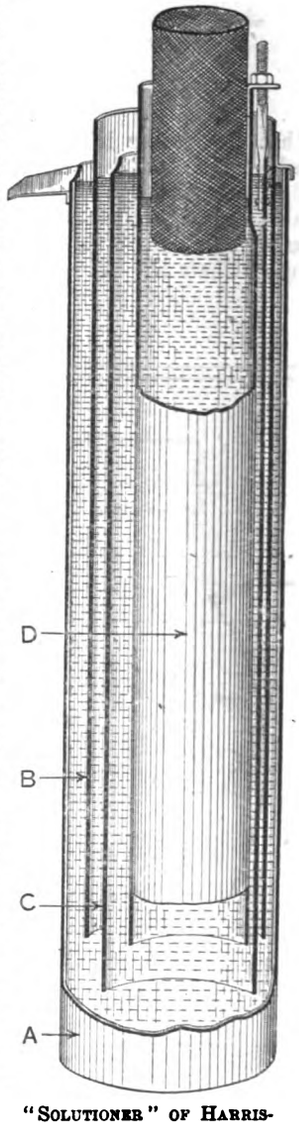
The feed pumps are by Messrs. J. P. Hall & Sons, and each is capable of delivering 4,500 gallons of water per hour, against a pressure of 160lb. per square inch. Provision has been made for two more pumps, and the four will complete the No. 1 pump-room equipment. Above the pump room are situated storage tanks, each capable of holding 8,000 gallons, on the top of which is a water softener by Messrs. Mather and Platt, which treats the water by the Archbutt-Deeley process. Under the race, between the flue and the main wall, is situated a first instalment suitable for 4,000 gallons per hour of a Harris-Anderson purifier supplied by the Harris Patent Feed Water Filter Co. This is designed to remove the emulsified oil from the condensed water by adding a certain proportion of chemical reagents so as to form a precipitate which holds the oil in suspension and is ultimately filtered off.

The whole of the condensed water is first passed through a "distributor," which diverts a certain proportion of it to two "solutioners." The latter are charged with sulphate of alumina and sodium carbonate respectively, in the solid form, and are so designed that the definite fractions of the water are converted automatically into solutions of the desired strength. The distributor, which we illustrate, and which performs the function of dividing up the water, consists essentially of a turbine made frictionless by being water-borne. As the water is led into this it rotates, and the nozzles discharge into an annular trough outside the tank in which the turbine floats. The effect of this is that the whole of the water is distributed uniformly over the annular trough, and in order to divide up the total water in the desired proportions the trough is divided into four compartments by radial partitions. The two smaller compartments receive 1 per cent. of the total flow, and two larger ones 49 per cent. each. The solutioner consists of an outer cylindrical casing A, open at the top and closed at the bottom. In this there are suspended three other cylinders, B, C and D, open both at the top and the bottom. The cylinders B and D are fixed in position, and C is adjustable vertically



THE DISTRIBUTOR OF THE "HARRIS-ANDERSON" PURIFIER.

by means of a screw. A lip or scollop is cut out of one part of the edges of the cylinders A and C, and that on cylinder A discharges into a spout to guide the solution to the desired point. The lip on cylinder C is set at a slightly higher level than the lip on cylinder A, this difference of level determining the strength of the solution. The water to be made into solution is led by a pipe into the space between C and D, while the substance to be dissolved, in any quantity, is placed in a wire gauze cage at the top of cylinder D, dipping down into the water. The water passes between C and D, meets the strong solution descending from the cage at the bottom of the apparatus, carries it into the outlet space between A and B, and away over the lip to the spout. This outer space then contains a column of solution, which is balanced by the column of water in the space between C and D. This column of water must be longer than the column of solution, so that as the latter increases in strength the level of the water between C and D rises. When the outflowing solution attains a certain strength, water overflows the lip on cylinder C, passes down between B and C, mixes with the solution at the bottom of the outlet space and prevents it getting any stronger. The amount of water flowing over this inner lip automatically adjusts itself to keep the solution at constant strength. The apparatus is set to deliver solution of any desired strength by adjusting the movable cylinder C. Raising this increases the strength, lowering diminishes it. The strength of the solution thus made is independent of the amount of water passing through the apparatus and of the amount of solid reagent present, and only depends upon the setting of C. The solution coming from each of the two solutioners is then passed, together with its corresponding half (or rather 49 per cent.) of the total condensed water, to the treatment vessel, whence the two parts are



"SOLUTIONER" OF HARRIS-ANDERSON PURIFIER.

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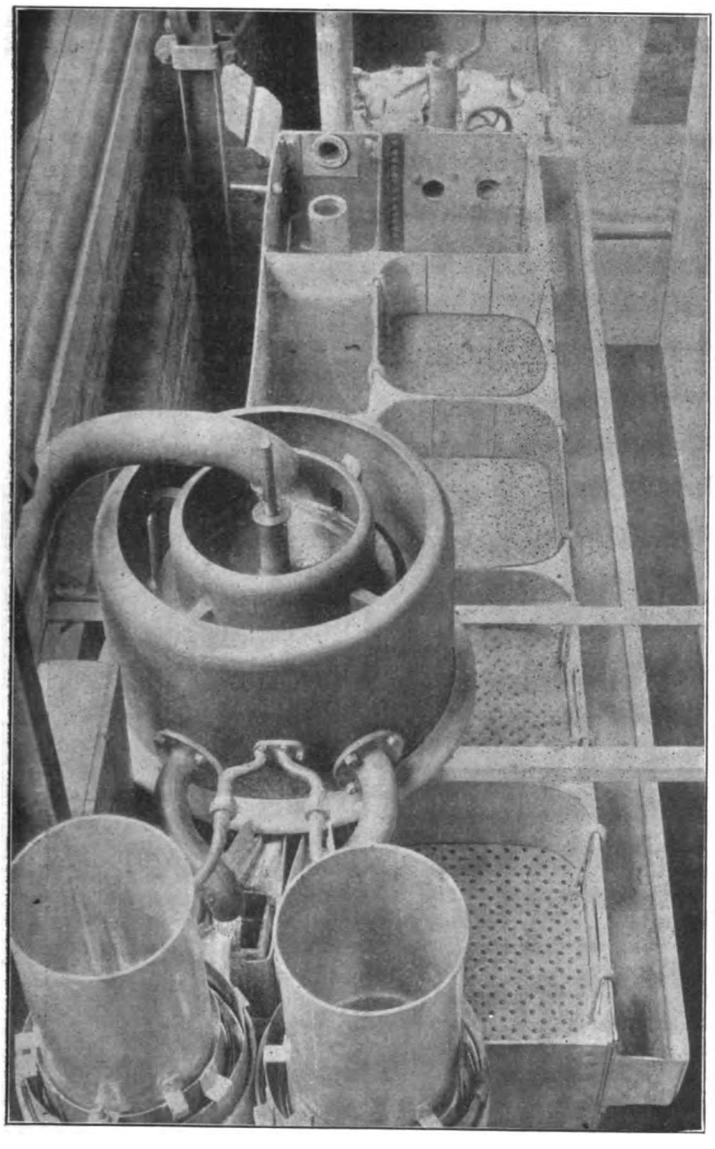
mixed and a gelatinous precipitate is formed. The liquid and precipitate, which latter retains the emulsified oil from the water, pass upwards through a coarse filtering medium, which detains a large amount of oil-bearing precipitate. The final or main filter removes the last trace of precipitate, and renders the water clear and free from oil. The finer filter, which we illustrate, consists of a number of discs of a special fabric gripped between metal grids provided with ports alternately at the centre and circumference, so that the whole forms a number of superposed filtering cells, which are enclosed in a common shell. The water to be filtered is admitted to the centre, passes into the cells by the central ports, through the medium, and out by the external ports. The filter is cleansed by stopping it, and running a rapid stream of water through it in the reverse direction, when the deposit is cleared from the medium and carried away by a sludge pipe. It is claimed that the cost of the reagents used up in the solutioners is not more than ½d. per 1,000 gallons of water.

On a light steel platform is carried the pipe range, all of which is within the boiler house, and is easily accessible; only the branch pipes for the engines are taken into the engine room. The main steam pipes are 6in. in diameter, and of welded steel; all bends are of solid drawn copper, with Holden and Brooke's steam driers, complete with steam traps, and Hopkinson's isolated valves on each boiler.

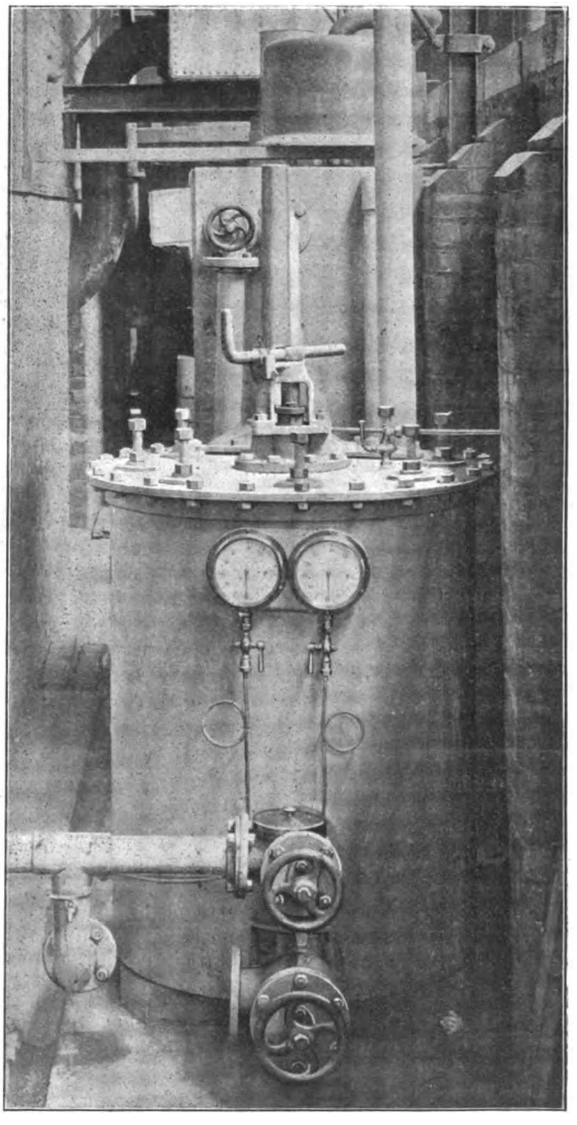
Engine-room Equipment.—There are, at present, two 125kw. Silvertown dynamos, coupled directly to Belliss three-crank triple-expansion marine-type enclosed engines, running at 400 revs. per min.; three Silvertown four-pole dynamos coupled directly to Belliss 500 H.P. triple-expansion engines, running at 360 revs. per min.; and there is provision for two 700kw. steam sets, which will be shortly installed. It is intended to make 700kw. hereafter the standard unit for the station.

Opposite the switchboard, and in line with the pump room and chimney, is situated the condenser pit. Provision has been made for three surface condensers, one of which, supplied by the Mirrlees-Watson and Yaryan Co., has already been fixed. Each set has to deal with the steam of 2,500 H.P. The condenser pumps are driven by a compound steam engine, and the air pumps are of the Edwards type. The circulating water is taken from an outside cooling pond (which holds 50,000 gallons), and on which is mounted a Klein natural draught wooden cooling tower. This pair of condensers will deal with the steam from one-half of the ultimate station, the engines being arranged equally on each side of the pit, and exhausting right and left into the condensers.

The switchboard is placed slightly above the floor level, on a wooden parquetry, and was supplied by Mr. Bertram Thomas. The instruments are mounted on enamelled slate panels, 2½in. thick, set in an iron frame, and finished off with wood moulding. There are three horizontal 'bus bars, and each machine has on the positive pole an automatic cutout, ammeter, and vertical 'bus bar, and can be plugged on to



General View of Purifier, showing Distributor, Solutioners and Filters.



Front View of Main Filter of "Harris-Anderson" Purifier.

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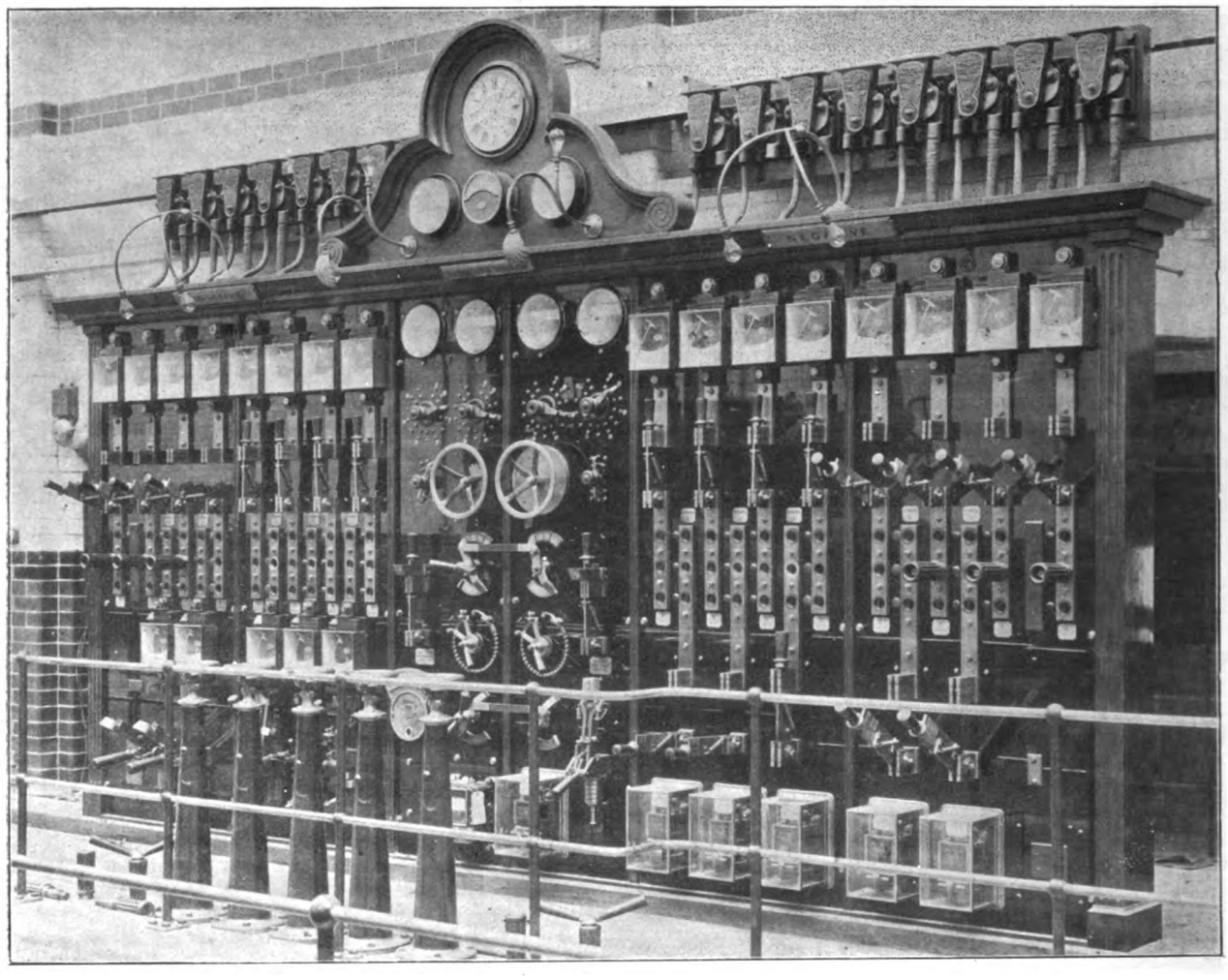
either of the three bars mentioned above. On the negative pole there is a wattmeter, knife switch, over-load fuse, and a vertical 'bus bar. Every feeder has on each pole an ammeter and long-break knife switch, and vertical 'bus bar similar to the dynamo 'bus bars. Thus each feeder can be plugged on to either of the main 'bus bars. Magnetic blow-out fuses are fixed on a separate frame at the back of the switchboard. The negative panels are on the left-hand side, and the positive on the right-hand side of the centre panel. On the centre panel are mounted dynamo voltmeters, with multi-voltmeter switch, booster switch, instruments for the battery charging booster, and the battery emergency switches. The dynamo rheostats are of the standard type, with revolving handles fixed immediately in front of this central panel and well under control.

In the battery room there are 180 Tudor cells, each with a capacity of 1,680 ampere-hours. These can be charged or discharged by a hand-regulated motor-driven booster, supplied by Messrs. D. Bruce Peebles & Co. This machine is capable of boosting from 0–80 volts, and has a carrying capacity of 400 amperes, being the maximum working load of the battery under normal conditions. In addition, there is a heavy battery switch which can be worked in emergency, and when the battery is under repair, capable of taking the full emergency load of the battery—viz., 800 amperes for one hour. For milking purposes there is a small motor-generator, also supplied by Messrs. Bruce Peebles & Co., located in a brick compartment within the battery room. This is connected with two pairs of trolley wires run above the central gangways between the rows of the cells, to which the milking leads can be connected. Above the battery room is situated a machine shop, containing a 12in. lathe, with bed long enough to take the longest shaft and gap to take the largest cylinder. This is motor-driven, the motor being contained in a casing under the head-stock. There is also a brass-finisher's lathe, shaping machine, radial drilling machine and a tool grinder. Adjoining this, in a fire-proof room, is the joiner's shop, containing a band saw, circular saw and grindstone, all of which are driven by Lundell motors.

A large development is taking place in the borough among the shipyards, which are gradually throwing out their obsolete plant and using electrical power. The demand is required at some distant points, and it has become necessary to make immediate arrangements for the installation of high-tension plant. Sub-stations will be erected in the first instance at South Docks and at Monkwearmouth, each being about 2 miles from the central station. These sub-stations will contain three-phase motor generators, the motors being run off a 5,500-volt circuit at 50 periods per second, and the generators being continuous current, 220-volt, delivering into the low-tension network. The cables will be three-core, drawn into Doulton's casings, laid in concrete. At the station it is proposed to remove Nos. 4 and 5 dynamos and couple them to motors at the sub-stations, and in their place to instal three-phase alternators, and to add two 750kw. machines. These will generate at 5,500 volts, 50 periods per second, and will be star-wound with the centre point earthed. It is intended eventually to convert the pioneer station into a sub-station, the machines to be driven from the main station at Hylton-road.



SWITCHBOARD AT SUNDERLAND.

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PRESSURE RISE IN HIGH-TENSION TRANSMISSION.

BY W. B. WOODHOUSE.

Long-distance high-tension transmission necessitates receiving apparatus possessing large impedance and transmission lines, either with considerable capacity or inductance according as the line is an underground insulated cable or a system of overhead wires. In considering the causes of excessive pressure rise and the means of safeguarding the system against undue stress, the subject naturally divides itself into three parts: The overhead line, the cable main and the receiving apparatus—*i.e.*, the transformers, switchboards and synchronous and non-synchronous machines.

The Overhead Line.—The trouble peculiar to overhead lines is that of lightning discharge; a direct discharge of lightning to a line will usually mean the breaking down of the line to earth, and a consequent short circuit. The impedance of the line itself is so great that the lightning jumps to earth by way of the nearest pole, and the generating and receiving stations only feel the induced effects; but the discharge of lightning in the neighbourhood of an overhead line may be sufficient to induce a dangerous rise of pressure, throw synchronous machines out of step, burn them up, or generally break down the insulation of the system and cause a short circuit. It is usual, therefore, to fit lightning arresters at each sub-station on the line, which allow a discharge to earth when the pressure exceeds a certain limit. As usually arranged, the arrester consists of a choking coil connected to each line, and having on the line side a connection to a spark-gap, the other side of which is earthed. There are two familiar types of spark-gaps. In the one a pair of curved horns is arranged, with a small gap between their lower extremities; the arc striking across this gap rises until the distance between the horns is great enough to break the arc. The other type consists of a number of knurled metal cylinders arranged with parallel axes and equal gaps between adjacent cylinders; the discharge jumps from gap to gap, the last cylinder being earthed. This separation of the total gap into a number of smaller gaps allows a large mass of metal to be used, so that any arc formed will be chilled and will more readily die out. Special alloys are used by some makers which are described as non-arcing. It is a matter of experience that brass is quite as effective. Under certain conditions when a discharge takes place across a gap or gaps, the line current follows and causes a short circuit. This being so, a non-inductive resistance, such as a carbon rod, is often placed in series with the gaps, lessening the chance of an arc holding. Another arrangement is to have two sets of gaps in series, shunting one of them with a non-inductive resistance; when a discharge takes place the arc starts across the unshunted gaps and then across the others, so that twice the number of gaps may be used without altering the striking distance. When the line current follows, the shunted gaps will not hold the arc, and it more readily dies out on the other set, due to the resistance.

The use of a fuse in series with the gaps is not to be commended. The design of a choking coil for such a purpose as the above is purely a matter of guesswork; if the lightning discharge be of exceedingly high frequency, a thick copper rod will prove as effective a device as any; but if, as is usually the case, a bank of transformers is connected at each end of the line, it seems to the writer that the transformers themselves will be the most effective choking coils that can be adopted. It will then be sufficient protection to fix a set of spark-gaps at each end of the line with a series resistance whose value must be determined for each particular case. In districts where thunderstorms are of frequent occurrence it may pay to run an earth wire above the transmission line, strong barbed wire being most suitable.

Cases have occurred in which the induced pressure in the transformer secondary due to lightning discharge has become excessive; the earthing of some point in the secondary seems sufficient precaution.

Rise of pressure may occur alike in cables and overhead lines due to (1) switching on and off, (2) change of current flowing, the extreme case of which is a short circuit.

Switching-on.—If to a circuit possessing resistance, R, and inductance, L, a steady pressure, E, be applied suddenly, then the pressure in the system will rise to a value E_1, where $E_1 = \frac{IR}{\epsilon^{\frac{Rt}{L}}}$* t = time, and $I = \frac{E}{R}$. At the moment of switching-on, $t = 0$, and E_1 is a maximum and equal to E; that is, the pressure rises to twice the applied pressure.

In the case of an alternating system, switching-on may occur when the applied ('bus-bar) voltage has any value from 0 to its maximum value (*i.e.*, $\sqrt{2}$ times the virtual), so that with a pressure of 10,000 volts the switching-on of a cable may cause an instantaneous rise of pressure to 28,000 volts. That the voltage induced ever reaches to this value is doubtful. Even though switching-on takes place at the worst possible moment, yet, as the generator possesses small capacity, at the moment of switching the pressure applied to the cable will fall, due to the capacity current demanded. This induced pressure passes as a wave along the whole line, and is reflected again and again, rapidly dying out, due to resistance and leakage losses.

Should, however, the period of oscillation of the wave coincide with that of some overtone in the wave of applied E.M.F., dangerous surging may be set up, due to the repeated impulses occurring synchronously with the return of the reflected wave. The danger of such resonance is, fortunately, remote, and can be guarded against.

Here it may be mentioned that, if a transformer be connected at the receiver end of such a cable, this wave of extra pressure may break down the end coils of the transformer—the end coils because the impedance of the coils next the lines is first called into action, and the stress falls on the insulation of those coils only, the pressure on the remaining coils rising gradually.

Where a number of sub-stations are arranged with alternative mains to the various stations there may occur the case of a cable of smaller capacity joining the one to be made alive at some intermediate point. That being so, the wave of double pressure will occur at the end of this smaller cable and induce a wave whose possible maximum is four times the 'bus bar pressure.

Switching-off.—Switching-off a transmission line which carries no current should cause no undue rise of pressure on the line, the pressure falling gradually; but the switching does not take place instantly, and there may occur a discharge and recharge several times before the circuit is finally broken; the stress on the dielectric is then the same as in switching-on. The inductance and capacity of the line are of minor importance in these cases.

Switching-off a Line carrying Current.—The most general case is a line possessing capacity, C, and inductance, L; if an alternating current, I, is flowing in this line, the electromagnetic energy stored up is $I^2L/2$ joules; when the circuit is suddenly opened all this energy is expended in charging up the cable as a condenser (if we neglect the loss of energy in heating the conductor and arcing at the switch); that is, $I^2L/2 = E^2C/2$, from which $E = I\sqrt{\frac{L}{C}}$, E being the value to which the pressure will rise on a sudden interruption of the current. The greater the capacity of the cable the smaller the rise of pressure when a given amount of energy is stored in it.

The severest case is when a short circuit occurs at the receiving end; in the case of a long overhead line the pressure rise may be enormous.

Safeguards.—The above stresses of a high-tension system are due to the manner in which the circuit is made or broken; the choice of switch-gear is of importance. Air-break switches become useless above 10,000 volts, due to the long arc formed and the possibilities of resonance effects. The oil-break switch also breaks circuit suddenly, but without a long arc; as pointed out above, this does not stress the system unduly. The ideal switch-gear should make or break circuit when the current wave passes through zero. Judging from the fact that disconnected cables are always found to be

* Cf. Perry's "Calculus," p. 240.

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charged, no switch-gear does this. Charging devices, such as a switch by which pressure is gradually applied to the mains, may be effective, but are unnecessary.

In the writer's opinion the system will be fully protected if spark-gaps be fixed between lines and earth, both on cables and overhead lines, the gaps being set to discharge at from once and a-half to twice the working pressure, the lower value for extra high pressures. Transformers and the stators of induction machines (both possessing considerable inductances) should not be switched direct on to the line, but should be shunted by a condenser at the moment of switching in or out.

In some experiments the writer recently made on spark-gaps, it was found that a row of gaps, arranged to discharge at 3,500 volts, kept the pressure of a line at about that voltage when a pressure of 5,000, 10,000, 15,000 and 20,000 volts was applied for several seconds. At the lower voltages the discharge was spread along the cylinders and was uniform. The higher the applied voltage the greater was the tendency to form large sparks, blistering the metal. Apart from such voltages as might occur from lightning discharge the gaps acted effectively.

PUMPING PLANT FOR CONDENSING WATER.*

BY CHARLES HOPKINSON.

The condensation of steam in the large quantities required in electric power stations is often a difficulty in those cases where a central site is selected. Even if economy does not demand condensation, public policy does. The discharge of aqueous vapour in large quantities is intrinsically and legally a nuisance. This objection has caused trouble to users of cooling towers, and was the reason for abandoning a cooling tower scheme as part of the Newcastle tramway power plant. As an alternative it was decided to pump from the river Tyne, distant some 500yds. horizontally and 86ft. vertically from the engine-house, and to utilise the energy of the water flowing back to the river. The first idea was to use reciprocating pumps and water-pressure motors directly connected, the loss in the system being replaced by motors supplied with electric energy from the power house. The usual course of advertisement and specification failed to elicit any suitable offer of reciprocating plant from contractors, and the centrifugal pump and turbine arrangement offered by Messrs. Mather and Platt was adopted, and the author believes that the arrangement may be found interesting in itself, and possibly useful as a precedent.

shunt-wound motors, and assisted by Gilkes' "Vortex" turbines on an extension of the pump and armature spindle. In these pumps the water enters the revolving wheel (23⅝in. diameter) axially, symmetrically on each side of the wheel, so that axial thrust is eliminated; the water then traverses the curved internal passages

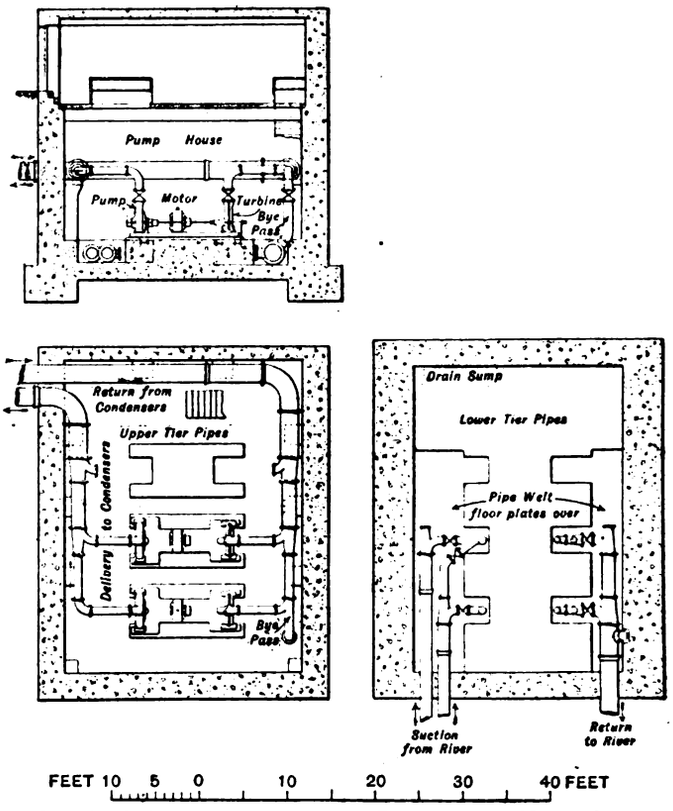

FIG. 2.—Circulating Pumps at Tramway Power Station, Newcastle-upon-Tyne.

between the vanes, and is discharged tangentially at the periphery, into a stationary guide ring of special construction. This ring is concentric with the revolving vanes, and conveys the water to an annular chamber in the body of the pump, where the velocity head

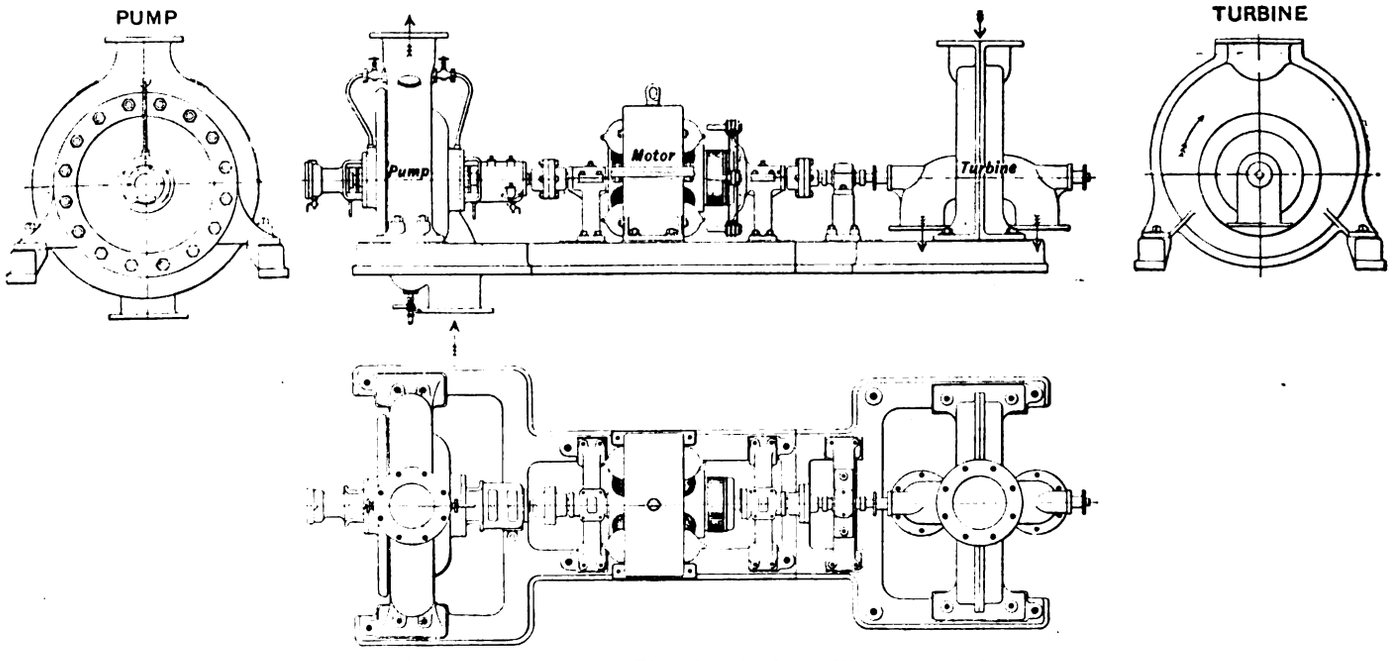

FIG. 1.—General Plan of Pumping Plant for Circulating Water through Condensers.

The system is designed to supply at present 75,000 gallons per hour, and to be conveniently capable of expansion to supply from 150,000 to 200,000 gallons per hour, as developments may require. The general arrangements are shown in Figs. 1 and 2.

The plant consists of three Mather and Platt's single-chamber high-lift centrifugal pumps; two are already installed, driven by

imparted to the water by the wheel is converted into pressure head. The turbine consists of a brass wheel, 13½in. diameter, surrounded by a supply chamber, from which the water is directed on to the wheel by movable guide vanes which regulate the flow to the wheel. After traversing the vanes of the wheel towards the axis, the water is discharged symmetrically on each side of the wheel. It will thus be seen that the construction of pump and turbine is the converse each of the other.

* Paper read at the Institution of Mechanical Engineers.

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The pipes have been put in of sufficient size to pass the ultimate supply with a moderate loss of head. Two 15in. suction pipes are provided, each available for the service of either of two pumps. The pumps deliver into a main 24in. bore rising to the power house, from which branches are taken to each surface condenser. The return water, collected in a similar main laid in the same trench, has

Circulating Water Installation.

High Lift Centrifugal Pump (Single Chamber) Bucket 23⅝" (600·6mm.) diam.

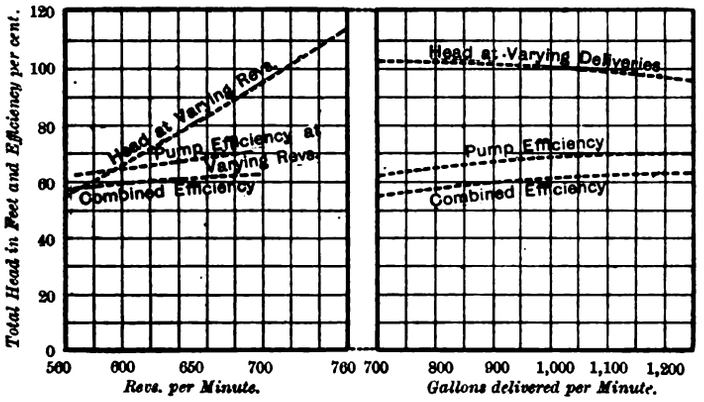

FIG. 3.—Constant Delivery of 1,250 Gallons per Minute (approx.).

FIG. 4.—Constant Speed of 700 Revs. per Minute (approx.).

NOTE.—Head includes a constant suction of about 15·5 feet.

Combined Pumping Plant Test.

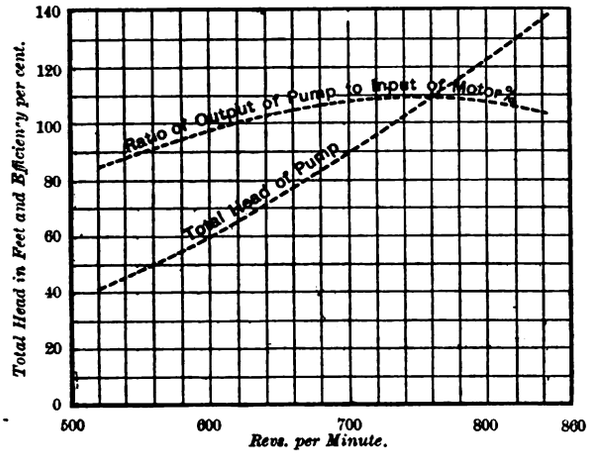

FIG. 5.—Constant Delivery of 1,250 Gallons per minute.

NOTE.—Average Head on Turbine is about 1 ft. less than Delivery Head on Pump, or about 9·3 ft. less than Head shown on Curve. Average Constant Suction on Pump = 8·3 feet.

branches to each turbine and a by-pass direct to the tail pipe of the turbines. The levels are given in the following table :—

Ordnance datum	0·00
High-water ordinary springs	7·83
Low-water ordinary springs	– 7·17
Low-water equinoctial	– 10·17
Pump-house floor	6·25
Centre of pump	8·22
Engine-house floor	85·9
Top of smaller condensers	85·0
Top of large condenser	97·0

The admission to the respective condensers is controlled by valves on the inlet and outlet.

It is evident that under such varying conditions of head the efficiency and duty will be somewhat variable. Tests were therefore made both with and without the auxiliary turbines at the makers' works, suction and delivery heads being obtained by throttling and the output measured over a notched weir. The curves (Figs. 3 to 5) show the principal results :—Fig. 3. Pump and motor only. Constant delivery : varying head and speed. Fig. 4. Pump and motor, relation of head to delivery, speed constant. Fig. 5. Pump, motor and turbine. Constant delivery : varying head and speed.

A comparison of Figs. 3 and 5 shows that the addition of the turbine reduces the power required in the ratio of 108 to 62—a saving of 42·6 per cent.—about half of the saving theoretically possible with perfectly reversible mechanism. In estimating the efficiency of the whole combination, it must be remembered that the loss of head in the pipes, and valves and condensers, is constant with a given flow, and that the head so lost is not available for the restoration of power in the turbine.

THE KALGOORLIE ELECTRIC POWER SCHEME.*

BY C. E. CROCKER.

The electric power and lighting plant of the above corporation is rapidly nearing completion. The tramways have already been supplied with power from the company's plant. As the principal purpose of the corporation is to supply electric current to the mines in the Kalgoorlie district for power and lighting purposes, a description of the plant may be of interest to the members of the Chamber of Mines. The erection of the plant was started in June, 1901, when the ground was broken for the foundations of the buildings and engines. The main building consists of an engine room, 160ft. by 40ft. in the clear and 40ft. to the eaves, and the boiler house, 120ft. by 43ft. These buildings are both constructed entirely of steel framework and covered with galvanised corrugated iron, the corrugated iron being attached directly to the steel work by means of galvanised iron straps. In this way all wood is entirely avoided, and, with the exception of the window frames and doors, the buildings are fireproof. The steel work of the engine house is of specially substantial proportions, as it is required to carry the 20-ton overhead travelling crane. All the buildings are supported on extensive concrete foundations, about 2,500yds. of concrete having been used in the foundations. In addition to the main buildings above-mentioned, there is a condensing plant, built of jarrah frame work and iron covering, measuring about 80ft. square.

The equipment of the plant comprises a complete evaporating apparatus, which is supplied with water taken from a shaft on the power site. The water is pumped from the shaft, which is 350ft. deep, by a direct-acting pump, driven by water-proof electric motor. This pump is installed at the bottom of the shaft, and delivers water to the four salt water storage tanks, located near the evaporating boilers. These salt water storage tanks are each 40ft. in diameter, and 14ft. deep, giving a total storage capacity of 440,000 gallons. The water from these tanks is carried to the evaporating plant, which consists of 10 cylindrical boilers, 5ft. in diameter and 20ft. long. These boilers are built in pairs, in rubble masonry and brickwork, the whole being set on a bed of concrete. The steam from the evaporating boilers is condensed in 40 vertical drums of the usual galvanised iron construction. These drums are 3ft. inside diameter, 6ft. outside diameter and 24ft. long. The fresh water from these cooling drums is stored in four steel tanks, each 16ft. diameter and 8ft. deep. From these storage tanks the water gravitates to the hot wells, which consist of two similar tanks.

The main boiler tank consists of eight 250 H.P. Babcock and Wilcox boilers. These boilers are arranged for wood fuel, and generate steam at a working pressure of 160lb. per square inch. Each boiler has a heating surface of 2,823 sq. ft. The boilers are arranged in four batteries, set on concrete foundations. The two boilers forming each battery are connected to one chimney. The four chimneys are of steel, 5ft. 6in. inside diameter, and 110ft. of steel work on a 10ft. pressed brick base, giving a total height of 120ft. Each of the boiler drums is fitted with double-pole lever safety valves. The entire boiler settings and chimney bases are lined throughout with firebricks. The feed-water for the boilers is pumped from the hot wells through a Holden and Brooke feed-water heater, by which the temperature is raised to 180deg. There are two feed-water pumps—one 8in. by 6in. by 12in. Tangyes' steam feed pump, and one 6in. by 12in. Tangyes' feed pump, driven by an electric motor. Ordinarily the motor pump will be used, this being a much more economical arrangement than running continuously with a steam pump. The main steam header is 10in. in diameter, from which 7in. pipes feed each engine. The piping is fitted with numerous valves, by which each engine can be run from any boiler, as may be desirable. Holden and Brooke steam separators are used on the steam pipes to each engine.

There are three main engines, each 22in. by 44in. by 36in., vertical cross-compound, built by D. Stewart & Co., of Glasgow. These engines are rated nominally as 800 I.H.P., but are guaranteed capable of a maximum of 1,200 I.H.P. The engines run at 100 revs. per min. The shafts are hollow, and each carries the revolving field of the electric generator and a flywheel 19ft. in diameter and weighing 33 tons. The revolving portion of the generator weighs about 16 tons, so that the total weight on the flywheel shaft is over 50 tons, including the crank discs. The engines are fitted with Corliss valve gear, the valves being placed on the ends of the cylinders, giving a very small piston clearance. The governor balls are driven by vertical shafting and Reynolds' gear belts.

The engines are required to govern within 2 per cent. under any condition of load, and to provide against any accident which might result from failure of the gearing controlling the regular valve gear, by reason of which failure the speed of the engine would be increased beyond 5 per cent., an auxiliary throttle-valve governor is provided, which will take effect in case the speed rises above 105 revs. per min. The engines are of very substantial construction, and are intended to supply an unusually steady and reliable service. In addition to the main engines, there are two 50 H.P. vertical compound high-speed engines direct-coupled to the continuous-current exciters.

* From the *Australian Mining Standard*.

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The exhaust steam from the engines is carried through a 24in. exhaust main, suspended under steel brackets along one side of the engine room, and passing into the building containing the Fouche condensers. These condensers form a very extensive system, being the largest and most complete condensing plant of this type which has been installed in Australia. The condensers now in course of erection have a capacity of 4,500 H P., and are guaranteed to give a vacuum of 13in. with an atmospheric temperature of 90deg. The condensing apparatus is divided into three independent groups, each group comprising three sets of radiators and fans. There are in all twenty-seven 7ft. fans, the air from which is discharged into the different air chambers and passed upwards through the radiators wherein the steam is condensed. In this condenser, the body of the steam is greatly sub-divided, being brought down into a thickness in the sections of the radiators of ¼in. Each group of condensers is provided with an air pump and grease pump. A complete system of grease separation and filtration is provided. The entire condenser was built by Frederic Fouche, of Paris. All the pumps and fans of the condensers are driven by electric motors manufactured by the Allgemeine Elektricitäts-Gesellschaft, of Berlin. The motors and pumps are installed inside the condenser building, while the fans and radiators are arranged around the outside. By means of this, the air blown through the condensers will have the shade temperature of the interior atmosphere.

The electric portion of the plant consists of three 500kw. three-phase 40-cycle dynamos, each direct-coupled to one of the main engines. These dynamos generate current at 600 volts potential. The generators are of the revolving-field type, which is the most substantial construction, and the revolving field is so designed as to cause the continuous circulation of a strong current of air through the exterior armature, thus greatly assisting in dissipating the heat. There are also two 35kw. continuous-current exciters, direct-coupled to the small engines previously mentioned, and also one 45kw. exciter, driven by a 70 H P. induction motor. These exciters are used for magnetising the fields of the large alternators. Under continuous running conditions, the motor-driven exciter will be used, as showing higher economy than those driven by the small engines. The current from all the electric machinery is carried through lead-covered cables in trenches to the switchboard, which is placed on an elevated platform in one end of the building. This switchboard is of blue Vermont marble, and is fully equipped with indicators and recording instruments. The entire electric equipment of the engine house was manufactured by the General Electric Co., of America.

For supplying the tramway system, two 250kw. rotary converters are being installed. These machines are used for converting the alternating current to 500-volt direct current, such as is required for tramway work.

The general distribution to the mines for lights and stationary motors will be direct from the 550 volts three-phase 40-cycle system. As the equipment of each portion of the plant is divided into three or more units, one of which is always to be held in reserve, the power supply will be of an entirely satisfactory and reliable nature. The company has built a railway siding into the works, by which wood is delivered immediately in front of the boilers, thus saving handling. The use of electric power from central generating stations is now almost universal, owing to its great convenience and reliability, and low initial cost of necessary apparatus. And as the power can be supplied at lower costs than it is possible to run a separate plant, the use of this power should soon be very extensive among the consumers on these fields. With the machinery at present installed, the company is able to supply some 2,000 H.P. in motors, in addition to the power required by the tramways.

ELECTRICITY WORKS ACCOUNTS.

St. Pancras Municipal Electric Supply Works.

Notwithstanding the naturally high value at which the fuel charge still remains, a very material reduction in the generating, works and total costs of this undertaking was effected during the 15 months to March 31st last. The receipts have also diminished, but to a less extent. It is disappointing to find that repairs and maintenance costs at the station have risen from the already high figure of 0·248d. per unit at which they stood in 1900. These high charges, with those for fuel, are to be held accountable for the still too high generating and works costs, because the management and property charges present most moderate values.

It is necessary to note that, included in the distribution expenses is the exceptional item of £725 for alterations in connection with the change of pressure to 220 volts, and that it was found desirable to take the meter readings earlier than formerly, having the effect of reducing the net profit by about £2,250, the benefit of which will accrue in the current year's account. We also learn that during the additional quarter included in the accounts a larger sum in repayment of loans was met than was proportional to the period.

London Electric Supply Corporation (Ltd.).

It is with pleasure that we are enabled to record the accounts of the comparatively most satisfactory operations of 1901 of this company. There is quite an element of pathos suggested by this statement of the regeneration of the undertaking almost simultaneously with the death of Lord Wantage in June of last year. The company practically owes its present existence to his generous financial support since 1888.

Passing to a brief consideration of the figures in our analysis, it will be seen that, while the management and property charges are very satisfactory for a company-worked undertaking in London, the generating and works costs still offer room for improvement. It is only natural, after the years of tribulation through which the concern has passed, that the capital load is heavy, and that amongst the generating costs the only relatively low item is that of repairs and maintenance at the station.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Isle of Wight (Company)	Dec. 20, 1901
Accrington (Municipal)	July 25, 1902	Islington (Municipal)	Nov. 23, 1900
Ayr (Municipal)	Oct. 11, 1901	Kens'gton & Knightsbr'(Co.)	Apr. 11, 1902
Barnsley (Municipal)	June 27, 1902	Kingston-upon-Hull (Mun.)	July 13, 1900
Bath (Municipal)	April 20, 1900	Kingston-on-Thames (Mun.)	June 20, 1902
Bedford (Municipal)	Aug. 3, 1900	Lancaster (Municipal)	July 25, 1902
Belfast (Municipal)	Aug. 8, 1902	Leeds (Municipal)	June 27, 1902
Birmingham (Company)	Sept. 15, 1899	Leicester (Municipal)	Jan. 26, 1900
Blackburn (Municipal)	Feb. 7, 1902	Leith (Municipal)	May 17, 1901
Blackpool (Municipal	Oct. 4, 1901	Leyton (Municipal)	Nov. 1, 1901
Bournemouth (Company)	April 18, 1902	Liverpool (Municipal)	April 4, 1902
Bolton (Municipal)	Nov. 29, 1901	London (Company)	April 25, 1902
Bradford (Municipal)	July 12, 1901	Londonderry (Municipal)	Feb. 16, 1900
Brighton (Municipal)	May 10, 1901	Manchester (Municipal)	Aug. 29, 1902
Bristol (Municipal	Aug. 8, 1902	Morley (Municipal)	July 25, 1902
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	July 11, 1902	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	July 11, 1902	Norwich (Company)	Dec. 13, 1901
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Aug. 29, 1902
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 22, 1902	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 23, 1900	Richmond (Company)	June 29, 1900
Crewe (Municipal)	July 11, 1902	Salford (Municipal)	Jan. 24, 1902
Croydon (Municipal)	Nov. 22, 1901	Scarborough (Company)	Dec. 20, 1901
Crystal Palace District (Co.)	Sept. 13, 1901	St. Helens (Municipal)	Jan. 10, 1902
Derby (Municipal)	Jan. 26, 1900	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. Pancras (Municipal)	July 5, 1901
Dover (Company)	May 2, 1902	Sheffield (Municipal)	Feb. 1, 1901
Dundee (Municipal)	Dec. 6, 1901	Shoreditch (Municipal)	Jan. 31, 1902
Eastbourne (Municipal)	Mar. 14, 1902	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Edinburgh (Municipal)	Dec. 6, 1901	South London (Company)	May 16, 1902
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 4, 1902
Folkestone (Company)	May 2, 1902	Southampton (Municipal)	Aug. 1, 1902
Glasgow (Municipal)	Sept. 27, 1901	Southport (Municipal)	Jan. 17, 1902
Gloucester (Municipal)	Aug. 30, 1901	Stafford (Municipal)	Aug. 16, 1901
Great Yarmouth (Mun.)	Dec. 13, 1901	Sunderland (Municipal)	Aug. 1, 1902
Greenock (Municipal)	Aug. 30, 1901	Taunton (Municipal)	June 16, 1899
Guildford (Company)	Oct. 19, 1900	Tunbridge Wells (Mun.)	Aug. 23, 1902
Halifax (Municipal)	Dec. 27, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hammersmith (Municipal)	Nov. 15, 1901	Walsall (Municipal)	May 23, 1902
Hampstead (Municipal)	Nov. 22, 1901	Wandsworth (Company)	May 9, 1902
Hanley (Municipal)	Aug. 9, 1901	Westminster (Company)	April 4, 1902
Harrogate (Municipal)	Jan. 25, 1901	Whitehaven (Municipal)	Feb. 8, 1901
Harrow (Company)	Dec. 21, 1900	Winchester (Company)	June 20, 1902
Hastings (Municipal)	July 18, 1902	Windsor and Eton (Co.)	July 19, 1901
Hereford (Municipal)	Jan. 17, 1902	Woking (Company)	Dec. 22, 1899
Hove (Company)	July 18, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Huddersfield (Municipal)	May 23, 1902	Woolwich (Company)	May 31, 1901
Hull (Municipal)	July 4, 1902	Worcester (Municipal)	April 18, 1902

REMARKS.

ST. PANCRAS (LONDON).—*a* At debit of suspense account on account of explosion, &c. *b* Lands £25,037. *c* over expended. *d* Proportion of engineers' salaries £495. *e* Buildings £151, engines and boilers £1,923, dynamos, exciters, accumulators £880, other plant and tools £167. *f* Proportion of engineers' salaries £173. *g* Of mains £2,400, on consumers' premises £1,101. *h* Carbons £544. *i* Of engineers' department and clerical staff. *j* Insurances £276, plant and engine room alterations £235, compensation £67. *k* £710 written off boilers transferred from Regent's Park station to the King's Road station. *l* Or 5d. per unit all round During first six months of 1900 6d. (1½ hours) to 3d. *m* During first six months 3d. per unit and 2d. for storage cells. *n* Inclusive of repairs, maintenance and carbons. *o* Or flat rate of 5d. *p* Including £1,000 written off accumulators and £600 written off meters. *q* Including £2,808 written off accumulators and £600 written off meters. *r* Lands £32,672. *s* Proportion of engineers' salaries £658, wages £1,873. *t* Buildings £473, engines, boilers, &c., £3,235, dynamos, exciters, &c., £1,161, other plant £212. *u* Proportion of engineers' salaries £542. *v* Of mains £2,366, on consumers' premises £350. *w* Carbons £973, repairs £350. *x* Insurances £475, loans expenses £143, compensation £190. *y* £3,000 to "Reserve," £1,000 written off accumulators, £414 off machinery for "sale of dry air machine," £378 written off cost of removing boiler from Regent's Park station and re-erecting at King's Road.

LONDON.—*a* After adding £227,566 total amount written off capital for depreciation, &c., to date. *b* £42 to purchase of current. *c* Salaries of engineers and officers £1,868, wages £5,915. *d* Buildings £414, engines and boilers £2,056, dynamos and exciters £173, transformers and accessories £6, other plant and tools £438. *e* Salaries of officers £1,243, wages £1,455. *f* Of mains £1,801, on consumers' premises £1,168. *g* Directors £500, salaries of manager, secretary, engineers' and clerical staff £2,642. *h* Law £67, auditing £85. *i* By sliding scale, also 6d. to 3d. by maximum demand system. *j* By maximum demand system. *k* Per respectively capacity and lamp connection at *end* of year.

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	ST. PANCRAS (LONDON).		LONDON.
Undertaking Worked by	St. Pancras Borough Council.		London Electric Supply [Corp. (Ltd.).
Date of Commencement of Supply	November, 1891.		1885.
System of Supply	3-wire continuous with batteries.		High-press. alt.-current with sub-stations and house trans.
Chief Engineer	S. W. Baynes.		G. W. Partridge.
YEAR ENDED	DEC. 31, **1900.**	MAR. 31, **1902.**	DEC. 31, **1901.**
QUANTITIES—			
Units generated	3,637,309	5,608,436	—
„ **SOLD (TOTAL)**	3,008,481	4,729,840	3,546,461
„ sold to consumers	2,296,386	3,588,763	—
„ sold for public lighting, &c.	712,095	1,141,077	nil
„ sold for traction	nil	nil	nil
„ used on works	218,014	365,686	Included in "units sold"
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	30·7	41·0	18·9[k]
Actual maximum supply demanded	2,275 kilowatts	2,610 kilowatts	3,000
Load factor	15·1%	20·7%	13·5%
Number of public lamps	416 arc, 2 (50 c.p.) glow	450 arc, 2 (50 c.p.) glow	—
Number of consumers	1,489	1,806	—
Connections to mains in 8-c.p. lamps at end of year	135,064	173,202	182,878
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	3,690	3,690	6,000
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£261,100 / £70·8	£335,620 / £91·0	£1,275,000 / £212
Share	— / —	— / —	850,000 / 142
Loan (including Debenture charges)	261,100 / 70·8	335,620 / 91·0	425,000 / 70·9
RECEIVED (TOTAL)	261,100 / 70·8	335,620 / 91·0	914,700 / 152
Share	— / —	— / —	582,200 / 97·0
Loan (including Debenture charges)	261,100 / 70·8	335,620 / 91·0	332,500 / 55·4
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	nil / —	360,300 / 60·0
Share (unissued)	— / —	— / —	267,800 / 44·6
Share (uncalled)	— / —	— / —	— / —
Loan (including Debentures)	nil / —	nil / —	92,500 / 15·4
REPAID (TOTAL)	21,187 / 5·75	27,841 / 7·55	— / —
RESERVE OR SINKING FUND	−658[a] / −0·178	−923[a] / −0·250	— / —
DEPRECIATION FUND	10,683 / 2·89	13,842 / 3·75	227,566 / 38·0
EXPENDED (TOTAL)	338,395[p] / 91·7	383,535[q] / 104	1,142,487[a] / 190
Lands and buildings	72,751[b] / 19·7	81,706[r] / 22·1	— / —
Plant	116,558[p] / 31·6	130,132[q] / 35·2	— / —
Mains	148,534 / 40·3	170,987 / 46·3	— / —
Miscellaneous	552 / 0·150	709 / 0·192	— / —
BALANCE OF CAPITAL ACCOUNT	−77,295[c] / −20·9	−47,915[c] / −13·0	— / —
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£48,938 / 3·900d.	£73,890 / 3·748d.	£71,167 / 4·815d.
Revenue from supply	38,364 / 3·058d.	58,985 / 2·990d.	67,230 / 4·550d.
„ meters, &c.	134 / 0·011d.	214 / 0·011d.	3,230 / 0·218d.
„ public lighting	9,847 / 0·786d.	14,263 / 0·724d.	— / —
„ supply for traction	nil / —	nil / —	— / —
„ miscellaneous sources	593 / 0·047d.	428 / 0·022d.	708 / 0·048d.
EXPENDITURE OUT OF REVENUE—			
TOTAL COSTS	£32,718 / 2·610d.	£48,247 / 2·448d.	£45,947 / 3·110d.
TOTAL WORKS COSTS	28,373 / 2·263d.	42,040 / 2·133d.	37,979 / 2·570d.
Generation of electricity	*21,854* / *1·743d.*	*33,290* / *1·688d.*	*32,599*[b] / *2·206d.*
Fuel (including cartage, &c.)	13,343 / 1·064d.	20,602 / 1·045d.	18,952 / 1·283d.
Oil, waste, water, stores	1,268 / 0·101d.	1,801 / 0·096d.	2,706 / 0·183d.
Wages at station	3,958[d] / 0·316d.	5,532[s] / 0·280d.	7,814[e] / 0·529d.
Repairs and maintenance at station	3,113[e] / 0·248d.	5,078[t] / 0·258d.	3,086[d] / 0·209d.
Distribution of electricity	*4,678* / *0·373d.*	*6,132* / *0·311d.*	*5,380* / *0·364d.*
Wages, &c.	1,172[f] / 0·093d.	1,944[u] / 0·099d.	2,698[e] / 0·183d.
Repairs, renewals of mains, &c.	3,506[g] / 0·280d.	4,188[v] / 0·212d.	2,682[f] / 0·181d.
Public lighting	*1,841* / *0·147d.*	*2,618* / *0·133d.*	— / —
Attendance	852 / 0·068d.	1,296 / 0·066d.	— / —
Renewals	989[h] / 0·079d.	1,322[w] / 0·067d.	— / —
MANAGEMENT AND PROPERTY CHARGES	4,472 / 0·357d.	6,207 / 0·315d.	7,968 / 0·539d.
Net rents	*24* / *0·002d.*	*34* / *0·002d.*	*302* / *0·020d.*
Rates and taxes	*1,445* / *0·115d.*	*1,951* / *0·099d.*	*2,717* / *0·184d.*
Management	*2,876* / *0·229d.*	*4,222* / *0·214d.*	*4,949* / *0·335d.*
Salaries	1,808[i] / 0·144d.	2,405[i] / 0·122d.	3,909[g] / 0·265d.
Stationery, &c.	285 / 0·023d.	269 / 0·014d.	232 / 0·016d.
Establishment charges	158 / 0·013d.	333 / 0·017d.	656 / 0·044d.
Law charges &c.	625 / 0·050d.	1,215[x] / 0·062d.	152[h] / 0·010d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£16,220 / 5·18%	£25,643 / 7·10%	£25,220 / 2·24%
Sum carried to Depreciation Fund	3,627[k] / 1·16%	4,791[y] / 1·33%	3,000 / 0·267%
Sum carried to Reserve Fund	3,940 / 1·26%	6,757 / 1·87%	— / —
Net interest on loans (incl. Debenture charges)	8,648 / 2·76%	13,898 / 3·85%	13,304 / 1·18%
Net profit for the year	5 / 0·002%	197 / 0·055%	8,916 / 0·793%
BALANCE FROM LAST ACCOUNT	1,134 / 0·362%	1,139 / 0·316%	49 / 0·004%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	1,139 / 0·364%	1,335 / 0·370%	8,966 / 0·798%
Deficit	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	66·9%	65·3%	64·6%
Expenditure per mean kilowatt capacity	£10. 8s. 2d.	£13. 1s. 5d.	£7. 13s. 2d.[k]
REVENUE PER MEAN KILOWATT CAPACITY	**£15. 11s. 7d.**	**£20. 0s. 0d.**	**£11. 17s. 0d.**[k]
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**7s. 10d.**	**9s. 7d.**	**7s. 9d.**[k]
Price charged for lighting, per unit	6d. (1 hr.) to 2d.[l]	6d. (1 hr.) to 3d.[o]	6d. to 4d.[i]
Price charged for power, per unit	2d.[m]	2d.	3d. to 2d.[j]
Price charged for public lighting	3d. per unit[n]	3d. per unit[n]	—
Receipts per unit for private supply	4·01d.	3·94d.	4·55d.
„ „ public lighting	2·70d.	2·45d.	
„ „ traction	—	—	

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THE LONDON COUNTY COUNCIL AND TECHNICAL EDUCATION.

A report of the sub-Committee of the London County Council "On the Application of Science to Industry" has recently been published, and is an interesting document. The Committee has addressed a letter to various persons asking the following questions:—Whether the decadence of any British industry could be directly attributed to defective technical education? What is the training best suited to qualify students to become leaders of those industries dependent on the application of chemistry, electricity, or electro-chemistry? Where can such training at present be found in London institutions? Whether the defects are due to insufficient and badly-paid teachers, or to students incapable of taking advantage of the special training owing to lack of general education? There were also other questions of a more precise nature, one of the objects of the Council in appointing the sub-Committee having been to ascertain "what, if any, developments are needed to secure efficient training for senior county scholars and other advanced students who desire to qualify themselves to take leading positions in scientific industries." Some of the gentlemen, or "witnesses," to whom this letter was addressed are eminent members of the electrical profession, but the majority of them are teachers or professors, and not manufacturers. We cannot help thinking that the Committee made a mistake in this selection. More importance should be given to the opinions of those who have to deal with the results of the present system of technical training than to the views of those who are engaged in administering this system, which, it is acknowledged, has many defects. College professors were able to give some very important evidence, and point out where the system is at fault from their point of view; but on a question involving the welfare, and perhaps the very existence of an industry, a greater number of the leaders of that industry should have been invited to speak.

Some of the conclusions of the Committee may, however, be particularly useful to those who favour indiscriminate technical education. It appears that the training of workmen is not at fault, and that the opportunities now open to the London workman for obtaining technical education in his trade are actually superior to those enjoyed by his German or American colleague. It is certainly desirable that the workman should be taught to take an intelligent interest in his work, and that facilities should be given to foremen to acquire a general knowledge of the technical principles which govern the application of workshop methods: and this is not difficult. It is an open question, however, whether the establishment of open evening classes and of smaller polytechnic institutions has not been overdone already. It is notorious that many of these evening classes are very badly attended, and that a large proportion of the evening students are not of the class for which this evening instruction

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was instituted. At the beginning of the session the classes are frequently full, by the middle they are half empty, and at the end of the year they have dwindled down to practically nothing. A very small percentage of evening students sit for the examinations and a still smaller percentage get through. And this small proportion consists chiefly of young men who subsequently add to the candidates for the smaller posts for which the junior engineer who has received orthodox technical college training and workshop experience is better fitted. Nevertheless, new institutions are still being opened, thousands of pounds are being spent, and the industry itself fails to receive any material benefit.

On the other hand, while the London County Council has been satisfied with applying its technical education grants without working on any very definite and useful system, the City and Guilds of London have been doing some really valuable work. The benefit that has been derived from the Central and Finsbury Technical Colleges will probably never be fully known, but it is certain that the electrical industry owes a large debt to the City and Guilds for founding and supporting these two most excellent institutions. To these colleges have been sent by the London County Council certain students who have been fortunate enough to win scholarships. These youths go straight from school to technical college, and at the end of two or three years they go forth, as their parents fully imagine, fully-fledged electrical engineers. Except in brief visits to works they have never been inside a workshop, and the necessity of earning a living by the time they have finished their college course prevents them from serving their time in the shops, and thus completing their engineering education and becoming engineers in the strict sense of the word. There are scores of such men sent out from our technical colleges and schools every year. Genius should be encouraged and assisted, and the poor man's son should be given every facility, but the present method of doling out scholarships looks very much like mistaken kindness. If the London County Council would pick out fewer scholars and equip them thoroughly by giving them three or four years in workshops in addition to the college course, they would confer an infinitely greater and more lasting benefit upon the industry than they do by launching numbers of half-trained men into a profession which needs such highly trained leaders, especially at the present time.

The Committee are of the opinion that the education of a leader of a scientific industry should include: A good general education on the classical or modern side of a secondary school up to the age of 17 or 18, and three years' training for the B.Sc., followed by two years "post-graduate" work in order to obtain the D.Sc. This is all very well for the man who is going to teach in a school, but it is not by any means an ideal training for a leader of a scientific industry. The training advised gives him no insight into the practical side of the work, and it is not likely that when a man gets to 23 or 24 years of age he is then going to spend an additional three or four years in works. Such a graduate would even be unsuitable for teaching in a technical college, although there are many who do act as heads of technical teaching departments and yet have never served their time in the workshops and drawing-office of an engineering works. The educational authorities abroad have set us an example by securing the services of chief engineers of large manufacturing firms to lecture in their colleges, and in some instances chief engineers or designers in large firms have taken appointments as heads of the electrical engineering departments of technical colleges; but such things in England are almost unheard of. It is said that it cannot be done because the salaries offered are not sufficiently remunerative; but if this be so, then some of the smaller local institutions should be abolished and a few hundreds a year added to the professor's salary. England holds the supremacy in the engineering industry now, and she is determined to keep it; but other countries are just as determined to wrest it from her.

In summing up, the Committee is convinced that the main causes of our failure in the scientific industries are: Lack of scientific training of the manufacturers themselves; the defective condition of our secondary education; lack of a sufficient supply of thoroughly-trained men, and of any properly-equipped institution. The whole situation is deplorable, but if fewer students were taken in hand, and those more thoroughly trained, it would be vastly improved. Prof. RAMSAY, in his evidence, strikes the key-note as far as the London County Council is concerned. He says: "The County Council of London, if it gives scholarships or exhibitions for the continuance of the study of advanced chemistry on the lines of the '1851 Exhibitions,' should bear in mind that there is such a thing as overstocking the market. While a number of able young men are at present being trained as chemists, the demand, I am afraid, for such men is not keeping up to the supply." It will be observed that Prof. RAMSAY refers only to chemists, but the words are equally applicable to electrical engineers, and, if anything, the position of the electrical industry in this respect is even worse than that of the chemical. We congratulate the Committee on making a genuine effort to solve such an important problem; and, although the effort may not be immediately productive of any beneficial effect, yet it is a step in the right direction, and cannot fail to awaken an interest in others responsible for the technical education of the future leaders of the electrical industry.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Temperature and Ionic Shock.—In the field of an electric current the mean velocity of the ions in the gas is greater than that of the neutral molecules. J. Stark points out that the velocity of a negative electron capable of ionising a molecule is about $1{\cdot}9 \times 10^8$ cm./sec, and that of a positive ion $8{\cdot}6 \times 10^6$ cm./sec. In many electric currents through a gas the mean temperature is only a few hundred degrees above the ordinary. For a temperature of 255°C. the neutral gas molecules of hydrogen would have an average velocity of $8{\cdot}68 \times 10^5$ cm./sec., nitrogen $9{\cdot}8 \times 10^4$, and carbonic acid $7{\cdot}8 \times 10^4$. The ionising ions move, therefore, from 100 to 1,000 times faster than the neutral molecules, and the latter may, therefore, be regarded as at rest with respect to the former. Anything which reduces the density of a gas, such as reduction of pressure or increase of temperature, increases the free path of the ionising ions. This implies that the absorption of kinetic ionic energy diminishes with increasing temperature and constant pressure, as noticed in the absorption of Lenard rays by gases. The author makes some interesting applications of this principle to the fall of the discharge potential and to luminous effects in vacuum tubes. Thus the extinction of the glow near a hot body is explained by the increase of the free path, and the consequently lesser absorption of energy from the moving ions.

[J. STARK, *Ann. der Physik.*, No. 8, 1902.]

Resistance of Insulators.—O. N. Rood, who some time ago prepared a standard resistance of the extraordinary value of 14,000,000 megohms, has made some important measurements of the internal resistance and surface resistance of certain insulators. The main difficulty experienced lay in obtaining a suitable contact between the electrodes and the insulators.

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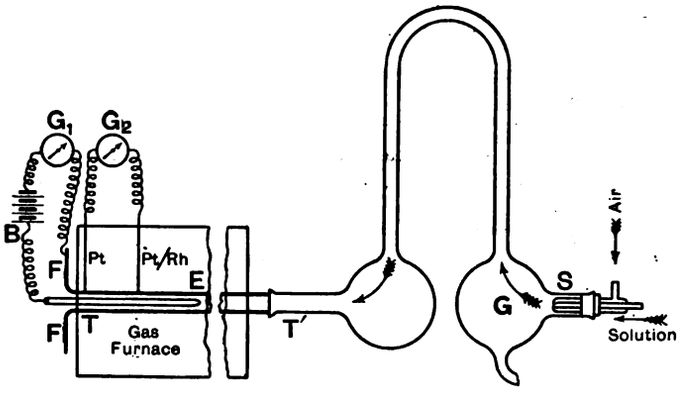
Gutta-percha was cemented to tinfoil electrodes by a gutta-percha solution, and in other cases a soft amalgam of tin was used. The internal resistance of a plate 1mm. thick and 1 sq. cm. in area was found to be 900,000 ohms in the case of quartz, 18·5 megohms for gutta-percha, 55 megohms for ebonite and 133 megohms for mica. As regards surface conduction, the resistance of 1 sq. cm. between terminals 1cm. long was found to be 1·6 megohms in plate glass, 22 megohms for cobalt glass, 482 megohms for gutta-percha, 521 megohms for quartz, about 2,000 megohms for ebonite and only 51 megohms for mica. It was found that glass has a high surface resistance in comparison with its internal resistance, and in glass condensers it is, therefore, advisable to increase the capacity by increasing the surface rather than by reducing the thickness. More especially, cobalt glass should be used. The author found that his high resistances of last year could be depended upon within a maximum error of some 7 per cent.

[O. N. Rood, *Am. Journ. Sc.*, August, 1902.]

Electrolysis of Vapours.—H. A. Wilson has succeeded in showing that Faraday's laws of electrolysis are applicable to vapours as well as liquids, and has thus bridged the gap separating liquid from gaseous conduction. He sent a spray of salt solution through a platinum tube placed in a gas furnace and determined the current between concentric electrodes in the usual manner. The apparatus is shown in the diagram, where TT′ is the platinum tube, E a platinum elec-



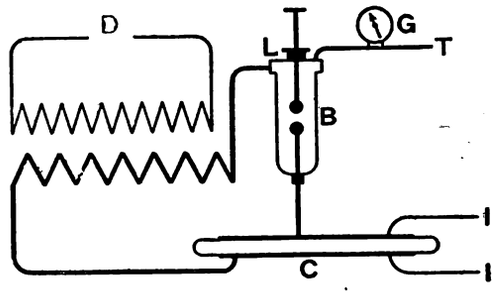
trode, S the Gouy sprayer, and G a bulb tube to catch the coarser spray. At a temperature of 1,800deg., as measured by the thermo-couple Pt – PtRh, the current through the salt attained a constant value, which the author calls the saturation current. This saturation current is inversely proportional to the electro-chemical equivalent of the salt, a rule which corresponds to Faraday's second law of electrolysis. The first law is fulfilled by the rule that the current is proportional to the amount of salt passing between the electrodes. This amount was determined by comparing the flame colouration it produced with that produced by a known quantity. The salts examined were Na_2CO_3, Rb_2CO_3, and Kl. Both the kinds of ions move slowly, probably owing to their carrying with them a large number of neutral molecules. But the negative ions are always the faster.

[H. A. Wilson, *Phil. Mag.*, August, 1902].

Electrical Properties of Diamond.—Density, hardness and quantitative combination with oxygen are at present accepted as the necessary and sufficient distinguishing qualities of diamond. A. Artom proposes to add certain electrical properties, some of which also happen to be very characteristic. The resistivity of diamond is about the same as that of ordinary glass, the values obtained by the author ranging from 0·2 to $1·3 \times 10^{12}$ (ohm-cm.) It is remarkable that graphite, the allotropic form of carbon into which the diamond is transformed at a high temperature, should possess a conductivity some 10^{15} times as high. Under the action of Röntgen rays, the conductivity of diamond is doubled, but the original resistance is restored at once on removing the rays. Like ice, diamond possesses a dielectric constant largely in excess of the value warranted by its refractive index. Theoretically, it should be about 7, but in reality it is anything from 10 to 17. The author takes this as an indication that the diamond, like ice, retains the dielectric constant it had in a previous liquid state. Possibly, also, certain hydrocarbons like CH_2 or CH_3 may be present in small quantities to raise the dielectric constant. Diamond shows residual polarisation, and consequent electric hysteresis. It is feebly paramagnetic and pyro-electric.

[A. Artom, *Accad. Sc. Torino, Atti.*, 1902.]

A High-pressure Spark-gap.—F. J. Jervis-Smith employs the novel device of increasing the pressure at the spark-gap in connection with a Tesla coil. In the diagram, B is a glass vessel closed with a metal lid, L, provided with a stuffing-box through which a screwed rod can be moved by means of a micrometer head, M. The tube T, to which is attached the pressure-gauge G, leads to an air force-pump. One end of the primary coil is attached to the lid, and the other to the condenser C. The wires II lead to the secondary of an induction coil. The discharge takes place at D. On raising the pres-



sure in B to two atmospheres, the sparks at D were greatly thickened, and acquired a great perforating power. A vulcanite tube with a wall 0·45cm. thick was instantly perforated, and so was a glass plate of the same thickness without cracking the glass. The author succeeded in cutting glass by a new method. A thick piece of plate glass was placed upon tinfoil in an oil bath. The foil was connected to one terminal, then on ruling a line with the other terminal as rapidly as the hand could move it the glass was found to be cut through along the path of the terminal. The new spark-gap is also very effective for producing Röntgen rays in electrodeless vacuum tubes.

[F. J. Jervis-Smith, *Phil. Mag.*, August, 1902.]

Electron Theory of Magnetism.—W. Voigt has made an interesting attempt to apply the electron theory to magnetism. The idea that Ampère's "molecular currents" consist of electrons revolving round the remainder of the atom was at once suggested by the Zeeman effect, and the author clothes this supposition in a mathematical form. The result is, however, disappointing in the first instance. It appears that if the electrons are supposed to have a free orbit, then, according to the electron theory, no induced magnetism is possible. The obvious alternative is to suppose that the revolutions or oscillations of the electrons are damped, and this assumption leads at once to a valuable and elegant theorem, which the author formulates as follows:—"When the electrons of a body move in a constant magnetic field they produce magnetic effects when their motion (against a resistance) is always interrupted by any irregular impulses, and thus maintained at a constant mean energy. The body will then show paramagnetic or diamagnetic properties accordingly as to whether the motion of the electrons after these impulses shows, on the whole, a surplus of potential or kinetic energy respectively." Such impulses must result from collision with neighbouring molecules and electrons, since the electromagnetic heat waves sent out in consequence of such collisions are compensated.

[W. Voigt, *Ann. der Physik*, No. 9, 1902.]

Electricity in Raindrops.—A. Schmauss has studied the behaviour of a jet of water falling through ionised air. It is known since Lenard that water falling through ordinary air upon a metallic plate communicates positive electricity to the plate and negative electricity to the air. The author finds that on ionising the air this effect is overlaid by another. The metal plate receives a negative instead of a positive charge, and only after several minutes does Lenard's effect

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regain ascendancy. Zeleny has shown that when a stream of ionised air is directed against a conductor, the latter, owing to the greater speed of the negative ions, acquires a negative charge. In the water jet the conductor is moved against the ionised air, and the effect is the same. Moisture seems to favour the absorption of negative ions. In any case, the explanation of the earth's negative charge is now pretty complete. C. T. R. Wilson has shown that negative ions are more effective as nuclei of condensation than are positive ions. His new experiments, as well as those of the author, show that drops already formed are capable of transporting negative electricity to the earth. It is well to remember that all experiments of this kind are complicated by Lenard's effect, which is probably of an electrochemical nature.

[A. SCHMAUSS, *Ann. der Physik*, No. 9, 1902.]

Ionisation of Air by Passage through Water.—In continuation of his recent experiments, J. J. Thomson has further studied the effect produced on the conductivity of air by bubbling it through water. The air from a large gas-holder of about 850 litres capacity was bubbled vigorously through water by making the air in the vessel circulate through a water pump; this treatment increased the conductivity of the air, and when the bubbling had been going on for some time the conductivity of the air was 10 or 12 times the initial conductivity. When once the air has been put in this highly conducting state it stays in it for a very considerable time; a large part of the conductivity produced by the bubbling remains in the air 48 hours after the bubbling has ceased; nor does it disappear when an intense electric force is kept applied to the gas. The effect produced by the passage of the air through water is similar to that which would be produced if the bubbling imparted a radio-active "emanation" similar in properties to those emitted by thorium and radium. The conducting gas can be passed from one vessel to another; it retains its conductivity after passing through a porous plug; passage through a long tube heated to redness destroys the conductivity; it takes, however, a very high temperature to do this. Temperatures less than 300°C. or 400°C. seem to produce comparatively little effect; if the gas is passed very slowly through a long tube filled with beads moistened with sulphuric acid the conductivity is destroyed. Unless, however, the stream of gas is very slow, the air retains a good part of its conductivity in spite of the sulphuric acid. Another point of resemblance between the "emanation" from radio-active substances and a gas in this state is that if a strongly negatively electrified conductor be kept in the gas for some time the conductor becomes radio-active; this activity was only reduced by about 20 per cent., when the conductor was washed in water and then heated in the flame of a Bunsen burner. The radio-activity reduced in this way disappears in the course of a few hours.

[J. J. THOMSON, *Proc. Cambridge Phil. Soc.*, Easter, 1902.]

Radio-active Rain.—Since a negatively-charged body exposed in the atmosphere becomes radio-active, apparently indicating the presence of some radio-active substance in the atmosphere, it occurred to C. T. R. Wilson to test whether any of this radio-active substance is carried down in rain. He boiled down freshly-fallen rain to dryness, and found a radio-active residue. The radio-activity was detected by means of the increase in the ionisation of the air within a small vessel, of which the top or bottom was of thin aluminium or gold leaf, the other walls being of brass. The vessel contained a gold leaf attached to a brass wire, the two forming a leaking system of small capacity. The rain was evaporated in a platinum bowl, which was cooled by floating on water, and then placed above or below the ionisation apparatus. The radio-active layer was strong enough to increase the rate of leakage to four or five times its normal value. Filtering the rain-water produced no effect. The radio-activity rapidly disappears, falling over 50 per cent. in the first hour. From the evaporation of distilled water or tap-water or of rain-water which had stood for some hours no radio-activity was obtained. No did such water yield a radio-active residue when exposed for some hours in the open air.

[C. T. R. WILSON, *Proc. Cambridge Phil. Soc*, Easter, 1902.]

THE CAPABILITIES OF THE MILAMMETER AND THE GALVANOMETER IN GENERAL AND SUBMARINE CABLE TESTING.

BY C. W. SCHAEFER.

(*Concluded from p. 757.*)

With an experience extending over a period of almost seven years, the Weston direct-reading milammeter leaves nothing to be desired in the way of portability, compactness and reliance; and, moreover, these instruments have the great merit besides of being able to withstand the rough usage that sometimes is inevitable.

Their simplicity and accuracy in telegraph work and for fault localisation is of such far-reaching importance in the economy of time and labour, that a few suggestions may here be made regarding the selection of an instrument which will ultimately be recognised, as even the bridge itself, an indispensable adjunct in every well-equipped testing room.

Besides the elimination of temperature corrections by properly compounding the shunt windings relatively to the component resistances in the moving-coil circuit, the general conditions to be satisfied are as follows:—

1. The instrument or its unshunted moving-coil system should be readily used, if required, as a signalling galvanometer, and the damping should consequently be diminished within reasonable limits.

2. It should be provided with suitable shunts to permit of the range being altered over a conveniently large scale.

3. These shunts should be so designed that the resistance of the instrument when used as a milammeter is practically constant throughout its entire range; and

4. Its resistance as a milammeter should be as low as possible.

The first condition is more a matter of scale arrangement, and can best be met by subdividing the scale, so that 10 or 15 divisions are indicated to the left and 150 to the right of the zero position of the index. Underneath the above scale should be a second scale, showing the values of the currents represented when the instrument is used in its unshunted condition, the value of the 150th division being conspicuously marked below it.

The accompanying diagram (Fig. 6) shows the theoretical connections for a shunt satisfying requirements 2, 3 and 4.

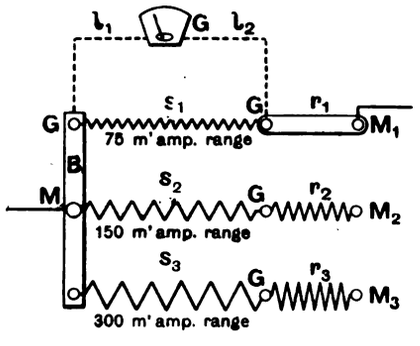

FIG. 6.

The compounded copper and phosphor-bronze wire shunts s_1, s_2 and s_3 have compensating resistances r_1, r_2 and r_3 so disposed that the resistance at each range will be practically the same. Wire of high specific resistance such as manganin may with advantage be used for the latter. The moving coil system G of the milammeter is joined to the common bar B, and on to the middle terminal of the desired range, by means of the copper flexible leads shown in the dotted lines l_1 and l_2. Since it can be shown that if an extraneous resistance, r_g, is added in the G circuit, the *indicated* currents will fall short of their *real* values in proportion to $\frac{G+s}{G+s+r_g}$, care should be taken at all times to see that the connections are thoroughly clean, and that the flexible leads, besides being of as low a resistance as possible, are not altered in resistance other than that due to temperature variation.

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As a further safeguard against this evil, the resistance of the unshunted coil system G should be made as large as possible relatively to s. This carries with it the additional advantage of making G a more useful and sensitive galvanometer when used independently for speaking purposes or as a direct-reading voltmeter.

The power expended on the coil winding of a particular Weston instrument being about 0·364 microwatt per division, that instrument could be so wound to a resistance of about 5ω (including the resistance of the controlling springs) and requiring a current $a_m = 0{\cdot}09$ milliampere per division.

Consequently, from equation (37) the shunt required for the range of half a milliampere per division would be $\frac{0{\cdot}09 \times 5}{0{\cdot}5 - 0{\cdot}09} = 1{\cdot}097\omega$. The resistance of the springs being known, the necessary proportions of copper and phosphor bronze for the shunt windings for the purpose of eliminating temperature corrections are easily determinable.

For the highest range of 2 milliamperes per division, the shunt would have to be 0·236 ω nearly, and the compensating resistance, say, $1{\cdot}1 - \frac{0{\cdot}236 \times 5}{0{\cdot}236 + 5} = 0{\cdot}87\omega = r_s$. With such a milammeter r_1 would be a strap of copper of negligible resistance.

To use the Instrument as a Direct-reading Voltmeter.—Theoretically it can be shown that a voltmeter (excepting those designed on electrostatic principles) in its most useful form for general requirements, is one in which its total resistance is relatively very high in comparison with the minimum resistance of the system across which it is placed. In other words, the current required to give the deflections should be as small as possible. In order that the instrument may be used as a direct-reading voltmeter, the necessary total resistance R in circuit with and including the unshunted coil G is found by the formula $\frac{E}{a_m} = R$, where E and a_m are respectively the "millivolts to be represented per scale division," and the "current-constant per division."

R may be marked on the instrument, or it is easily determined by dividing the total deflection in divisions by the current value of that deflection, and multiplying the result by 1,000.

Then, if we prefer to make the 150 divisions equivalent to 75 volts—*i.e.*, make the measured voltages one-half of the indicated values—we halve R and so on.

Example.—An instrument having a current constant $a_m = 0{\cdot}09$ milliampere, and a resistance of 5ω, is required to be used as a direct-reading voltmeter. Find the value of R.

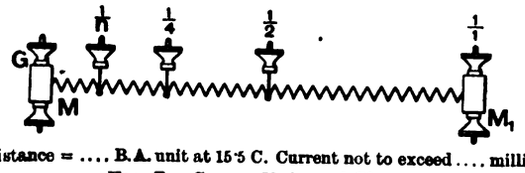
$$R = \frac{1{,}000}{0{\cdot}09} = 11{,}111\omega.$$

The resistance, therefore, to be added to G is 11,106ω.

For deflections of two divisions per volt, the resistance should be $\frac{11{,}111}{2} - 5 = 5{,}550\omega$ added to G. For the greater refinement required in the measurement of currents in the order of a few microamperes, the supreme excellence of the Sullivan galvanometer is indisputable both for laboratory and ship work, provided care he taken to avoid the Gerard effect. Its rapidity of action and deadbeatness, coupled with the ease with which it is balanced for use at sea, are all factors of great importance in the Sullivan galvanometer; and further, the potential per unit deflection is small, giving the instrument a range which is quite impossible in any system of pivoted coil. The resistance of the suspensory system, too, is so small relatively to the moving coil resistance that when used across a copper shunt, the coefficient for temperature is nil.

In consideration of these facts, I may describe a special shunt I have constructed and used which has the advantage of being a *universal* one for all Sullivan or other copper-wound proportional deflection galvanometers, whilst its resistance also is practically constant. The main, or "milammeter," terminals are situated at the extreme ends M and M_1 of a copper resistance constituting the maximum shunt (see Fig. 7), whilst separate terminals are situated at intermediate points along that resistance in inverse ratio to the desired multiplying powers, and in this respect, after all, is merely a form of potentiometer. The galvanometer is joined to the terminal G, and by means of the other terminals, or a king plug, to the various multiplying powers at will. Then the resistance of any galvanometer having been carefully determined at the same temperature as the shunt, the coefficient per division deflection for the maximum $\frac{1}{1}$ shunt is $a_m\left(\frac{G}{s} \times 1\right)$; the bracketed value being a constant at all temperatures for any particular coil.

Similarly, for the $\frac{1}{n}$th shunt, the bracketed constant becomes $n\frac{G}{s} + 1$, and so on. A convenient resistance for such a shunt is about 1 ohm total, sub-divided into $\frac{1}{1}$, $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{10}$ parts. This, when used with Sullivan galvanometers of the ordinary pattern requiring some 40 microvolts per division, would give approximate coefficients of 0·04, 0·08, 0·16 and 0·4 milliampere



Total resistance = ... B.A. unit at 15·5 C. Current not to exceed .... milliamperes

FIG. 7.—Copper Universal Shunt.

per division, giving a total range up to about 300 milliamperes. Although it is easy to work out the coefficients when $\frac{G}{s}$ is once known, for handy reference these constants would be determined for each galvanometer coil likely to be used, and tabulated as follows:—

Coefficients for copper universal shunt No. .....
Resistance of shunt = 0·95 B.A. unit at 15·5°C.

No. of galvanometer and coil.	Resistance of galvanometer at 15·5°C. B.A. units.	G/s	Multiplying power of shunts.			
			1/1	1/2	1/4	1/10
No. 50 – A.....	609	641	642	1,283	2,565	6,411
No. 3—I.	876	922	923	1,845	3,698	9,221
No. 3—II. ...	849	894	895	1,788	3,576	8,938

Then, supposing we find the current-constant a_m of a coil A to be 0·06 microampere, and that when using the $\frac{1}{2}$ shunt we obtain a deflection of 300 divisions. Unit deflection with that shunt represents a current of $0{\cdot}06 \times 1{,}283 = 76{\cdot}98$ microamperes (or 0·07698 milliampere), and, therefore, it is merely necessary to multiply the deflection by this constant to find the value of the indicated current. In the instance above quoted it is $300 \times 0{\cdot}07698 = 23{\cdot}094$ milliamperes. The determination of a_m by milammeter method has the advantage over that by simple deflection through a high resistance, because in the latter the high effective resistance of the cell under the exceedingly small currents should be known, especially if small cells are used, whereas the milammeter method is free from that source of error. The resistance of the instrument when used with the above shunt is practically 1 ohm whatever the multiplying power of the shunt may be, because the shunting effect of the galvanometer ordinarily would be too small to cause any appreciable variation. In addition to the 1 ohm universal shunt, I would also recommend having another one of 10ω resistance, designed to work with an extreme current of 30 to 40 milliamperes with subdivisions of $\frac{1}{1}$, $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ parts. This will be found most useful for purposes of fault localisation by simultaneous methods, having a range roughly from 5 to 40 microamperes per division for the usual type of Sullivan galvanometer. If desired to make the coefficient a more simple one by adding R_g, that resistance should also be copper-wound, so as to compensate automatically for temperature.

With these extended uses for the reflecting galvanometer, it would be an advantage, too, to eliminate scale corrections by the construction of special scales for definite and usual focal distances. It would then simply be necessary to place the scale at the right distance, parallel to the zero position of the coil, and with its extreme ends equidistant from the axis of the coil. Where ordinary scales are used, I prefer adopting a fixed

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distance and marking the *errors* above each 50 divisions on the scale where the corrections become applicable.

For all practical purposes, with a scale distance of from 1,500 to 1,600 divisions, the corrections commencing at the 100 divisions and advancing in 50's to 350 are: 0·1, 0·3, 0·8, 1·6, 2·8 and 4·5, being subtractive in each case. It is easy to estimate the intermediate values and good practice to get accustomed to apply these corrections.

Amongst its many other advantages, the Sullivan galvanometer can claim superiority over the fixed-coil type in so far as there is no cocoon fibre to be influenced by thermal or hygroscopic changes, and, therefore, with perfectly rigid supports for the suspensory system, the current-constant will be unaffected when once the suspension has settled down to and attained its permanent stretch, and so long as the tension screw is not tampered with. For shore or laboratory work this obviates the necessity of redetermining the constant a_m, except as a check from time to time.

It is desirable to test the galvanometer for equal deflections on either side of zero as well as from other points on the scale, and, if necessary, by readjustment of the coil's position between the pole-pieces, to eliminate the Gerard effect.

Mr. Jona has, I believe, pointed out that the damping of the coil may be decreased, if desired, by means of a magnetic shunt with comparatively small reduction of the current-constant. The use of this contrivance will in some cases be a valuable addition where the nature of a fault in a submarine cable is so flighty that bridge readings are impossible, and reliance can alone be placed upon maximum swings of the deflection due to the momentary reduction of its resistance, which resistances are either calculated or found by reproduction method.

In such cases, where two or more faults exist in a cable, or where, for other reasons, co-operation from the distant end becomes impossible, the magnetic shunt will remove the sluggishness that would render the milammeter insensitive to the rapid changes that frequently occur in practice. The field of the milammeter does not end here, for there are a multitude of other uses to which it may be put, such, for instance, as the tracing of certain faults in dynamo armatures, imperfect connections in secondary batteries or low-resistance mains, &c. It has in more than one instance proved its value in serving as a tell-tale in indicating whether an observer at a distant station is taking his tests properly, or using the right direction of current. Outside the province of telegraph electricians, methods upon which the evolution of the foregoing equations depend will, I think, afford an additional means of comparing resistances in the order of a few microhms and upwards with a standard.

In conclusion, I may remark that as a groundwork a little familiarity with the use of the milammeter, and the laws governing its behaviour, besides saving an enormous amount of valuable time, will greatly simplify existing methods, and give a more intelligent and powerful grasp of general testing than is possible by any other means.

ON ELECTROMOTIVE WAVE ACCOMPANYING MECHANICAL DISTURBANCE IN METALS IN CONTACT WITH ELECTROLYTE.*

BY PROF. J. CHUNDER BOSE, M.A., D.SC.

(*Concluded from p.* 765.)

Abnormal Response.—But the modification of which I have spoken does not stop short of mere abolition of responsive power, but sometimes proceeds further, and actually reverses the sign of response—the excited wire becoming cuproid. This abnormal effect is sometimes found even in fresh unannealed wires, when feeble vibrations (of amplitude of 5deg. or less) may give rise to a negative response, but vibration of stronger intensity gives rise to the usual positive response. At other times the molecular modification is more pronounced, and there is a persistent reversal of response. But even in such cases long-continued vibration transforms the abnormal negative to the normal positive. I give below photographic records which exhibit this. In Fig. 8, *a*, the transformation took place during continued vibration. To detect the point of transformation, I experimented with a platinum cell which exhibited the abnormal effect, and took a long series of records of responses to uniform vibrations acting at intervals of a minute. In the record (Fig. 8, *β*) I have been able to catch the point, or rather points, of transition.

Thus we may distinguish the following typical cases. Beginning with the case of extreme molecular modification, we have (1) a condition which gives rise to negative response; after continued vibration the negative becomes less negative, and ultimately becomes converted into positive; (2) an irresponsive or neutral condition; vibration or annealing transforms it into positive; (3) a sluggish, feebly positive, becoming more and more positive after continued vibration; (4) a steady and permanent condition, when the responses are uniform; and lastly (5) when vibration is continued for too long a time the positive tends to become less positive, the responses decline—a state of things which we designate as fatigue.

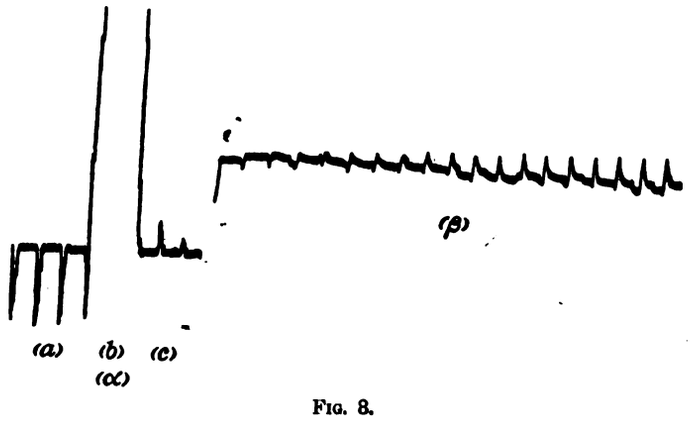

FIG. 8.

(*a*), Abnormal negative (downward) response (*a*) converted into normal positive (upward) response (*c*) after continued vibration (*b*) (tin). (*β*) Shows points of transition from the abnormal negative to the normal positive (platinum).

Increased Electromotive Variation with Increased Intensity of Stimulus.—When the intensity of stimulus is increased by increasing the amplitude of vibration, the electric response is enhanced. The following is a pair of records (Fig. 9) for increasing amplitudes from 5deg. to 40deg., and decreasing amplitudes from 40deg. to 5deg. The vibrations are imparted at intervals of one minute. It will be noticed how the response is enhanced with increasing stimulus. It will also be noticed that whereas recovery is complete in one minute when the vibration amplitude is small, it is not quite complete within that time, when the vibration amplitude is large. Greater strain prolongs the period of recovery. Owing to want of complete recovery, the base line is tilted slightly upwards. This slight displacement does not materially affect the results, provided the shift-

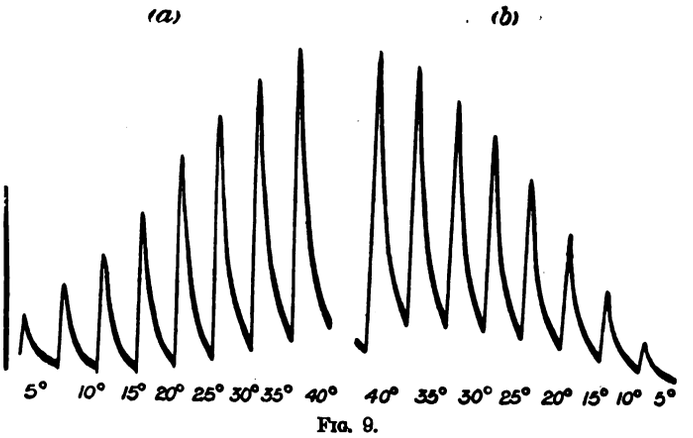

FIG. 9.

Photographic records of response curves. (*a*) from 5° to 40°; (*b*) from 40° to 5°. The vertical line = 0·1 volt.

Table I.—*Showing the Increasing Electromotive Effect due to Increasing Amplitude of Vibration.*

Vibration amplitude.	Deflection. 23 dns. = 0·1 volt.	
Degrees.	Ascending.	Descending.
5	5·5	5
10	13	12
20	25·5	26
25	33	32
30	39	39
35	43	43
40	47	48

* A preliminary account of this investigation was given in a Paper "On Response in Organic Substances," read before the Royal Society, June 6, 1901.

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ing is slight. From other records taken through a greater range of stimulation, it appears that in a curve obtained with electromotive variations as ordinates and amplitudes of vibrations as abscissæ, the first part of the curve is, generally speaking, slightly convex to the abscissa (the convexity is pronounced when feeble stimulation gives negative response), it is then straight in the middle and concave in the last part. A limiting deflection is approached with high amplitude of vibration. The shape of the curve is modified by the molecular condition of the wire.

Maximum Effect.—If, instead of a single vibration of a given amplitude, we superpose a rapidly succeeding series, the individual effects are added up and a maximum deflection is produced which remains practically constant as long as the vibration is maintained. (A single ineffective stimulus may thus become effective by the additive effect of several.) Too long-continued vibration may cause fatigue, but during half a minute or so the maximum effect is very definite (in tin). For a definite amplitude of vibration there is a definite maximum, which increases with the amplitude. For example, a single vibration of 5deg. gave a deflection of 3·5 divisions; the same, when continued at the rate of four times per second, gave a maximum deflection of 18 divisions.

Again, with the same wire, a single vibration of 10deg. gave a deflection of 4·5 divisions, but continued vibration gave the definite maximum of 37 5 divisions. I give below a curve (Fig. 10) which shows the maximum effect for different amplitudes of vibration.

Hysteresis.—Allusion has already been made as to the increased sensitiveness conferred by preliminary vibration. Being desirous of finding out in what manner this is brought about, I took a series of observations for an entire cycle—that is to say, a series of observations were taken for maximum effects, starting from 10deg. and ending in 100deg., and backward from 100deg. to 10deg. Effect of

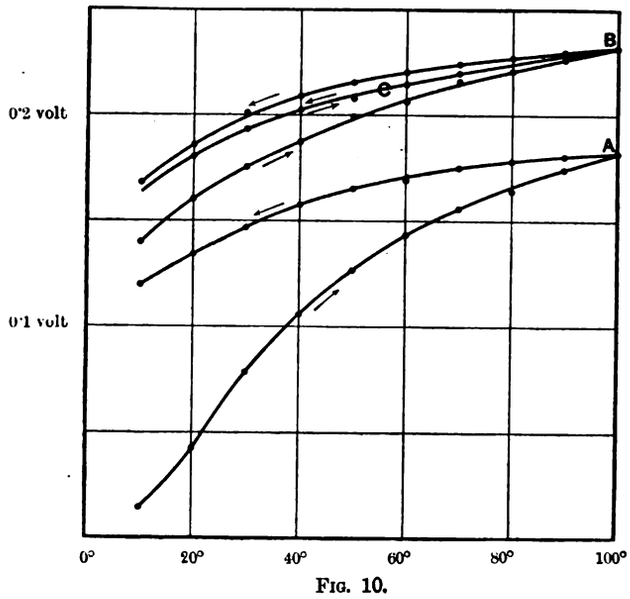

FIG. 10.

Cyclic curves of maximum effects due to increasing and decreasing amplitude of vibration. A, fresh wire; B, after annealing; C, the same after three cycles. Abscissa represents the amplitude of vibration; the ordinate represents the corresponding electromotive variation.

hysteresis is very clearly seen (Fig. 10, A); there is a considerable divergence between the forward and return curves, the return curve being higher. On repeating the cycle several times the divergence is found to be very much reduced; the wire, on the whole, is found to assume a more constant sensitiveness. In this steady condition, generally speaking, the sensitiveness for smaller amplitude of vibration is found to be greater than at the very beginning, but the reverse is the case for stronger intensity of vibration.

Effect of Annealing.—I repeated the experiment with the same wire, after pouring hot water and allowing it to cool to the old temperature. It will be seen from the cyclic curve (Fig. 10, B) (1) that the sensitiveness has become very much enhanced; (2) that there is relatively less divergence between the forward and return curves. Even this divergence practically disappeared at the third cycle, when the forward and backward curves coincided (Fig. 10, C). The above results show in what manner the excitability of the wire is enhanced by purely physical means.

It is very curious to notice that the substitution of Na_2CO_3 solution as electrolyte produces results very similar to that produced by annealing—that is to say, not only is there a great enhancement of sensitiveness, but there is also a reduction of hysteresis. Another curious point is that, whereas with ordinary fresh wire the addition of Na_2CO_3 greatly enhances the sensitiveness, after the wire has been annealed there is comparatively little further increase of sensitiveness due to the addition of the reagent.

Effect of Chemical Reagents.—I shall now give photographic records of a few typical cases which will graphically illustrate the influence of chemical reagents. The mode of procedure is as follows:—The cell is filled with water, and photographic records are taken of responses to single vibrations of constant amplitude, applied to one of the two wires at intervals of one minute. The responses will be found uniform. Chemical reagent is now added, and similar vibrations applied as before. The responses will exhibit either an increase or diminution, depending on the exciting or depressing power of the reagent. It is also quite easy to obtain duplicated results by alternately vibrating the A and B wires. Uniform responses, alternately positive or negative, will be first obtained; after the addition of reagent *both* will exhibit either an increase or a diminution. As has been said before, a very high external resistance, varying from 1 to

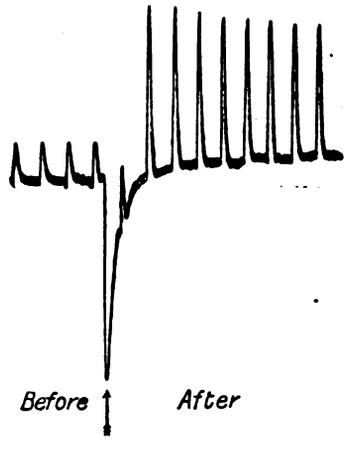

FIG. 11.

Enhanced response by the action of Na_2CO_3 solution on platinum. The intensity of stimulus is kept constant throughout. The curves to the left show the responses before, and those to the right after, the application of Na_2CO_3.

5 megohms, is interposed in the external circuit, the slight variation of internal resistance of the cell due to the addition of the reagent being then quite negligible compared with the total resistance of the circuit. That there is no appreciable variation in the total resistance can be independently verified by applying a known E.M.F. before and after the addition of the reagent, when the resulting deflection will be found to be the same in the two cases. The responsive deflections are thus simply proportional to the electromotive variations produced.

Chemical Excitants.—The following record (Fig. 11) exhibits the increased response due to the action of Na_2CO_3 on Pt. Another record shows an exactly similar effect on tin. The record of effect

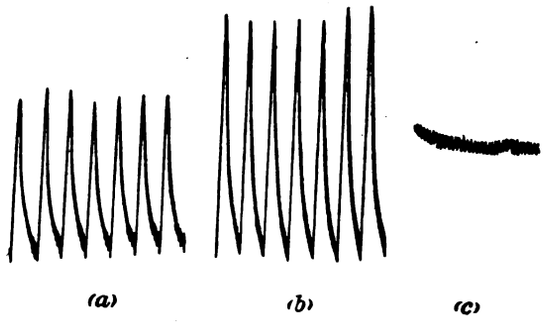

FIG. 12.

Records showing the opposite effects of weak and strong solutions. *a*, Normal response; *b*, increased response due to addition of 0·3 per cent. KHO; *c*, abolution of response by 3 per cent. KHO. The trace *c* should have been engraved merely as a thick trace.

was taken two minutes after the application. Other records taken immediately after show that the enhanced responsiveness takes place gradually with time. (See also Fig. 7, and compare the general similarity between the enhancement of response produced by preliminary vibration and by the action of Na_2CO_3.)

Depressants.—Other reagents, like KBr (10 per cent.), produce a depression in the response. There are again others which abolish the response almost completely, for example, 3 per cent. KHO solution (Fig. 12, C). One of the most effective reagents which abolishes the response in oxalic acid. The depressing effect of this reagent is

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so great that a strength of 1 part in 10,000 is often sufficient to produce an abolition of response.*

Opposite Effects of Varying Strengths of Solution.—The most curious effect is that exhibited by some reagents when the strength of solution is varied. This is clearly seen in the following record (Fig. 12), in which (*a*) gives the normal response in water. KHO solution was now added so as to make the strength three-parts in a thousand, and (*b*) shows the enhancement of response thereby produced. A further quantity of KHO was now added so as to increase the strength to three-parts in a hundred. This caused (*c*) a complete abolition of response. (Refer to Fig. 2, *c*, *d*.)

I shall now briefly mention some of the interesting points in connection with the action of chemical re-agents. (1) The effect of re-agent is not only to increase or diminish the height of response, but also to modify the time relations. By the action of some the quickness with which the maximum effect is reached is enhanced, others produce a prolongation of the period of recovery. Curious effects of this in producing diphasic variation has already been mentioned. (2) In a sensitive annealed wire the further enhancement of response by Na_2CO_3 is not so great as in a fresh wire. The effect produced by a re-agent is thus seen to depend, to some extent, on the previous condition of the wire. (3) A certain time is required for the full development of this effect. With some the maximum effect takes place almost instantaneously, while with others it takes place gradually. Again, the effect may with some reach a maximum, after which there is a slight decline. The after effect of some re-agents is transitory, while that of others is very persistent.

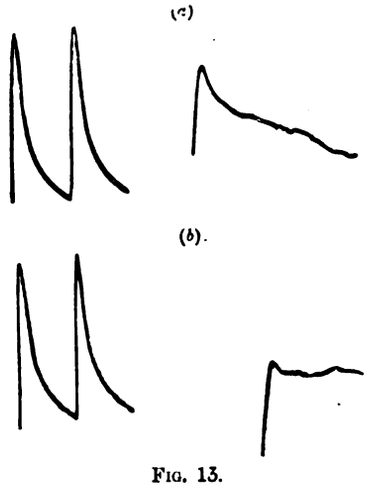

FIG. 13.

Photographic records showing the effect of "molecular arrest." The two curves to the left of each set show the normal response; curve to the right in (*a*) shows partial and in (*b*) complete arrest, produced by the reagent.

It is difficult to say how much of this modification of responsiveness by various re-agents is due to "physical" and how much to "chemical" cause. It has been shown that the responsive power does not depend on the chemical activity of the substance. Tin is more responsive than zinc. Pt in distilled water shows response. Strong acids and alkalies abolish response, but very dilute KHO enhances response. Oxalic acid, even in minute quantities, abolishes it. Neutral Na_2CO_3 enhances it, but dilute NaCl produces no change in the normal response. The responses of the same wire under different physical modifications are different, and under certain meleular modification the sign of response is even reversed; but continued vibration makes the response normal. Again, the enhancement of response produced by Na_2CO_3 can be closely imitated by the effect of continued vibration. The stimulating effect of this re-agent gradually attains a maximum. The after effects of some chemical reagents persist even after all traces have been removed. For example, in a certain experiment the A and B wires gave each a response of 23·5 divisions. The wires were lifted from the cell, and the A wire touched with dilute oxalic acid. It was then rubbed under tap-water with a piece of cloth, so as to remove all traces of the acid. On replacing the wire on the cell, the responsiveness of the untouched B was found unchanged, but that of A had undergone an abolition. The depressing action is often so persistent and deep that I have on many occasions failed to revive the response even after the surface layers had been removed by rubbing the wire with emery-paper. The wire so treated may, after a long time, exhibit partial recovery of its responsive power.

The facts described above seem to show that the enhancement or depression of response may, at least to a considerable extent, be due to the increase or diminution of molecular mobility conferred by the chemical reagents. With a given stimulus, the height of response and the form of the response curve will be determined by the element of molecular friction. In connection with this, it is instructive to obtain records of the vibrations of a torsional pendulum, the friction of which may be gradually increased by immersing the pendulum more or less in a viscous fluid or sand. The various types of response-curves in metals are found to be very similar to those thus obtained.

Of these I give an interesting example. With moderate friction the successve curves obtained with the pendulum are like those given in the left of Fig. 13 (*a*). With increased friction the height of the curve is diminished, the maximum is reached later, and the recovery is prolonged (like the curve in the right of Fig. 13, *a*). With still greater friction the recovery is arrested.

It would appear as if the reagents which abolish response in metals produce a similar molecular arrest. The following photographic records seems to lend support to this view. If the oxalic acid be applied in large quantities, the abolition of response is complete; but on carefully applying just the proper amount, I find that the stimulus evokes a responsive electric variation which is less than the normal, and the period of recovery is very much prolonged from the normal one minute before to five minutes after the application of the reagent Fig. 13, (*a*). In the next record Fig. 13, (*b*) the arrest is more pronounced—*i.e.*, there is now no recovery. Note also that the maximum is attained much later. Stimuli applied after the arrest produce no effect, as if the molecular mechanism became locked up.

* The various phenomena connected with the response in organic substances—the negative variation—the relation between stimulus and response—the increased response after continuous stimulation—the abnormal response converted into normal after long-continued stimulation—the diphasic variation—the increase of response by stimulants, decrease by depressors and abolition by "poisons," so-called—all these are curiously like the various response phenomena in living tissues. A complete account of the mutual relation between the two classes of phenomena will be found in a work to be shortly publiseed, "On the Response in the Living and Non-living" (Messrs. Longmans).

THE FINANCIAL BASIS AND DESIGN OF ELECTROLYTIC METAL REFINERIES.*

BY ARNOLD PHILIP, B.SC., A.I.E.E., F.I.C.

(*Continued from page 718.*)

The Preparation of Estimates for, and Design of, an Electrolytic Copper Refinery.—From the various equations which have been developed above it is now possible to readily prepare estimates for the establishment of electrolytic copper refineries upon a sound basis, and to predict beforehand what the profits of working will be with considerable accuracy.

Let us then imagine that it is proposed to invest, say, £10,000 as capital in an electrolytic copper refinery, and it is desired, as a preliminary, to decide upon the size and cost of the works which should be built, the necessary ground area, the output in tons of refined copper per year, and the probable profits which are to be looked for if the venture is carried out.

Firstly, it is necessary to fix upon the most favourable locality, and this must be so chosen that the difference of price between the cost per ton of the refined and the unrefined copper, including the cost of gold and silver present, is a maximum, whilst the cost of fuel and labour are as small as possible. The condition that freightage for markets should be as low as possible is included in the condition that the difference between spot values of the refined and unrefined metal per ton shall be a maximum.

Having then selected our locality we can with very close accuracy know the values of the quantities involved in our formulæ, namely, cost of coal per ton, cost of labour per man per week, cost of melting 1 ton of copper, and the difference between the spot values of the refined and unrefined copper per ton. Thus, let K = £10,000, P′ = £80, P = £68, P″ = £72, S = £25, t = 1in., a = 250 amperes per square inch, w = £1, c = £1, m = £0·5, and let D have successively all values between 1 and 25 amperes per square foot, and let $p = \frac{9}{100}$.

The first step then is to calculate out the value of the area of land required for each current-density employed, and this may be done from the formula

$$A = \frac{30(K - 150)}{4\cdot05\frac{P'D}{a} + 0\cdot5D + 0\cdot176D^2 + 19\cdot5 + 0\cdot3S + 1\cdot3tP} \quad (22)$$

* Copyright. From a forthcoming work by the Author, entitled: "The Electro-plating and Electro refining of Metals."

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Table VI.—Details of the Capital and Annual Expenditure on, and of the Profits available from, an Electrolytic Copper Refinery in which a total capital of £10,000 is invested, calculated for every value of current-density at the cathode from 1 to 25 amperes per square foot, P′ = £80; P = £68; S = £25; w = £1; c = £1; m = £0·5; t = 1in.; $p_1 = \frac{9}{100}$; P″ = £72 in lines 23 and 24 and = £73 in lines 25 and 26.

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Current-density employed ...	1	2	3	4	5	6	7	8	9	10	11	12	13
2	Cost of offices	158·17	166·0	173·5	180·6	187·3	193·6	199·2	204·6	209·5	213·9	218·1	221·4	224·6
3	Cost of refinery buildings.....	613·2	601·6	588·8	574·6	560·3	544·8	527·4	512·3	496·1	479 5	464·3	446·5	430·5
4	Cost of power plant	9·81	38·5	84·78	147·1	224·2	313·8	413·7	524·6	642·7	767·2	898·9	1029·0	1163·0
5	Cost of dynamos & switchboard	4·57	17·97	39 57	68·66	104·6	146·4	193·0	244·7	299·9	358·0	419·6	480·0	543·1
6	Cost of electrolytic vats	981·1	962·5	942·1	919·4	896·4	871·6	844·5	819·6	793·6	767·2	742·9	714·4	688·9
7	Cost of circulating plant	32·7	64·16	94·2	122·6	149·4	174·32	197·02	218·56	238·08	255·73	272·36	285·76	298·44
8	K_1	1799·56	1850·73	1922·95	2012·96	2122·2	2244·5	2374·82	2524·36	2679·88	2841·53	3016·16	3177·06	3348·54
9	Cost of electrolyte.....	681·3	668·3	654·2	638·4	622·4	605·2	586·4	569·2	551·1	532·7	515·8	496·1	478·3
10	Cost of anodes	5559·0	5454·0	5338·0	5210·0	5079·0	4939·0	4785·0	4644·0	4496·0	4347·0	4209·0	4048·0	3903·0
11	Cost of conductors.....	105·9	207·4	305·3	397·3	484·2	564·9	638·4	708·2	771·4	828·7	882·6	926·0	967·2
12	Cost of stock copper	1853·0	1818·0	1779·0	1736·6	1693·0	1679·6	1595·0	1548·0	1498·6	1449·0	1403·0	1349·3	1301·0
13	K_2.....	8199·2	8147·7	8076·8	7982·3	7878·6	7788·7	7604·8	7469·4	7317·1	7157·4	7010·4	6819·4	6649·5
14	Total capital = $K_1 + K_2$	9998·76	9998·43	9999·75	9995·26	10000·8	10033·2	9979·62	9993·76	9996·98	9998·9	10026·5	9996·5	9998 0
15	Depreciation and repairs on K_1	161·91	166·5	172·98	181·08	190·98	201·96	213·66	227·16	241·11	255·69	271·44	285·93	301·32
16	Annual cost of labour	49·05	96·24	141·30	183·90	224·10	261·48	295·53	327 84	357·12	383·59	408·54	428·64	447·66
17	Annual cost of melting copper	51·1	100·0	147·2	191·5	233·4	272·4	307·8	341·2	371·9	399·6	425·6	446·5	466·3
18	Annual cost of fuel for power.	6·02	24·74	54·48	94·54	144·0	201·7	265·9	337·0	413·0	492·9	577·6	661·0	747·8
19	Salaries of management, &c...	411·12	421·76	432·03	441·68	450·8	459·3	466·97	474·3	480·93	486·94	492·6	497·14	501·5
20	Annual rent and taxes	6·811	6·682	6·54	6·383	6·22	6·05	5·86	5·69	5·50	5·32	5·15	4·96	4·78
21	Total annual charges.....	686·01	815·92	954·50	1099·08	1249·49	1402·86	1555·72	1713·19	1869·57	2024·04	2180·93	2324·17	2469·36
22	Tons of copper refined	81·76	160·4	235·5	306·5	373·5	435·8	492·56	546·4	595·2	639·3	680·9	714·4	746·1
23	Total profits (P″ = £72).....	- 358·97	- 174·3	- 12·50	126·92	244·51	340·34	414·52	472·41	511·23	533·29	542·67	533·43	515·04
24	Percentage profits (P″ = £72).	- 3·59	- 1·74	- 1·25	1·269	2·44	3·40	4·14	4·72	5·11	5·33	5·42	5·33	5·15
25	Total profits (P″ = £73).....	- 277·2	- 13·92	223·0	433·4	618·0	777·1	907·1	998·8	1106·4	1172·6	1223·6	1247·8	1261·1
26	Percentage profits (P″ = £73).	- 2·77	- 1·39	2·23	4·33	6·18	7·77	9·07	9·98	11·06	11·72	12·23	12·47	12 61
27	Area of land required in sq. ft.	2452·8	2406·0	2355·0	2299·0	2241·0	2179·0	2111·0	2049·0	1984·0	1918 0	1857·0	1786·0	1722·0
28	Cost of refining, per ton	8·39	5·09	4·05	3·59	3·34	3·22	3·16	3·13	3·14	3·16	3·20	3·25	3·31

		14	15	16	17	18	19	20	21	22	23	24	25
1	Current-density employed.....	227·4	228·8	281·9	233·7	235·3	236·6	237·6	238·4	239 0	239·6	239·8	240·0
2	Cost of offices	414·8	399·3	384·1	369 6	355·4	341·8	328·7	315·9	303·8	292·1	280·8	270·2
3	Cost of refinery buildings.....	1300·0	1437·0	1573·0	1708 0	1843·0	1974·0	2103·0	2229 0	2352·0	2473·0	2588·0	2701·0
4	Cost of power plant	606·8	670·8	734·1	797·3	859·1	921·2	981·5	1040·0	1097·0	1154·0	1208·0	1260·0
5	Cost of dynamos and switchboard	663·6	638·9	614·6	591·3	568·5	546·8	525·9	506·4	486·0	467·4	449·3	432·2
6	Cost of electrolytic vats	309·68	319·4	327·88	335·0	341·16	346 32	350·56	353·8	356·32	358·32	359·4	360·2
7	Cost of circulating plant	3522·28	3695·2	3865·6	4034·9	4203·16	4366·72	4527·36	4683·5	4834·1	4984·4	5125·3	5263·6
8	K_1	460·8	443 6	426·6	410·6	594·9	379·6	365·2	351·0	337·5	324·5	312·0	300·1
9	Cost of electrolyte	3760·0	3620·0	3482·0	3351·0	3222·0	3098·0	2980·0	2864 0	2754·0	2649·0	2546·0	2449·0
10	Cost of anodes.....	1003·0	1035·0	1063·0	1086·0	1106·0	1122·0	1136·0	1147·0	1154 0	1161·0	1165·0	1167·0
11	Cost of conductors.....	1253·3	1206·6	1160·0	1117·0	1074·0	1032·0	993·3	954·6	914·6	883·0	848·6	816·3
12	Cost of stock copper	6477·1	6305·2	6132·2	5964·6	5796·9	5632·2	5474·5	5316·6	5160·1	5017·5	4871·6	4732·4
13	K_2.....	9999·4	10000·4	9397·8	9999·5	10000 06	9998·92	10001·76	10000·1	9994·2	10001·9	9996·94	9996·0
14	Total capital = $K_1 + K_2$	316·98	332·55	347·85	363·15	378 27	392·94	407·43	421·47	435·06	448·56	461·25	473·67
15	Depreciation and repairs on K_1	464·52	479·10	491·82	502·5	511·7	519·5	525·84	530·70	534·48	537·48	539·16	540·30
16	Annual cost of labour	483·9	499·1	512·4	523·5	553·1	541·2	547·8	552·9	556·8	559·9	561·6	562 7
17	Annual cost of melting copper	835·6	923·7	1011·0	1097 0	1184·0	1269·0	1352·0	1432·0	1511·0	1589·0	1663·0	1736·0
18	Annual cost of fuel for power	505·3	508·6	511·5	513·9	516·0	517·7	519·2	520·3	521·2	521·8	522·2	52?·5
19	Salaries of management, &c.....	4·60	4 43	4·26	4·10	3·94	3·79	3·65	3·51	3·37	3·24	3·12	3·00
20	Annual rent and taxes	2610·91	2747·49	2878·84	3004·16	3127 06	3244 12	3355·92	3460·88	3561·91	3659·98	3750·33	3838·17
21	Total annual charges	774·2	798·5	819·7	837·5	852·9	865·8	876·4	884·5	890·8	895·8	893·6	900·5
22	Tons of copper refined	485 89	446·51	399·96	335·84	284·54	219 08	149·68	77·12	1·29	- 76·78	- 155·93	- 236·17
23	Total profits (P″ = £72)	4·85	4·46	3·99	3·35	2·84	2·19	1·49	0·77	0 13	- 0·77	- 1·56	- 2·36
24	Percentage profits (P″ = £72)	1260·0	1245·0	1219·6	1183·3	1137·44	1084·8	1026·1	961·62	892·09	819 02	742·67	664·3
25	Total profits (P″ = £73).....	12·60	12·45	12·19	11·83	11·37	10·84	10·26	9·61	8·92	8·19	7·42	6·64
26	Percentage profits (P″ = £73)	1659·0	1597·0	1537·0	1478·0	1421·0	1367·0	1314·0	1264·0	1214·0	1169·0	1123·0	1081·0
27	Area of land required in sq. ft.....	3·37	3·44	3·51	3·59	3·67	3·74	3·83	3·91	3·99	4·08	4·17	4·26
28	Cost of refining, per ton.....												

This equation (in which A is given in square feet) is obtained from equation (13), the value of T being replaced by $\frac{DA}{30}$ to which it is equal. See equation (2).

The results of these calculations are given in Table VI., column 2.

The next step is to determine the output of the works in tons of refined copper per annum, which can be done by means of equation (2)—namely, $T = \frac{DA}{30}$.

The results of these calculations for each current-density from 1 to 25 are given in Table VI., lines 27 and 22.

Having thus obtained the output of the works T for each current-density employed, we may proceed to calculate out all the various items of capital and annual expenditure by means of the formula already developed in equations (3) to (20). This has been done and the results arranged in Table VI. Finally, the annual total profits are calculated out from equation (21), and are given in line 23 of Table VI., when P″ = £72, and in line 25 when P″ = £73. The percentage profits under each of these conditions are tabulated in lines 24 and 26 respectively.

The way in which the percentage of profits varies with the current-density is also shown in the form of two curves plotted with percentage profits as ordinates and current-density as abscissæ. One curve shows the variations of percentage profits with the current-density, when the difference between the price of the refined and the anode copper is £4 per ton, and the second when this difference is £5 per ton. In both cases, however, the cost of the anode copper is £88 per ton. The curves, in fact, represent the numerical results in lines 24 and 26 of Table VI. plotted as ordinates, with the current-densities in line 1 plotted as abscissæ.

Actual Cost of Electrolytic Copper Refineries.—The foregoing results given in Table VI., and on the curves, have been calculated out chiefly in order to indicate the precise line in which the problem of the best design of an electrolytic copper refinery for the establishment of which in a neighbourhood a definite amount of capital is available, should be attacked. Whatever opinion may exist as to the values of the constants adopted the *form* of the expressions must be closely in accord with the truth, and, in my opinion, the constants selected cannot be largely in error. Besides the general reasoning given in the earlier portion of this chapter, there are two other pieces of independent evidence which point to a con-

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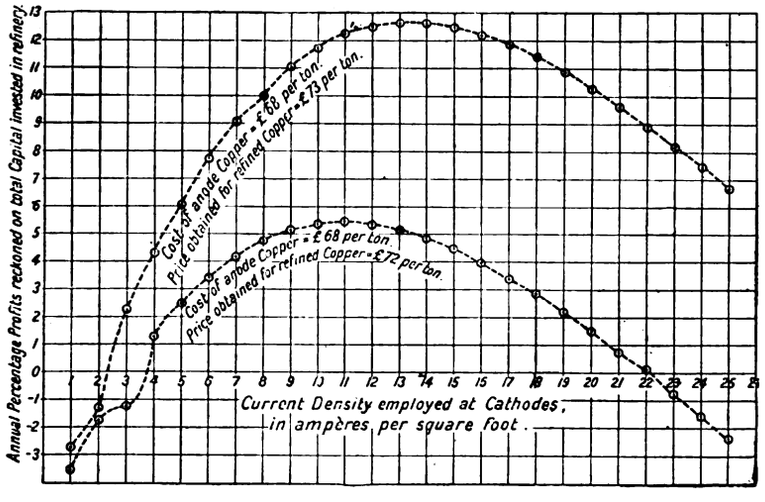
siderable accuracy in the method of calculation adopted. Firstly, the results obtained in Table VI. show in line 28 that the smallest cost of electrolytically refining a ton of copper is just over £3, and this is precisely the amount which it is stated to cost from results obtained in the best manufacturing experience.

Thus the cost per ton of refining copper electrolytically when the anodes and cathodes are arranged in the usual parallel method in the vats is stated by Peters* to be £3. 5s., whilst when arranged in the series method, as in the process adopted by Hayden, Stalmann and others, Peters states the cost of refining to be about £3. 8s. per ton. Thofehrn estimated the cost of his special high current-density process of refining to be £3. 6s. 8d. per ton (*The Electrician*, Vol. XXXVIII., p. 147, 1896), whilst when using the ordinary process, at Anaconda, he considered that the cost was £2, 18s. 6d. per ton. These figures do not allow anything for the value of the silver and gold recovered, which is an extra source of profit.

T. Ulke states (*Electrical Review*, New York, Vol. XXXVIII., 1901, pp. 85 and 101—103) that the cost of refining 1 ton of anode copper is less than £1. 13s. 4d. at the Raritan Copper Refinery at Perth-Amboy, which is now the largest in America,


Annual Percentage Profits reckoned on total Capital invested in refinery.
Cost of anode Copper = £60 per ton.
Price obtained for refined Copper = £73 per ton.
Cost of anode Copper = £68 per ton.
Price obtained for refined Copper = £72 per ton.
Current Density employed at Cathodes; in ampères per square foot.

Showing the variation of the profits obtainable in an electrolytic copper refinery in which a capital of £10,000 is invested when the current-density at the cathodes is varied. The details of the various constants involved are given at the head of Table VI. The two above curves are, in fact, a graphical representation of the two lines 24 and 26 on Table VI.

with an output of 150 tons of copper per day. To reduce the costs of refining to this very low value automatic machinery is employed for casting the anodes, and every possible labour-saving device is adopted. I find it difficult to believe that this last estimate can possibly cover all the costs of production. For I am of the opinion that if the cost of labour and the salaries for management, &c., were reduced to zero the cost of refining one ton of copper electrolytically could not be less than about £1. 10s.—always provided that the value of the gold and silver separated from the anode copper is not considered as a set-off to part of the cost of refining.

Secondly, F. R. Badt has published estimates for an electrolytic copper refining plant to give an output of 5,357 long tons of copper per year (*Electrical Engineer* of New York, Vol. XIII., 1892, p. 598), and he finds that £28,900 would be required for the plant installed, not including the copper anodes and stock copper. Whilst if the current density is assumed to be 12 amperes per square foot of anode (this current-density is selected because it is that most generally employed in America, for which country F. R. Badt's estimates are made) it is found that the total capital required as calculated out by the foregoing formulæ is £29,460. Badt does not state how his results were calculated out, but presumably they represent his experience of some of the better known American refineries. The results as obtained by Badt, and by calculation by the formula here developed, do not differ by 2 per cent., a striking result when one considers that they are independently obtained.

I place Badt's estimates and my own side by side :—

Badt's Estimate. (Output of 5,357 long tons per annum.)			Calculated from formulæ (D = 12 T = 5,357).		
Buildings	£6,000		Refinery buildings	£3,359	
Pavement	400		Office buildings...	685·7	
Rails and travelling tackle	400				£4,044·7
		£6,800			
Pipes	800				
Vats	1,500		Vats	5,357	
Sheet lead lining	5,600		Circulating plant...	2,142·8	
Lead burning	300				7,499·8
Steam injector	200				
		8,400			
Dynamos	6,000		Dynamos		3,613
Steam engine and shafting	4,600		Power plant		7,741
Electrolyte	900		Electrolyte		3,732
Conductors	2,200		Conductors		2,830
Total	£28,900		Total		£29,460·5

The estimate which Badt made for the necessary anodes and stock copper was only £16,000, and as copper in 1892 had an average value for G.M.B. brands of about £45·5 per ton (according to H. R. Merton & Co.'s lists) the number of tons of copper allowed by Badt for anodes is 351·6 tons—that is, a weight of only 6·56 per cent. of the total annual output of the refined copper of the refinery. But the estimate for the copper anodes and stock copper calculated out from the formulæ is £35,828 when copper costs £60 per ton—that is, 597·13 tons, or 11·147 of the total annual output of the refinery. In my opinion, Badt's estimate of the weight of copper for anodes and stock copper was seriously too low, for at Anaconda the weight of anodes alone without stock copper is, as already pointed out, as high as 10 85 per cent. of the total annual output of the refinery (*Electrical World and Engineer*, Vol. XXXVII., pp. 186-187, abstracted in *Science Abstracts*, Vol. IV., 1901, p. 423), and it is not at all probable that the total amount of copper anodes and stock copper can be reduced much below this amount unless it becomes economically possible to employ current-densities considerably larger than those which Badt's estimates for power plant show that he must have contemplated.

(*To be concluded.*)

* "Modern Copper Smelting." Peters.

STANDARDISATION OF PIPE FLANGES AND FLANGED FITTINGS.*

BY ROBERT E. ATKINSON.

In connection with the preparation of this Paper, communications have been addressed to upwards of 200 British and foreign firms manufacturing valves and other kinds of flanged fittings, approximately 120 of these have replied sending tables of standards used by them, and expressing a sincere desire to see some universal standard adopted. Broadly speaking, the variation in the practice of these 120 firms was comparatively slight, but in no two cases did the tables sent agree in every particular, there being just sufficient variation to prevent the requisite interchangeability. There was, however, a generally expressed desire for the adoption of a uniform standard. In some other countries this question has received attention for many years, and has been the subject of exhaustive reports. In 1894 the American Society of Mechanical Engineers, together with the Master Steam and Hot Water Fitters' Association, appointed a joint committee to deal with it, and in July of that year they presented a report containing a table of standard flanges,† which was adopted by these societies, and by the principal valve and fitting manufacturers of America, Table 1. The intention of the compilers of this standard was that it should apply for all pressures; but latterly pressures carried on boilers, &c., have increased very rapidly, and it was consequently found that for pressures above

* Abstract of Paper read before the Institution of Mechanical Engineers, Friday, April 18th.

† *Bulletin*, Master Steam and Hot Water Fitters' Association, July, 1894.

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125lb. the flanges adopted were too small in diameter, and had an insufficient number of bolts. Recognising these imperfections, Mr. J. C. Melloon, of the General Fire Extinguisher Co., Providence, R.I., U.S.A., in April, 1891, called a meeting of the principal valve and fitting manufacturers of America, which resulted in the formation of an additional table of flanges, to apply to pressures 125lb. to 250lb.,* Table II. This was adopted unanimously, the date appointed for the commencement of its use being January 1, 1902. A definite movement of the same character has also been made in Germany. In the year 1900 the Society of German Engineers compiled an exceedingly valuable and minute report on standards of pipes and flanges for high-pressure steam.† That part of the report which refers to the flanges is embodied in Table IV. This table, however, dealt only with flanges for a pressure of 8 to 20 atmospheres (118lb. to 294lb.); but some time previously this society, with the Society of Gas and Steam Fitters, jointly compiled a table for flanges of pipes for pressures up to 8 atmospheres (118lb.), Table III. So far as can be ascertained from inquiries in other countries, no definite standard has been formulated elsewhere; but inquiries have elicited from various parts strong expressions of opinion in favour of standardisation, as the following interesting extract from the letter of a French correspondent will sufficiently indicate:—"Unhappily in France we have no regular standard for flanges. It would certainly be the best thing for all heating and mechanical engineers if an international standard should be formulated. In our country, where French, American, German and English valves and fittings are simultaneously in trade competition, it is for engineers a true nuisance with the different sizes of flanges." In Great Britain most of the leading engineering firms use a standard more or less applicable to their own particular requirements.

Table I.—*Standard Flanges adopted by the Society of Mechanical Engineers and the Master Steam and Hot Water Fitters' Association of America.*

For Pressures up to 100lb.

Diam. of pipe.	Diam. of flange.	Diam. of bolt circle.	No. of bolts.	Size of bolts. Pressure under 80lb.	Size of bolts. Pressure 80lb. and over.	Flange, thickness at hub for iron pipe.	Flange, thickness at edge.	Width of flange face.
in.	in.	in.		in.	in.	in.	in.	in.
2	6	4¾	4	½ × 2	⅝ × 2	1	⅝	2
2½	7	5½	4	½ × 2¼	⅝ × 2¼	1⅛	1⅛	2¼
3	7½	6	4	½ × 2½	⅝ × 2½	1¼	¾	2¼
3½	8½	7	4	½ × 2½	⅝ × 2½	1½	1⅛	2½
4	9	7½	4	⅝ × 2¾	¾ × 2¾	1⅜	1⅛	2½
4½	9½	7¾	8	⅝ × 3	¾ × 3	1⅜	1⅛	2⅝
5	10	8½	8	⅝ × 3	¾ × 3	1½	1⅛	2½
6	11	9½	8	⅝ × 3	¾ × 3	1½	1	2½
7	12½	10¾	8	⅝ × 3¼	¾ × 3¼	1½	1⅛	2¾
8	13½	11¾	8	⅝ × 3½	¾ × 3½	1¾	1⅛	2¾
9	15	13	12	⅝ × 3½	¾ × 3½	1¾	1⅛	3
10	16	14¼	12	⅝ × 3⅝	¾ × 3⅝	2	1⅜	3
12	19	17	12	⅝ × 3¾	⅞ × 3¾	2	1½	3½
14	21	18¾	12	⅝ × 4¼	1 × 4¼	2	1⅝	3½
15	22½	20	16	⅝ × 4¼	1 × 4¼	2	1⅝	3⅝
16	23½	21¼	16	⅝ × 4¼	1 × 4¼	2¼	1⅞	3¾
18	25	22¾	16	1 × 4¾	1⅛ × 4¾	..	1⅞	3½
20	27½	25	20	1 × 5	1⅛ × 5	...	1⅛	3¾

Table II.—*Standard Flanges adopted in America, January* 1, 1902.

For Pressures 101lb. to 250lb.

Diam. of pipe.	Diam. of flange.	Thickness of flange.	Diam. of bolt circle.	No. of bolts.	Size of bolts.
in.	in.	in.	in.		in.
2	6½	⅞	5	4	⅝
2½	7½	1	5⅞	4	¾
3	8¼	1⅛	6⅝	8	⅝
3½	9	1⅛	7¼	8	⅝
4	10	1¼	7⅞	8	¾
4½	10½	1⅛	8½	8	¾
5	11	1⅝	9¼	8	¾
6	12½	1⅛	10⅝	12	¾
7	14	1½	11⅞	12	⅞
8	15	1⅝	13	12	⅞
9	16	1¾	14	12	⅞
10	17½	1⅞	16¼	16	⅞
12	20	2	17¾	16	⅞
14	22½	2⅛	20	20	⅞
15	23½	2⅛	21	20	1
16	25	2¼	22½	20	1
18	27	2⅜	24½	24	1
20	29½	2½	26¾	24	1⅛
22	31½	2⅝	28¾	28	1⅛
24	34	2¾	31¼	28	1¼

* *Power*, November, 1901.

† *Proceedings* of the Society of German Engineers, January, 1900.

Table III.—*Standard Flanges compiled by the Association of German Engineers and the Association of Gas, Hot Water and Steam Fitters.*

For Steam Pressures up to 118lb. (8 atmospheres).

Inside diam. of pipe.		Diam. of flange.		Diam. of bolt circle.		Cir. pitch of bolts.		No. of bolts.	Size of bolts.
mm.	in.	mm.	in.	mm.	in.	mm.	in.		in.
40	1 9/16	140	5½	110	4 3/8	87	3 7/16	4	½
50	1 15/16	160	6 5/16	125	4 15/16	98	3⅞	4	⅝
60	2⅜	175	6⅞	135	5 5/16	106	4 3/16	4	⅝
70	2¾	185	7 5/16	145	5 11/16	114	4½	4	⅝
80	3 5/16	200	7⅞	160	6 5/16	125	4 15/16	4	⅝
90	3½	215	8 7/16	170	6 11/16	131	5 3/16	4	⅝
100	3 15/16	230	9 1/16	180	7⅛	140	5½	4	¾
125	4 15/16	260	10¼	210	8¼	165	6 5/16	4	¾
150	5 15/16	290	11 7/16	240	9 7/16	125	4 15/16	6	¾
175	6⅞	320	12 9/16	270	10⅝	141	5 9/16	6	¾
200	7⅞	350	13¾	300	11 13/16	157	6 3/16	6	¾
225	8⅞	370	14½	320	12 9/16	166	6 9/16	6	¾
250	9⅞	400	15¾	350	13¾	136	5 11/16	8	¾
275	10 13/16	425	16¾	375	14¾	147	5 13/16	8	¾
300	11 13/16	450	17¾	400	15¾	157	6 3/16	8	¾
325	12 13/16	490	19 5/16	435	17⅛	136	5 11/16	10	¾
350	13 13/16	520	20 1/16	465	18 5/16	146	5 13/16	10	¾
375	14 13/16	550	21 5/16	495	19½	155	6⅛	10	¾
400	15¾	575	22⅝	520	20 1/16	166	6 9/16	10	¾
425	16¾	600	23 5/16	545	21 7/16	144	5 11/16	12	¾
450	17¾	630	24 13/16	570	22 7/16	150	5 15/16	12	¾
475	18¾	655	25 13/16	600	23⅝	157	6 3/16	12	¾
500	19 11/16	680	26¾	625	24⅝	163	6 7/16	12	¾
550	21 11/16	740	29⅛	675	26⅝	152	6	14	1
600	23⅝	790	31⅛	725	28 9/16	141	5 9/16	16	1
650	25 9/16	840	33 1/16	775	30½	134	5 5/16	18	1
700	27 9/16	900	35 7/16	830	32 11/16	144	5 11/16	18	1
750	29½	950	37 13/16	880	34⅝	138	5 7/16	20	1

Table IV.—*Standard Flanges compiled by the Association of German Engineers in* 1900.

For Steam Pressures 118lb. to 294lb. (8 to 20 atmospheres).

Inside diam. of pipe.		Diam. of flange.		Diam. of bolt circle.		Cir. pitch of bolts.		No. of bolts.	Size of bolts.
mm.	in.	mm.	in.	mm.	in.	mm.	in.		in.
30	1 3/16	125	4 15/16	95	3¾	50	1 31/32	6	½
40	1 9/16	140	5½	110	4⅜	57	2 9/32	6	½
50	1 31/32	160	6 5/16	125	4 15/16	63	2 15/32	6	⅝
60	2⅜	175	6⅞	135	5 5/16	70	2 3/4	6	⅝
70	2¾	185	7 5/16	145	5 23/32	76	3	6	⅝
80	3 5/16	200	7⅞	160	6 5/16	84	3 5/16	6	¾
90	3½	220	8 21/32	180	7⅛	95	3¾	6	¾
100	3 15/16	240	9 7/16	190	7½	100	3 15/16	6	¾
125	4 15/16	270	10⅝	220	8 21/32	85	3⅜	8	¾
150	5 15/16	300	11 13/16	250	9⅞	98	3⅞	8	¾
175	6⅞	330	13 1/16	280	11	87	3 7/16	10	¾
200	7⅞	360	14¾	310	12 3/16	81	3 3/16	12	¾
225	8⅞	390	15⅜	340	13 7/16	88	3½	12	1
250	9⅞	420	16 9/16	370	14 9/16	96	3 25/32	12	1
275	10 13/16	450	17¾	400	15¾	88	3½	14	1
300	11 13/16	480	18 29/32	430	16 15/16	84	3 5/16	16	1
325	12 13/16	520	20 1/16	465	18 5/16	89	3 9/16	16	1⅛
350	13 13/16	550	21 21/32	495	19½	96	3 25/32	16	1⅛
375	14 13/16	580	22 13/16	525	20⅝	92	3 21/32	18	1⅛
400	15¾	605	23 13/16	550	21 21/32	86	3 3/4	20	1⅛

In further reference to the American table (I.-II.), it will be noted that the diameters of flanges for pressures above 125lb. are larger than those for lower pressures. To the author this does not appear to be necessary, and, as it prevents the use of a valve or fitting constructed for the higher pressures in connection with low-pressure pipes and flanges, it is likely to lead to confusion. The high-pressure flanges appear to have been made larger, and the diameter of the bolt circles correspondingly large, in order to provide for the use of very thick material in the pipes. It, however, seems practicable to reduce the diameter of these high-pressure flanges to such an extent that the low-pressure flanges might be increased without serious objection, and thus make one standard common to all pressures. With regard to the bolt holes, it will be observed that in the standards of both 1894 and 1901 the number of bolts in a flange is in every case divisible by four, and that the bolt holes are not drilled on the centre line of a valve or fitting, but symmetrically on each side of it. In the standard for pressures up to 125lb., four bolts in a flange are considered sufficient for pipes up to and including 4in. inside diameter, but for pressuress above 125lb., four bolts are used for the flanges for 2in. and 2½in. pipes, and eight bolts for flanges on 3in. to 5in. pipes inclusive. As to the standards adopted by the German Society of Engineers, there is again a lack of uniformity in the outside diameter of flanges, and in the number of bolts used for various pressures. The flange diameters are the same in both standards for all pressures and for all pipes up to those having an inside diameter

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of 80mm., but beyond these, though the difference is comparatively slight, it is nevertheless sufficient to prevent interchangeability, as will be seen by reference to the tables. To take, as an instance, a pipe 150mm. (approximately 6in.), inside diameter, in the low-pressure standard the flange is 290mm. ($11\frac{7}{16}$in. diameter), whilst the high-pressure standard flange is 300mm. ($11\frac{13}{16}$in.) diameter for the same size pipe. It will also be observed that they have not considered it expedient to adopt the principle, that the number of bolts should be divisible by four, although there is evidence to show that the advisability of this course was pointed out to the committee of the society referred to. Messrs. Schäffer and Budenburg—who have works in Germany, England and America—prepared a table which, the author understands, they submitted to the said committee, and in which the bolts are arranged so that in every case the number is divisible by four. The following is an extract from the report of the German Society of Engineers regarding this :—

"It was suggested that the number of bolts to be used should be divided by four. Such suggestion would have led to unsuitable measurements of flanges, and consequently the disadvantages would have exceeded the advantages expected to be derived. As, moreover, such a rule has not been adopted with respect to the standards for the flange pipes for a low pressure, the committee abstain from assenting to this suggestion."*

Judging from these remarks the Association of German Engineers, in compiling their standard of flanges for pressures of 8 to 20 atmospheres (118lb. to 294lb.) appear to have been influenced to a considerable degree by the standard which was already in existence with them for pressures below 8 atmospheres (118lb.), and generally to have formulated the standard on a purely theoretical basis, without sufficient regard to practical considerations. It is said that difficulty is experienced with these German standards in general use, mainly on account of the number of bolts not being divisible by four, and that valves and other fittings must be kept in stock undrilled, until the manufacturer receives an order from the user, giving the exact position of the holes, which may or may not be required to be drilled on the centre line of the valve spindle, or fitting. It may be added that, in speaking of German practice, it is understood that the pressures are "absolute," while the English and American are gauge pressures.

In the general course of English practice this difficulty as to the number of bolt holes is equally apparent, 6, 10 and 14 bolts being used for various sizes, in disregard of the advantage of the principle of the divisibility by four—a principle which has been adopted with great success for some years by the firm with which the author is connected. In preparing this standard, the following have been adopted as guiding principles :—Uniformity in the outside diameter of flanges for varying conditions. Uniformity in the number of bolt holes and diameter of bolt circle.

The number of bolts should in all cases be divisible by four.

The fact that uniformity is desirable will be appreciated, when it is realised that wrought steel and iron pipes are often connected with cast steel and cast-iron valves and fittings, and cast-iron pipes with valves and fittings of gunmetal, &c. ; and, further, that flanges are attached to pipes by being screwed, brazed, welded and riveted. The first point to take into account, if uniformity is to be obtained, is that the flange must be large enough in diameter to allow of a sufficient thickness of metal to enable the pipe, even if of cast iron, to withstand the maximum pressure, and still leave space for accommodation of the head and nut of the bolt. As cast iron is the metal of least tensile strength commonly used in the construction of valves and fittings, it follows that the largest dimensions will be required when this metal is used, with the possible exception of steel and wrought-iron pipes constructed with flanges of angle rings riveted on to the pipe.

By designing the standard flange suitable for a maximum pressure of 250lb. it is apparent that, if uniformity is preserved, the flanges for very low pressures will be larger than is necessary for strength ; but as a separate standard would otherwise be required for low pressures, it would appear to be better to choose the lesser of two evils, and permit the slight excess of material for the low pressures. It should, however, be borne in mind that this excessive material would occur in the diameter only of the low-pressure flange, and that its thickness could be made proportionate to its duty. These thicknesses have been calculated with an allowance for the tensile breaking strain of 4 tons per square inch, with a minimum factor of safety of 20.

(To be concluded.)

Underground Telephone Wires in U.S.A.—It is stated that the sum of £20,000 is being spent in the construction of a tunnel for telephone wires between Minneapolis and St. Paul, Minn., U.S.A. The object of the tunnel is to protect inter-urban service from interruption by storms, and to increase the capacity for communication between the two cities.

* *Proceedings* of the Society of German Engineers, January, 1900.

CORRESPONDENCE.

TWO-WIRE *v.* THREE-WIRE DISTRIBUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I have read with interest your remarks on the Papers read and discussed before the Incorporated Municipal Electrical Association, and particularly your remarks on my Paper on "The Relative Merits of Two- and Three-wire Distribution." The principal point criticised was my statement as to relative costs, and it was said my contention that only 40 per cent. of the copper used was saved by a three-wire system was wrong, and that this figure should have been $68\frac{1}{2}$ per cent. In my written reply to the discussion, I have shown that an error has been made by my critic—viz., that instead of comparing two 1 sq. in. cables with three (0·25, 0·125, and 0·25 sq. in.), which would show a saving of $68\frac{3}{4}$ per cent., he should compare two pairs of 1 sq. in. with a three-wire (1, 0·5 and 1 sq. in.), which comparison shows a saving of only 40 per cent. The proportion will hold, of course, for any particular section. In the first example, whatever the section taken, the outers of the three-wire system will be working at a current density of 2,000 amperes per square inch, which is impracticable.

I assert, therefore, emphatically, that my figure of 8 per cent., which I state to be the saving on a three-wire system *laid complete* with separate cables, as against a two-wire system, is correct. I, of course, also added figures showing the additional losses in the two-wire system, and what these losses would represent in a network of certain dimensions; and the point was that these additional losses only represented a small increase in expenses in a system of fair dimensions. I quite agree with you that if one compares two and three-wire systems of the same dimensions, and with the same maximum drop of volts, the whole conditions will be changed, but that is exactly what I did not do, and, moreover, did not consider it necessary to do under the conditions given in my Paper. The additional trouble of balancing, I admitted, was not of great importance, but I wish to dispense with as many auxiliaries as possible. I know that you will find numerous cases where a number of lamps have been burnt out by short-circuits on one side of a three-wire system. I know of many from practical experience (not in Sunderland), and I assure you that this is not a negligible quantity. I say that this risk must be eliminated. The greater point is, of course, electrolysis. It is difficult to refer to specific cases of leakage—firstly, because engineers have an objection for some reason to having it made public ; and, secondly, because they are not aware of it until the cable burns out. I am sorry that several engineers, who I knew could have given valuable (and to me supporting) evidence on this point, did not discuss this matter, though present at the reading of the Paper. I challenge any engineer in charge of a direct-current system to deny that his negative cables, after a few years' service, are not damp from end to end—whether the system be solid or drawn-in. I refer, of course, to separate cables for each pole. The most resistent is the concentric, but this has to me another serious drawback—viz., the disruption of the supply locally when a fault occurs ; and, further, my experience of lead-covered cables in direct-current work shows that, after a time, the lead itself becomes pitted, due to minute currents traversing it, and when this pitting penetrates the sheathing, of course a fault results.

I question your remark that leakages chiefly occur at junction boxes. My experience is that the whole insulation of the negative cable becomes thoroughly saturated, in addition to the damp creeping into the cables from the ends.

I must also beg to differ as to the localisation of faults on a three-wire system. When the middle wire is earthed it is quite conceivable, and has been recorded, that with two faults, on the positive and negative respectively, the middle-wire leakage recorder will give no evidence, neither will the earth lamps give any evidence. I have also found a difficulty in localising faults on the third wire itself, without upsetting the supply, unless there were outside balancing sub-stations as well as the balancing at the station, which would seem to be neces-

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sary on a big system. In small systems I would most probably adopt a three-wire distribution if direct current, two-wire if alternating; but in Sunderland and the larger towns, where, for many reasons, one must adopt high-tension transmission, it is a fact that there is no appreciable difference between high-tension sub-stations and duplicate feeders, with a two-wire distribution therefrom on the one hand, and a three-wire 500-volt system of feeders and distributors on the other—either in capital cost or general efficiency.

Time will show whether one is justified, but Mr. Trotter's remarks in the discussion on Mr. Faraday Proctor's Paper, about the smallness of currents required to pit lead plates after one month's burial, were significant.

It is of no use being blind to faults if one sees them. I think our duty should be to meet them boldly and correct them.—Yours, &c., JOHN F. C. SNELL.

Sunderland, Sept. 2.

ELECTRICAL TRAMWAYS AND OMNIBUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Though I do not happen to agree with your correspondent, Mr. Edward Clarke, he must not assume that I am "in something of a fog." Mr. Clarke still appears to disregard the fact that a tramcar running on rails has no overtaking powers under any circumstances whatever—a rather important matter when coming at close quarters with the subject.—Yours, &c., CHARLES BRIGHT.

Sept. 3.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) and St. Marylebone Borough Council.

ARBITRATION.

In *The Electrician* for May 16 we summarised the proceedings before Mr. C. A. Russell, K.C. (umpire), and Mr. Robert Vigers and Mr. W. C. Ryde (arbitrators) in the important arbitration between the above-mentioned parties to settle the amount to be paid over by the Marylebone (London) Borough Council to the Metropolitan Electric Supply Co. (Ltd.) for the purchase by the borough council of that portion of the company's electricity undertaking situate within the metropolitan borough of St. Marylebone. The proceedings have been held at the Surveyor's Institution, Great George-street, Westminster, and after the preliminaries were settled on April 19 the main proceedings were commenced on May 12, and have proceeded from time to time from that date until Aug. 7, when they were adjourned until Oct. 20 next.

Our previous report digested the proceedings up to May 14, when Mr. Balfour Browne's opening speech for the company was concluded, and a number of surveyors gave evidence as to the value of the company's buildings, &c., within the prescribed area. Previous to this evidence, Mr. John Conacher, general manager of the Metropolitan Company, had been called, and was examined by

Mr. CRIPPS, K.C., who first examined Mr. Conacher as to the dates on which electricity supply was first given from the Metropolitan Company's various stations, including the new station at Willesden, from which current was first supplied in November, 1899. Continuing, witness said the original system of supply, with the exception of that from the Whitehall station, was the alternating-current high-pressure system, which was adopted under the best advice obtainable at the time of the starting of the company's operations. It was fully recognised at the time that this system was wasteful, so far as current was concerned, but was economical from the capital expenditure aspect. It would have involved a very large capital outlay to have changed the system to a continuous-current supply, and this was, therefore, not taken into consideration until the company's undertaking was firmly established in the various districts, and the time became ripe for the change to the continuous-current system. The voltage at which the high-tension current was distributed from the stations was 1,000 volts. This was transformed on the consumer's premises down to 100 volts. This system involved an enormous loss of energy, and the company found they were generating 50 per cent. or more current than they could account for. This proved a source of very great expense, and the company early in 1897 commenced the work of altering their system to one of low-tension networks, and the system was now almost completely one of continuous current. The Marylebone area was changed to the new system of supply in 1898. This change involved the establishment of sub-stations with bank transformer, by means of which the transformation was effected in bulk at the sub-stations instead of being effected in detail on the consumers' premises. This change resulted in a great reduction in the waste previously prevailing. The company at once began to transfer consumers from the old system to the new in sections or districts, and it took from July 5, 1898, to Sept. 19, 1901, to carry out the operation, and, in fact, the work is not yet quite completed. A very large sum of money had already been spent upon this conversion, and the whole scheme would cost £140,000 by the time it was finished. One portion of Marylebone was still being supplied on the old high-tension system with house transformers, and there were other portions of the company's area not yet ripe for the change to continuous current. The time would, however, doubtless come when these portions would have to be changed over.

Mr. CRIPPS: Now, as regards the trunk mains which come from Willesden, they are carried in a conduit?—Yes, in flat conduits divided into five spaces.

You have spaces in these conduits, I understand, for another five mains?—Yes, we have not taken up the whole space, and can lay another five mains on the top of the existing five. We have, in addition, the right to the alternative route.

Coming to the generating stations, what is the capacity of Manchester-square?—2,100kw.

And the capacity of the Rathbone-place station?—825kw.

Your method of working by the linked system between the various stations had to go before the Board of Trade in 1896, and was then sanctioned?—Yes.

1891 was your first complete year of working?—Yes, we began supply in 1889 and 1890, but 1891 was our first complete year practically.

Your gross revenue in that year was £12,120?—Yes.

And in 1901, which is the latest full year we have, it is £100,833?—Yes, eight times the amount of the first year's revenue in 10 years. The gross revenue doubled itself in 1893, again in 1896, and a third time in 1900. The increase between 1900 and 1901 was as much as the whole gross revenue in 1891.

Regarding 1901, I see the increase was less than in one or two years before; were there special reasons for this?—Yes, Marylebone is largely residential, and the death of Queen Victoria and the continuance of the Boer war reduced the number of visitors and affected the sale of current considerably.

The number of consumers has increased?—Yes, there has been a large and constant increase in the number year by year. In 1891 it was 354, in 1901 4,194, and in the first four months of 1902 the increase is on a greater ratio. 218 consumers were added to the end of April, whereas in 1901 only 453 consumers were added during the year. This indicates a much larger growth in the immediate future than even in the past. The 218 consumers for 1902 compares with 152 for 1901, and the increase would be greater towards the end of the year when connections are made for the winter supply. The lamp connections have shown a continuous increase up to the year 1899. In 1900 the number went down a little owing to the Willesden station not being ready to supply. This, again, was owing, in the main, to the great engineering strike of 1897. In this emergency the company were compelled in the winter of 1899 to disconnect a certain number of customers in order that the remainder might have full voltage. This had the effect of considerably checking business in 1900, and would account for the fall in the number of new consumers in that year, and the drop in the increase in the number of lamps connected.

Mr. CRIPPS: I see you have added for the first four months of 1902 13,097 lamps connected, compared with only 6,969 in 1901.—Yes.

Then, as to the number of units sold?—During the last four or five years these increases have been very large. In 1894 the increase was 259,000 units, 1895 295,000, 1896 241,000 (the reduction was due to the company adopting the more accurate method of reading), and in 1900 the number of units sold was 675,000. In 1901 this increase fell for the reasons I have given.

Then, as to the unit consumption per consumer and per lamp?—If you start from 1895 there has been a steady increase in these items. The number of units sold per consumer in 1895 was 982; in 1901, in spite of exceptional circumstances, this had increased to 1,164. The number of units per lamp installed has continuously grown until it is now 18·60 per 8 c.p. lamp.

That goes to show that, in addition to the increase in the number of consumers, each consumer tends to take more light?—Yes, that is undoubtedly the case.

Your contention is, further, that this rapid increase has come from a comparatively small proportion of the inhabited houses in the Marylebone area, and that you have an infinite capacity of increase so far as the term of your concession is concerned?—Yes, for the next 28 or 30 years.

What was the number of inhabited houses in Marylebone at last census?—13,536.

What was the number wholly or partially supplied by the Metropolitan Company on Dec. 31, 1900?—3,108.

In your calculations you take as the approximate number of possible consumers 18,273?—That must be accepted with qualification, as I hope to show that the possible number of consumers in houses already connected is very much greater now than was the case at the end of 1900, but assuming that we have exhausted the proportion of additional consumers from these houses we find that 22·95 per cent. were on the company's supply at that time.

You mean that in the 3,108 houses you already supply you have not come to the end of your consumers?—No; we had 4,194 at the time the particulars were compiled, but we have more now, and we shall get more as time goes on. We have only now obtained 22·95 per cent. of our possible customers.

A discussion followed as to the ratios upon which the calculation of possible consumers was based, the witness stating that the value of the figures was to express the view, which the company hold, that they have a possible market which will be by no means absorbed or taken up during the period of their concession, the witness pointing out that for the first four months of 1902 158 new houses, averaging 59 lamps each, had been connected with the company's system, compared with 85 new houses, averaging 43 lamps each, in the corresponding period of 1901, and the company had added during the same period 57 new consumers in the houses which were connected at Dec. 31, 1901.

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Mr. CRIPPS: In some cases you have more houses than consumers, whilst in others there are more consumers than houses?—Yes. Out of the 3,108 houses, 2,728 represent only 2,586 consumers—*i.e.*, certain consumers have more than one house, but in 200 cases there are two consumers in each house, and in 49 cases three consumers in each house.

The percentage of consumers to houses is growing?—Yes. For instance, we have just had in the last fortnight's returns, and already the figures as to the number of new consumers in houses connected prior to Dec. 31, 1901, has increased, and brings up our number of consumers in these houses already to 4,269 compared with 4,194, the figure previously given; and as time goes on this increase in the proportion or disproportion between consumers and houses is going on as an increase in the number of consumers. Taking the actual number of houses supplied, apart from the probable increase in this number in the future, we expect a considerable increase of business due to the increase in the number of consumers. The houses are at present only very partially supplied, and where re-construction or re-building is going on the houses are being wired for the electric light almost invariably, and this is also the case generally in the case of buildings whose leases expire. In one case recently the tenancy of a house changed hands, and no fewer than 765 electric lamps were put into this house, where previously no electric lamps had existed. We have taken portions of a large number of thoroughfares in the district as an illustration of the present partial electric lighting and the probability of large increases, taking only the houses where electric lighting has been introduced more or less partially. Taking one thoroughfare—Portland-place—we have 76 out of 89 houses occupied. One of these houses has 620 lights, another 538 and another 471, five varying between 300 and 400, 12 between 200 and 300, 12 between 160 and 199, 16 between 100 and 159, 22 between 50 and 99, and six are under 50, the lowest being 20. We consider that as time goes on the lighting in those houses will gradually grow up to the higher levels. A house in Portland-place that has only 22 lights is, from our point of view, practically unlighted, and taking the average of the whole number of lights in these 76 connected houses, this average is 158. In Park-crescent there are 20 houses lighted out of 27, ranging from 269 lights to 43; the average is 151, and half the houses are below the average. This is the case with all the thoroughfares we have taken.

Mr. CRIPPS: One further illustration. Based upon certain particulars that we possess, you get the information that in 1901 additions were made to the lamps in 59 houses connected at various times between 1890 and 1900. I see the original installations in those 59 houses between 1890 and 1900 was 5,334 lamps?—Yes.

And in 1901 I understand this total had increased to 20,616 lamps?—Yes; and 600 lamps were added in the last year.

I see you have another illustration in connection with the number of units supplied. Taking a group of consumers whose accounts amounted to more than £100 per annum over a period of years: the increase in their consumption has been from 548,000 units to 1,260,000. One other figure as to this increased rate of consumption. While the number of houses wholly or partly connected has increased by 78 per cent. in the last four years, the number of units sold has increased by how much?—113 per cent.

You mean per house?—Yes; in 1897 the number of houses connected was 1,747. This number has become 3,108, an increase of 78 per cent. In 1897 the number of units sold was 2,169, last year it was 4,617, an increase of 113 per cent. per house, so that the number of units sold increased in larger proportion than the number of houses.

And now as to population of the houses in Marylebone?—I have looked at the census returns of 1901, and have compared them with 1891. In the latter year 41 per cent. of the whole population (58,627 out of 140,000) lived in one or two-roomed tenements, whereas in 1901 that class had been reduced to 45,915, showing a diminution in the class of population which does not use the electric light.

Sir EDWARD CLARKE, K.C. (for Marylebone): Have you the total Marylebone population in 1891 and 1901?—Yes, 142,404 in 1891 and 133,301 in 1901, or 9,103 less, which shows that, whereas the total population is only 9,103 less, the poor class of the population is 12,712 less, due largely to the clearances for the Great Central Railway and to the improvement of property in the borough, as, where the poorer class of property is taken down, the tendency is to put up a better class, and this is all in favour of the electric light.

Mr. CRIPPS: One other point. What was the rateable value in 1891 and in 1901?—In 1891 this was £1,451,654, and in 1901 £1,679,239, an increase of 16 per cent., notwithstanding the decrease in population, or £10. 3s. 6d. per head in 1891 and £12. 11s. 11d. in 1901, an increase per head of the population of 24 per cent. Marylebone's rateable value is £12. 11s. 11d., compared with London as a whole £8. 15s. 4d.

Coming to another set of statistics, you have a table here which shows the greater use of the electric light by houses which have been rebuilt, and in this table flats are introduced. Take an instance. You mention Harley Mansions, Marylebone-road. This is now a set of flats, and you have estimated for 2,000 lamps. This is a large figure?—Harley Mansions is a large block of flats which are now practically finished. They stand upon the site of a house and grounds to which we made no supply, and in putting down 2,000 lamps I have kept well within the mark.

There are other cases of a similar character, notably in Oxford-street?—Yes, we have practically come to terms here, and we estimate the number of lamps at 2,400.

This is a case where you have actually 2,400 lamps, and at the time of the demolition of the old buildings you had none at all?—Yes.

Taking St. John's Wood. This district covers about 480 acres?—Yes.

And the number of your consumers in that district at Dec. 31, 1901, was 517—Yes, rather more than one customer per acre.

You expect a large increase when this area of large houses and grounds becomes occupied with smaller houses with diminished grounds as London grows?—Yes.

And your concession goes on to 1931?—Yes.

You consider that during the whole of that period, having regard to the considerations you have referred to and the claims made, your business will continue to increase?—Yes, as there is a very large field only beginning to be developed, and a practically unlimited market. There are three main causes at work in connection with this development—the growing standard of lighting, which is an important factor; the greatly increased demand for building sites, which must in its turn increase the demand for houses and will lead to the construction of buildings of a loftier character; and basements being utilised to a greater extent than was possible when gas was the sole illuminant. These factors must greatly increase the number of the company's customers. As to the flats, we have selected 51 blocks of flats which have been built during the last nine years and have compared the amount of current supplied last year to these new buildings with the amount of current supplied to 227 old houses which stood on the sites of these 51 flats. These old houses took 171 units, the new flats took 242,272 units, and this was not the full extent of their probable requirements, as certain portions were unlet. The old houses pulled down were practically of no value to us, but the new houses are all potential customers.

So far you have dealt with electric lighting. You have hardly yet developed to any appreciable extent the use of electricity for motor or purposes other than lighting?—No, in Marylebone only 78,000 units were sold for driving motors and heating and cooking in 1901 out of a total supply of 4,617,244 units. In 1900 we supplied 43,000 units and in 1899 17,000. We have, in fact, discouraged consumers from using electricity for motor driving and have recommended them to wait till the change-over to continuous current has been completed. As soon as this work is completed and we can push the motor and heating business, a very great advance will be made. This class of business is in its infancy in London, and I hold that there will be a very large field in Marylebone in future years for this class of business.

As to the average charge for current during these years?—We have the right to charge 8d. per unit, with a minimum of 13s. 4d. per quarter, the rate being subject to revision by the Board of Trade every seven years at the instance either of the company, of the local authority or of the London County Council. At August, 1896, the first period when such revision could have been demanded, our actual average price was 6½d., and for municipal lighting other than street lighting 4d., for motor driving and heating 3d. or 4d.

Do you consider that with your business going on increasing you could maintain substantially your present charges?—Yes; the average price in 1901 was 5·24d.

I see by your estimates for the year 1931 you expect to sell 24,850,000 units for electric lighting and 7,950,000 for motor driving and heating—a total of 32,800,000 units—and the gross revenue is put at £519,762?—This is with a diminished charge per unit down to 4·38d., with the price for current for motors and heating at 2d., the average price ultimately falling to 3·80d. per unit.

With regard to these estimates we will take the figures for 1902. Compared with those for 1901, how do you make up these estimates?—Taking the last five years, the annual increase has ranged from 566,000 to 675,000. This was the figure for 1900, and the average increase of these five years was over 600,000 units. Taking the rate at which consumers are coming in, in 1902 we think it reasonable to expect we shall reach for lighting, 5,200,000, an increase of 661,513 over 1901. This is a percentage increase of 14·57. If you take the years 1897 to 1900 the annual lighting increase has grown from 560,000 to 649,000. 1901 was an exceptional year, as I have explained, and the number of increased units was only 541,000. The first four months of 1902 show a larger increase than at any previous similar period. Up to April 29 we added 13,097 lamps, compared with 26,982 for the whole of 1901, or for the period up to April 29, 1901, 6,969 lamps.

Leaving 1902 and going to 1906, you have a rate of annual increase rising by certain percentages. On what is that estimate based?—It is based upon what I have mentioned as the increased extent to which new customers are coming on, and upon the fact that building is very active in Marylebone, and that changes are taking place which will bring into useful connection with the company's mains houses that are at the present time of no value to us.

For 1906 and the next five years you keep the rate of increase stationary at 750,000 units?—Yes; we think that having reached 750,000 increase (having got to 650,000 in 1900) we may fairly average that as the maximum we can reasonably expect over a series of years.

Then after 1911 a slight decrease is shown in the annual accretions?—Yes; to the number of new houses there must be a limit. What that limit may be it is difficult to say. If we go on adding as we have during the last five years, we shall have doubled the number of houses connected to our mains in 10 years—that is to say, 46 per cent. of all the houses will have been connected, and the residue will be 54 per cent., compared with 80 per cent. at the present time. We think, therefore, it is reasonable, apart from any other cause, to assume that the addition of houses will not progress so rapidly after that time.

The second element is the increase in consumption per house?—Yes, and that, I think, will go on for the remainder of the term very much as it is going on now.

After 1911, the period we have just passed, you have an annual increase of 700,000 units for the years up to 1918?—Yes. I think a diminution will occur, and we have made this diminution down from 750,000 to 700,000 650,000 and 600,000. In arriving at these estimates we have put all our special knowledge into our calculations after making a very close study of the question. We have considered the increase of the gas companies during the last 30 years, when they have had to meet the competition of cheap mineral oils and to face electric lighting. They are still maintaining considerable increases, which last year reached 3¾ per cent., whereas our estimated increase has been put at only 2·47 per cent.

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The gas companies allege they have had a rough time?—Yes, and say with regard to the very class of house which is bringing us so much business that if they were to sell gas at 1s. per 1,000 cubic feet they could not keep the electric light out.

Now with regard to the rate of charge. Do you see any reason why you should not sustain that rate?—There is nothing unreasonable in that calculation.

Your figures show that in 1931 your gross revenue from the sale of electric current for lighting only will be £453,512?—Yes, our revenue has doubled itself two and three times in two, three and four years respectively. The next period of doubling would be between 1906 and 1907, and the fifth period would, according to our calculation, take place in 1920.

This gross revenue from the period 1891 to 1901 is the entire gross revenue, including motors and lighting?—Yes, the motor supply has hitherto been very small, and in 1901 the revenue was only £1,230.

The UMPIRE: In your estimate of 5·25d. per unit for 1902, does that take account of meter rents?—No; meter rents are not included in these tables. This price is for current solely. The 5·24d. is the average price for 1901, exclusive of meters, but taking into account the proportion of current supplied for motors and heating.

Mr. CRIPPS: Would you supply motor current at a lower price than for lighting? Could you supply us with the figures separately—that is, could you give, instead of 5·24d., what is the average price for lighting only?—It is 5·28d. after deducting £1,232 received from the supply of current for motors, although this is really too large an amount to deduct, as this motor supply is given to one consumer under contract at a low average price.

Taking the averages which are given in your estimates down to the year 1931, these represent not much more than half your allowed maximum?—Yes; and if you take both kinds of current—lighting and motor—it is less than half the maximum, the average being 3·80d. against 8d.

Now, with regard to power for motor-driving and heating, you look forward to having a substantial sale of current for these purposes, with a corresponding substantial income?—Certainly. We put the total for the present year at 100,000 units—an increase of 22,000 over 1901—and estimate that within the next two years, when the continuous-current system is introduced into the Marylebone district, that we may look for an increase in each of these two years of 100,000 units, and when that system is complete the company will be in a position to sell current for motor driving and heating to such an extent that we may look forward to an increase at the rate of 150,000 units a year for the next three years, and afterwards, for another period of three years, to a further increase of 200,000 units a year, until we get, in 1910, 1,350,000 as the total for the year.

Now, as to meter rental. How do you deal with those?—Down to 1897 the company charged rentals both for meters and for house tranformers. In 1898 the transformer charge was abolished. Meter rentals are set out in the estimates for four years, and show that, in addition to revenue from the sale of current, 3 per cent. more was received by the company in each year from meter rentals. We have a right in our provisional order to make these meter charges, but the consumer may put up his own meters. It is, however, the invariable custom of the company to supply the meter.

Then, what about the public lighting?—We have not dealt with any expectation in respect of street lighting in the future. So far as there is any public lighting it is included in our past figures. There a few lamps supplied by the company in Regent-street, the revenue from which is a negligible quantity.

(To be continued.)

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The directors of the Metropolitan Electric Supply Co. (Ltd.), 16, Stratford-place, London, W., invite applications for the position of chief engineer of the company. Applications to secretary, Mr. E. Cunliffe Owen. See advertisement.

Preston Corporation require a resident electrical engineer capable of designing and superintending the construction and working of electric tramways. An advertisement contains further particulars. Applications to the town clerk (Mr. H. Hamer), Town Hall, Preston, by noon Sept. 8.

Doncaster Electricity committee invite applications for the position of chief assistant electrical engineer. Applications to chairman of committee, Electricity Works, Grey Friars-road, Doncaster, by 16th inst. See advertisement.

An assistant mains engineer is required for the electricity department of Bristol Corporation. Applications to city electrical engineer (Mr. H. Faraday Proctor) by Sept. 16. See advertisement.

Maidenhead Corporation have vacancy for a pupil at their electricity works. Applications to resident electrical engineer (Mr. C. O. Milton), Guildhall, Maidenhead, by Sept. 20.

Rochdale Corporation have a vacancy for a shift engineer. Applications to borough electrical engineer by noon Sept. 8.

Sunderland Forge and Engineering Co. (Ltd.), Pallion, Sunderland, require a foreman armature winder. See advertisement.

An electrical assistant is required for a large factory in the South of England. See advertisement.

A working electrician is required to look after a continuous-current lighting and power plant, bells and signals. See advertisement.

Mr. R Coveney, formerly superintendent of the Cardiff electricity works, and recently in the service of the Isle of Thanet Electric Light and Traction Co., has been appointed manager and resident engineer of the Ashton-under-Lyne Corporation electric tramways.

Mr. R. Borlase Mathews, Wh.Ex., has been appointed teacher of magnetism and electricity and electrical engineering at the Great Eastern Railway Mechanics Institute, Stratford.

Mr. Fernie, assistant engineer at Worthing, has been appointed on the staff of the Edinburgh Corporation electricity department, and Mr. Broadhurst, of Watford, succeeds Mr. Fernie.

Mr. J. Keenan, of Bradford, has been appointed assistant engineer at Taunton Corporation electricity works.

Owing to the imminent transfer of the undertaking of the Woolwich District Electric Light Co. to the Woolwich Borough Council, Mr. T. M. Colson has resigned his position of resident engineer in order to become engineer and manager to the Hamilton Electricity Supply. Mr. H. Walker has been appointed successor to Mr. Colson at Woolwich.

EDUCATIONAL NOTICES.

Owens College, Manchester.—We have received a copy of the syllabus of courses on electro-chemistry and electro-metallurgy given at Owens College, Manchester, together with particulars of fees, &c. The director of the physical laboratories is Prof. Arthur Schuster, Ph.D., F.R.S., and the assistant lecturer and demonstrator on electro-chemistry is Mr. R. S. Hutton, M.Sc.

Technical Education.—The Associations of Technical Institutions, of which Prof. J. A. Wertheimer, B.Sc., is hon. secretary, has just published a set of interesting statistics in regard to technical high schools in the German Empire. These statistics show that these schools seldom contain students under 18 years of age. The figures are for the winter session 1901-2, and relate to the high schools of Aachen, Berlin, Darmstadt, Dresden, Hanover, Karlsruhe and Munich. In the civil engineering division the total number of students was 2,257, in mechanical and electrical engineering 5,503, in the chemical and metallurgical division 1,180. For purposes of comparison, figures are appended for the United Kingdom, and show for all branches of engineering 2,259, and for applied chemistry, including dyeing, metallurgy, &c., 667. In the figures for the seven German high schools in our list, the total number of students in attendance was 11,032, plus 283 foreign students at Karlsruhe, 1,775 non-matriculated students and 962 casual students, making a total of over 14,000 in the following subjects:—Agriculture, architecture, civil engineering, mechanical and electrical engineering, naval architecture and marine engineering, chemical and metallurgical, general knowledge and chemistry. The figures for the United Kingdom are for students 15 years old and upwards who took complete technological courses at all the chief universities, colleges, polytechnics, &c., in the kingdom where the following branches of technology are included:—Agriculture, brewing, building trades, bakery and confectionery, chemistry (applied), including dyeing, metallurgy, &c.; engineering, forestry, leather industries, mining, naval architecture, navigation, telegraphy and textile industries. The total number of these students is 3,873. In the German figures first, second, third and fourth-year students are given, as well as those who have attended for more than four years, and in the United Kingdom figures first, second and third-year students and those who have attended more than three full years. The statistics show most significantly how much larger is the number of students attending the German high schools compared with those attending the more or less similar educational establishments in the United Kingdom. The population of the German Empire is 56,345,014 and of the United Kingdom 41,454,621.

Airdrie.—Public electric lighting was inaugurated on Monday. The Council obtained a provisional order in 1898, which was transferred to the Scottish House-to-House Electricity Co. about 18 months ago. For public lighting 10 arcs and over 100 16 c.p. incandescents are employed.

Aberdeen.—The report of the city electrical engineer (Mr. J. A. Bell) on the past year's working of the electricity undertaking, states that the tramway department has become a larger consumer; 172 additional consumers have been connected during the year, 45 being private residences. The total number of consumers is now 950. 90 new motors, aggregating 353 H.P., have been added, 66 being hired from the Corporation. The total number of motors is 216, representing 838 H.P. Electrical heating has increased by the equivalent of 621 33-watt lamps, and 46 private arc lamps have been added, making the total 235. Public arc lamps, including harbour lighting, stand at 235. The total number of consumers on the mains for lighting, heating, cooking, motors, &c. (excluding traction), on July 31, was equivalent to 101,473 33-watt lamps.

Alnwick.—Electric current was supplied here for the first time on Thursday last by the Northern Counties Electricity Supply Co.

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Bridlington.—Application has been made for sanction to a loan of £25,000 for electricity works. A recent canvass has shown the Council that a number of tradesmen desire a supply of electric current.

Burnley.—On Wednesday a proposal to expend £4,500 on extensions of the electricity generating plant was referred back by the Corporation.

Bury (Lancs.).—The Council decided yesterday to serve notice on the Bury, Rochdale and Oldham Tramway Co. to sell so much of its undertaking as lies within the borough area.

Cannock.—A committee has been formed to visit electricity works in Great Britain with a view to preparing an electric lighting and refuse destructor scheme for this district.

Cheltenham.—The Council is seeking authority to apply for a provisional order to extend the area of electricity supply to Leckhampton, Swindon, Prestbury, Southam, Brockhampton and Woodmancote.

Mr. Lawrence has given notice of the following motion :—

That a statement as to the financial position of the electric lighting undertaking of the Corporation be forthwith prepared, showing (1) the amount of money expended on capital account to March 31, 1902 ; (2) the profit or loss on revenue account for the past year, before and after paying interest on loans and the amounts set aside for sinking fund ; (3) the amount of accumulated deficiency or accumulated profit for the seven years, 1896 to 1902.

Chile.—There is neither electric nor gas lighting in the town of Talcahuano, except some isolated electric lighting plants, owned chiefly by the Government, for lighting the docks and buildings. The British Vice-Consul considers there is an opening for British enterprise here. The town has a population of 18,000.

Traiguen, a neighbouring town to Talcahuano, is lighted electrically by plant installed by a German firm. There is also in this town a private electric railway running from a large mill to the Government railway. Installations of electric lighting and tramways on a small scale is a feature of the somewhat slow development in this part of the world.

Compulsory Arbitration.—At the sitting of the Trades Union Congress yesterday (Thursday) a motion in favour of compulsory arbitration in labour disputes was rejected by 961,000 votes to 303,000.

Coventry.—Sanction to loans of £19,411 for additional generating plant and extensions of mains, and of £1,000 for the provision of electric motors to be let out on hire, have been received by the Council.

Crewe.—The Council has decided to obtain a report from an electrical engineer on the various electric tramway schemes which have come before the Council for sanction.

Croydon.—The Corporation propose to lease to the British Electric Traction Co. or their approved nominees the tramways from the Red Deer to Purley, from Thornton Heath Pond to Norbury, and the line along Station-road and Wellesley-road for 18 years and seven months from June 1, 1902. The lessees pay as yearly rental 6½ per cent. on the cost of construction and electrical equipment, rolling stock and other works carried out and expenditure incurred by the Corporation, and £100 per mile per annum for the maintenance of the routes ; also, by way of further rent, an annual sum equal to interest at the rate of 6½ per cent. upon moneys expended by the Corporation, with the consent of the lessees, on the construction, improvement or alteration of any works connected with the tramways. The company will purchase from the Corporation, during the term of the lease, all electrical energy required for working the lines at 2d. per unit.

Dewsbury.—Friction has arisen between the Corporation and the British Electric Traction Co. as to the manner in which the latter are constructing their tramways in the district, and an appeal has been made by the Corporation to the Board of Trade.

Douglas (Isle of Man).—Mr. O. R. Edmondson sends us a brief description of the journey taken by their Gracious Majesties the King and Queen on the electric tramways at Douglas. Their Majesties were accompanied by Princess Victoria and the Portuguese Ambassador, and travelled by saloon car over the lines of the Isle of Man Electric Tramways and Power Co. from Douglas to Ramsey, a distance of 18 miles, in one hour. The car was in charge of, and was driven by, Mr. Frank Edmondson, the company's chief engineer. Mr. Edmondson claims that this is the first occasion on which His Majesty has made use of the electric tramway as a means of locomotion.

Dover.—In consequence of the acquisition of the undertaking of the Dover Electricity Co., the engineer (Mr. Woodman) and the secretary (Mr. Beeton) have been requested to attend future meetings of the Council.

East Ham.—An electric tramway extension from the Beckton railway crossing to the "Ferndale" was opened for traffic last week.

Exeter.—Sanction to a loan of £66,478 for the erection of new electricity works has been obtained by the Council. In granting the loan the Local Government Board have struck out £1,400 in respect of a debt on the old works. The accepted tender for the erection of the new station amounts to £14,000, and the tender for plant and general equipment, £29,707. Other items include extension of mains, £9,000 ; main feeders, £3,500 ; sub-stations, switchgear, &c, £1,000 ; transformers, £1,138 ; meters, £1,800 ; mechanical stokers and accessories, £1,400 ; feeding pump and weighbridge, £1,200 ; contingencies, £2,000. The Council have confirmed the provisional acceptance of the tender of the British Westinghouse Co. for the plant and equipment of the station at £29,707.

Foots Cray and Sidcup.—The Council are considering the question of adopting electric lighting, and negotiations are proceeding with the Bexley District and Woolwich Borough Councils in regard to supply of electricity in bulk.

Glasgow.—The Tramways committee propose to pay their consulting engineer (Mr. H. F. Parshall) £250 for two visits made to America to expedite the completion of electrical machinery and engines for the Pinkston power station and for other extra work, and also £250 in respect of his keeping, at the request of the general manager, a second resident engineer in Glasgow for 12 months, which was not provided for in the agreement with Mr. Parshall. The general manager (Mr. Young) has reported that the great majority of the cars have been provided with the Tidswell guards, and others are being fitted up.

Prof. A. Barr reports that he has tested the two Musgrave engines in the Pinkston power station, and finds that they fulfil all the conditions of the contract.

Halifax.—The Tramways committee recommend extensions of the tramways from Stump Cross to Hipperholme and from Salterhebble to Greetland.

Hawick.—A company is promoting a scheme for the construction of electric tramways here, and at the last Council meeting it was decided, on the motion of Provost Mitchell, to grant wayleaves on terms to be agreed.

Holyhead.—The Council have purchased a site for electricity works at £3,000. An electric lighting scheme prepared by Mr. Pryce White (estimated to entail an expenditure of about £16,000) is under consideration.

Lanchester.—The Rural Council have decided to adopt electric lighting, provided arrangements can be made with the Hamsteels Colliery Co. for a supply of current. The company is already supplying current to Quebec, a neighbouring district.

Leeds.—The Council are recommended to extend the electric tramway from Oldfield-lane into Lower Wortley.

Lewes.—The Council have postponed consideration of the tender for extensions of the electric lighting until their next meeting. The estimate, which includes 12 arcs at £13 per annum, amounts to £223. 10s.

Light Railways.—The Board of Trade have, after modification, confirmed the Wakefield and District Light Railways (Extension); the South Norfolk Light Railway (Extension of Time), and the Spen Valley and Morley Light Railways (Extensions) orders.

Long Eaton.—The Council have made arrangements with the West End Mill Co. for the supply of electric current for public lighting.

Mica Deposits.—It is reported that important deposits of mica have recently been discovered in French Guinea. Samples can be seen at 63, Boulevard des Dames, Marseilles, and inquiries regarding the working of these deposits must be made to M. Famechon, Conakry, French Guinea.

Monmouth.—Extensions of the electric light mains to afford a supply of current to the borough court and jury room are being made.

Municipal Telephony.—Worcester General Purposes committee on Tuesday sought authority to engage Mr. A. R. Bennett, at a fee of 30 guineas, to prepare a report on the question of establishing a municipal telephone service. A long discussion took place, and an amendment was moved to refer the matter back for further consideration. Ultimately both amendment and resolution were rejected by large majorities.

Rotherham Council were recommended by a committee on Wednesday to support the application of Sheffield Corporation for a licence to establish a municipal exchange for the Sheffield area, but an amendment referring the matter to the Parliamentary committee was adopted. Ald. Gummer thought it of no use "jumping out of one monopoly into another," and they ought to have fuller information in regard to the proposals of Sheffield.

Mutford and Lothingland.—Messrs. Barber and Croft are applying for an order to supply electricity in this district. No objection will be raised by the Council.

Northampton.—The Council, having failed to come to terms with the Northampton Electric Light and Power Co. for the purchase of its undertaking, has decided to apply for a provisional order for establishing electricity supply. The company offered to give a supply for the Council's tramway at 1¼d. per unit.

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Norwich.—The Council on Tuesday authorised the expenditure of £7,363 for the extensions of the electricity undertaking set out in our last issue.

Patent Amendment.—Notice is given in an advertisement that Mr. W. M. Brown, of 240, Locust-street, Johnstown, County of Cambria, Pennsylvania, U.S.A., seeks leave to amend specification of letters patent No. 9,786 (1902) for "Improvements in electric switches and in the application of same to electrically propelled vehicles." Particulars of the proposed amendment are given in the *Illustrated Official Journal* (Patents) of Aug. 27, and notice to oppose must be given within one calendar month from that date.

Perth.—The Council have decided to proceed to arbitration on the question of the purchase of the local tramways.

Railway Station Lighting.—The North-Eastern Railway Co. have adopted electric lighting at their station and mineral sidings at Kirkby Stephen. The water power of the river Eden is utilised in the generation of current. The contract for the supply and erection of plant was placed with Messrs. Gilbert Gilkes & Co, of Kendal.

Reigate.—Application for a loan of £3,500 for cable extensions has been made.

Ross.—The local electric light company is about to quote terms for a supply of electric current for public lighting.

Sicily.—In a report on the trade of Sicily for the year 1901 Mr. Consul Churchill states that the use of electrical machinery in the sulphur mines of the Catania district is increasing, and there has recently been erected at the Trabonella mine, the largest on the island, a 120 H.P. gas-engine plant with equivalent Dowson gas-producing apparatus. The installation includes four 110 H.P. dynamos for generating current for winding, surface haulage, a number of 20 H.P. pumps, electric lighting, both surface and underground, and for a mill which grinds macaroni, &c., for food for the workpeople, ensuring economy and cleanliness in manufacture and preparation.

The operations in the Catania district of the Helios Co. have been suspended, owing to the prevailing financial depression in Germany. The company had already completed about 3 miles of line, and some £20,000 caution-money is involved in these operations. The work is being carried out for the municipal authorities of Catania.

Slough.—The Slough and Datchet Electric Supply Co. (Ltd.) was recently formed to supply electric current in Slough and Datchet. Negotiations are in progress for the acquisition of a site for the station, and orders for generating plant, &c., have been placed. Current will probably be available during the coming winter. The Windsor Installation Co are interested in the new company.

Smoke Nuisance.—At the South-Western Police Court (London) on Wednesday, Battersea Borough Council appeared to a summons (issued by the Council) for allowing black smoke to issue from the chimney of the municipal electricity works. The solicitor (Mr. P. Caudwell) created amusement by saying that he appeared for the complainants and the defendants. The magistrate ultimately made the usual prohibition order on a first offence.

South Africa.—The *British and South African Export Gazette*, in a trade report for the past month, states that two Natal municipalities have entered the market for tramway material and rolling stock. The boom in motor cars at Cape Town, Bloemfontein and Johannesburg is responsible for much business in hand and in course of registration. Valuable contracts for pipes and tubes continue to be received on account of municipal and mining corporations. The call for mining machinery, stamp batteries and general equipment is steady and improving, but shipments to Cape Colony and Natal of electrical goods have been much below previous forwardings. The enlargement in the consignments of telegraph material is due mainly to Government requirements for the Orange River Colony.

Durban Municipal Council propose to establish a telephone exchange, at an estimated cost of £80,000, and tenders are to be invited.

The equipment of the new *Natal* Government railways machine shops at Durban is being supplied by the South African General Electric Co. It includes 119 electric motors, varying from 15 H.P. to ⅛ H.P., and six 300 I.H.P. steam dynamos, three electric cranes, six electric capstans, &c. At the Maritzburg machine shops a three phase plant for lighting and power is being erected.

Tenders for plant for a new electricity station at *Durban*, entailing an expenditure of £25,000, are to be invited.

At a recent meeting of the *Durban* Council objection was made to the acceptance of the tender of Messrs. Macartney, McElroy & Co. for additional tramcars at £10,000, on the ground that a British firm actually manufacturing cars should be given the preference. The mayor explained that the motors would be of British make, but the car bodies would have to be procured from America, as they were urgently wanted.

Maritzburg Council will shortly invite tenders for tramway rolling stock, motors, &c.

Pretoria Council are considering the question of the construction of electric tramways, but in the meantime the Pretoria Tramway Co. has applied for leave to resume its horse-drawn service.

The various improvement works projected by the *Johannesburg* Council will involve an expenditure of about £6,000,000. Electric tramways and extensions of the electric lighting system are among the schemes under consideration.

Tenders are being invited for the erection of electricity supply works at *Ladysmith*.

In connection with the new harbour works at *Cape Town* the engineer's proposals include electric lighting and the provision of electric cranes.

The erection of electric power plant at the Sabiwa Central gold mine, *Rhodesia*, is under consideration.

Southwark (London).—The Borough Council have been notified by the London Electric Supply Corporation of intention to lay high and low-tension mains in some thoroughfares in the district, and to construct underground converter chambers and inspection boxes of the usual pattern; and also by the County of London Co. of intention to lay conduits along the north side of St. George's-road.

Swansea.—The Tramways committee, which has been for some time investigating the merits of the various systems of electric traction, now recommends that the extensions of the electric lines in the district be made on the Kingsland mechanical surface contact system. The length of the proposed extensions is about 3½ miles of double track.

The Telegraph in German East Africa.—The German Imperial Chancellor (Count von Bülow) has replied to the German Colonial Society's application for an extension of the telegraph system in the Cameroons that, though the Government recognises the importance of establishing an extended network of telegraph or telephone lines, the obstacles in the way of speedy action being taken in that direction lie in the financial dependence of the protectorate, whilst there was no justification for the allocation of moneys to that purpose out of proportion to the undeveloped economic position of the colony. He further pointed out that the telephone line between Victoria and Buea had been completed, and the work of establishing a telegraph line between Duala and Buea had been commenced. The colonial estimates for 1903 will include a proposal for connecting Duala and E'deg by telegraph.

Tramway Bye-laws.—Leeds Council are reported to have sanctioned some new bye-laws which give permission to conductors of the municipal tramcars to allow an excess of passengers on tramcars on wet days and holidays, the conductor to be the judge of the weather outlook, but on holidays to have no option but to admit eight extra passengers if they can be squeezed in. The statement we give above has gone the round of the public journals, and no question has been raised as to the power of the Leeds Council to encourage any such overcrowding. The question arises whether, bye-law or no bye-law, a person in charge of a licensed vehicle will be allowed to carry an excess number of passengers.

Underground Telegraph Wires.—In a communication to the Hull Chamber of Commerce, the Postmaster-General states that the underground telegraph system from London to the North is being extended to Warrington, where it will join the existing underground line between Manchester and Liverpool. Next year the line may be continued, not only northwards towards Scotland, but also eastwards towards Leeds and Bradford.

Wallasey.—Application has been made for a further loan of £52,350 for extensions of the electricity works to meet probable requirements to 1910. The loan includes £1,140 for additional land, £4,500 for engine house and £4,000 for boiler house, £500 for offices, £2,000 for chimney, &c., £3,750 for five boilers and seatings, £1,000 for economiser, £1,500 for two condensers, £18,000 for three 500kw. direct-current generators, £3,000 for fuel stores and elevators, £3,500 for transformers, switch-gear and sub-stations, and £5,600 for 7 miles of cable.

Wolstanton.—The Board of Trade has informed the Council that, as at present advised, it is not prepared to require the Potteries Electric Traction Co. to so employ speed indicators that they shall be visible to persons inside the cars.

Worcester.—The Worcester Tramways (Ltd.), who are converting the city tramways to electric traction, have applied for an extension of time beyond Dec. 1, when they are bound to take electric current from the Corporation mains, as owing to the rejection by the Council of the scheme for double lines in the centre of the city, unavoidable delay had been caused, and new plans had had to be prepared. The Tramways committee, in view of the fact that as far back as April they urged the company to complete their work by July, and that the new generating station would be completed in time to supply the current, urged the Council to refuse the extension, and this suggestion was adopted.

Workhouse Lighting.—The Newcastle-on-Tyne Guardians, who are re-modelling their establishment, have decided to adopt electric lighting, at a cost of £1,500.

Darlington Guardians are also considering a proposal to light their workhouse electrically.

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Worthing.—The Council have engaged Messrs. Burstall and Monkhouse to prepare plans, &c., in connection with their proposed light railway scheme, at a fee of 125 guineas. The question of obtaining powers for extending the electric lighting mains to the parishes about to be included in the borough is under consideration by the Electric Light committee.

Annual Outing.—On Saturday the staff and employés of the Sir Hiram Maxim Electrical and Engineering Co. had their annual outing at Margate. The company dined at the Arcadian Hotel, Sir Hiram Maxim presiding, supported by the works manager (Mr. A. W. Hill) and the members of the staff. Mr. Hill proposed the toast "Success to the Company," and Sir Hiram, in replying, said that the company, with others, were feeling the unfair foreign competition, and it would need the united efforts of all branches of the company to work together with a view to keeping costs as low as possible. Their business was growing larger every day.

Presentation.—Last week a marble clock and a pair of bronze statuettes were presented by the staff of the Weston-super-Mare and District Electric Supply Co. to Mr. S. G. Leech, engineer and manager, on the occasion of his marriage.

Marriage.—Mr. T. J. Ballard, mains department superintendent, Sheffield electricity works, was married on Aug. 27, to Miss Agnes Thompson, eldest daughter of Mr. J. T. Thompson, South-street, Sheffield Moor.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Reading Corporation invite tenders for the supply, delivery, drawing in and connecting up of all feeder cables, rail return cables, test wires, &c., with joint boxes and jointing, and the carrying out of tests; also the supply, delivery, erection and connecting up of all poles, brackets, wires, cables, insulators, switch-boxes and other fittings, and the carrying out of tests, for their electric tramways department. Specifications, &c., from the engineers (Messrs. J. Bowen and I. E. Winslow), Town Hall, Reading, and specifications and drawings may be seen at, but not obtained from, the office of Mr. I. E. Winslow, 35, Parliament-street, Westminster, S.W. Tenders to chairman of Tramways committee by noon, Sept. 18. An advertisement contains further particulars.

Swindon Corporation invite tenders for the supply, delivery and erection of one complete lighting switchboard, with all instruments and accessories. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester, and may be obtained from the former office only. An advertisement contains further particulars. Tenders to the town clerk (Mr. Robert Hilton) by Sept. 19.

Bristol Electrical committee invite tenders for two 750kw. single-phase steam alternators. Specifications from the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol, to whom tenders by noon Sept. 16. See advertisement.

Bristol Guardians invite tenders for supply of boilers, heating apparatus, laundry and kitchen machinery and general engineering plant and for electric wiring and fittings, &c., for their new infirmary at Stapleton. Tenders to clerk by noon Sept. 10.

Burton-on-Trent Corporation invite tenders for the supply and laying of electric mains, conduits, junction boxes, &c. Specifications, &c., may be inspected at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, or at the borough engineer's office, Town Hall, Burton-on-Trent, from either of whom copies, with forms of tender, may be obtained. An advertisement contains further particulars. Tenders to town clerk, Town Hall, before noon Sept. 30.

Dundee Gas Commissioners invite tenders for the supply and erection of water-tube boilers, with mechanical stokers and superheaters and induced draught apparatus. Further particulars are given in an advertisement. Specifications, &c., from the city electrical engineer, Mr. Walter H. Tittensor, and tenders to the clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by Sept. 24.

Dundee Gas Commissioners also invite tenders for the supply of carbons for public lamps. Specifications from city electrical engineer (Mr. Walter H. Tittensor), and tenders to Sir Thomas Thornton, LL.D., by Sept. 24. See advertisement.

The managers of the *West London School District* invite tenders for the electric lighting, &c., of their schools at Ashford, Middlesex. Further particulars are given in an advertisement. Specifications, &c., may be inspected at the office of the consulting engineer (Mr. T. J. Digby), 32, Shaftesbury-avenue, W., or at the schools. Tenders, addressed to the managers at the schools, Ashford, by 6 p.m. 25th inst.

The Directors of the *Commercial Gas Co.* invite tenders by 17th inst. for the present stock and for the production of retort carbon for 12 months from Sept. 30. Some further particulars will be found in an advertisement.

By command of the *Postmaster-General* tenders will be received until 10 a.m. of Sept. 29 for the supply of Swedish, Norwegian or Finland red fir telegraph poles, and for creosoting same. Forms of tender and particulars of Mr. S. C. Hooley, controller of stores, G.P.O., London, E.C.

Aston Manor Urban District Council invite tenders for steel coal bunkers and a coal conveyor for their electricity generating station. Tenders to chairman of Electric Lighting and Tramways committee by noon Sept. 19.

The directors of the *North-Eastern Railway Co.* invite tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle on-Tyne. Tenders to secretary, York, by noon Oct. 7.

King's Norton and Northfield Urban District Council are prepared to lease their powers under their electric lighting order of 1898. Offers to Mr. E. Docker, 10, Newhall-street, Birmingham, by Sept. 18.

Bedford Electricity committee invite tenders for the supply and delivery of two boiler feed pumps. Tenders to chairman by Sept. 15.

Southampton Corporation invite tenders for electrical plant for street alarms, steam fire engine, &c. Tenders by 24th inst.

Bury Tramways committee invite tenders for construction of permanent way of four tramway routes. Tenders by Sept. 24.

St. Petersburg (Russia) Town Council require tenders for the reconstruction of the existing three horse-drawn tramways in the city to electric traction, and for the construction and equipment of an electric power station. Conditions of tender, &c., can be obtained (by post or telegraph) from the Stadt-Amt., St. Petersburg, where projects have to be lodged and tenders sent by the 1st (14th) Nov.

Tenders are called for by the *Spanish* postal telegraph authorities, Madrid, for the construction, laying and maintenance of a submarine telegraph cable between Santa Isabel de Fernando Po and Kings Belltown, in the Cameroons, the length of the cable being 71 nauts. Tenders to the Director-General of Posts and Telegraphs, Madrid, by Sept. 29.

The Minister of the Interior, *Madrid* (representing the Director-General of Postal Telegraphs), is authorised to purchase, without formality of tender, 17,000 telegraph posts, 12,500 7 metres in length, 3,500 8 metres and 1,000 9 metres, at prices fixed for the last supplies of the goods. Particulars are given in the Madrid *Gazette* for Aug. 19.

We recently gave particulars of 30,000 porcelain telegraph insulators required by the *Spanish* Department of Posts and Telegraphs, Madrid. Under the same conditions a further quantity of 30,000 porcelain telegraph insulators are now required. Tenders by Sept. 10. The conditions, which are the same as for the former supply, are published in the *Madrid Gazette*, in which all particulars relating to Spanish Government tenders will be found. Any copy of the *Gazette* can be seen, by appointment only, at *The Electrician* offices.

TENDERS RECEIVED AND ACCEPTED.

Wolverhampton Guardians have accepted the tender of Messrs. G. H. Woods & Co., Blackburn, for the supply and erection of electricity generating plant, and for wiring, supplying fittings, &c., for the electric lighting of the new workhouse at New Cross at £6,802. The contractors will instal Belliss engines, E.C.C. dynamos, Chloride accumulators and Callender mains.

Messrs. Willans and Robinson (Ltd.), Rugby, have recently received the following orders:—

For a 600 H.P. engine for driving a traction generator of the Lancashire Dynamo and Motor Co. at Wrexham.

Two 380 H.P. engines for direct coupling to dynamos of the Cie Internationale d'Electricité for the Liège City electric tramways.

Warrington Corporation have accepted the tender of Messrs. G. F. Milnes & Co. for a set of car-lifting jacks, an armature-removing bogie, and two 12-ton travelling jacks for £60, and that of the St. Helens Cable Co. for cables at £276. 4s. 6d.

Eastbourne Council have accepted the tender of Messrs. Manlove, Alliott & Co. for the supply and erection of a six-cell refuse destructor and three boilers at £3,892.

The following contracts have recently been placed with Messrs. Belliss and Morcom (Ltd.), Ledsam-street Works, Birmingham:—

One 400 H.P. steam engine coupled direct to a British Westinghouse dynamo, for Farnworth.

A 200 H.P. engine coupled to a Dick-Kerr generator, for Epsom.

Four 145 H.P. engines coupled direct to British Westinghouse generators, for Stretford.

Two 300 H.P. triple expansion engines for coupling to Crompton dynamos, for Bloemfontein, South Africa.

Dover Town Council have accepted the tender of the British Insulated Wire Co. for cable extensions to the Admiralty Pier.

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Worthing Corporation have accepted the tender of Messrs. R. W. Blackwell & Co. for steam and exhaust pipes, condensing plant, &c., at £438.

The tender of Messrs. Rowland Carr & Co., 6 and 8, Lime-street-square, London, E.C., has been accepted for the supply of 1½ miles of cast-iron troughing by the Maidstone electricity department.

BUSINESS NOTICES.

Messrs. R. Waygood & Co. (Ltd.) have acquired the business of the Otis Elevator Co. (Ltd.), and in future will trade as Waygood and Otis (Ltd.) Although their various productions will be manufactured in this country, an arrangement has been made with the Otis Elevator Co. (U.S.A.) whereby they acquire the exclusive licence and use of all their patents, patterns and designs. The company's principal works, head office and city offices will remain as at present.

Dr. Heinrich Traun, trading as the Harburg India Rubber Comb Co., Hamburg and Harburg-o./E., has taken his sons, Mr. Heinrich Otto and Dr. Friedrich Adolph Traun, into partnership, and business will be carried on under the style of Vulcanite Works, Dr. Heinr. Traun & Sons, formerly Harburg India Rubber Comb Co. The British agent is Mr. F. Winter, 8, Redcross-street, London, E.C.

The South-Western Electrical Contracting and Maintenance Co. are removing to 2, Fulham Palace-road, S.W., and Mr. John Carnaby has been taken into partnership by the company.

LIQUIDATIONS.

At meetings of creditors and shareholders of the Sensitised Paper Mfg. Co. (Ltd.) on Monday, the O.R. (Mr. Winearls) reported that the company was registered on June 19, 1900, to acquire from the Electrical Inkless Printing Syndicate (Ltd.) the exclusive licence for England and Wales to use an invention for the manufacture of a special paper for printing purposes called sensitised paper, on which printing could be done without ink upon the application of an electric current. The nominal capital of the company was £100,000 in £1 shares, but only seven shares had been allotted. The company which was to acquire the licence for £8,000 in cash and £60,000 in fully-paid shares never commenced business, and the purchase agreement was never carried out. No steps were taken to obtain working capital, and, beyond the purchase of machinery, nothing was done towards the manufacture of paper. The statement of affairs showed unsecured liabilities £916, the only asset consisting of unpaid calls, the value of which was uncertain. No quorum was present at either of the meetings, which were, accordingly, adjourned for a week.

The Mangano Electric Process (Ltd.) is to be wound up voluntarily. Mr. H. C. Emery, 15, George-street, London, E.C., is liquidator.

The Metropolitan District Electric Traction Co. (Ltd.) is to be wound up voluntarily. Mr. W. E. Mandelick, 16, Hamilton House, London, E.C., has been appointed liquidator. Claims by Sept. 30.

A meeting of the Coley Electric Works (Ltd.) will be held on Sept. 30 at 4, King-street, London, E.C., to receive an account of the winding up.

A meeting of creditors in the liquidation of the Electric Lamp Regenerating Co. (Ltd.) will be held at Carey-street, London, W.C., on 19th inst. at 11:30. Contributories will meet at noon.

Plant for Sale.—Mr. Thomas Johnson, Prescott-street, Wigan, has for sale three electric generating sets, each set giving 400 to 600 H.P. See advertisement.

Two complete Parsons steam turbine generating sets are for sale. Particulars from Mr. F. Stobart, Lambton Office, Fence Houses, Co. Durham. See also advertisement.

Messrs. Whittaker Bros. (Ltd.), Dudley, have for sale a 16kw. compound-wound dynamo (230 volts) and a watt-hour meter. See advertisement.

Messrs. Carr Bros., Darlington, have for sale a 150kw. alternating current three-phase B.T.-H. dynamo; a 60kw. three-phase motor and two spare armatures; also three nearly new Babcock and Wilcox water-tube boilers. Further particulars in advertisements.

Tractors for Military Purposes.—The War Office competition for tractors for military purposes, which was announced for the spring of 1903, will be postponed until October, 1903. Intending competitors should apply on Oct. 1 for forms of entry for the competition to the Secretary, Mechanical Transport, War Office, Horse Guards, Whitehall, S.W., which should be returned by Jan. 1, 1903. See advertisement.

Catalogues, &c.—The Société d'Applications Industrielles, of 20, Rue Lafayette, Paris, are issuing an attractive pamphlet describing the distribution of electrical energy in the department of the Aude at 20,000 volts. The pamphlet contains a map of the district and of the different works and other undertakings which the Société are supplying with current from their large generating works at Fabrezan, St. George's, Narbonne and Carcassonne. The situations of these stations are very picturesque, and are well shown in some excellent photographs which are included in the pamphlet.

Desrumaux's Automatic Water Softener and Purifier (Ltd.) have ready a pamphlet very fully describing the Desrumaux patent system of water softening and purification. Some large installations of this apparatus have been put down by the Desrumaux Company, and illustrations of some of these are included in the pamphlet.

Dealing briefly with the merits of the Stirling boiler and describing the different types and sizes of this apparatus, a catalogue reaches us from the Stirling Boiler Co., 25, Victoria-street, Westminster, S.W. The text of this particular pamphlet relates chiefly to the use of these boilers in sugar refineries, but the particulars given of the boilers are of general interest. Some excellent illustrations are included.

The "Emitevas" Electrical Fittings Co., 31, Brooke-street, London, E.C., has a sheet circular ready directing attention to a special class of electrical fittings.

Arc Lamp Gear.—The Gilbert Arc Lamp Co. inform us that they have brought out this year a new arc lamp raising gear, which has been adopted in many towns; a special design of automatic cutout for arc lamps; and a new automatic switch for switching on and off incandescent lamps on arc lamp posts by means of the arc lamp circuit.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Aug. 27 to Sept. 2, with the ports of destination:—

Africa—Cape Town, £216; Durban, £263; East London, £50. *Argentina*—Buenos Ayres, £595 (including £206 telegraph material). *Australasia*—Fremantle, £34; Melbourne, £193 (telegraph wire); Perth, £65; Sydney, £225. *British Guiana*—Demerara, £160 (telegraph cable). *Ceylon*—Colombo, £205. *China*—Shanghai, £159. *Holland*—Amsterdam, £117. *Hong Kong*, £16. *India*—Bombay, £75; Calcutta, £325; Madras, £16. *Japan*—Nagasaki, £212. *Portugal*—Lisbon, £35. *Russia*—St. Petersburg, £320 (telegraph material). *Spain*—Malaga, £74. *Straits Settlements*—Singapore, £58. Total £3,414, against £298,013 in the corresponding week last year (Aug. 23 to Sept. 3).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 17, 1902.

15,926. T. McIntyre. Edinburgh. Detachable link chain for electric light fittings.
15,935. J. H. Sadler. Newcastle-on-Tyne. Life-guard.
15,944. Tangye Tool and Electric Co. and A. H. Bate. Brushes.
15,949. S. Jevons. Birmingham. Brushes.
15,952. W. S. Andrews. Electric motor control. (Date applied for, July 25, 1901, date of application in U.S.)*
15,953. R. H. Read. Controllers for electric motors. (Date applied for, July 26, 1901, date of application in U.S.)*
15,954. C. D. Haskins. Electric switches. (Date applied for, July 27, 1901, date of application in U.S.)*
15,955. E. M. Hewlett and T. E. Button. Electrically operated switches for circuit-breakers. (Date applied for, Jan. 7, 1902, date of application in U.S.)*
15,956. R. Fleming. Electric indicating instruments. (Date applied for, Nov. 21, 1901, date of application in U.S.)*
15,963. C. Vellino. Lead plates for secondary batteries.
15,977. J. Bush and M. T. Medway. Electric lifts.

July 18, 1902.

15,981. E. M. Munro and H. J. Rogers. Bristol. Mechanical rail scrapers.
16,014. C. V. Drysdale. New Barnet. Wattmeter.
16,015. E. L. Thorp. Electrolysing apparatus.
16,041. A. C. Reyrolle. Electrical resistances.
16,042. A. C. Reyrolle. Electric switches.
16,048. H. Leitner and R. N. Lucas. Dynamo-electric machinery.
16,062 and 16,064. H. H. Lake. Electric railways. (General Electric Co., U.S.)
16,063. H. H. Lake. Third-rail contact shoes for electric railways. (General Electric Co., U.S.)

July 19, 1902.

16,072. W. J. Rollo. Glasgow. Electric motors for ceiling fans. (P. S. Swan, India.)

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16,092. E. HUGHES and M. READ. Manchester. Life-guard for electric tramcars.
16,117. R. B. RANSFORD. Attaching pole pieces to castings of dynamos. (Deutsche Elektrizitäts Werke zu Aachen, Garbe, Lahmeyer & Co., A.-G., Germany.)*
16,121. B. TYCHONISKI and K. DOLLINGER. Telegraphing and telephoning on non-isolated submarine lines.
16,130. A. SIMS. Electric furnaces.

July 21, 1902.

16,142. J. EDMONDSON, W. A. PURDON, J. W. DAWSON and EDMONDSON AND PURDON. Halifax. Apparatus indicating current has reached a pre determined amount, and for closing switch.
16,143. A. WHITE. Sunderland. Suspending electric light pendants.
16,154. I. V. ZEALANDER and W. WILSON. Manchester. Cable and trolley wire hangers.
16,160. T. CHALMERS. Manchester. Lampholders.
16,165. W. N. STEWART. Electric fire-extinguishing apparatus.
16,178. J. W. KIRK. Applying and removing incandescent lamps.
16,191. W. J. HARE and J. P. HARE. Electric train signals.*
16,205. A. HEYLAND. Dynamo-electric machines.
16,232. A. N. THORIN. Regulating devices for arc lamps.*

July 22, 1902.

16,264. C. M. DORMAN, R. A. SMITH and H. G. BAGGS. Salford. Switches and cutouts.*
16,270. A. GOLDSMITH. Electric facia sign.
16,293. H. H. LAKE. Switches. (G. E. Co., U.S.)*
16,294. H. H. LAKE. Electromagnetic switches. (G. E. Co., U.S.)*
16,319. G. C. MARKS. Adjusting lamp cords. (Crescent Novelty Co., U.S.)*
16,323. J. A. BAUER. Electric heating and cooking apparatus.
16,325. J. DAVIDSON. Liverpool. Dynamos.
16,332. J. G. W. ALDRIDGE. Collectors for electric railways and tramways on the overhead conductor system.
16,340. W. S. BURNETT. Electrical selecting instruments.*
16,341. H. VIERTEL and GEBR. SIEMENS & Co. Prevention of formation of deleterious vapours by electric discharges in air.

July 23, 1902.

16,354. H. DANZER. Manchester. Accumulators.
16,358. L. GURWITSCH. Manchester. Electrolytic processes.
16,391. G. WEISSMANN. Incandescent lamps, and to circuits and conductors therefor, for decorative and other purposes.
16,394. G. L. ADDENBROOKE and L. ROBINSON & Co. Adjustable resistances and the method of using same.*
16,402. H. SHOEMAKER. Wireless telegraph systems.*
16,406. G. E. HEYL-DIA. Liverpool. Waterproofing covered or insulated wires and in apparatus therefor.

July 24, 1902.

16,419. A. J. DAVIDSON. Crossgar. Electrically changing weaving shuttles before weft has become exhausted.
16,449. J. T. ARMSTRONG and A. ORLING. Electric communication between distant stations.
16,485. E. GAUD. Carbon-brush holder for dynamos.
16,488. A. VANDAM and T. H. MARSH. A quick make-and-break snap-off tumbler switch.
16,489. H. SEFTON-JONES (W. P. Thompson & Co.). Electric motors for automobiles. (E. Cantono, Italy.)
16,492. H. LEITNER and R. N. LUCAS. Cutouts and regulators.
16,495. J. E. BOUSFIELD (G. F. Redfern & Co.). Automatic electric chain-welding machine. ("Union" A.G., Switzerland.)*

July 25, 1902.

16,521. P. DEWHIRST. Liverpool. Electric lift controller.
16,529. M. I. PUPIN. Reducing attenuation of electrical waves. (Date applied for, Dec. 14, 1901, date of application in U.S.)*
16,550. S. P. THOMPSON. Controlling alternating currents for signalling.
16,556. G. BREWER. Electric furnaces and the production of chemicals in such furnaces. (E. R. Taylor, U.S.)*
16,564. C. D. ABEL. Electrically-controlled air brakes. (Siemens & Halske A.G., Germany.)
16,575. J. W. RECORD, H. BROOKER and W. H. GOSS. Apparatus for measuring electrical resistance.

July 26, 1902.

16,597. J. T. STUDLEY. Wireless telegraphy and telephony.
16,610. R. HADLEY and F. J. TAYLOR. Birmingham. "Tumbler" switches.
16,612. W. A. SHAW. Manchester. Switchboards for street fire alarms.
16,641. K. MARTIN. Negative system for telephotographic purposes.

July 28, 1902.

16,664. M. MERCIER. Manchester. Trolley heads or collectors.
16,680. H. OPPENHEIMER. Electric adapters. (A.G. Mix and Genest, Germany).
16,706. W. STRICKLAND. Galvanic cells.
16,711. SIEMENS BROS. & Co. and W. DIESELHORST. Conductors.
16,727. L. M. ERICSSON. Portable telephone instruments.*
16,740. A. ZEHDEN. Electro-magnetic motors and generators.*
16,750. J. ECK. Ventilation of enclosed electric machines.

July 29, 1902.

16,755. W. GARNER and A. ROBERTS. Manchester. Life-guard.
16,764. H. L. P. BOOT. Tunbridge Wells. Electric time switches.
16,776. U. HORSFALL and J. CROWTHER. Manchester. Electric safety clutch for hoists.
16,808. H. MCGOWAN. Adjustable pendant fittings.
16,817. A. GOLDSMITH and W. J. BOUGHTON. Electric facia sign.
16,824. A. J. A. GHISLAINE MARICHAL. Electro-plating.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

7,524. QUAIN. Electrical heating and apparatus therefor.
8,883. NETTER and QUEYROUL. Electric signals for railways.
10,700. HACKING, HANCOCK and LEIGHTON. Sectional conductor system of tramways.
13,510. MASON and BROWN. Electrical time-checking clock.
13,958. BRITISH THOMSON-HOUSTON Co. (Haskins). Indicating devices for measuring instruments.
13,984. BARHAM. Storage batteries.
14,236. SIEMENS BROS. & Co. and SIEMENS. Working and controlling of electrically-driven cars.
14,466. STIENS and SMITH. Storage batteries and electrolytes.
14,919. SHOEMAKER and GEHRING. Wireless telegraphy.
14,931. MCWHIRTER. Electricity meters.
15,427. MARINO, MABINO, MARINO and RATCHKOWSKY. Electrolytic deposition of metals.
15,474. JUSTICE (Rowland Telegraphic Co.). Telegraphic distribution.
15,475. JUSTICE (Rowlands Telegraphic Co.). Telegraphic inter-communication.
15,664. MURDAY and STANDARD TIME Co. Electric clocks.
15,876. WEST. Storage batteries.
16,121. HOOKHAM. Electricity meters.
16,182. HARDINGHAM (Waskowsky). Connecting boards for junction boxes and multiple cables.
16,276. RICHTER and ESCHLER. Electric automobile motors.
16,277. RICHTER and ESCHLER. Electric traction motors.
16,677. PÖRSCKE. Electrodes for galvanic batteries.
16,827. EDMONDSON. Electric ignition.
16,911. HEATON and SMITH. Plug and socket detachable switch.
16,941. CODD. Arc lamps.
16,950. MARSH and LUCAS. Switches and combinations of same with wall plugs.
17,023. HOBART. Alternating-current transformers.
17,088. MACKIE and GLYN. Dynamo-electric machines.
17,090. BOULT (International Electrograph Co.) Distantly reproducing pictures.
17,278. ROBINSON. Cable carts and drums.
17,381. MAWSON and MIRZA. Electric lighting of railway carriages.
17,416. TIMON. Protection from falling wires.
17,425. BRITISH WESTINGHOUSE ELECTRIC AND MFG. Co. (Stilwell). Circuit-breaking apparatus.
17,485. HARTIG and GLASER. Lamp socket or holder.
17,618. KNOWLES (Stierlin). Current distributing and collecting devices.
17,641. HOBART. Dynamo-electric machinery.
17,656. REDFERN (Soc. Anon. de l'Industrie Verriere et ses dérivés). Manufacture of glass by electricity.
17,664. PICHLER. Transformers, exciter coils and field magnets.
17,766. OPPENHEIMER (A.G. Mix and Genest). Cutouts.
17,860. Sir W. G. ARMSTRONG, WHITWORTH & Co. and STUART. Electric primers.
18,023. BRISTOL. Storage batteries.
18,079. NEWELL and HERR. Electric heating of cars.

1902.

252. HINTZE. Switch for electric currents.
993. WOMERSLEY and WOMERSLEY. Telegraph and telephone wires.
1,402. COLLINS and COLLINS. Operating the points of overhead wires and of rails on electric tramways.
1,435. RAILING and IDE. Coupling joint for wires and fittings.
1,684. JUNGNER. Electrodes. (Date applied for, January 22, 1901.)
2,248. LAKE (Spalding). Galvanic belts.
3,811. MILDON. Electrical signalling apparatus for railways.
4,445. FALLER. Automatic telephone system. Date applied for, Aug. 22, 1901.)
4,650. HART. Signalling systems for electric railroads.
4,865. BARRETO. Automatic circuit breakers of induction apparatus.
5,129. LOEWEN. Electric switches.
5,468. WILLENBÜCHER. Trolley heads.
5,711. JACOB. Devices for driving dynamos.
5,818. EVANS (A.E.G.). Prevention of sudden alterations in periodicity in alternating-current plants.
5,944. WISE (Peirce). Telegraph system.
5,982. SHOEMAKER. Electric telegraph systems and relating more particularly to wireless systems.
7,188. ILGNER. Control of electric reversible rolling mills.
7,689. STRUBLE. Electric signalling on railways.
7,736. READ. Extinguishing arcs. (Date applied for, April 3, 1901.)
7,751. JOHNSON. Trolley retractors. (Date applied for, Oct. 12, 1901.)
7,792. LÜTZ. Electric cooking and heating apparatus.
7,809. SCOTT, TYZACK and WRIGHT. Arc lamps.
8,020. NEELEMANS. Controlling and engaging apparatus for railway points and signals operated by electricity.
8,189. MCDONNELL. Electric circuit regulating devices.
8,190. OTIS ELEVATOR CC. (Otis Elevator Co.) Controlling motors of electric elevators.
8,308. OTTO. Electric light-cure arc lamps.
8,315. CHAPMAN. Couplings for electric table decorations.
8,583. HADDAN (Bergmann Electricitäts-werke A.G.). Pincers for electricians.
8,653. MCINTYRE. Holders lamp shades and the like.
8,747. SIEMENS BROS. & Co. (Siemens and Halske A.G.). Locking devices of electrical blocking apparatus for railways.

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NEW COMPANIES, STATUTORY RETURNS, &c.

ISAAC FROST & SONS (LTD.)—Reg. Aug. 27, capital £10,000 in £1 shares (4,000 preference), to acquire and carry on the business of brass founders and finishers as Isaac Frost & Sons. The first directors are W. T. Frost (chairman), A. S. Frost and J. E. Frost. Reg. office: 8, Allen-street, Clerkenwell, E.C.

NORTHAMPTON STREET TRAMWAYS CO. (LTD.)—Reg. Aug. 20, capital £45,000 in 4,000 ordinary and 500 preference shares of £10 each, being a re-incorporation of the Northampton Street Tramways Co., constituted by Acts of 1880, 1882 and 1892, and refer to the construction, maintenance and working of tramways in and near Northampton. At the date of the conversion (July 18) all the shares were taken up and all except two fully paid. Reg. office: 72, Abingdon-street, Northampton.

VANDAM, MARSH & CO. (LTD.)—Reg. Aug. 29, capital £20,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical, telegraphic, telephonic and magnetic supplies, electrical and mechanical engineers, &c., and to take over the business of A. Vandam & Co. The subscribers are A. Vandam, T. H. Marsh, Miss R. A. Homood, Mrs. A. A. Bland, Miss J. J. Stubbings, Miss A. L. R. Marsh, Mrs. M. L. and Mr. C. O. Vernede. The first directors are A. Vandam and T. H. Marsh. Reg. office: 15, Gerrard-street, Soho, W.C.

WESTERN ELECTRIC RAILWAYS DEVELOPMENT CO. (LTD.)—Reg. Aug. 28, capital £120,000 in £1 shares, to carry on the business of tramway and railway proprietors, carriers of passengers and goods, and constructors and workers of tramways and railways, &c., to supply electricity, to contract for public and other works, to promote companies, &c.

ELECTRIC CONSTRUCTION CO. (LTD.)—In the return to July 24 the capital is £400,000 in 50,000 preference and 150,000 ordinary shares of £2 each, of which 31,390 preference and 112,100 ordinary have been taken up. £2 per share has been called up on 18,245 preference and 2,100 ordinary shares, and £40,690 has been received. £246,290 is considered as paid on 123,145 shares. Mortgages and charges, £250,000.

ELECTRICAL POWER STORAGE CO. (LTD.)—The return to July 24 gives the capital as £100,500 in 100 founders' and 20,000 ordinary shares of £5 each, of which 66 founders' and 18,592 ordinary have been taken up. £5 per share has been called up on 66 founders' and £4 per share on 3,132 ordinary shares, and £13,332. 5s. 1d. has been received, including £474. 5s. 1d. paid on four founders' and 405 ordinary shares forfeited. £77,300 is considered paid on 15,460 shares. Mortgages and charges, £28,400.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24 1/16d. per oz. (Sept. 4). Consols (2¾ per cent.) 93⅞—93¾ for money, 93 13/16—96 15/16 for account; 2½ per cent. 94¼—94⅜ (Sept. 4). Consols Pay day, Oct. 2; Stocks and Shares Continuation Days, Sept. 9 and 24; Ticket Days, Sept. 10 and 25; Pay Days, Sept. 11 and 26; Mining Share Carry-over Days, Sept. 8 and 23.

BRITISH POWER, TRACTION AND LIGHTING CO. (LTD.)—Negotiations are proceeding for disposing of the works and business of this company.

CAVEHILL AND WHITEWELL TRAMWAY CO.—At a special meeting at Belfast on Tuesday, the directors were empowered to issue 45,000 ordinary £1 shares for the electrical equipment of the line.

COMMERCIAL CABLE CO.—A quarterly dividend of 1¾ per cent. on the capital stock has been declared, payable Oct. 1. Transfer books will be closed from 20th inst. to Oct. 1 inclusive.

DAVIS AND TIMMINS (LTD.)—The 6 per cent. preference dividend has been declared for the June half-year.

DORMAN, LONG & CO. (LTD.)—It is proposed to increase the capital of this company to £1,000,000, consequent on the re-modelling of the works on American lines. The company will absorb the old-established firm of Bell Brothers (Ltd.). Sir Lothian Bell becomes chairman of the company.

HOVE ELECTRIC LIGHTING CO. (LTD.)—The directors have resolved to pay an interim dividend on Oct. 15 on the paid-up share capital at the rate of 7 per cent. per annum for the six months ended June 30.

MERSEY RAILWAY CO.—The chairman (Mr. James Falconar), at the meeting on Friday, attributed the falling-off in the receipts to the competition of the Birkenhead electric tramways. Experience showed that wherever steam locomotion in tunnels had to compete with electric tramways, the former went to the wall and the electric trams secured the traffic. It was on that ground that the policy of the Mersey Company of abandoning steam and adopting electricity had been based. The date fixed for completing the work of conversion to electric working was Jan. 15. By adopting electricity the heavy cost of ventilation would be almost entirely abolished, the cost of haulage would be substantially reduced from about 1s. per train mile to about 6d., while the saving in time on the journey would be 25 per cent.

MUNICH TRAMWAYS CO.—During the year ended June 30 the company carried 45,580,000 passengers, the receipts averaging 38·22pf. per car-kilometre. The working expenses were 63·75 per cent. of the receipts, and the net profits amounted to 609,179m. A dividend of 11 per cent. has been declared.

SIR HIRAM MAXIM ELECTRICAL AND ENGINEERING CO. (LTD.)—Mr. Lachman has ceased to be a director of this company, and the vacancy on the board has been filled by the election of Mr. Thomas Wood as deputy-chairman.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed Sept. 10 a special settling day in £105,000 4 per cent. first mortgage debenture stock (in lieu of 4½ per cent. first mortgage debenture stock now quoted) and provisional scrip certificates for a further issue of £135,000 4 per cent. first mortgage debenture stock of *Willans and Robinson (Ltd.)*, and have ordered same to be quoted in the official list. Sept. 17 has been appointed as a special settling day in 400,000 £1 fully-paid shares of the *Cape Town Consolidated Tramways and Land Co. (Ltd.)*. The committee have also ordered £1,000,000 preferred stock (in lieu of 200,000 £5 preferred shares now quoted) of the *National Telephone Co. (Ltd.)*, to be quoted. The committee have been asked to appoint a special settling day in and to grant a quotation to a further issue of 10,000 £10 6 per cent. cumulative preference shares in the *County of London and Brush Provincial Electric Lighting Co. (Ltd.)*.

TYNESIDE TRAMWAYS AND TRAMROADS CO.—At the meeting on Saturday the chairman (Mr. W. A. Watson Armstrong) expressed the opinion that the system would be in working operation next week. He hoped that all hostility between the Newcastle Corporation and the company had now ceased, and that a friendly, practical scheme for an exchange of running powers over each other's lines would be arranged without recourse to Parliament.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Aug. 23	1,210	+ 195	12	13,939	+ 3,252
Ayr Corporation	,, 30	440	...	15	6,088	...
*Birmingham Tramways.	,, 30	4,997	+ 371	8	39,625	+ 1,102
*Blackburn Corporation..	,, 29	872	+ 78	23	19,187	+ 3,431
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood	Sept. 1	1,564	+ 410	9	12,125	- 854
Bolton Corporation	Aug. 31	1,662	+ 215	22	36,226	+ 2,179
Bradford Corporation ...	,, 31	3,479	+2,294	22	74,700	+50,682
Brighton Corporation ...	,, 31	1,095	...	40	29,142	...
Brisbane Tramways.....	July 16	2,238	+ 367	3	7,096	+ 1,517
*Bristol Trams & Carriage	Aug. 29	5,060	+1,301	8	41,745	+ 8,201
*Buenos Ayres & Belgrano	,, 3	2,710	+ 182	5	13,978	+ 798
Burnley Corporation ...	,, 30	757	+ 382	‡22	15,737	+ 5,953
Calcutta Tramways Co...	,, 30	R24.304	+R4,010	9	R222,035	+R37,462
Cardiff Corporation	,, 30	1,886	...	22	30,284	...
Carlisle Tramways Co....	,, 30	232	+ 26	†35	6,168	+ 409
Central London Railway	,, 30	5,632	+ 220	9	57,214	+ 5,186
Chatham & Dist. Lt. Rys.	,, 28	550	...	¶10	5,366	...
City & South London Ry.	,, 31	2,537	+ 585	9	24,678	+ 8,117
Cork Elec. Tramways Co.	,, 28	895	+ 368	§34	19,249	+ 3,015
Devonport & Dist. Trams	,, 22	517	- 18	33½	14,415	+ 472
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	,, 30	319	+ 12	22	5,424	- 154
Dublin & Lucan Railway	,, 31	163	+ 10	9	1,273	- 68
Dublin Southern Dist....	,, 29	1,678	+ 157	†9	10,271	- 430
Dublin United	,, 29	4,435	+ 314	†9	35,338	
Dudley—Stourbridge ...	,, 22	842	- 3	33½	24,855	+ 3,233
*Dundee Corporation ...	,, 27	810	+ 124	...	...	...
East Ham Council	,, 30	557	+ 79	10	5,345	+ 717
Gateshead & Dist. Trams	,, 22	871	+ 166	33½	24,249	+ 3,846
Glasgow Corporation ...	,, 30	12,505	- 581	13	154,231	- 3,607
Gravesend	,, 22	202	...	3	715	...
Greenock & Port Glasgow	,, 22	648	+ 430	33½	16,619	+10,073
Hartlepool Tramways ..	,, 22	330	+ 28	33½	8,504	+ 1,024
Hull Corporation	,, 30	1,773	+ 121	22	38,863	+ 1,590
Isle of Thanet Co.	,, 30	1,887	+ 377	9	13,701	+ 399
Kidderminster & Dist....	,, 22	155	- 17	33½	4,176	- 1
Leeds Corporation	,, 30	5,446	+1,140	22	119,353	+19,900
*Liverpool Corporation....	,, 23	9,870	- 312	34	327,543	+26,156
Liverpool Overhead Rly.	,, 31	1,550	- 120	‡9	14,688	- 1,066
Manchester Corporation	,, 30	5,595	+3,425	63	179,517	...
Merthyr.....	,, 22	205	- 74	33½	6,814	- 1,332
Middleton	,, 22	322	...	21½	6,728	...
Newcastle-on-Tyne Corp	,, 30	2,984	...	...	...	...
Oldham, Ashton & Hyde.	,, 22	690	+ 9	33½	17,588	+ 597
Perth (W.A.) Elec. Trams	,, 29	952	+ 259	¶34	36,483	+ 6,103
Poole & Dist.....	,, 22	378	- 54	33½	8,486	- 170
*Portsmouth Corporation	,, 30	2,258	+1,096	...	...	...
Potteries	,, 22	1,419	- 51	33½	48,718	+ 1,854
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ...	,, 31	4,204	+ 519	9	38,932	+ 9,688
Southampton Corp.	,, 28	1,176	+ 91	...	...	...
Southend Corporation...	,, 27	482	+ 118	21	6,637	...
Southport Tramways ...	,, 22	481	+ 144	33½	8,501	+ 2,923
*S. Staffordshire Trams...	,, 22	742	- 192	33½	25,868	+ 123
Sunderland Corporation.	,, 31	1,530	+ 350	22	27,403	+ 2,382
Swansea Trams.....	,, 22	556	- 58	33½	15,780	+ 1,105
Taunton Trams.....	,, 22	86	- 24	33½	2,230	- 24
Tynemouth & Dist.	,, 22	454	+ 5	33½	9,677	+ 891
Weston-super-Mare	,, 20	367	...	15½	3,638	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 22	309	+ 197	33½	5,997	+ 4,000

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Aug. 27.		Price Wednesday, Sept. 3.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 3.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Hl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½	¾	½	¾	...	...	...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103	106	103	106	4 6 0	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11⅛	12⅛	11⅛	12⅛	5 12 0	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101	104	101	104	4 6 7	...	...	...
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord	9⅛	10	10	10⅜	3 16 2	...	10½	...
20,000	5	3/6	Do. 7 per Cent. Preference	9⅛	10	10	1⁰⅛	3 6 8	March and September	10⅜	...
30,000	5	3/6	Calcutta Elec. Supply Ord. (1 to 30,000) .. ex rights	7⅛	8⅛	7	8	3 15 0	...	7⅝	...
10,000	5	...	Do. (30,001 to 40,000) ex rights	7	8	7	8	...	...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	106	108	106	108	3 14 8	...	...	...
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	9½	9	9½	5 5 3	February and August	9⅝	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	5⅝	5½	5⅝	3 18 3	,, ,,	5⅝	5⅛
40,000	5	...	Do. City Undertaking 4½% Cum. Pref.	4⅝	5⅛	4⅝	5⅛	...	...	4⅞	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	...	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½	5⅝	5½	5⅝	2 12 2	March	5½	5⅝
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	9	10	9	10	5 0 0	February and August	9½	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12	13	12	13	4 12 4	January and July	12⅛	13⅜
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 5 0	...	105½	105
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½	9⅜	8½	9⅜	4 4 3	...	8⅞	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12⅝	11½	12⅝	4 16 0	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	109	112	109	112	4 1 1	...	...	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5⅝	6⅛	5⅝	6⅛	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10½	11½	10½	11½	4 6 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6⅝	6⅞	6⅝	6⅞	4 8 11	January and July	...	...
£30,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105	108	105	108	3 15 0	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛	...	...	...	...
49,850	5	2/6	Do. 6 per Cent. Preference xd	4⅝	5⅛	4⅝	5⅛	5 4 9	...	5	4⅞
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	96	99	96	99	4 1 2	Mar., June, Sept., Dec	97½	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15	16	15	16	4 7 6	April and October	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	108	112	108	112	4 0 5	June and December	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99	102	99	102	3 9 2	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary	13¾	14½	13¾	14½	4 2 9	March	...	...
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	97	100	97	100	4 0 0	...	...	...
300,000	1	...	Rand Electric	⅞	1	⅞	1	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 7 0	April and October	...	...
40,000	5	5 0	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97	100	97	100	3 10 0	...	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2½	3	2½	3	...	...	...	...
30,000	5	...	Urban Electric Supply Ord. (£3 paid)	2⅞	3⅛	2⅞	3⅛	...	...	2⅞	2½
30,000	5	...	Do. 5% Cum. Pref.	2⅞	3⅛	2⅞	3⅛	...	...	...	...
110,000	1	5 6	Westminster Electric Supply Ordinary	11	12	11	12	4 11 8	March and September	1⅛	11⅜
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5⅝	6⅛	5⅝	6⅛	4 0 0	...	6	5⅞
			TELEGRAPHS.								
£67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98	102	98	102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅛	4⅛	3⅛	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£778,840	Stock	15 0	Anglo-American	47	50	47	50	5 17 0	Feb., May, Aug., Nov.	...	...
£3,105,580	Stock	30/6	Do. Preferred	92	94	92	94	6 2 4	,, ,,	93⅝	92½
£3,105,580	Stock	2 0	Do. Deferred	7⅛	7⅝	7⅛	8	1 5 0	,, ,,	7⅝	7 1/16
13,333,300	$100	$1⅛	Commercial Cable Capital Stock	160	170	160	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	95	97	95	97	4 2 6	,, ,,	95⅛	95½
16,000	10	4/0	Cuba Submarine Ordinary	5	6	5	6	6 13 4	February and August	5⅛	...
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 6	,, ,,	13⅜	...
13,000	5	2/0	Direct Spanish Ordinary	2½	3½	2½	3½	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7	8	7	8	6 5 10	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞	103¾	99⅞	103⅞	4 7 8	January and July	...	...
60,710	20	4/0	Direct United States Cable	10	11	10⅛	10⅞	6 0 11	Jan., Apr., July, Oct.	...	...
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos.)	99	102	00	103	4 7 1	June and December	...	...
£4,000,000	Stock	65/0	Eastern Ordinary .. xd & bonus .. [to 1,200) (red.)	118	128	12	126	5 11 1	Jan., Apr., July, Oct.	124½	124
£1,855,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	88	91	90	93	3 15 8	,, ,,	91½	89½
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108	112	108	111	3 13 0	May and November	108	...
300,000	10	2/6	Eastern Extension	11½	12¼	12	12½	5 12 0	Jan., Apr., July, Oct.	12⅛	11⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	112	107	110	3 13 0	February and August	108⅛	107⅛
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	98	101	99	102	3 18 7	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	100%	103%	101%	104%	3 17 6	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen	25	27	25	27	5 11 1	January and July	...	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos	99	102	99	102	4 8 1	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red	38	42	38	42	5 19 1	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 xd	102	106	101	105	5 14 3	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3½	4⅛	3½	4⅛	...	...	...	...
30,008	2½	...	West Coast of America	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97	100	97	100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	¼	½	¼	½	...	May and November	...	...
34,563	10	£/0	Do. 6 per Cent. 1st Pref.	4½	5½	4½	5½	11 8 6	,, ,,	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3	4	3	4	...	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	January and July	...	...
207,930	10	3/0	Western Telegraph (late Br zil'n Submarine)	11½	12⅛	11⅝	12⅛	5 14 3	Mar., June, Oct., Dec.	12	11⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1896)	101	104	102	105	4 15 10	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	97	100	97	100	4 0 2	...	99½	97⅝
			TELEPHONES.								
44,000	£5	5 0	Chili Telephone (fully paid)	3½	4	3½	4	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/0	2/0	1/0	2/0	15 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	⅝	½	⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	,,	...	...
£1,983,333	Stock	6%	National Co. Preferred Stock	92	96	93	96	6 5 0	...	94	93
£1,966,667	Stock	4½%	Do. Deferred Stock	54	58	55	57	7 17 10	...	56½	55½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	11	13	12	13	4 12 4	February and August	12⅝	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	10	12	10	12	4 12 4	,, ,,	11 15/16	11⅞
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	4⅞	5⅛	5 0 1	,, ,,	...	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	95	99	96	99	3 10 10	June and December	...	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6	...	...	...
171,504	1	0/8½	Oriental	1/16	1 1/16	1/16	1 1/16	5 12 11	April and October	...	...
58,000	5	4/6	United River Plate	4⅛	5⅛	4⅛	5⅛	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅛	5	4⅛	5	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 16 2	June and December	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	5⅝	5⅛	6	5 0 0	...	...	...
180,227	10	4/9	Globe Telegraph and Trust	9	10	9⅛	9⅝	5 7 8	Jan., Apr., July, Oct.	9⅝	9 7/16
180,042	10	3/0	Do. 6 per Cent. Preference	13	14	13⅛	13⅝	4 7 3	,, ,,	13 11/16	13⅜
11,980	8	4/0	Reuter's	6⅛	7⅛	6⅛	7	5 14 3	April and October	...	...
8,108	£100 Cert	6%	Submarine Cables Trust	110	120	110	120	5 0 0	,,	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Shares.	Last Dividend.	Name.	Previous Week's Price, Aug. 27,	Price Wednesday, Sept. 3.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 3. Highest	Lowest
			ELECTRIC RAILWAYS, TRAMWAYS, &c.			£ s. d.			
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4⅜ 4⅝	4¼ 4½	4 8 11	April and October	4⅞	4¾
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125 130	125 130	4 12 2	,, ,,	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9 11	9 11	2 14 7	,, ,,	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	8½ 9½	8½ 9½	5 5 3	,, ,,	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95 100	95 100	4 10 2	,, ,,	...	...
15,000	10	4/0	Blackpool and Fleetwood Tramways xd	13½ 14½	13 14	4 12 10	,, ,,	...	...
75,000	5	...	Brisbane Electric Trams. Investment Ord.	4⅜ 5⅛	3⅞ 4⅛	...	,, ,,	...	...
75,000	5	2/6	Do. 5% Cum. Pref.	4½ 5	4⅜ 5	5 0 0	,, ,,	...	...
£400,000	Stock	4½%	Do. 4½% Deb, Prov. Certs.	103 106	103 106	4 5 0	,,	105⅜	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	20½ 21½	20½ 21½	3 11 2	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	,, ,,	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106 108	106 108	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7 7⅛	7 7⅛	2 13 4	,, ,,	...	...
20,000	10	5/0	Do. 5% Preference	9⅛ 9⅜	9⅛ 9⅜	5 2 7	May and November	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	103¾ 105¾	103⅝ 105⅞	4 6 5	,, ,,	...	...
100,000	10	12/0	British Electric Traction Ordinary	12⅛ 13⅛	12⅛ 13⅛	6 13 4	,, ,,	13	12⅞
100,000	10	6/0	Do. 6% Cum. Pref.	12⅛ 13	12⅛ 12⅞	4 14 1	February and August	12⅞	12⅝
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	,, ,,	126	125⅞
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝ 1⅞	1⅝ 1⅞	...	,, ,,	1 13/16	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅞ 5⅛	5 5⅛	5 9 1	,, ,,	5 1/16	5
37,500	5	10/0	Do. "B"	5 5⅛	5 5⅛	5 9 1	,, ,,	5 5/16	...
£220,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 9	,, ,,	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 11	,, ,,	...	...
70,000	10	6/0	Calcutta Tramways	7 7⅛	7 7⅛	4 0 0	,, ,,	...	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107 109	107 109	4 3 1	,, ,,	...	...
£80,000	1	1/2⅞	Cape Electric Tramways Shares	2⅛ 2⅜	2⅞ 2⅝	6 14 9	,, ,,	...	...
£1,800,014	Stock	4%	Central London Ordinary Stock	103 106	103 106	3 15 6	June and December	105⅛	...
£494,993	Stock	4%	Do. 4% Preferred Stock	104 107	104 107	3 14 9	,, ,,	...	...
£494,993	Stock	4%	Do. Deferred Stock	103 106	103 106	3 15 6	,, ,,	106	...
£698,201	100	4%	Do. 4% Deb.	115 118	115 118	3 7 8	,, ,,	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5⅛	5 5⅛	4 10 9	,, ,,	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	,, ,,	101½	...
£1,330,000	Stock	3%	City and South London Railway Con. Ordinary	72 74	72 74	3 11 7	February and August	73⅛	72⅝
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	,, ,,	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	... ...	... ...	...	,, ,,	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	127 130	128 131	3 16 6	,, ,,	...	...
£200,000	Stock	5%	Do. (1896)	126 129	126 129	3 17 6	,, ,,	...	...
£150,000	Stock	5%	Do. (1901)	121 125	121 125	4 0 0	,, ,,	...	...
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115 118	115 118	3 9 7	May and November	117½	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛ 12⅛	11⅛ 12⅛	4 8 0	,, ,,	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14⅛ 15⅛	14⅛ 15⅛	3 17 5	,, ,,	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	,, ,,	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4 4⅛	4 4⅛	6 13 4	,, ,,	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99 102	99 101	4 18 0	,, ,,	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	,, ,,	...	...
20,000	10	8%	†Imperial Tramways Ordinary xd	23 24	23 24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13⅛ 13⅞	13⅛ 13⅞	4 7 3½	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	108 110	108 110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4⅛ 5	4⅛ 5	5 0 0	,, ,,	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary xd	4⅜ 4⅝	4⅜ 4⅝	2 4 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference xd	9⅞ 10⅛	9⅞ 10⅛	4 17 7	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	99 101	99 101	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	10⅜ 11⅛	10⅜ 11⅛	4 8 11	,, ,,	11⅛	11
30,999	10	2/3	Do. (£7. 10s. paid)	8 8⅛	8⅛ 8⅜	4 5 9	,, ,,	...	...
£655,341	Stock	3%	Do. 4% 1st Mortgage Debenture Stock	108 110	108 110	3 12 9	,, ,,	108⅛	108⅜
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	81 83	81 83	...	,, ,,	...	...
$5,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112 117	112 117	4 5 7	,, ,,	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) xd	106 108	104 106	4 14 3	,, ,,	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	106 108	108 110	4 2 2	,, ,,	...	...
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 13 4	,, ,,	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½ 4½	3½ 4½	6 13 4	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93 98	93 98	5 2 0	,, ,,	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100 103	100 103	4 17 5	,, ,,	...	...
13,334	10	8/0	Potteries Electric Traction Ordinary	8½ 9½	8½ 9½	4 4 3	,, ,,	...	...
20,000	10	8/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 1	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108 111	108 111	4 1 10	,, ,,	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	... ...	... ...	...	,, ,,	...	...
51,132	1	-	Do. 6% Preference (14/0 paid)	... ...	... ...	...	April and October	...	...
50,000	1	-	Do. 6% Preference (fully paid)	... ...	... ...	...	,, ,,	...	...
500,000	Stock	...	Do 4½% Debenture Stock (70% paid)	... ...	... ...	...	January and July	...	...
£540,800	Stock	8%	Waterloo and City Ordinary	90 93	90 93	3 4 6	June and December	91	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛ ¼	⅛ ¼	6 13 4	,, ,,	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛ ¼	⅛ ¼	...	,, ,,	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	¼ ⅜	¼ ⅜	12 0 0	March and September	...	...
70,000	5	5/0	British Insulated Wire Ordinary xd	7¼ 7½	7¼ 7½	6 9 0	July and February	...	...
80,000	5	3/0	Do. 6 per Cent. Preference	5⅝ 6	5⅝ 6	5 0 0	January and July	...	...
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	101 104	101 104	4 6 1	,, ,,	...	...
200,000	5	3/0	British Westinghouse 6% Preference	5⅞ 6⅛	5⅞ 6⅛	4 18 0	,,	6⅛	6
£500,000	Stock	14/0	Do. 4 per cent. Mortgage Deb. Stock	103 105	103 105	...	,,	104	103½
108,731	...	...	Brush Electrical Engineering	1⅛ 1⅜	1⅛ 1⅜	...	March	...	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅛ 2	1⅛ 2	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock xd	102 105	100 103	4 7 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	93 98	93 98	4 11 6	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15⅛ 16½	15⅛ 16½	4 10 11	,, ,,	16½	15½
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	6⅜ 6¼	6⅜ 6¼	4 0 0	,, ,,	6⅜	6⅛
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109 113	109 113	3 19 8	November and May	...	...
£150,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	⅞ 1⅛	⅞ 1⅛	5 6 8	,,	1 1/16	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	94 99	94 99	4 11 0	,,	93	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ 1	9 2 0	March	...	...
85,000	3	1/9⅜	Crompton and Co. (Nos. 1 to 54,000)	2½ 3	2½ 2¾	6 10 5	January and July	2 1/16	2 1/16
£100,000	100	5%	Do. 5 per Cent. First Mortgage Deb. (red.) *	101⅞ 106⅞	101⅞ 106⅞	4 14 4	,, ,,	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜ ⅝	⅜ ⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1⅜ 2⅛	1⅜ 2⅛	...	,, ,,	...	...
£344,022	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	74 78	74 78	5 3 0	June and December	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	78 83	78 83	6 2 10	,, ,,	...	...
50,000	5	4/0	Edmundson's Electricity Corporation Ord.	6⅛ 6⅜	6⅛ 6⅜	5 3 8	Half-yearly	6 1/16	...
30,000	5	3/0	Do. 6% Cumulative Preference	6 6⅛	6 6⅛	4 12 4	,,	6⅜	6⅛
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107 110	107 110	4 2 1	,,	108⅜	...
112,100	2	1/2⅛	Electric Construction Co.	1⅝ 2⅛	1⅝ 2⅛	5 6 8	January and July	1 15/16	1 13/16
31,390	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅜ 3	2⅜ 3	4 13 4	July	...	...
£ 32,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 102	99 102	3 19 1	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...	,, ,,	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾ 1⅛	¾ 1⅛	...	,, ,,	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	9⅜ 10⅛	10 10⅛	4 15 3	,, ,,	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	99 102	100 103	3 18 11	,, ,,	...	...
35,000	5	6/0	Henley's Telegraph Works Ordinary xd	16 17	16 17	4 14 2	February and August	16 3/16	16 1/16
35,000	5	2/3	Do. 4½ per Cent. Preference xd	5⅛ 5⅜	5⅛ 5⅜	3 18 3	,, ,,	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) xd	111 115	103 113	3 19 8	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20⅜ 21½	4 13 0	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½ 15½	14½ 15½	6 9 0	July	...	...
27,350	12	12/0	Telegraph Construction and Maintnce.	38 41	38 41	5 17 0	March and July	40	39½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
25,000	5	8/0	Do. Manufacturing Ordinary	... ...	... ...	5 14 3	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	... ...	... ...	4 3 4	,, ,,	...	...
66 666	5	5/0	Willans and Robinson Ordinary	... ...	... ...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	... ...	... ...	...	,, ,,	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee have refused to quote these.

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NOTES.

AFTER an interval of over a quarter of a century the British Association once again meets at Belfast, this time under the presidency of the renowned chemist Prof. JAMES DEWAR. Early on Wednesday, if not indeed on Tuesday, the capital of northern Ireland gave signs of unusual activity promising a more than ordinarily well-attended meeting of the Association. For weeks past the leading hotels have been booked practically full, and Irish hospitality is taxed to the utmost by the multitudinous influx of visitors. At noon yesterday the total number of members of all classes was announced as 1,589. The public proceedings commenced as usual by the delivery of the President's address on Wednesday night, a large and distinguished audience assembling in the Grosvenor Hall. We commence an abstract of this interesting address in our issue this week.

YESTERDAY morning the various sections commenced their several proceedings in full vigour, the exchange of visitors from one section to the other being greatly facilitated on this occasion by the arrangements allowing of all the sectional meetings being held in the convenient group of buildings which constitute Queen's College. Although these buildings are situated at some distance from the centre of Belfast, where the majority of members are quartered, the generosity of the Belfast Street Tramway Co. in giving all members unlimited free passes went far towards annihilating that distance. At Queen's College the secretarial and other offices are also situated; and, in this connection, we cannot fail to express the vividness with which the death of the late genial and courteous assistant-secretary, Mr. GRIFFITH, impresses itself at this season upon us. We fully endorse the tribute of praise spoken by Prof. H. E. ARMSTRONG in his presidential address to Section L yesterday. Mr. GRIFFITH, indeed, "displayed a fulness of sympathy altogether rare among officials." We wish we could say that his mantle had fallen upon his successor.

AMONG presidential addresses, that of Prof. JOHN PERRY to Section G will probably have excited the greatest interest in the electrical members of the Association. The subject was "The Education of Engineers," a subject on which Prof. PERRY is an enthusiast. It is framed in the uncompromising language of the enthusiast; but as we understand that, contrary to usual practice, this address is to serve as the opening for a discussion on the subject of the education of engineers, we prefer not to comment upon it until after that discussion has taken place. Suffice it now to say that although Prof. PERRY said some very hard things about the education of youths in this country, and about the teaching of Latin; and although he criticises severely much of the practice in vogue in our scientific and engineering educational institutions, he is, happily, no advocate of the importation of German or other Continental "systems" ready made. "What we must strive for is the discovery of a British system suiting British boy and man." The gist of Prof. PERRY'S address appears to be that, in his opinion, the best educational scheme for the budding engineer is what he terms "the Finsbury system."

WE need offer no apology for devoting a large amount of space to a description of the large "Waterside" electricity works in New York. Its plant capacity of 72,000kw. renders this station, we believe, larger than any other in the world. The Berlin electricity works, which are said to be the largest owned by a single Corporation for an urban electric light and tramway supply, have an aggregate engine capacity of about 150,000 H.P., but this is divided between six stations, and at Niagara the present equipment of 105,000 H.P. is divided between two power houses. The first part of our description of the New York station, published in our issue of August 29th, dealt with the arrangement of the buildings themselves and the whole generating plant; this week we give an account of the switchboard arrangements, which are in some respects unique, and in the concluding article the distributing network and sub-stations will be dealt with at some length.

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Although a three-phase system with distribution on the low-pressure three-wire system, the plant cannot be said to follow the precise lines of either the most modern American or European practice in matters of detail. It combines certain features of both, and its description merits careful perusal by electric light and power engineers.

It is just possible that an interesting experiment may shortly be made in the City of London to relieve the congestion of pipes and mains under the streets. A Bill was brought before Parliament in 1900 seeking to obtain rather arbitrary powers for the purpose of building subways in the City of London. This Bill, if it had been passed in its original form, would have empowered the Corporation to compel the various gas, water and electric supply companies to use these new subways, and would have given the Corporation the right even to have removed mains from their existing position under the streets in order to place them in these subways. The Bill was naturally opposed by the companies interested, and was passed in a modified form, the use of the subways being no longer made compulsory, except in the case of mains to be laid in streets after subways have been completed there. A *résumé* of the main provisions of the Act will be found in *The Electrician*, Vol. XLV., p. 962, and a description of the subways already existing in the City (about 2½ miles in all) appeared in *The Electrician*, Vol. XLVI., p. 194. We believe that no large scheme of subways has been put under construction yet, although slight additions to the present small and discontinuous network may be completed in the near future, for the "Mayor and Commonalty and Citizens" of the City of London have now passed a series of rules and regulations for the use, not only of their existing subways, but also of those authorised under the Act above referred to. These rules, which are now obtainable at the offices of the Corporation, are, on the whole, very reasonable, as are also the rentals which it is proposed to charge, and we should be glad to see the experiment tried if any new streets are to be made within the City's jurisdiction. The limited use to which new subways under old streets would be put, renders the expense of their construction hardly justifiable in most cases.

A report has just been issued by the Labour Department of the Board of Trade containing particulars and statistics of the various strikes and lock-outs which took place during 1901. Although the number of separate disputes was less than in any previous year dealt with, and the number of persons directly and indirectly involved was also smaller, yet in the matter of aggregate duration the figures were larger than in either of the two previous years, though smaller than in 1897 or 1898. The increase is chiefly due to disputes in the mining and quarrying industry. It is distinctly encouraging to learn that strikes and lock-outs are on the decrease, but it is a most serious matter that no less than 4,142,287 working days were lost in 1901. Of these, more than 50 per cent. are due to the mining and quarrying industry, but 601,558 are classified as being in the metal, engineering and shipbuilding trades. All this time means so much trade lost to the country, to say nothing of the individual losses to those employers and employed immediately concerned.

Alexander the Great and the Nebular Theory.—Yesterday's *Standard* says that "even when Prof. Dewar had liquefied hydrogen, chemists were not left, like Alexander, to shed tears because they had no other gases to conquer."

International Telephony.—The *Daily Chronicle's* Rome correspondent states that telephonic communication will be established in November between Rome and Milan and between Rome, France, England and Switzerland.

Electricity applied to Incubators.—According to the *Natal Witness* there has been invented, by Mr. Frank Beresford, of Pietermaritzburg, an electric incubator, worked on the principle of the electric curling-iron heater. It is stated that the Natal Government has already ordered a specimen.

American Municipal Electricians.—The (American) International Association of Electricians will hold its Seventh Annual Convention at Richmond, Va., U.S.A., on October 7th, 8th and 9th. Various Papers on telephones, telegraphs, fire alarms and similar subjects will be read and discussed.

Christiania University.—In connection with the celebration of the 100th birthday of the Norwegian mathematician Niels Henrick Abel, several foreign mathematicians received the degree of doctor *honoris causâ*, among them being Prof. Forsyth, Lord Kelvin, Lord Rayleigh and Sir George Gabriel Stokes.

Magazine Fuse Holder.—A means for automatically inserting a fuse in an electric circuit has been recently patented by Mr. J. T. Watson, of Scranton, Pa. It is a magazine fuse holder, and the number of fuses available is only limited by the size of the box which incases the apparatus. When the fuse blows the holder drops by its own weight, allowing the next holder to fall into place, thereby closing the circuit again.

A New Double Filament Lamp.—A new double filament incandescent lamp has recently been brought out in America. It consists of two filaments—one large and the other small—either of which can be placed in circuit by means of a small switch placed in the cap of the lamp and controlled by two cords. The large filament gives the full candle-power of the lamp—8, 16 or whatever it may be—and the small one gives the equivalent of 1 c.p.

London-Brussels Telephone Service.—Some particulars as to the telephone cable which was being laid between England and Belgium were published in *The Electrician*, Vol. XLVII., p. 625. The laying of the cable is already complete as well as the lines connecting it with London. It appears, however, that the formal agreement between the two countries is still to be concluded, and it may be a few months before direct telephonic communication will be possible between Brussels and London.

Electric Railway Experiments in Berlin.—It will be remembered that the experiments on the Wannsee Railway of running some of the regular trains electrically did not give very satisfactory financial results. It is reported that more thorough experiments will be made between Potsdam and Gross-Lichterfelde, on which section of the line the steam-driven trains will be discontinued, and lighter electrical trains, consisting of three motor coaches and capable of seating 206 passengers, will be run at more frequent intervals.

Personal.—Capt. C. W. Davy, R.E., has been appointed superintendent of telegraphs of the Central South African railways, by which name the joint systems of the Transvaal and the Orange River Colony will in future be known. Capt. Davy is a member of the Institution of Electrical Engineers, and before proceeding to South Africa was for several years associated with the engineering department of the Post Office telegraphs as assistant superintending engineer at Exeter, and latterly as superintending engineer of the southern engineering district.

Wireless Transmission of Power.—The following offer is contained in sec. 3 of the Rules and Regulations Governing the Aeronautic Competition of the St. Louis World's Fair, 1904:—"One prize of $3,000 is offered for a successful attempt to drive an air-ship motor by energy transmitted through space, either in the form of electric radiation or in some other form of electric energy, to an actual amount of $\frac{1}{10}$ (0·1) H.P. at

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the point of reception and at a distance of at least 1,000ft. The test must be made on the exposition grounds by experts satisfactory to the jury."

A New Telephone Meter.—A new way of charging for telephone service has recently been patented by Mr. Thomas Baret, of Sydney, New South Wales. He proposes, says *Telephony*, of Chicago, to charge for the total length of the conversations, and not for the total number. His meter consists of a clockwork device which is at rest except at such time as conversation is being held, and then it is at work registering the actual time consumed by the talk. The up-and-down movement of the switch-lever throws the clock into action, shuts it off and keeps it wound.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
St. Lucia—St. Vincent	May 9, 1902
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Santa Cruz—Teneriffe	July 7, 1902
Puerto Plata—Martinique	July 10, 1902
Anjer—Kalianda	Aug. 2, 1902
Guantanamo—Mole St. Nicholas	Aug. 5, 1902
Cayenne—Pinheiros	Aug. 13, 1902

Electric Railway to Vesuvius.—In our issue for August 15th, page 658, we notified the fact that Messrs. Cook's project for an electric railway from Naples to the crater of Mount Vesuvius was being urgently protested against by the Faculty of Science in the University of Naples. Notwithstanding this, however, the work has actually now been commenced, and Messrs. Brown, Boveri & Co. are supplying the electrical equipment to the designs of Mr. Strub. The power station is to be equipped with two Swiss gas engines and continuous current generators, and the line voltage will be from 550 to 750 volts.

Electric Traction in the Pennsylvania Tunnels.—According to the *Railway Review* of Chicago, the Pennsylvania Railway is understood to have given the Westinghouse Electric and Mfg. Co. a contract for the engineering work in connection with the electric equipment of the New York tunnels. It is said to be the intention of the Pennsylvania Company to operate trains through the tunnels on the third rail system, and for this purpose a number of large motors will be built. Already the Railway Company is having constructed at the Westinghouse works a locomotive designed for heavy freight traffic, to serve as a sample of those to be used in the tunnels.

A Penny-in-the-Slot X-ray Machine.—A patent has just been issued in America to Mr. I. M. Hunter for a coin-controlled X-ray machine for public use. The external appearance of the apparatus is similar to that of the automatic cinematograph machines so commonly seen on railway platforms and other places. The observer places a coin in the slot, moves a lever, puts his hand, or whatever he wishes to examine, into a box without any sides, and looks down at it through a fluorescent screen which forms the top of the box. The coin, on being inserted, closes the primary circuit of an induction coil worked by a few dry cells, and the vacuum tube is in a position immediately below the object to be observed.

An Electrical Tabulating Machine Applied to Cost Accounting.—The *American Machinist* of August 16th, publishes an article dealing with a new electrical tabulating machine used, among other places, in the accounting department of the New York Central and Hudson River Railway. Its inventor has also adapted it to the work of factory cost accounting, in which it shows, by means of a card, the workman's number, time in hours and quarters, number of job, and whether work done by day labour or contract. The cards are filed and punched in such a manner that any contract or part of a contract can be analysed with the greatest of ease, and every detail of the manufacture of any particular article checked from start to finish.

Technical Education in America.—The contract for building the new electrical engineering laboratory for the Massachusetts Institute of Technology has been awarded to a Boston contractor. It is said that this will be the best equipped and most modern electrical laboratory for educational purposes in the world. Prof. Puffer, of the Institute, recently visited electrical laboratories in Europe and obtained many valuable ideas. Dr. Louis Duncan, the recently appointed head of the electrical department, has directly supervised the plans for the building, which is to be ready for use during the fall term. The laboratory will be known as the Augustus Lowell Laboratory of Electrical Engineering, as a recognition of Mr. Lowell's long and intimate association with the Institute.

The Newcastle Tramways.—The daily papers last Friday contained an announcement that, owing to the dismissal of three men in the employ of the Newcastle Tramways, a mass meeting of the employés had been held, and that, failing the reinstatement of the men, a strike was imminent. On inquiry at Newcastle we learn that this was an entirely erroneous statement of the position of affairs, as no serious incident had occurred. Three men were dismissed two weeks ago for various offences, and one or two of them summoned meetings of their friends in the Corporation service, who threatened to strike. Their trade union, however, refused to recognise that there was any subject for dispute, and even the men who held the meetings, and were only a few in number, have apparently thought better of handing in their notices.

An Electric Postal System.—A Reuter telegram, dated Rome, September 10th, states that Signor Galimberti, Minister of Posts and Telegraphs, and Baron Squitti di Palermiti e Guarno, Under-Secretary of State for Posts and Telegraphs, together with the high officials of the Italian Postal Department, have examined a scheme submitted by an engineer, named Piscicelli, for the establishment of an electric postal service. It is proposed, by means of this system, to transmit letters in aluminium boxes, travelling along overhead wires at the rate of 400km. an hour. A letter could thus be sent from Rome to Naples in 25 minutes and from Rome to Paris in five hours. Signor Galimberti has appointed a technical commission to report on the system before instituting a series of experiments between Rome and Naples.

High-speed Electric Railway.—The initial trip over the Aurora, Elgin and Chicago Electric Railway, which was constructed for unusually high-speed cars, was recently made, and it is intended to conduct some tests in the near future in which the cars will be equipped with motors and gearing designed to run 160 miles per hour. The first trial trip, says the *Railway Review* of Chicago, was in no sense a speed test, but was made simply to test the rails, roadbed and cars to see that the whole operated satisfactorily. Six cars to be used in regular service have already been received by the railway from the Niles Car and Mfg. Co., and these are geared to run 75 miles an hour. They are constructed after the lines of the standard Pullman car, and are 47ft. 6in. long, seating 56 passengers each. The cars are equipped with Christensen air brakes and Van Dorn couplers.

Storage Battery Fumes in Street Cars.—Complaints against the storage-battery cars on the 34th-street surface line in New York city have been taken up by the Health Commissioner of the city. The batteries, according to a report in *Engineering News* of New York, give off fumes which pass into the car, and which, by irritating the membranes of nose and throat, often greatly inconvenience passengers. The Commissioner has called upon the Interurban Street Railway Co., which operates the line in question, for an abatement of the nuisance, and threatens to stop the running of the storage-battery cars if no remedy is forthcoming. The company replies through its counsel that it is unable to do anything against the fumes, and that the Commissioner has no jurisdiction in the matter, the motive power being virtually protected by the franchise of the line.

Single-Phase Railway in America.—The Westinghouse Company have just secured the contract for the complete electrical equipment of the Washington–Baltimore Railway with single-phase plant. The length of the line is a little short of 40 miles, and there is a branch to Annapolis having an additional length of about 15 miles. There will be only one power-house, at which current will be generated at 15,000 volts and transmitted to step-down transformers placed at suitable intervals,

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which will lower the voltage to 1,000 and feed current direct to the trolley wire. There are to be four 100 H.P. motors on each car, and, the speed being variable, they are said to possess characteristics that adapt them to railway service as well as continuous-current motors. The car equipments are designed for a normal speed of 40 and 45 miles, and a maximum speed of 60 miles per hour. The Westinghouse Company, says the *Electrical World* of New York, have been experimenting with this system for some considerable time, and they are now so confident of success that they have undertaken the whole of the work, and it is proceeding with all speed.

Wireless Telegraphy.—The following letter from Mr. H. Cuthbert Hall, managing director of Marconi's Wireless Telegraph Co., appeared in yesterday's daily papers :—

Your readers may be interested to learn that Mr. Marconi, who left England on August 23rd on the "Carlo Alberto," the flagship of the Italian Navy, has been in daily communication by wireless telegraphy with our long-distance station at Poldhu, Cornwall.

We have received from him to-day from Spezia (Italy) a telegram in which he says that he has received perfect messages direct from Poldhu inside Gibraltar harbour and throughout the entire course of the Mediterranean tour. A reference to the map of Europe shows that the messages must have passed across the Bay of Biscay and Spain, across France and across the Alps.

Telegrams for the King of Italy and the Italian Minister of Marine have been sent from Poldhu and correctly received on the tape of our wireless telegraph receiving apparatus on the "Carlo Alberto" in Spezia harbour.

Mr. Marconi has been commanded to visit the King of Italy, and has been informed by the Italian Minister of Marine that the "Carlo Alberto" is at his disposal for taking part at once in a Transatlantic test of our long-distance stations. The ship will, therefore, take him almost immediately to Cape Breton, where our Canadian station for Transatlantic telegraphy is installed, and subsequently to the long-distance station installed by us at Cape Cod, Massachusetts, U.S.A., and now owned by the Marconi Wireless Telegraph Co., of America.

Trouble on the Charing Cross Co.'s Mains.—Wednesday's daily papers contained a rather exaggerated account of a slight accident which took place on the Charing Cross and Strand Electricity Supply Corporation's mains on Tuesday morning. We are officially informed that the facts of the case are these: Shortly after 8 a.m. it was discovered that there was something wrong on a distributing main in Panton-street, Haymarket, and a man was sent to disconnect the main in question. On opening the necessary surface box the man encountered the flame produced by the burning insulation of the cable, and being badly burnt was unable to make the disconnection. If this had not happened the accident would probably not have been noticed; but as it was the fire spread a short distance, and the fronts of some buildings were slightly scorched. The mains in Panton-street are old ones which have been down some years, and only about 30yds. were affected. The supply was resumed in Panton-street at 9 o'clock on the same morning, and there was no interruption on any other part of the system. The mains in question are laid in ducts with through ventilation, and not on the "solid" system.

Direct 3,000-volt Three-Phase Traction in Italy.—The Italian Government having granted the necessary permission, the Colico–Sondrio and the Colico–Chiavenna sections of the Valtellina Railway in Northern Italy, which have been running for some months past as experimental lines, are now operating a daily service of passenger and goods trains, the inauguration having taken place on the 4th inst. The line from Colico southwards to Lecco along the shore of Lake Como will be completed and ready for operation in a few weeks. The feature of this installation is the use of 3,000 volts three-phase alternating as the working pressure at the motors, power being supplied to the line from a generating station which utilises the water power of the falls of the river Adda, the transmission line pressure being 20,000 volts. The whole of the equipment has been installed by Messrs. Ganz & Co. of Budapest, and a great deal of information respecting the method of working, which is known as the "Kando" system, was given during the arbitration proceedings to determine whether this particular high-tension system or the ordinary continuous-current system at the usual voltage should be applied to the working of the Inner Circle. The essential points of the system were detailed in the evidence on behalf of the Metropolitan Railway Co., and will be found very fully reported in *The Electrician*, Vol. XLVIII., pp. 91, 101 and 132. The length of the lines now actually working in Northern Italy is about 100km., and it is only on account of the good results given by the tests that they have at last been officially sanctioned. One of the worst dangers anticipated was in respect of fire consequent on the high-tension trolley wire snapping and falling on the trains, should the safety device fail to act. During the tests, however, the automatic cut-out has given great satisfaction, the 8,000-volt trolley wire having been allowed to fall on to the roof of the train without doing the slightest damage.

Accident on the Glasgow Electric Tramways.—Shortly after 9 p.m. on Saturday last, a most serious accident occurred on the Glasgow Corporation electric tramway service, which resulted in the death of a lady and the detention of five other passengers in the Royal Infirmary, besides slightly injuring a number of others. At present the cause of what actually took place is chiefly a matter of conjecture, but this much is clear —viz., that when one of the cars had reached the station in Renfield-street, which is on an up-grade, it started to run backwards as the motorman was about to restart towards the terminus at Possilpark. Getting quite beyond the control of the officials in charge, the tramcar gained great speed, and crashing into another one coming up the slope, forced this backwards, and the two vehicles careering downwards at still greater speed came into collision with a third car, and all three travelled some distance before leaving the rails without, fortunately, overturning, although one of them crashed through a shop window. The motorman's story is that when releasing the brakes in order to apply the power to start, the pin of the brake handle fell out and the handle itself came away, which resulted in his overbalancing, and that as soon as he recovered he applied the electric brake, which failed to act. A possible explanation is that the man so far lost his nerve as to have forgotten, when applying the electric brake, to change over the reversing handle as he should have done on account of the change in direction of the car's travel. It may be added that none of the passengers who kept their seats were injured. The report by Mr. John Young, the manager of the Glasgow Corporation tramways, is as follows :—

Car No. 690 proceeding from Govan to Possilpark had reached the head of Renfield-street, and had stopped at the stopping-place before turning into Cowcaddens. As the motorman was applying the hand brake, the brake ratchet handle came away in his hand owing to the locker pin having worked loose and come out, thus allowing the handle to get free from the spindle. These handles are examined daily, and no explanation can be given of this occurrence. Clearly the proper course for the motorman would have been to apply the power at that moment to keep the car forward. The other course was to reverse and apply the electric brake. The latter is evidently what the motorman attempted to do, but in some way not quite clearly explained he failed to stop the car. The motorman says he called to the conductor on the rear platform to apply the brake. In any case, the conductor remained on his platform, and was very severely injured. The car had naturally gained very considerable speed before it reached Sauchiehall-street. The first car in the way was a Pollokshields and University, which was standing on the up rails at the station just below Sauchiehall-street. The driver of this car saw the blue car backing downhill; he put on his brake hard and jumped off. The impact checked the runaway car, but did not stop it. Both cars kept the rails and ran backwards. They did not gain much speed until they crossed the line of Bath-street. The next up-going car was a car from Dennistoun. The driver of this car, seeing the car in front backing down on him, stopped his car below West Regent-street, braked it up and stepped off. This car practically stopped the car running downhill for the moment, but could not hold against the combined pressure and weight. The driver of the Dennistoun car, seeing his car being moved backward by the others, stepped on to his platform hoping to put on power; but in the meantime his conductor, on the top of the car, seeing what was coming, pulled off and tied down his trolley. The three cars moved back to the points at St. Vincent-street. The speed gained at this point was not great, as the driver of the Dennistoun car had no difficulty in stepping off as his car entered the points. The three cars left the rails at the points. The impetus was only sufficient to run the first two cars on to the foot-path over the kerb, which is very low at this point. Traffic was resumed after about half an hour's delay. Neelly, driver of the Possilpark car, has been over six years in the service. He has had about one and a-half year's experience as a motorman, and has always borne a good record and been looked upon as a most reliable man. The conductor of his car, George Campbell, the only employé injured, is also an old servant with an excellent record. He was trained to the duties of motorman as well as conductor.

The Board of Trade appointed Major E. Druitt, R.E., to hold a local inquiry into the accident, and the inquiry was opened yesterday.

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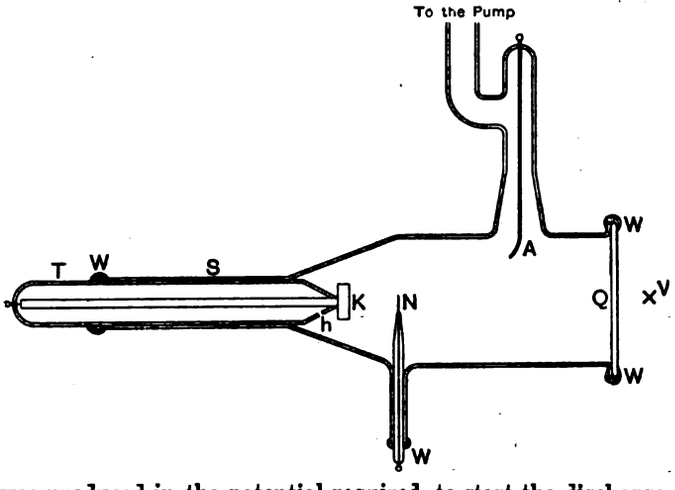
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Cathode Fall and Ultra-violet Light.—The "cathode fall of potential" or "negative drop" is the difference of potential between the cathode and the outer limit of the dark cathode space. According to Stark's theory, the normal cathode fall represents the ionising energy of the positive ions, and varies with the gas and the metal, as well as other circumstances. It is small in the case of the chemically active metals, as these have a great "catalytic" power upon the formation of free positive ions. W. C. Baker has endeavoured to produce some effect upon the cathode drop by using a polished zinc plate, as in photo-electric experiments, and illuminating it with ultra-violet light. He used a tube having a quartz window, Q, a copper wire anode, A, a probe, N, and a cathode, K, attached to a smaller tube, TS, which could be slid out to polish the cathode and refixed with sealing wax at W. The ultra-violet light was derived from the spark of an induction coil at V. The author found that the ultra-violet light produced no effect upon the negative drop, nor did the change of current amount to one-half per cent. But a marked effect



was produced in the potential required to start the discharge. In a case quoted, the reduction was from 558 to 510 volts. The effect was due to an action upon the cathode, and not to a volume ionisation of the gas.

[W. C. Baker, *Proc. Cambridge Phil. Soc.*, Easter, 1902.]

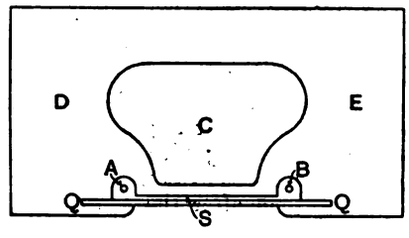
Optical Behaviour of a Charged Metal Surface.—Since positively and negatively charged bodies behave differently in many physical processes, it seems probable that some difference should be observed in the effect of charging a metallic mirror positively or negatively on light reflected from the mirror. P. V. Bevan supposes that a charged metal consists of the metal itself in the ordinary condition with a surface layer of negative electrons or positive ions. The charge will alter the equations for the metallic medium by introducing this new layer, which, however, may be considered very thin as compared with the wave-length of light. The author works out the new equations, and arrives at the conclusion that to obtain a change of phase of $\frac{1}{100}$th of a wave-length by reflection from a negatively charged surface the surface-density must be $\frac{3}{2} \times 10^6$ electrostatic units per square centimetre. This is too great for practical observation. If a condenser consisting of two metallic films deposited on mica be used, and light transmitted through the positive and reflected from the negative film, the effect of the positive film would probably be much smaller than the other, and could be neglected. If the mica were 10^{-4}cm. thick, a sensible change of phase would be obtained with a difference of potential of 90,000 volts between the films. But it is hardly likely that the mica would stand the strain.

[P. V. Bevan, *Proc. Cambridge Phil. Soc.*, Easter, 1902.]

Induced Radio-activity.—J. J. Thomson has undertaken an investigation to see whether the induced radio-activity shown by a metal rod after long-continued negative electrification in the open air would occur if the rod were placed in a closed vessel, instead of outside in the open air. The closed vessel was a zinc gasometer 102cm. high and 75cm. in diameter. The vessel was insulated and used as one of the electrodes, the other electrode being a metal tube placed at the axis of the cylindrical gasometer. These two electrodes served to measure the saturation current through the ionised gas, and any radio-activity of the rod would be indicated by an increase in the ionisation, and consequently in the saturation current. Now, after the rod had been connected with the negative terminal of a Wimshurst machine for six or seven hours no increase in the current could be observed, showing that the rod had not acquired any radio-activity in the closed space. To impart such radio-activity, it was found necessary not only to keep the rod negatively electrified, but to temporarily ionise the air by means of Röntgen rays as well. On the Wimshurst and the Röntgen rays being shut off, the current showed an increase of some 16 per cent., which disappeared on substituting a similar rod which had not been electrified.

[J. J. Thomson, *Proc. Cambridge Phil. Soc.*, Easter, 1902.]

Ionisation of Solutions.—A negative result of some interest has been obtained by J. A. Cunningham in an attempt to ionise solutions by ultra-violet light and Röntgen rays. Such ionisation would shed some light on the disposal of the energy absorbed by a substance with an absorption spectrum. The author experimented with Carey Lea's solution of colloidal silver and various other solutions. He used an electrolytic cell of the shape of which the diagram shows a horizontal section. The body DE of the cell was made of paraffin cast



under the exhausted receiver of an air-pump in order to expel air bubbles. Two vertical holes, A and B, contained the platinised wire electrodes, and a recess, S, was cut into the front of the paraffin until it reached these holes, so that the quartz or ebonite plate, QQ, left a flat chamber with two lateral expansions. The cavity C was left for purposes of cooling by water circulation. No distinct increase of conductivity, apart from the temperature effect, was obtained with ultra-violet light. With Röntgen rays, on the other hand, the author claims to have obtained a distinct though small effect, amounting to 3·7 per cent. in a solution of Hoffmann's violet, 0 8 per cent. in a dilute solution of colloidal silver, and 0·25 in an ammoniacal solution of silver chloride. No effect was found in uranyl or silver nitrates.

[J. A. Cunningham, *Proc. Cambridge Phil. Soc.*, Easter, 1902.]

Pyro-magnetism and Piezo-magnetism.—The phenomena of pyro-electricity and the more recently-discovered piezo-electricity may have magnetic analogies, though no positive results have hitherto been published. W. Voigt discusses them from the point of view of the electron theory, and comes to the positive conclusion that such magnetic analogies actually exist, though they are probably very small. The general argument is that if, as shown by the Zeeman effect, solid bodies contain electrons moving in closed orbits, then these electrons must have conditions of symmetry which depend upon the symmetry of the structure of the body, and nothing is in the way of supposing that crystals of certain systems acquire permanent magnetic moments which might be influenced by heat or pressure. The author is engaged in a systematic search for crystals showing the new magnetic properties. For this purpose crystals are divided into 32 groups, and are examined in the shape of cylinders. So far, the results have been practically negative. The magnetic moment per unit volume of dolomite is about 2,000 million times smaller than the electric moment

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per unit volume of tourmaline. In apatite the ratio is 55 million. It is remarkable that the occurrence of piezo-magnetism is probable in 12 groups of crystals, and that of piezo-electricity in only three. The small value of the effects sought is due to the velocity of light appearing in the denominator.

[W. VOIGT, *Ann. der Physik.*, No. 9, 1902.]

Solar Protuberances and Terrestrial Magnetism.—Sir Norman Lockyer has studied the astronomical observations by Tacchini, Ricco and others with a view to discover some connection between solar phenomena and terrestrial magnetism. He has arrived at the following interesting conclusions as regards the frequency of visible protuberances in the different latitudes of the sun and magnetic storms :—(1) That the epochs of magnetic storms classed by Ellis as "great," and those of the greatest chromospheric activity of the sun *near its poles* are identical; (2) that the general curve of terrestrial magnetic activity is nearly the same as that of the protuberances near the solar equator.

[Sir N. LOCKYER, *Comptes Rendus*, August 25, 1902.]

Nature of Radio-activity.—E. Rutherford and F. Soddy show that the major part of the radio-activity of thorium is due to a non-thorium type of matter, ThX, possessing distinct chemical properties. This substance is temporarily radio-active, its activity falling to half its value in about four days. The constant radio-activity of thorium is maintained by the production of this material at a constant rate. Both the rate of production of the new material and the rate of decay appear to be unaffected by the most drastic physical and chemical transformations. Since the molecular condition of radio-active substances has no effect upon their radio-activity, the latter must be an atomic phenomenon. Since, at the same time, new types of matter are produced, the chemical changes producing them must be occurring within the atom. It is apparent that we are dealing with phenomena outside the sphere of known atomic forces. The only general conclusion we can draw is that the atoms after the process have an energy smaller than their original energy. The properties of matter that fulfil the necessary conditions for the study of chemical change without disturbance to the reacting system are few in number. Radio-activity may, therefore, take its place beside the spectroscope and the polariscope as a delicate and valuable new means of chemical research.

[E. RUTHERFORD and F. SODDY, *Phil. Mag.*, September, 1902.]

Mechanism of Induced Radio-activity.—J. J. Thomson, after describing some further experiments on air bubbled through water and on the ionisation of air by a charged rod, furnishes the following theory of the phenomena observed. In consequence of the negative electrification of the wire, positive ions move up to it when it is placed in an ionised gas; some of the ions do not discharge to the wire, but stick close to it, forming a coating of positive electricity round it. Between this coating and the wire there will be a strong electric field tending to draw negative electricity from the wire. This will enable negative electrons to leave the wire, and if they thus move through a difference of potential of 2 volts they will ionise the gas by ionic shock. Thus the ionising power of the wire is due to a kind of polarisation, and the author has, indeed, succeeded in producing a similar ionisation by means of a polarised negative electrode from an electrolytic cell. A similar theory will explain the fact that bubbling through water greatly increases the ionisation of the air. The drops carried through the glass wool cannot greatly exceed 10^{-5}cm. in diameter. A layer of positive ions outside would pull out the negative electrons as before, and each drop would become a kind of cathode emitting ionising cathode rays. The positive layer would be formed through the medium of H_2O_2.

[J. J. THOMSON, *Phil. Mag.*, September, 1902].

Dimensions of Cathode Phenomena.—Goldstein's first, second and third cathode layers are now known as the canal rays, the Hittorf or Crookes dark space, and the negative glow light. N. Hehl has made a special study of their dimensions in various circumstances. He confirms the observation that the cathode drop remains constant as long as the cathode is only partly covered with light. The length of the glow is directly proportional to the current strength. As long as the cathode is not quite covered the current strength is also independent of the amount of light covering it. The ratio of current density and pressure is constant in nitrogen, whereas in hydrogen the ratio of current to the square of the pressure is a constant. When the cathode is quite covered the potential increases directly as the current. The length of the canal ray space increases first rapidly, and then slowly, while the dark space decreases rapidly and then sinks down asymptotically. The most characteristic quantities in a vacuum discharge are the cathode drop, which is independent of the pressure but dependent upon the gas and the metal, and the current density existing when the cathode is incompletely covered with light. The latter is lower in hydrogen than in nitrogen, and lower with a cathode of platinum or graphite than with one of aluminium.

[N. HEHL, *Physikal. Zeitschr.*, September 1, 1902.]

Gaseous Discharge in a Rotating Magnetic Field.—As an extension of Lecher's experiment with a conductor in a rotating magnetic field, J. J. Taudin Chabot substitutes for the wire a vacuum discharge. The magnet used was a bell electromagnet, and against its central piece was mounted a vacuum tube so that the magnetic field between the centre and the circumference of the bell magnet traversed the tube radially. The current thread in the vacuum tube revolved about the magnet pole in the usual manner as discovered by Ampère, making about one revolution per second. Then the magnet and tube were set in rotation about a vertical axis, the connections being kept up by means of sliding contacts. It was then noticed that the rotation had a well-marked influence upon the magnetic rotation of the current thread, contrary to the case in the wire. The rate of rotation was sensibly accelerated by mechanical rotation in the same sense, and retarded or even reversed by a mechanical rotation in the opposite sense. On suddenly reversing the direction of rotation, it was noticed that the portions of the discharge nearest the electrodes changed first, and that the middle portion was dragged round apparently with reluctance. No induced currents owing to the alteration of the rotation were noticed.

[J. J. TAUDIN CHABOT, *Physikal. Zeitschr.*, September 1, 1902.]

Absorption of Projected Electrons.—It is well known that the absorption of cathode rays by thin metallic plates decreases when the discharge potential—*i.e.*, the velocity of the projected electrons—is increased. W. Seitz has studied the quantitative relation between absorption and discharge potential, and declares that the coefficient of absorption is inversely proportional to the fifth power of the velocity, or the $\frac{5}{2}$th power of the difference of potential. This law would mean that the penetrative power of projected electrons is enhanced 243 times by increasing their velocity three times. The investigation required the knowledge of the discharge potential, the number of electrons passing through the Lenard window, and the number of electrons absorbed by it. The potential was obtained from an electrometer attached to the cathode. The cathode rays absorbed by the window were measured by means of a galvanometer connected with it, and those penetrating the window were caught in a metallic box connected with a second sensitive electrometer, which served to measure the unabsorbed rays. The voltage employed ranged from 13,200 to 15,800. The author intends to extend the range of potentials. The window used was a piece of aluminium foil 0·00082cm. thick, attached to a platinum tube by Wien's method.

[W. SEITZ, *Physikal. Zeitschr.*, September 1, 1902.]

The Milan–Gallarate Electric Railway.—In consequence of the serious collision which took place a few weeks ago, this line has now been equipped with an automatic electric block system of signalling.

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THE WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.*

(*Continued from page 744.*)

Switchboards.—As will be seen from the diagrammatic plans, the high-tension switchboard, which is placed at the west end of the building, occupies four galleries. The main operating board is on the third gallery of the engine room, on practically the same level as the top engine platform. The course of the current from a single generator can be traced by referring to Fig. 6, which is a vertical cross-section through all four galleries. From the generator the current is carried in single conductor cables through the generator oil switch A on the first gallery to the oil selector switch B on the top gallery. The object of these selector switches is to permit the generator to be connected to either the main or auxiliary 'bus bars, both of which run along the rear of this gallery. From the 'bus bars the current passes down through two oil-break switches, D and E, to the feeders. The object of having two switches in series is to make certain that one at least will operate to cut off the feeder when necessary. From the oil switches the feeders pass down to the basement and out into the subways, as shown in Fig. 7. The vertical section, 4ft. wide through the switchboard galleries, thus contains all the high-tension connections of one generator, and is so thoroughly protected by the fireproof brick partitions that it is claimed that one section complete with cables, switches and transformers might be burned up without injury to any of the others.

Oil Switches.—The oil switches used are of two types, one furnished by the General Electric Co., and the other by the General Incandescent Arc Light Co., both being new types. In the oil switches supplied by the General Electric Co. six simultaneous breaks are made by the raising of copper connecting U's fastened to a common yoke by wooden rods. Fig. 8 shows the connections for operating these switches. The heavy lines on the right indicate the course of the high-potential current from the 'bus bars to the underground transmission lines. The lighter lines show the connections for operating the oil switches and indicating instruments. The switch designated "automatic" is so called because it is opened by an overload relay, the non-automatic switches being controlled only from the switchboard. With the connections as shown the oil switches are open. They are closed as follows:—The small controlling switch marked SPDT is raised, thus making contact on the upper point. This closes the circuit through a ½ H.P. series motor and a solenoid shown at the end of the shaft. The motor starts, and at the same time a worm and gear wheel is connected to it by the action of the solenoid. The gear wheel revolves and carries a crank-pin off a dead centre, which pin is the middle point of a toggle. As soon as it is carried out of line, a powerful spring closes the oil switch, carrying the crank pin through nearly 180deg. This motion is independent of the motor, which runs free, gaining speed as the spring closes the switch. There is a ratchet connection between the crank shaft and gear wheel which permits the former to be carried around by the switch mechanism free of the latter. The moment the action of the spring ceases the ratchet catches and the crank-pin is carried through the remainder of the 180deg. by the motor, which then cuts itself off. The crank pin is then again on a dead centre, being now the lower point of a toggle. During the latter part of the closing action the opening

* Abstract from the *Electrical World* of New York.

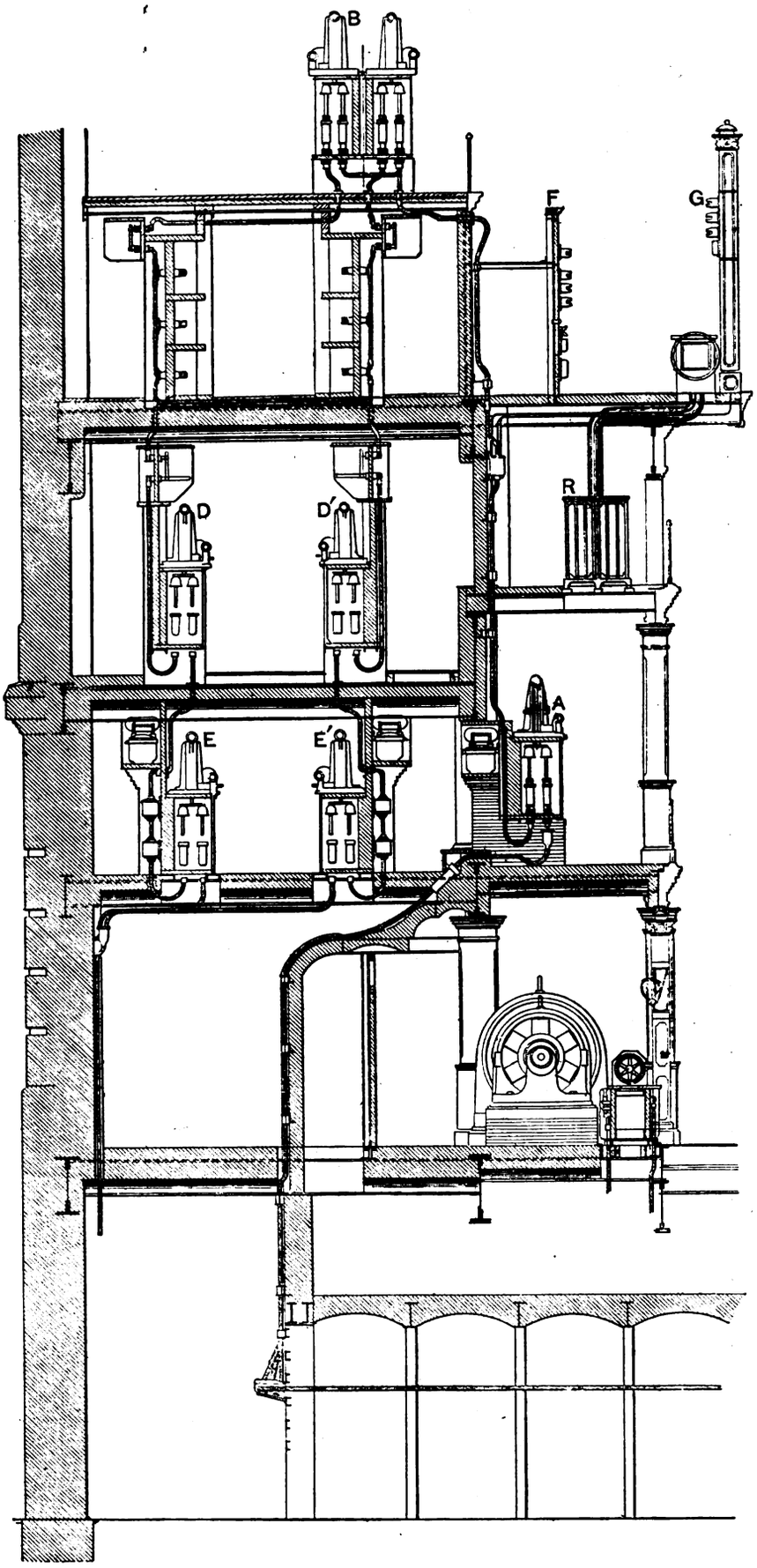

FIG. 6.—SECTIONAL VIEW OF HIGH-TENSION SWITCHBOARD.

A Generator oil-switch. B Selector oil-switches connecting generator to either main or auxiliary 'bus bars. D Non-automatic feeder oil-switch. D' and E' Same for another feeder. F Feeder instrument panel. G Generator instrument panel. R Field rheostat controlled from generator pedestal.

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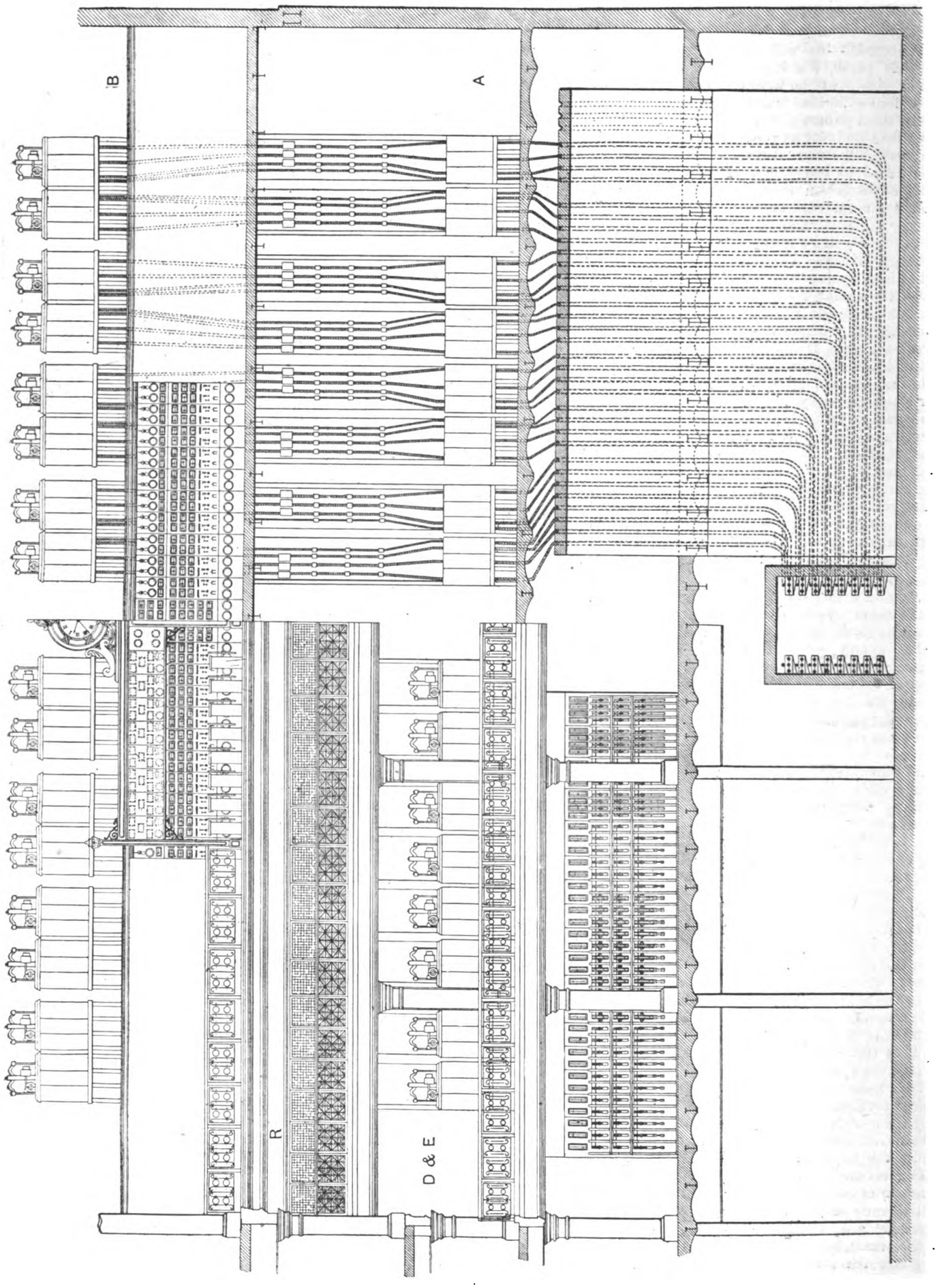

FIG. 7.—PART ELEVATION AND SECTION OF FIVE-STORY HIGH-TENSION SWITCHBOARD

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spring is compressed and four spiral springs are extended, all tending to open the switch, but unable to do so because of the condition due to the dead centre. The entire operation takes about one second.

The main switch may now be opened by throwing the operating switch to the lower contact, closing the motor circuit through the finger 2. The toggle is thus upset and the switch flies open, actuated not only by the opening spring, which is similar to that which closes the switch, but also by the four extra springs. The opening is therefore made even quicker and more certain than the closing action.

The only difference between the automatic and non-automatic oil switches is that the controlling switch of the former, marked "Aut. Switch" in the figure, in addition to being operated by hand, is opened by a tripping solenoid in

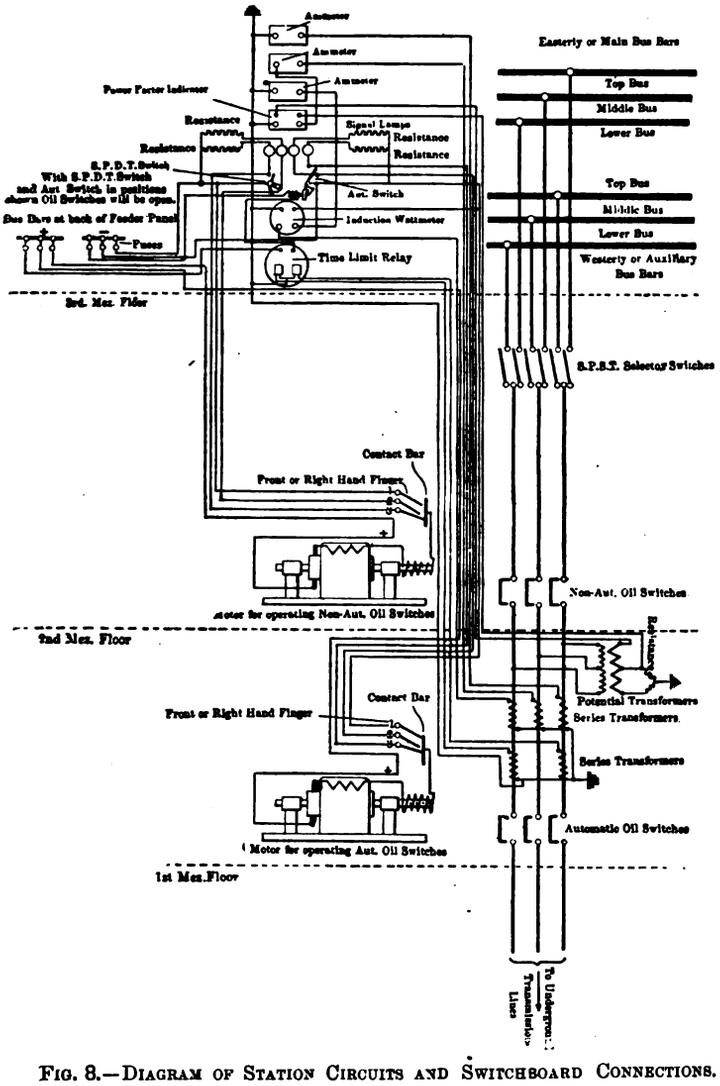

FIG. 8.—DIAGRAM OF STATION CIRCUITS AND SWITCHBOARD CONNECTIONS.

case of overload. Guide rods are provided, which prevent binding against the soapstone cover and ensure the accurate alignment of the contact parts. If it is desired to operate the compartment switch by hand, a pair of rods with screw eyes at the base are provided, into which can be hooked a handle for operating it manually. Air bumpers are supplied to take up the final rush of the solenoids, so that no jar is transmitted to the supporting structure.

Fig 9 shows the connections by which the main switch is operated from the switchboard or by the time limit relay. The cut shows the switch open; to close it, close the operating switch, thus energising the right solenoid. The switch starts to move and almost instantly the blade A moves from point 1 to point 2, shutting the operating switch, so that the motion of the main switch must continue until it is completely closed. At the moment of closing the blade A moves from point 2 to point 3, leaving the switch ready to be opened. In opening, the blade A jumps first to point 4, shunting the operating switch, and when the main switch is open, returns to 1, completing the cycle and leaving the connections, as shown in the figure. The time limit relay is operated by current transformers in the feeder circuits. Should the current in the feeder exceed the amount for which the device is set, one of the small plungers shown is raised, and releases a disc, which revolves until it closes the circuit of a tripping solenoid which opens the operating switch. This opens the main switch in the manner already described. The relay may be set so as to take any desired amount of time after the contact disc starts before it finally opens the operating switch. The figure also shows the connections by which the pilot lamps indicate to the operator the position of the main switch. The contacts for this are independent of the position of the operating switch.

The General Incandescent switch chamber is of brick, divided by soapstone partitions into three compartments, one for each phase, and has a removable soapstone front. In each compartment are two oil wells, consisting of seamless brass tubing, with insulating lining, mounted upon porcelain

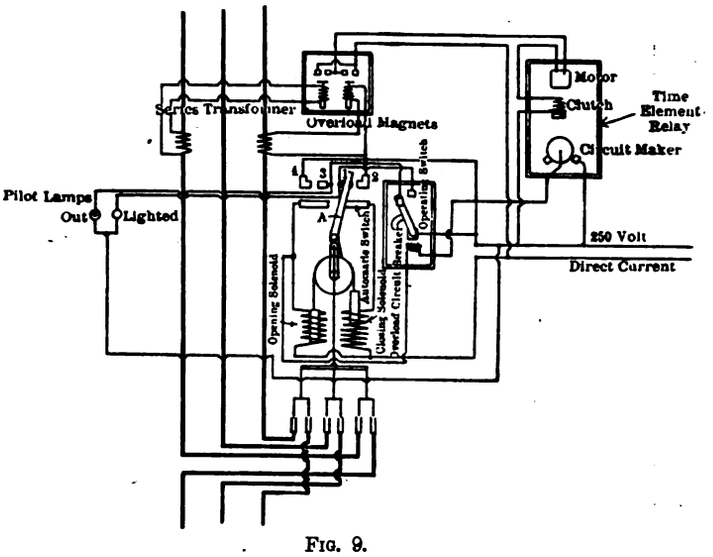

FIG. 9.

insulators and connected by an inverted copper U connector. A wooden rod, which, after heating to drive out the sap, has been boiled in paraffin for 24 hours, connects this U to an iron rod at the top of the switch to which the U's in the other two phases are similarly joined. This iron rod has a motion of over 14in., and when raised lifts the U's in the oil chambers so as to make two 12in. breaks in each phase. The switch is actuated by two solenoids, which operate a crank and connecting-rod movement so arranged that very little work is required of the solenoid at the beginning and end of its motion. The cores of the solenoids are connected by a steel tape passing over a wheel, which is turned 180deg. to the right or left, as the right or left solenoid is excited.

The Low-Tension Selector Switchboard.—The low-tension selector switchboard (Fig. 10) on the first floor really consists of two distinct switchboards, each with three sets of 'bus bars, which in case of emergency can be connected together. One of these is the exciter switchboard, from which is supplied current to the fields of the generators, and all the apparatus for operating the generator and feeder oil switches, relays, &c. The other switchboard is that of the local rotary converter sub station, which supplies the low-tension feeders in the neighbourhood, and also the crane, elevator and other motors in the building.

For the exciter 'bus bars the current is furnished by the four exciter generators and exciter storage battery, which will be charged by a special booster. In general practice the exciters and generator fields will be connected to the lower set of 'bus bars, which will be run at a potential of 240-250 volts. If it is necessary at the same time to carry the extreme

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overload with low power factor on some of the generators, thereby requiring maximum field excitation, their fields will be connected to the upper 'bus bars, which will be supplied with current via the booster, or by an exciter run at higher voltage. The middle 'bus bar of the exciter switchboard will be connected by the tying-in switch to the same 'bus bar on the local rotary switchboard, so that current from the rotaries can be used for field excitation in so far that current from the rotaries or from the feeders connected to the general external low-tension network can be used for field excitation in case of emergency.

The exciter generators will feed the 'bus through reverse current circuit breakers, so that in case of the high-tension circuit breaker opening on the alternating-current motor, the direct-current generator will be automatically disconnected from the 'bus as soon as it runs as a motor. For the local rotary station 'bus bars the current will be supplied by six rotaries of 500kw. capacity each, a local storage battery and a local booster. To this 'bus are connected eight low-tension feeders, which supply the section of the city between Fourth Avenue and East River and 30th and 50th-streets.

At present there is but one battery and one booster installed, and the two switchboards are operated as one. This was

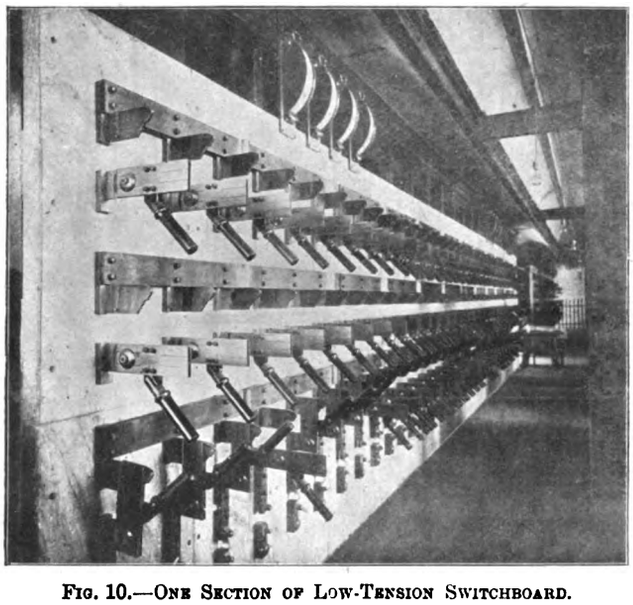

Fig. 10.—One Section of Low-Tension Switchboard.

rendered possible by having the fields of the main generators, the fields of the exciter generators, the motors (or solenoids) on the oil switches, tripping coils of the time limit relays, crane motors, elevator motors, coal conveyor motors, &c., all wound to operate satisfactorily at from 240 to 250 volts.

All the ammeters are of the Van Vleck edgewise pattern, manufactured by the Weston Electrical Instrument Co. They are of the shunt type. For the ammeters on the feeders, part of the conductor is used for the shunt. In all other cases special alloy shunts are used.

Low-Tension Operating Switchboard.—The rheostat dials, switches, &c., for controlling the exciters, rotaries and boosters are mounted upon pedestals, and directly above the pedestal of each machine is a marble panel containing the instruments. On each exciter pedestal there is a direct-current main switch, the field rheostat dials, field-break switch and the pilot switch and overload relay for controlling the oil switch. Above these are the field rheostat dial, the field-break switch, receptacles for synchronising and balancing plugs, and pilot switch for operating the magnetic switches which are placed between the static transformers and the rotary. On the booster pedestals is a combination starting and main switch for the booster motor, and main switches for closing the circuits of each of the booster dynamos.

The 'bus from which current is to be taken and the 'bus to which it is to be fed are determined by the switches on the selector switchboard. Above these are the rheostat dials for each dynamo, field switches, &c. The apparatus for the control of the battery is mounted directly above the booster pedestal. This consists of four special reversing switches of the push-button type to control the motors operating the cell switches, which are placed in a room in front of the battery room and separated from it by an "acid fume proof" partition. Above the push-button switches are the indicators, which show the number of cells in circuit—that is, the position of the end cell switches.

The Cable Vault.—The cables coming from the generators are carried on cable racks through a cable vault running the full length of the operating room between the two rows of engine foundations. A view of this vault showing some of the cables in position is given in Fig. 11. Each rack contains three lead-covered, paper-insulated, single-conductor cables of 500,000 circ. mills cross-section, two lead-covered cables carrying the field current, and smaller wires for the motor operating the engine governor, signalling, &c. Each rack contains the wiring for one generator, and is separated from its neighbours by fireproof partitions. From the cable vault the cables are fanned out and pass up through bricked-in ways to the oil-break switches on the first switchboard gallery.

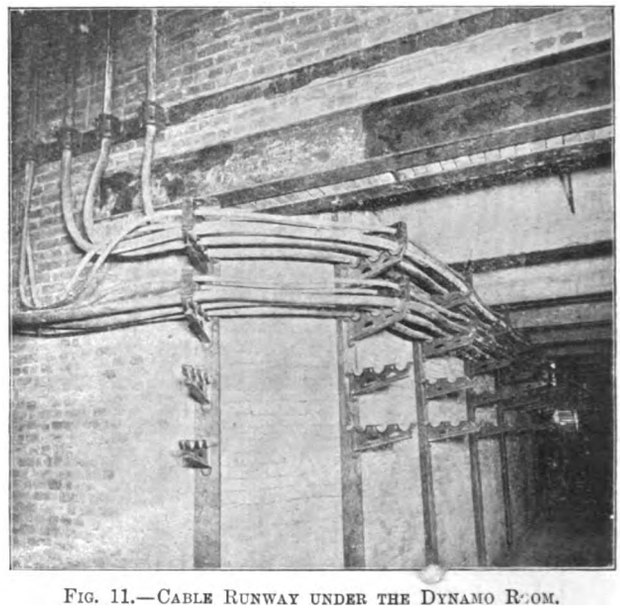

Fig. 11.—Cable Runway under the Dynamo Room.

The vaults by which the cables leave the building are of most ample and solid construction, there being in reality a fine large cable chamber extending out from under the west front of the station, with abundant duct capacity for increase in service up to the full generating limit of the plant.

(*To be concluded.*)

SOME NEW POLYPHASE MACHINERY.

Messrs. Dick, Kerr & Co. inform us that they have recently standardised a complete series of alternating-current machinery, including three-phase generators and induction motors. Among a number of contracts of considerable size which they are completing are sets of three-phase plant for the London County Council generating and sub-stations, the Sydney Corporation and the Stalybridge, Ashton and Dukinfield joint electricity board, a large two-phase generator for the Fulham Borough Council, and some single-phase alternators for the Bexley District Council.

Following the practice which they have adopted in their continuous-current machinery, Messrs. Dick, Kerr & Co. construct the stator frame of cast iron and built in two halves, which are securely bolted together by means of finished bolts. The lower half of the frame is provided with feet, which rest upon the foundation bed-plate, and in the larger machines this half of the frame is provided with a special screw, which will permit the stator frame to be racked over to such a position as to leave the rotor completely exposed. Following the usual practice, the stator core is made of thoroughly annealed soft iron laminations,

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the individual laminations being well insulated from each other. The iron comprising the laminations is of a special composition, which has been arrived at after a great number of experiments, and, the manufacturers state, is practically free from the increase of the hysteresis loss with age to which much attention was drawn a few years ago. The laminations are held in position in the frame by means of retaining machined bolts.

The coils of the stator winding are former wound and embedded in rectangular slots held in position by wooden wedges, and they can, in consequence, be easily and quickly replaced. Fig. 1 shows the general design of the stator frame. The coils are protected outside the laminations by means of a cast-iron shield cast in sections and bolted to the frame, this being easily removable. This shield, being perforated, does not interfere with the ventilation of the stator winding.

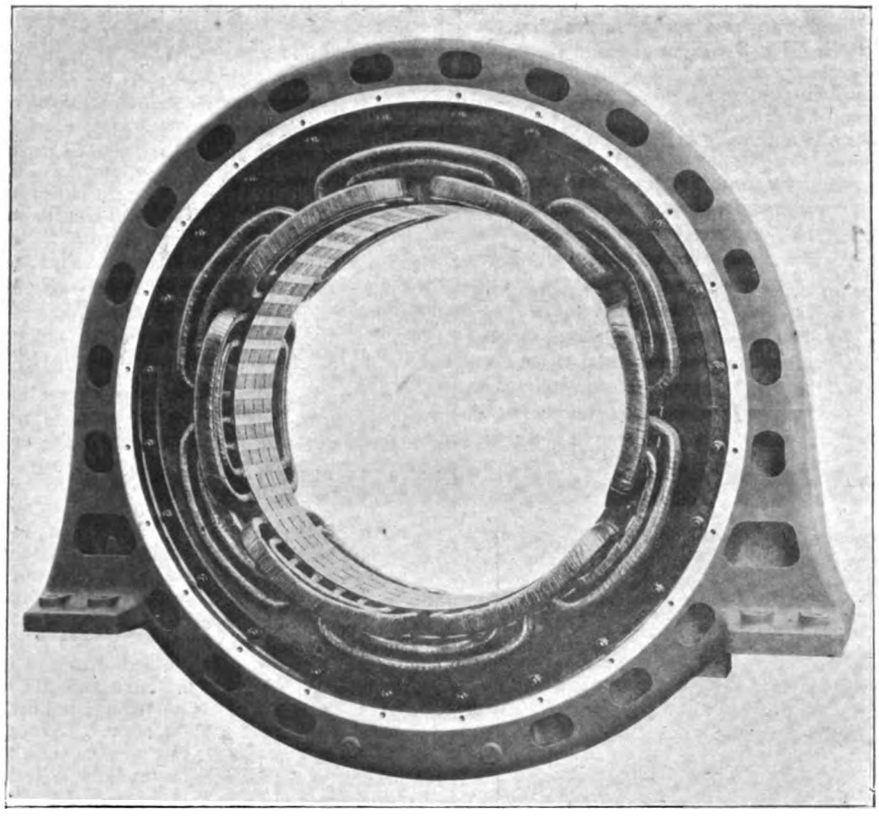

FIG. 1.—STATOR OF MESSRS. DICK, KERR & CO.'S THREE-PHASE ALTERNATOR.

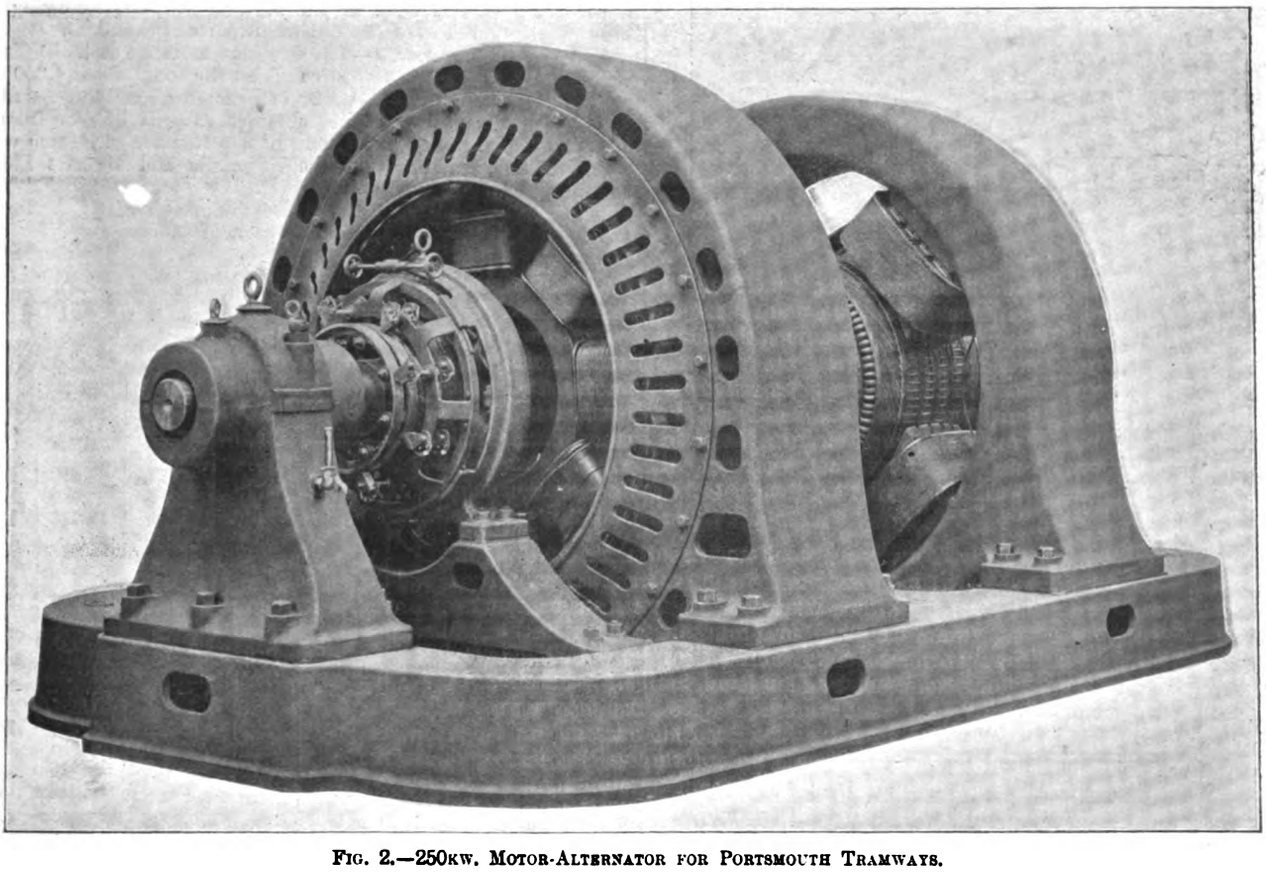

FIG. 2.—250KW. MOTOR-ALTERNATOR FOR PORTSMOUTH TRAMWAYS.

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The rotor spider is made of best quality cast iron, and, as seen in Fig. 3, is of strong design. Its hub is provided with a flange for bolting to engine flywheel, and it is pressed on to the shaft by hydraulic pressure and key seated. On the spider rim dovetailed laminations are secured by means of machined bolts and cast-iron flanges, and are then ready to receive the pole-pieces. Ventilating spaces are provided in the laminations and spider for cooling the field coils. The rotor shown in Fig. 3 differs slightly from the standard practice in that the coils are mounted on a steel rim. The pole-pieces are made of laminated steel, and held together between two cast-iron steel end plates. Their upper part is of a T-shaped construction, designed to hold the field coils firmly in position, and the lower part of the pole-pieces is dovetailed for fixing on the rim of the rotor, and is held in position by means of keys. The removal of the field coils is effected by sliding the pole-pieces from the dovetailed groove parallel to the shaft, and this is accomplished without disturbing any other part of the machine. In accordance with standard practice the shape of the pole-pieces is designed to give a distribution of the lines of force in the air-gap to produce an approximately sinusoidal E.M.F. wave.

When the excitation voltage permits, the field coils are wound with a single layer of copper strip, wound edgewise and insulated between the turns by means of a specially-prepared fibrous insulation. The external surface of the windings is left bare, being protected by insulating varnish only, thus allowing a rapid radiation of heat.

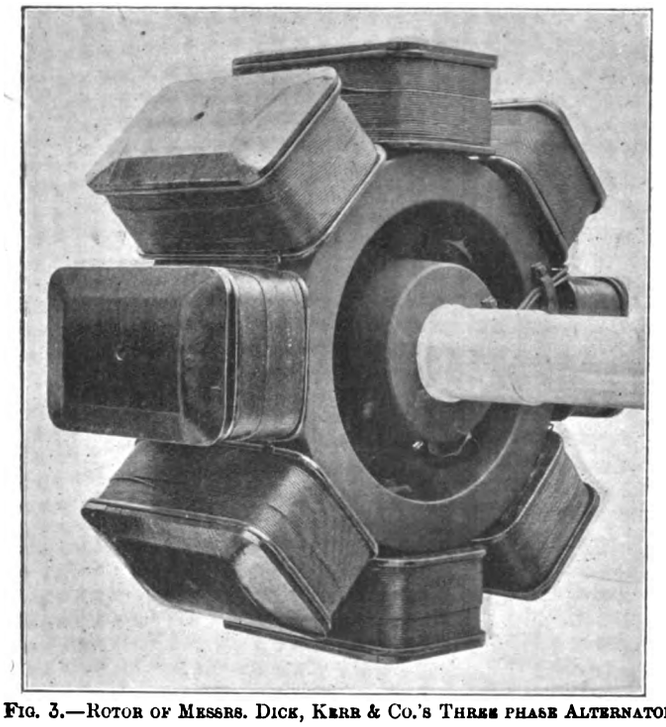

FIG. 3.—ROTOR OF MESSRS. DICK, KERR & CO.'S THREE PHASE ALTERNATOR.

In testing the machinery before delivery the field windings of the rotor are subjected to an insulation test of 2,500 volts alternating current between the coils and the frame, and windings of the stator are tested at from two to three times their normal voltage.

Figs. 1 and 3 are portions of a set of machines which are being made for the Portsmouth Corporation and the Horndean light railways. They comprise four motor alternator sets, a complete view of one being given in Fig. 2. Two of these sets will be placed in the generating station of the Portsmouth tramways, three-phase high voltage current being transmitted to a sub-station on the Horndean light railway system. At this sub-station the alternating side of the combination will become the motor, continuous current being taken from the other end of the machine direct into the line. The effective kilowatt capacity of this machine is 250.

Some recent tests which the makers have made on these sets gave a temperature rise, after six hours run, of 39°F. on the stator core, and on the field about 70°F.

Large Transformers.—What are said to be the largest electric transformers ever manufactured, says the *Electrical World* of New York, have been put in operation at Chambly and Montreal. These transformers are 20 in number and have a total capacity of 750,000 lights. By their use the voltage is raised to 25,000, and transmitted to Montreal, where it is lowered to 2,000.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO.'S POWER STATIONS.*

BY W. D. HUNTER.

The Forth Banks station of the Newcastle and District Electric Lighting Co. was originally equipped with three Lancashire boilers, 30ft. by 7ft. 6in., and four Parsons single-phase turbo-electric alternating generators of 75kw. capacity each, and the total capacity at present is 3,000kw. This includes two 400kw. continuous-current turbo-electric generators, which were erected about two years ago to meet the immediate demand for electrical energy for power purposes. This demand continues to grow, and in order to keep pace with it the Newcastle and District Electric Lighting Co. are now erecting at their new works in the Close two continuous-current turbo-electric generators of 1,000kw. capacity each. The Forth Banks works are peculiarly situated on the side of a hill, the engine and boiler rooms forming terraces one above the other. Advantage of such a site could not have been taken without great expense had it been necessary to provide substantial engine foundations, but with the Parsons turbine these can practically be dispensed with. The total area of the engine-room is only 400 sq. yds., and in that space, as stated above, there are fixed turbo-generators representing a total capacity of 3,000kw. Water is drawn for condensers from the river Tyne. The water pipes are laid in a brick-lined tunnel about 100yds. long, and terminate in a condenser chamber sunk to mean tide level. There are two sets of condenser plant—one for surface condensation dealing with light loads, and the other for jet condensation and capable of condensing 48,000lb. of steam per hour. Fig. 1 shows the engine-room. The pumps are worked by an engine fitted with rocking levers and spear rods, the engine being fixed at boiler-room floor level. This plant was made by Messrs. R. and W. Hawthorn, Leslie & Co., and has been at work for nine years to the entire satisfaction of the company.

The site of the new works (the Close works) at present being constructed and equipped, is immediately on the side of the river Tyne, situated about midway between the High Level and Redheugh bridges. The works when completed will have a capacity of 12,000kw., or about 20,000 I.H.P. The engine and boiler rooms, with coal store overhead, run parallel with the river from which the circulating water for condensers will be drawn. Coal will be brought to the works in barges, and conveyed to the coal bunkers and furnaces by special plant. The workshops, stores, &c., will be situated at the east end of engine room, where provision is left for building these on. The cross section, Fig. 2, shows clearly the relative positions of the various parts of the machinery. The following is a brief description of the more important parts of the plant.

Turbo-electric Generators.—The two generators are each of 1,000kw. capacity, the E.M.F. being 500 volts and the speed about 1,800 revs. per min. By adopting this size of generator, excellent results in regard to economy of steam are obtained, as will be seen from the following table, giving particulars of a test made at Heaton works on one of the generators for the Newcastle and District Electric Lighting Co.'s Close works.

It will be observed from Fig. 3 that the machine is of the tandem form, and has really two dynamos, each of 500kw. capacity. The armatures are interchangeable, and if necessary one dynamo may be run independently of the other. The steam turbine portion of the generator is of the makers' latest improved construction, and is

Speed.	S.V.P.	Cyl. Vac. 30" bar.	Super-heat F°.	Volts.	Average kw.	Water:	
						Per hour.	Per kw.-hour
1,690	138	26·0	71	500	1011·6	21,734	21·48
1,680	140	26·0	86	500	909·0	18,610	20·47
1,700	142	26·2	128	500	894·6	17,760	19·85
1,660	144	26·3	132	500	890·7	17,020	19·1
...	144	26·3	135	500	882·9	17,171	19·43
1,700	145	26·3	137	500	874·04	16,983	19·43
...	145	26·3	137	500	901·06	17,500	19·42
1,680	146	26·3	136	500	896·7	17,302	19·29
1,640	142	26·4	136	500	862·2	16,479	19·11
...	142	26·6	133	500	877·2	16,800	19·15
1,640	146	26·3	131	500	944·17	17,903	18·96
1,660	140	26·3	142	500	986·6	18,434	18·78
1,710	135	26·3	146	500	942·5	17,559	18·52
1,710	135	26·4	182	500	942·6	17,460	18·52
...	140	26·5	195	500	878·06	15,857	18·06
1,710	146	26·6	221	500	863·28	15,493	17·94
...	145	26·5	237	500	897·84	15,922	17·73

It should be noted that these results were obtained when the machine was running some 10 per cent. under full load. At full load, with a 27in. vacuum and 240°F. superheat, the consumption would fall to about 17·0lb. per kilowatt-hour.

* Abstract of a Paper read before the Newcastle meeting of the Institution of Mechanical Engineers.

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arranged for the full expansion of steam from the boiler pressure to that corresponding to within 1in. of the barometer. The expansion is carried out in three barrels or cylinders of definite length and diameter to suit. The revolving portion is carried on large journals, and transmits the power to the armatures through a special claw coupling arranged at one end. At the opposite end a worm and thrust collars are fitted, the former being geared to a wheel which works the oil pump for automatic lubrication by means of a crank-disc shaft. The fixed portion of the cylinder is designed to rest upon the supports provided at each end, and at the exhaust the foot is rigidly bolted to the bedplates, while at the steam end provision is made for the foot to slide on the pedestal without altering the alignment; provision is thereby made for any alteration due to expansion.

Steam is brought right on to the cylinder top, and is controlled by suitable valve gear as near to the working shaft as possible, so that all losses are minimised. The steam enters the first chamber and passes the "runaway" valve, which, under ordinary working conditions, is open; the steam is then in contact with the working valve, and the quantity passing is controlled by means of the steam relay gear fixed directly above. This gear is automatic in its action, and works in conjunction with an electrical solenoid. In addition, there is provided a pulsating motion to keep all parts of the lever and valve gear in movement, and to ensure prompt action on any change of load being made. The electric solenoid is energised by the main circuit, and maintains automatically constant voltage at all loads. The action is as follows:—Should the voltage rise above the normal on change of load the solenoid core is lowered, and a small balancer piston hung at the opposite end of the lever is raised a proportionate amount; this allows the steam which keeps the regulating valve in action to escape more quickly, and the valve closes a little. If the voltage falls the opposite effect is produced, and so quick is the response to any change of load that it is easy to maintain the pressure within 2 per cent. of the normal.

The dynamos are of the latest type, and embody all the improvements which experience alone can show to be desirable. Great care is taken to ventilate the armature thoroughly, and as much skill is required to effect a balance, extra attention is given to the various parts both before and after they are assembled on the shaft. The brush rocking-gear is very interesting; it is automatic in its action, and is controlled directly from the steam cylinder. The effect is to place the brushes instantly on the best working position of the commutator, no matter what the change of load may be. The floor space occupied by each machine is 38ft. 6in. by 6ft., or only 231 sq. ft. area.

The heaviest parts do not exceed:—

Cylinder bottom	5½	tons.
„ cover	3½	„
„ shaft	2½	„
Armature	3	„

Boilers.—The five boilers at present erected were made by the Stirling Boiler Co. Each of these boilers is capable of evaporating 18,000lb. of water per hour at 250lb. pressure per square inch. The boilers are fired with chain-grate stokers, which work with absolute smokelessness in this type of boiler. Each boiler consists of three top drums and two lower water drums connected by banks of tubes. The feed is admitted to the back top drum, passes down the last bank of tubes and thereby comes in contact with the hot gases before they leave the boiler, thus reducing the chimney temperature to a minimum. The feed-water being heated in its passage down the back bank of tubes deposits mud and sediment in the bottom drum, whence it can be readily blown off, and as this drum is far removed from the fire no injury will result from a considerable accumulation of solid matter in same. This arrangement of the boiler thus has an economiser and purifier action, so that if there is any deposit it takes place in the rear position, and the water is purified before reaching the tubes over the fire. With the special design of combustion chamber, surrounded on three sides with fire brick, a high initial temperature is obtained, thus ensuring perfect combustion and an absence of smoke; it also admits of an inferior quality of coal being burned with high efficiency. The design of the boiler is simple, as the tubes are expanded direct into the drums, and access to the interior is obtained by opening five manhole doors. The makers supply a simple arrangement for cleaning the interior of the tubes, and provision is made for a steam-jet to blow soot off the outside surfaces.

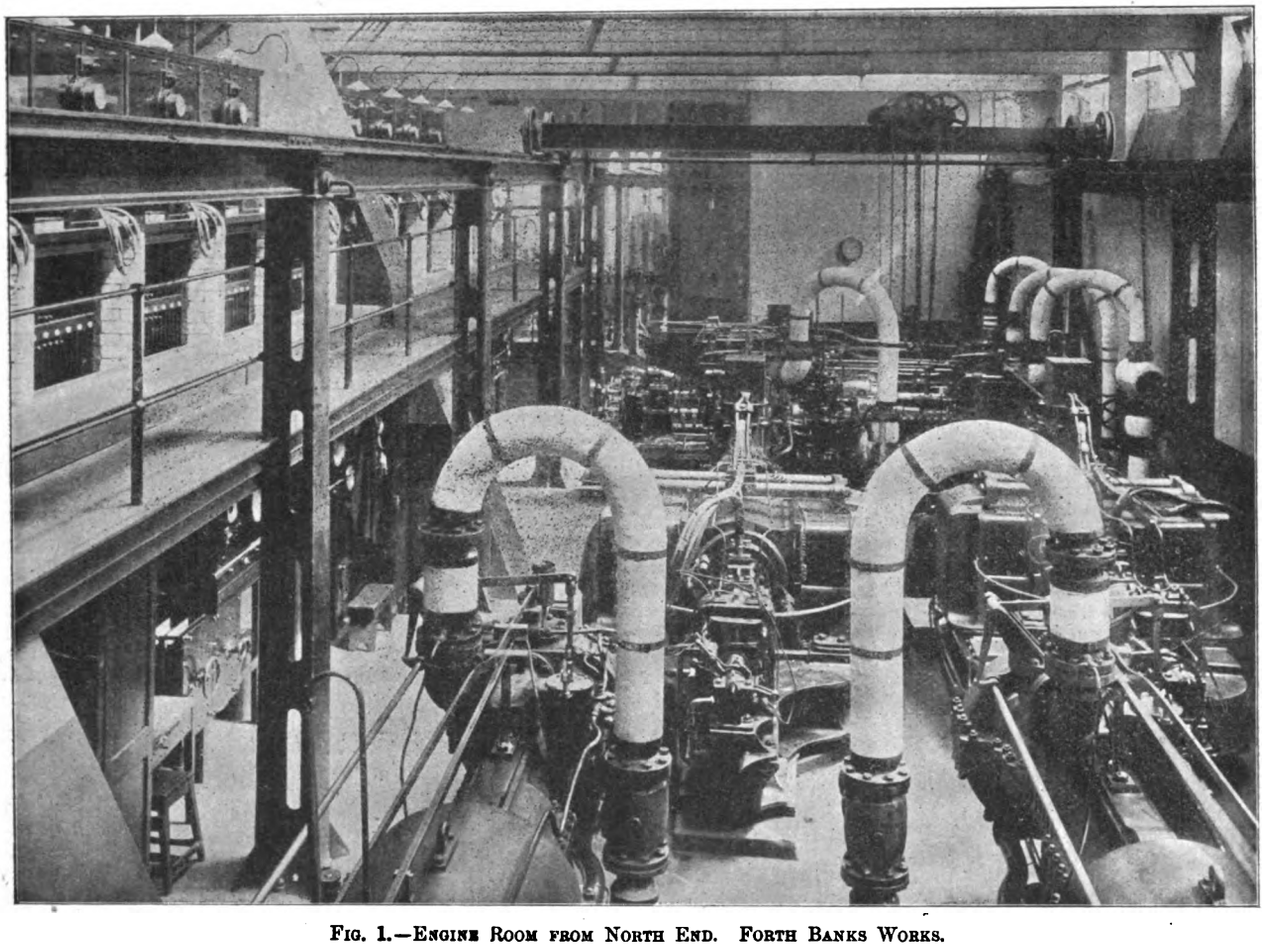

FIG. 1.—ENGINE ROOM FROM NORTH END. FORTH BANKS WORKS.

Boiler Feed Pumps.—The boiler feed pumps are supplied by Messrs. G. and J. Weir, Cathcart, and consist of two of this firm's well-known standard single direct-acting pumps, each 9½in. diameter water cylinder by 12½in. steam cylinder and 24in. stroke. These pumps are single cylinder double-acting and vertical. The pump ends are of cast iron, fitted with gun-metal liners, and the pump rods are of cold rolled manganese bronze. The valve gear is positive—that is, the steam valve can never be in such a position that the

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pump will not start immediately steam is turned on. In these pumps the steam is use expansively, and the cut-off can be regulated from the outside while the pumps are working, thus making them extremely economical as regards steam consumption. The pumps are very simple, and all the parts are readily accessible.

A 15-ton overhead traveller, supplied by Messrs. Vaughan & Son, Manchester, spans the Close works engine-house. The girders and end carriages are of the box riveted type, the latter being each fitted with two steel-tyred travelling wheels. The crab is carried on four steel runners, keyed on steel axles revolving in gunmetal bearings; spur gearing is used throughout, the whole being machine-cut with the exception of the barrel wheel and pinion. In conjunction therewith a magnetic brake is provided to sustain the load. When current is switched on to the hoisting motor, it puts into circuit an electromagnet possessing sufficient power to raise the brake lever, and render the brake inoperative at the moment that hoisting or lowering commences, and also during their continuance. Directly current is switched off the motor, the brake applies itself automatically and without any attention whatever on the part of the operator. The advantage of this is obvious, as if from any cause during working operations the current should fall, the brake magnet would instantly release the brake and allow it to take charge of and sustain the load. There are two barrels, each machine-grooved and fitted with wire rope; the large barrel has right and left-hand grooves to secure vertical lifting and equal distribution of load on both girders. Both barrel hooks revolve on hardened cast-steel balls and plates.

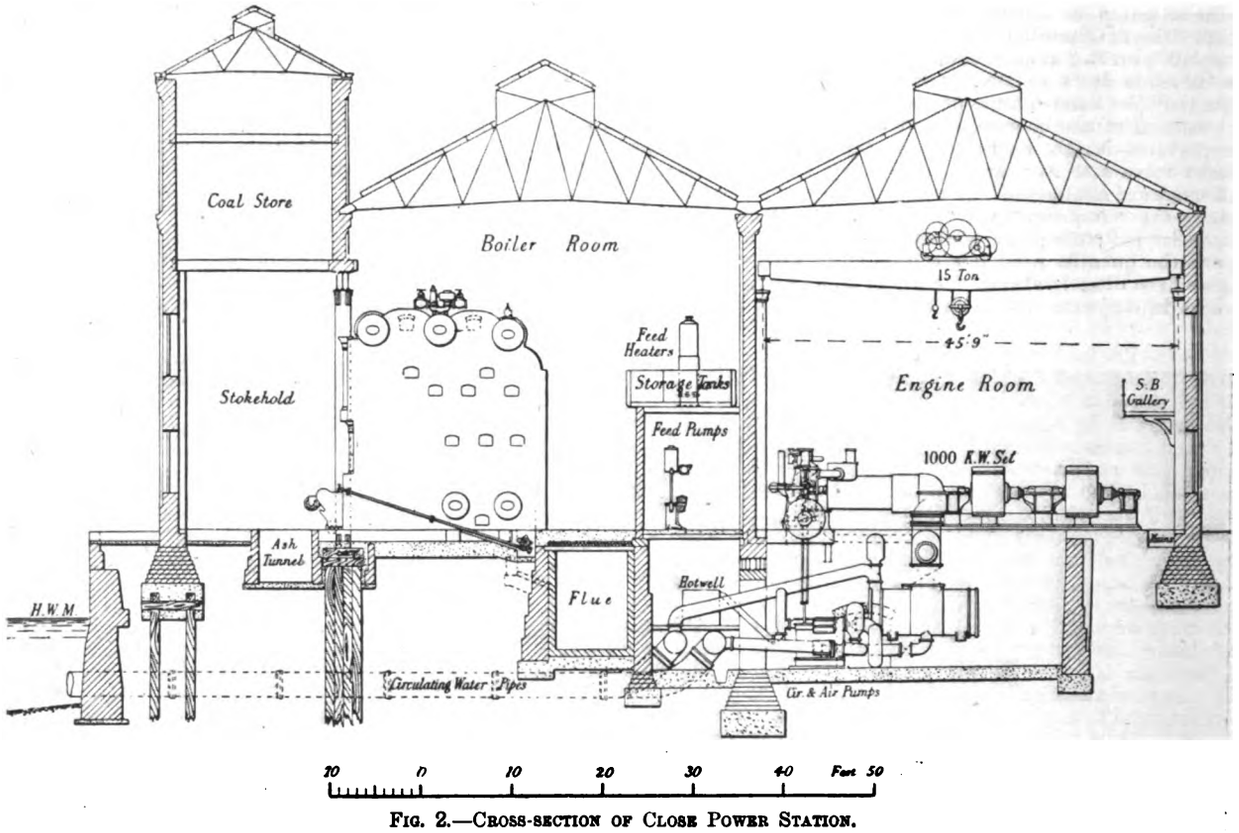

FIG. 2.—CROSS-SECTION OF CLOSE POWER STATION.

The speeds of the crane are as follows:—

Hoisting, 15 tons at	4ft.	per minute.	
Do.	7½ do.	8ft.	do.
Do.	2 do.	30ft.	do. small barrel.
Longitudinal traverse ...	200ft.	per minute	light.
Cross traverse	100ft.	do.	light.

By regulation of the controllers the above speeds can be varied instantly from maximum to zero. The three movements of the crane are effected by three series-wound motors, each having its own controller, the latter being carried on the crab and operated by cords from the ground floor. The powers of the motors are:—

Hoisting	6 H.P. at 300	revs. per min.
Longitudinal traverse ...	6 H.P. at 600	do.
Cross traverse	3 H.P at 300	do.

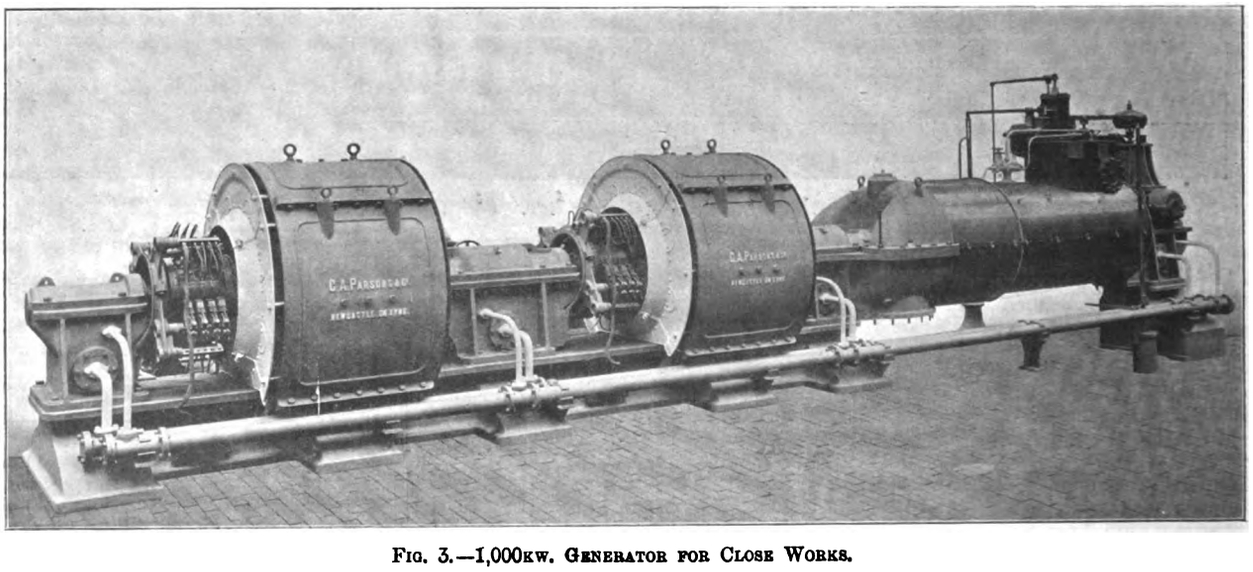

FIG. 3.—1,000KW. GENERATOR FOR CLOSE WORKS.

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For short periods these are capable of developing double their rated powers. In connection with the hoisting-gear a stop motion is provided for the purpose of automatically breaking the circuit and preventing overwinding. The efficiency is about 50 per cent, the loss including all the mechanical friction of the gear as well as that of the motor.

Condensing Plant.—The condensers and pumps, which are shown in the cross-section of the buildings (Fig. 2), were made by Messrs. John Abbot & Co., of Gateshead. The condensers have each a cooling surface of 3,000 sq. ft.; ample provision is made for examination by means of large doors, and the internal arrangements are all in accordance with the latest Admiralty practice. The pump cylinders are fitted with liners, and have rods of Delta metal. Ample passage ways are provided in the circulating pump so that the velocity of water never exceeds 4ft. per second at any part. The engines for driving these are of the vertical compound type, with provision for admitting high-pressure steam to low-pressure cylinder for starting. The bedplate is bolted to fixed girders above the pumps, and two heavy-balanced flywheels are provided. The pump-rods are balanced by means of rocking levers and weights worked off the cross-heads. The engines were made by Messrs. Carrick and Wardale, of Gateshead.

Switchboard.—The switch-gear is of the cellular type, constructed by Ferranti Limited, and consists of heavy black enamelled slates grouted into the station wall, and divided off into a number of pigeon-hole recesses by vertical division slates, the principle being to have a complete compartment for each apparatus used on the gear. The switchboard comprises six dynamo panels, each of the six dynamo panels including the following:—Voltmeter, ammeter, two single-pole switches with reverse current automatic devices, and section of regulating table on which the open type regulating resistances are controlled by means of a hand-wheel. In the centre of the board is a large 6,000 ampere wattmeter placed between the 'bus bars to register the total watts generated by the machines. An earth recording ammeter with cutouts and one mid-wire ammeter are placed under the wattmeter panel in the regulating table. To the left provision is made for two balancers, complete with main switches, ammeters and starting resistances. The three-wire feeder panels are arranged to the left of the board, and each panel comprises two voltmeters, two ammeters, two switches, and maximum current automatic devices provided with time limit relay. Each generator and feeder panel is designed to carry 1,000 amperes, and to break under the severer conditions likely to be existent under emergencies. In designing this gear, it has been the aim to simplify the connections to a minimum degree consistent with the efficiency and convenience of working. As a result, the entire arrangement is simple and easy for the operator to understand, and having all connections clearly visible before him, there is very little opportunity for errors to be made, which otherwise might lead to disastrous results. It is impossible to place too great stress upon the necessity of rendering the switchboard free from fire risks. The theory of splitting up the whole into small compartments has been carefully considered with this in view. Moreover, there is an absence of inflammable material, and when compared with the old flat board type of switch-gear, it is not only interesting but eminently satisfactory to see the way in which strip cable connections are avoided.

PROF. JAMES DEWAR'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION.*

The members of an Association whose studies involve perpetual contemplation of settled law and ordered evolution, whose objects are to seek patiently for the truth of things and to extend the dominion of man over the forces of Nature, are even more deeply pledged than other men to loyalty to the Crown and the Constitution which procure for them the essential conditions of calm security and social stability. I am confident that I express the sentiments of all now before me when I say that to our loyal respect for his high office we add a warmer feeling of loyalty and attachment to the person of our Gracious Sovereign. At this, our second meeting held under the present reign, whose sentiments are realised all the more vividly, because, in common with the whole empire, we have recently passed through a period of acute apprehension, followed by the uplifting of a national deliverance. The splendid and imposing coronation ceremony which took place just a month ago was rendered doubly impressive both for the King and his people by the universal consciousness that it was also a service of thanksgiving for escape from imminent peril. No one in his wide dominions is more competent than the King to realise how much he owes, not only to the skill of his surgeons, but also to the equipment which has been placed in their hands as the combined result of scientific investigation in many and diverse directions. He has already displayed a profound and sagacious interest in the discovery of methods for dealing with some of the most intractable maladies that still baffle scientific penetration; nor can we doubt that this interest extends to other forms of scientific investigation, more directly connected with the amelioration of the lot of the healthy than with the relief of the sick. Heredity imposes obligations and also confers aptitude for their discharge. Intelligent appreciation of scientific work and needs is not less but more necessary in the highest quarters to-day than it was 43 years ago, when His Royal Highness the Prince Consort brought the matter before this Association in the following memorable passage in his presidential address:

> We may be justified, however, in hoping that by the gradual diffusion of science and its increasing recognition as a principal part of our national education, the public in general, no less than the Legislature and the State, will more and more recognise the claims of science to their attention; so that it may no longer require the begging box, but speak to the State like a favoured child to its parent, sure of his paternal solicitude for its welfare; that the State will recognise in science one of its elements of strength and prosperity, to protect which the clearest dictates of self-interest demand.

Had this advice been seriously taken to heart and acted upon by the rulers of the nation at the time, what splendid results would have accrued to this country! We should not now be painfully groping in the dark after a system of national education. We should not be wasting money, and time more valuable than money, in building imitations of foreign educational superstructures before having put in solid foundations. We should not be hurriedly and distractedly casting about for a system of tactics after confrontation with the disciplined and co-ordinated forces of industry and science led and directed by the rulers of powerful States. 43 years ago we should have started fair had the Prince Consort's views prevailed. As it is, we have lost ground which it will tax even this nation's splendid reserves of individual initiative to recover. It is hardly possible to over-rate the benefits that may accrue from the King's intelligent and continuous interest in the great problem of transforming his people into a scientifically educated nation. From this point of view we may congratulate ourselves that the heir to the Crown, following his family traditions, has already deduced from his own observations in different parts of the empire some very sound and valuable conclusions as to the national needs at the present day.

The saddest yet the most sacred duty falling to us on such an occasion as the present is to pay our tribute to the memory of old comrades and fellow-workers whom we shall meet no more. We miss to-day a figure that has been familiar, conspicuous, and always congenial at the meetings of the British Association during the last 40 years. Throughout the greater part of that period Mr. George Griffith discharged the onerous and often delicate duties of the assistant general secretary, not only with conscientious thoroughness and great ability, but also with urbanity, tact and courtesy that endeared him to all. The British Association owes him a debt of gratitude which must be so fully realised by every regular attender of our meetings that no poor words of mine are needed to quicken your sense of loss, or to add to the poignancy of your regret.

The British Association has to deplore the loss from among us of Sir Joseph Gilbert, a veteran who continued to the end of a long life to pursue his important and beneficent researches with untiring energy. The length of his services in the cause of science cannot be better indicated than by recalling the fact that he was one of the six past presidents boasting 50 years' membership whose jubilee was celebrated by the Chemical Society in 1898.

It is impossible for me in this place to offer more than the barest indication of the great place in contemporary science that has been vacated by the lamented death of Prof. Alfred Cornu, who so worthily upheld the best traditions of scientific France. Cornu was admirable alike in the use he made of his opportunities and in his manner of discharging his duties. He was at once a great investigator and a great teacher. His death has inflicted a heavy blow upon our generation, upon France, and upon the world.

The British Association, together with the whole scientific world, has had to deplore the unexpected death of Sir Frederick Abel, past president of the British Association, and one of the most representative and successful chemists of his generation. His early work was directed to organic chemistry, but he diverted his energies to other channels, and especially to problems of naval and military armament. He had the satisfaction of living through the age of gunpowder, and of seeing those nitro-compounds of his early studies replace the old black gunpowder. We owe him a deep debt of gratitude for his contributions to many learned societies, and for his services in the cause of scientific education. It would be difficult to overestimate the great services which he rendered to science and the State, and on some future occasion an adequate account of his life and work must be attempted.

The presidential address delivered by Tyndall in this city 28 years ago will always rank as an epoch-making deliverance. In the Belfast discourse Tyndall dealt with the changing aspects of the long unsettled horizon of human thought, at last illuminated by the sun-

* Delivered at Belfast on Wednesday.—*Abstract.*

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rise of the doctrine of evolution. His views as a strenuous supporter and believer in the theory of evolution were naturally essentially optimistic. He had no sympathy with the lugubrious pessimistic philosophy whose disciples are for ever intent on administering rebuke to scientific workers by reminding them that, however much knowledge man may have acquired, it is as nothing compared with the immensity of his ignorance. That truth is, indeed, never adequately realised except by the man of science, to whom it is brought home by repeated experience of the fact that his most promising excursions into the unknown are invariably terminated by barriers which, for the time at least, are insurmountable. He who has never made such excursions with patient labour may indeed prattle about the vastness of the unknown, but he does so without real sincerity or intimate conviction. His tacit, if not his avowed, contention is, that since we can never know all, it is not worth while to seek to know more; and that in the profundity of his ignorance he has the right to people the unexplored spaces with the phantoms of his vain imagining. The man of science, on the contrary, finds in the extent of his ignorance a perpetual incentive to further exertion, and in the mysteries that surround him a continual invitation, nay, more, an inexorable mandate. Tyndall's cry was, "Commotion before stagnation, the leap of the torrent before the stillness of the swamp."

The Endowment of Education.

These are days of munificent benefactions to science and education, which, however, are greater and more numerous in other countries than in our own. Splendid as they are, it may be doubted, if we take into account the change in the value of money, the enormous increase of population, and the utility of science to the builders of colossal fortunes, whether they bear comparison with the efforts of earlier days. But the habit of endowing science was so long in practical abeyance that every evidence of its resumption is matter for sincere congratulation. Mr. Cecil Rhodes has dedicated a very large sum of money to the advancement of education, though the means he has chosen are, perhaps, not the most effective. It must be remembered that his aims were political as much as educational. He had the noble and worthy ambition to promote enduring friendship between the great English-speaking communities of the world, and knowing the strength of college ties, he conceived that this end might be greatly furthered by bringing together at an English university the men who would presumably have much to do in later life with the influencing of opinion, or even with the direction of policy. But, apart from the main idea of fostering good relations between those who will presumably be influential in England, in the colonies, and in the United States, Mr. Rhodes was probably influenced also by the hope that the influx of strangers would help to broaden Oxford notions and to procure revision of conventional arrangements.

Dr. Andrew Carnegie's endowment of Scottish universities, as modified by him in deference to expert advice, is a more direct benefit to the higher education. For while Mr. Rhodes has only enabled young men to get what Oxford has to give, Dr. Carnegie has also enabled his trustees powerfully to augment and improve the teaching equipment of the universities themselves. At the same time he has provided as far as possible for the enduring usefulness of his money. His trustees form a permanent body external to the universities, which, while possessing no power of direct control, must always, as holder of the purse-strings, be in a position to offer independent and weighty criticisms. More recently Dr. Carnegie has devoted an equal sum of 10 million dollars to the foundation of a Carnegie Institution in Washington. Here again he has been guided by the same ideas. He had neither founded a university nor handed over the money to any existing university. He has created a permanent trust charged with the duty of watching educational efforts and helping them from the outside according to the best judgment that can be formed in the circumstances of the moment. Its aims are to be—to promote original research; to discover the exceptional man in every department of study, whether inside or outside of the schools, and to enable him to make his special study his life-work; to increase facilities for higher education; to aid and stimulate the universities and other educational institutions; to assist students who may prefer to study at Washington; and to ensure prompt publication of scientific discoveries. The general purpose of the founder is to secure, if possible, for the United States leadership in the domain of discovery and the utilisation of new forces for the benefit of man. Nothing will more powerfully further this end than attention to the injunction to lay hold of the exceptional man whenever and wherever he may be found, and, having got him, to enable him to carry on the work for which he seems specially designed. That means, I imagine, a scouring of the old world, as well as of the new, for the best men in every department of study—in fact, an assiduous collecting of brains similar to the collecting of rare books and works of art which Americans are now carrying on in so lavish a manner. As in diplomacy and war, so in science, we owe our reputation, and no small part of our prosperity, to exceptional men; and that we do not enjoy these things in fuller measure we owe to our lack of an army of well-trained ordinary men capable of utilising their ideas. Our exceptional men have too often worked in obscurity, without recognition from a public too imperfectly instructed to guess at their greatness, without assistance from a State governed largely by dialecticians, and without help from academic authorities hidebound by the pedantries of mediæval scholasticism. When contemplating these splendid endowments of learning, it occurred to me that it would be interesting to find out exactly what some definite quantity of scientific achievement has cost in hard cash. In an article by Carl Snyder in the January number of the *North American Review*, entitled "America's Inferior Place in the Scientific World," I found the statement that "it would be hardly too much to say that during the hundred years of its existence the Royal Institution alone has done more for English science than all of the English universities put together. This is certainly true with regard to British industry, for it was here that the discoveries of Faraday were made." I was emboldened by this estimate from a distant and impartial observer to do, what otherwise I might have shrunk from doing, and to take the Royal Institution—after all, the foundation of an American citizen, Count Rumford—as the basis of my inquiry. The work done at the Royal Institution during the past hundred years is a fairly definite quantity in the mind of every man really conversant with scientific affairs. I have obtained from the books accurate statistics of the total expenditure on experimental inquiry and public demonstrations for the whole of the nineteenth century. The items are—

Professors' salaries—Physics and chemistry	£54,600
Laboratory expenditure	24,430
Assistants' salaries	21,590
Total for 100 years	£100,620

In addition, the members and friends of the Institution have contributed to a fund for exceptional expenditure for experimental research the sum of £9,580. It should also be mentioned that a Civil List pension of £300 was granted to Faraday in 1853, and was continued during 27 years of active work and five years of retirement. Thirty-two years in all, at £300 a-year, make a sum of £9,600, representing the national donation, which, added to the amount of expenditure just stated, brings up the total cost of a century of scientific work in the laboratories of the Royal Institution, together with public demonstrations, to £119,800, or an average of £1,200 per annum. I think if you recall the names and achievements of Young, Davy, Faraday and Tyndall you will come to the conclusion that the exceptional man is about the cheapest of natural products. It is a popular fallacy that the Royal Institution is handsomely endowed. On the contrary, it has often been in financial straits; and since its foundation by Count Rumford its only considerable bequests have been one from Thomas G. Hodgkins, an American citizen, for experimental research, and that of John Fuller for endowing with £95 a year the chairs of chemistry and physiology. In this connection the Davy-Faraday Laboratory, founded by the liberality of Dr. Ludwig Mond, will naturally occur to many minds. But though affiliated to the Royal Institution, with, I hope, reciprocal direct advantages, that laboratory is financially independent, and its endowments are devoted to its own special purpose, which is to provide opportunity to prosecute independent research for worthy and approved applicants of all nationalities. The main reliance of the Royal Institution has always been, and still remains, upon the contributions of its members, and upon corresponding sacrifices in the form of time and labour by its professors. It may be doubted whether we can reasonably count upon a succession of scientific men able and willing to make sacrifices which the conditions of modern life tend to render increasingly burdensome. Modern science is, in fact, in something of a dilemma. Devotion to abstract research upon small means is becoming always harder to maintain, while at the same time the number of wealthy independent searchers after truth and patrons of science of the style of Joule, Spottiswoode and De la Rue is apparently becoming smaller. The installations required by the refinements of modern science are continually becoming more costly, so that upon all grounds it would appear that without endowments of the kind provided by Dr. Carnegie the outlook for disinterested research is rather dark. On the other hand, these endowments, unless carefully administered, might obviously tend to impair the single-minded devotion to the search after truth for its own sake to which science has owed almost every memorable advance made in the past. The Carnegie Institute will dispose in a year of as much money as the members of the Royal Institution have expended in a century upon its purely scientific work. It will at least be interesting to note how far the output of high-class scientific work corresponds to the hundredfold application of money to its production. Nor will it be of less interest to the people of this country to observe the results obtained from that moiety of Dr. Carnegie's gift to Scotland which is to be applied to the promotion of scientific research.

Applied Chemistry, English and Foreign.

The diplomatic and consular reports published from time to time by the Foreign Office are usually too belated to be of much use to

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business men, but they sometimes contain information concerning what is done in foreign countries which affords food for reflection. One of these reports, issued a year ago, gives a very good account of the German arrangements and provisions for scientific training, and of the enormous commercial demand for the services of men who have passed successfully through the universities and technical high schools, as well as of the wealth that has accrued to Germany through the systematic application of scientific proficiency to the ordinary business of life. We cannot show in the United Kingdom, notwithstanding the immense range of the chemical industries in which we once stood prominent, more than one-third of the professional staff employed in Germany. It may, perhaps, be thought or hoped that we make up in quality for our defect in quantity, but unfortunately this is not the case. Details are given in the report of the training of 633 chemists employed in German works; 84 per cent. have received a thoroughly systematic and complete chemical training, and 74 cent. of these add the advantages of a university career. Compare with this the information furnished by 500 chemists in British works. Of these only 21 per cent. are graduates, while about 10 per cent. hold the diploma of a college. It ought to be mentioned that about 21 per cent. of the 500 are Fellows or Associates of the Institute of Chemistry, whatever that may amount to in practice, but of these a very large number have already been accounted for under the heads of graduates and holders of diplomas. These figures, which I suspect are much too favourable on the British side, unmistakably point to the prevalence among employers in this country of the antiquated adherence to rule-of-thumb, which is at the root of much of the backwardness we have to deplore. It hardly needs to be pointed out to such an audience as the present that chemists who are neither graduates of a university, nor holders of a diploma from a technical college, may be competent to carry on existing processes according to traditional methods, but are very unlikely to effect substantial improvements, or to invent new and more efficient processes. I am very far from denying that here and there an individual may be found whose exceptional ability enables him to triumph over all defects of training. But in all educational matters it is the average man whom we have to consider, and the average ability which we have to develop. Now, to take the second point—the actual money value of the industries carried on in Germany by an army of workers both quantitatively and qualitatively so superior to our own. The consular report estimates the whole value of German chemical industries at not less than 50,000,000 sterling per annum. These industries have sprung up within the last 70 years, and have received enormous expansion during the last 30. Moreover, the fundamental discoveries upon which this gigantic industry is built were made in this country, and were practically developed to a certain extent by their authors. But in spite of the abundance and cheapness of the raw material, and in spite of the evidence that it could be most remuneratively worked up, these men founded no school, and had practically no successors. Now, what is the explanation of this extraordinary and disastrous phenomenon? I give it in a word—want of education. We had the material in abundance when other nations had comparatively little. We had the capital, and we had the brains, for we originated the whole thing. But we did not possess the diffused education without which the ideas of men of genius cannot fructify beyond the limited scope of an individual. I am aware that our patent laws are sometimes held responsible. The patent laws have only contributed in a secondary degree, and if the patent laws have been bad the reason for their badness is, again, want of education. Make them as bad as you choose, and you only prove that the men who made them, and the public whom these men try to please, were mislead by theories instead of being conversant with fact and logic. But the root of the mischief is not in the patent laws or in any legislation whatever. It is in the want of education among our so-called educated classes, and, secondarily, among the workmen on whom these depend. It is in the abundance of men of ordinary plodding ability, thoroughly trained and methodically directed, that Germany at present has so commanding an advantage. It is the failure of our schools to turn out, and of our manufacturers to demand, men of this kind, which explains our loss of some valuable industries and our precarious hold upon others. Let no one imagine for a moment that this deficiency can be remedied by any amount of that technical training which is now the fashionable nostrum. It is an excellent thing, no doubt, but it must rest upon a foundation of general training. Mental habits are formed for good or evil long before men go to the technical schools. We have to begin at the beginning; we have to train the population from the first to think correctly and logically, to deal at first hand with facts, and to evolve, each one for himself, the solution of a problem put before him, instead of learning by rote the solution given by somebody else. To my mind, the really appalling thing is not that the Germans have seized this or the other industry, or even that they may have seized upon a dozen industries. It is that the German population has reached a point of general training and specialised equipment which it will take us two generations of hard and intelligently directed educational work to attain. It is that Germany possesses a national weapon of precision which must give her an enormous initial advantage in any and every contest depending upon disciplined and methodised intellect.

Liquid Hydrogen and Helium.

Hydrogen is an element of especial interest, because the study of its properties and chemical relations led great chemists like Faraday, Dumas, Daniell, Graham and Andrews to entertain the view that if it could ever be brought into the state of liquid or solid it would reveal metallic characters. After the beautiful discovery of Graham that palladium can absorb some hundreds of times its own volume of hydrogen and still retain its lustre and general metallic character, the impression that hydrogen was probably a member of the metallic group became very general. The only chemist who adopted another view was my distinguished predecessor, Professor Odling. In his "Manual of Chemistry," published in 1861, he pointed out that hydrogen has chlorous as well as basic relations, and that they are as decided, important and frequent as its other relations. From such considerations he arrived at the conclusion that hydrogen is essentially a neutral or intermediate body, and therefore we should not expect to find liquid or solid hydrogen possess the appearance of a metal. This extraordinary prevision, so characteristic of Odling, was proved to be correct some 37 years after it was made.

No definite conclusion could be reached regarding the physical properties of liquid or solid hydrogen, and the only way to arrive at the truth was to prosecute low-temperature research until success attended the efforts to produce its liquefaction. This result I definitively obtained in 1898. The case of liquid hydrogen is, in fact, an excellent illustration of the truth already referred to, that no theoretical forecast, however apparently justified by analogy, can be finally accepted as true until confirmed by actual experiment. Liquid hydrogen is a colourless, transparent body of extraordinary intrinsic interest. It has a clearly defined surface, is easily seen, drops well—in spite of the fact that its surface tension is only the 35th part of that of water, or about one-fifth that of liquid air—and can be poured easily from vessel to vessel. The liquid does not conduct electricity, and, if anything, is slightly diamagnetic. Compared with an equal volume of liquid air, it requires only one-fifth the quantity of heat for vaporisation; on the other hand, its specific heat is 10 times that of liquid air or five times that of water. The coefficient of expansion of the fluid is remarkable, being about 10 times that of gas; it is by far the lightest liquid known to exist, its density being only one-fourteenth that of water; the lightest liquid previously known was liquid marsh gas, which is six times heavier. The only solid which has so small density as to float upon its surface is a piece of pith wood. It is by far the coldest liquid known. At ordinary atmospheric pressure it boils at minus 252·5deg. or 20·5deg. absolute. The critical point of the liquid is about 29deg. absolute, and the critical pressure not more than 15 atmospheres. The vapour of the hydrogen arising from the liquid has nearly the density of air—that is, it is 14 times that of the gas at the ordinary temperature. Reduction of the pressure by an air-pump brings down the temperature to minus 258deg., when the liquid becomes a solid resembling frozen foam, and this by further exhaustion is cooled to minus 260deg., or 13deg. absolute, which is the lowest steady temperature that has been reached. The solid may also be got in the form of a clear transparent ice, melting at about 15deg. absolute, under a pressure of 55mm., possessing the unique density of one-eleventh that of water. Such cold involves the solidification of every gaseous substance but one that is at present definitely known to the chemist, and so liquid hydrogen introduces the investigator to a world of solid bodies.

The strong condensing powers of liquid hydrogen afford a simple means of producing vacua of very high tenuity. When one end of a sealed tube containing ordinary air is placed for a short time in the liquid, the contained air accumulates as a solid at the bottom, while the higher part is almost entirely deprived of particles of gas. So perfect is the vacuum thus formed, that the electric discharge can be made to pass only with the greatest difficulty. Another important application of liquid air, liquid hydrogen, &c., is as analytic agents. Thus, if a gaseous mixture be cooled by means of liquid oxygen, only those constituents will be left in the gaseous state which are less condensable than oxygen. Similarly, if this gaseous residue be in its turn cooled in liquid hydrogen a still further separation will be effected, everything that is less volatile than hydrogen being condensed to a liquid or solid. By proceeding in this fashion it has been found possible to isolate helium from a mixture in which it is present to the extent of only one part in 1000. By the evaporation of solid hydrogen under the air-pump we can reach within 13deg. or 14deg. of the zero, but there or thereabouts our progress is barred. This gap of 13deg. might seem at first sight insignificant in comparison with the hundreds that have already been conquered. But to win 1deg. low down the scale is quite a different matter from doing so at higher temperatures; in fact, to annihilate these few remaining degrees would be a far greater achievement than any so far accomplished in low-temperature research. That the zero will ever be reached by man is extremely improbable.

(To be concluded.)

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TRAMCAR BRAKES.

As a result of the deplorable accident at Glasgow, tramway engineers will now, doubtless, be paying more attention to their brake equipment than hitherto. Before the official inquiries have been made at Glasgow we prefer not to consider too closely the actual causes which contributed to the accident or to apportion the blame. However, we consider it our duty, as a technical journal, to go further than merely chronicling such occurrences and adding perfunctory expressions of regret. We must not shrink from looking boldly at the broad technical and engineering questions which such accidents bring forcibly to the front; and in the case of tramway accidents due to brake failures we may say frankly that these accidents have been far too numerous in the past, and that far too many of them have been due to avoidable causes. So much is involved in failure to control tramcars expeditiously and with certainty by their brakes, that too much attention cannot be devoted to this important and even vital question, although we will admit that few problems connected with the working of tramcars are more troublesome. In the present article we propose to review its general technical aspects.

The method generally in use in this country is to supplement the hand brake with slipper brakes. The advantage of the slipper brake over the hand brake is due to the fact that the coefficient of friction between wood and iron is greater than between iron and iron. The slipper brake is certainly effective, and its use can be recommended for cars equipped with single four-wheel trucks. On these, almost its only disadvantage is that on sharp curves it does not engage well with the rail, as the axis of the shoe is on the chord subtended by the wheel base. On double truck cars the problem of equipping with slipper brakes becomes much more difficult. There is but little room to attach the brake to the trucks, and if this could be done satisfactorily it would be difficult to work them from the platforms on account of the swing of the car; besides, to get the effective use of the weight of the car, each truck would have to be equipped, and they would have to be worked in unison from each platform. It needs no special discussion to show how impracticable and unwieldy such an arrangement would be in practice.

The other well-known types of brakes for tramcars are the electric brake and the air brake. The electric brake gives excellent service. It has one great advantage in that the wheels automatically release when the braking power is sufficient to skid them. It also responds in a measure to another requirement of a good brake—namely, that the power applied in braking should diminish with the speed. It is a well-known fact that the coefficient of friction between the wheels and the rail is a function of the speed. The greater

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the speed the greater the coefficient. Any man who has handled an electric tramcar has experienced this himself: when the brakes are applied at high speed and are left for the car to come to a stop, oftentimes the wheels will commence skidding when the speed is diminished to a certain point, and the car then is not under the control it should be, and does not make the quick stop that is expected of it. The electric brake exercises its greatest braking action at the highest speed, which diminishes to zero when the wheels are stopped either from the stoppage of the car or from their being blocked and skidding. The objection to the electric brake is that it requires careful inspection and considerable up-keep. The insulated conducting wires leading to the magnetising bobbins are subjected to considerable vibration, which results in a tendency to shear them off at the points where they enter the metal brakes. There is a further and more serious objection in that the motors become generators during the braking period, and so do not get the chance to cool that they would otherwise have. In practice, this means that the motor capacity, where electric brakes are used, must be at least 20 per cent. in excess of what it otherwise would be.

The air brake has become the standard for steam railways and for electric lines which develop a high speed and give a service similar to that of a steam railway. On the ordinary street tramway, however, its use has been very limited in this country; but on the Continent and in America it is coming into quite general use. It possesses many advantages. The motor man can regulate the speed of his car accurately and with little difficulty in descending a grade by simply applying what pressure he desires in the brake cylinders. That air brakes would be used almost exclusively on tramcars hardly admits of a doubt if there were some simple and cheap way of compressing the air. There have been three methods applied for this purpose: First, in installing at a station or depôt an air compressor, leading the compressed air by pipe to a charging station on the route. The cars carry tanks of sufficient capacity for a car to make the round trip using the air brakes. This method can only be applied to a limited extent, however, as there are not many lines where the system of charging stations would be convenient. Besides, as considerable cubic space must be given in the storage tanks carried on the car, it becomes almost prohibitive to consider such a solution with double-deck cars. There is insufficient room under the seats, and therefore the natural place for carrying the tanks is on the car roofs. The second system is to put the air pump on the car axle, which works continuously while the car is moving, and which generates sufficient pressure in the small storage tanks carried underneath the car body. This would be an excellent system if the pumps could be maintained, but they work under such severe conditions that it has been found in practice that at the end of six months or a year they are worn out, and their up-keep becomes very onerous. The remaining method is to work the air pump placed on the car by means of an electric motor. This motor is automatic in its action, so that, when the pressure in the tanks falls below a given amount, the motor is started and continues running until it is automatically cut off when the pressure reaches the desired amount. This last method is the one that is now being adopted on most of the new applications of air brakes to tramcars. The principal objection to it appears to be in the matter of first cost.

In France all tramcars are inspected by a Government engineer before they are allowed to be put into circulation. The test applied for braking is that known as the "Three Twenties." This means that a car having a speed of 20km. per hour, and descending a grade of 20mm. in a metre (1ft. in 50ft.), must be stopped in a distance of 20 metres without the use of sand. This can be done, providing the track is thoroughly wet or thoroughly dry, and naturally the trials are only made under such conditions. If the track is at all greasy or muddy, sand would have to be used. Such tests, however, are of little practical value, for though the car may have brakes to comply with the conditions, it becomes a question of up-keep—whether the brakes would fulfil the conditions of the test after a little service. A more important and practical regulation is that the air brakes, electric brakes, or whatever system is applied to supplement the hand brakes, should be the normal and regular method of braking adopted by the motorman, and the hand brakes should only be used in reserve when the power brake of whatever description fails. The advantage of this system is two-fold. First, the use of the power brake relieves the motorman of a great amount of physical strain which he is subjected to when he uses the hand brake regularly for stopping the cars. Anything that lightens the labour of the motorman is to the advantage of the public, as his duties are sufficiently onerous at the best, and he is much better able to act quickly and intelligently in an emergency if he is not physically fagged out. Secondly, the power brake, of whatever description, is one that requires a greater amount of inspection than the hand brakes. If it is allowed to be only used in an emergency the probability of its being out of order when wanted becomes largely increased, but if it is the regular brake used it has to be kept in order, any slight defect in its working is immediately noted by the motorman, and the car receives immediate attention. We consider that if the electric cars in this country are equipped with power brakes, either electric or air, this feature should not be overlooked, and such brakes should be used as the regular brakes if the best results are to be obtained.

The most important precaution of all, whatever system of brakes be adopted, is that the motorman should be thoroughly schooled in the use of his brakes, and he should not be allowed to take charge of a car until he is able to explain their working in detail to the inspector. It needs no argument to prove that a man can act in an emergency much more intelligently when he is acquainted with the mechanism which he is controlling. For example, there have been numerous instances where the electric brake has not worked because the motorman had not been sufficiently drilled in its application. Not all motormen that are running cars equipped with electric brakes are sufficiently aware of the fact that to apply the brake the reversing handle should always be in the direction the car is moving. If the car stops on an up grade and then descends, this handle must be reversed when applying the electric brake, otherwise the brakes are inoperative. This seems simple enough, but if not carefully drilled into the motorman it may result in a most serious accident.

To sum up, our opinion is that slipper brakes can be used to supplement hand-wheel brakes for single truck cars; but where the profile of the line is such as to make the working of hand brakes, both wheel and slipper, exhausting to the motorman, we think that power brakes should be used. On bogie truck cars, power brakes should always be fitted, and it is probably the best practice to order that such brakes should be used regularly and the hand brake only as a reserve. Last, and not least, we think that no man should be passed as a fully-fledged motorman until the manager or his representative is convinced of his thorough knowledge of the brakes and of his capacity to use them in the most effective manner when the emergency arises.

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OBITUARY.

SIR FREDERICK ABEL.

The death of Sir Frederick Abel, which occurred suddenly on Saturday night at his residence in Whitehall Court, has cast a deep shadow over the proceedings of the British Association at Belfast this week; for he always took an active interest in their meetings and discussions, and was president at the second Leeds meeting in 1890.

It was by his distinguished career as chemist to the War Office, from 1854 to 1888, that Sir Frederick Abel acquired most fame, and it was during these 34 years that he conducted the researches leading up to the adoption of the present smokeless powder, or "cordite," which has so completely replaced the old black powder in modern warfare. He it was who also fixed the "flash-point" of petroleum at 78deg. after most exhaustive experiments. In 1887 he was appointed secretary and general director of the then newly-formed Imperial Institute, and carried out these duties for many years, his labours, however, receiving but small recognition. He took great interest in technical education and research, and his name is well known in connection with the City and Guilds of London Institute, of which he was chairman of the executive committee. He was created C.B. in 1877, was Commissioner to the Electrical Exhibition at Vienna in 1883, was knighted in that year, created K.C.B. early in 1891, and made a baronet in 1893.

Sir Frederick Abel's intimate connection with the electrical profession dates from 1877, when he was president of the Institution of Electrical Engineers, then the Society of Telegraph Engineers. His inaugural address consisted of a discussion on Dr. Matthiessen's experiments on conductivity of copper and alloys, and on the chemical composition of various insulating materials. During his presidency several Papers of extreme interest were read before the society, including "Shunts," by Sir (then Mr.) W. H. Preece, "The Electrical Qualities and Effect of Light on Selenium," by the late Mr. Willoughby Smith, "Researches in Electric Telephony," by Prof. Alex. Graham Bell, and an account of a "New Form of Electric Light" which had been experimented with in Paris, and which proved to be no other than the famous Jablochkoff candle. Sir Frederick also served at various times as president of the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, and the Iron and Steel Institute, was a fellow of the Royal Society, and among his numerous writings was a treatise, in 1884, on electricity as applied to explosive purposes. The deceased baronet was born in 1827, being thus 75 years old at the time of his death. He was twice married, but has left no heir to the baronetcy.

REVIEWS

(Copies of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

The Elements of Physical Chemistry. By J. Livingstone R. Morgan. 2nd edition. (New York: John Wiley & Sons; London: Chapman and Hall.) 1902. $2.

The author defines physical chemistry as "that branch of the science of chemistry which has for its object the study of the laws and theories governing chemical phenomena," a science, as he explains, lying on the borderland between physics and chemistry. His book, therefore, deals with the laws of gases and of chemical change, the theory of solutions, thermo-chemistry and electro-chemistry. It is a small volume, primarily intended as a class-book (the author is Adjunct Professor of Chemistry at the Columbia University), but in his preface Dr. Morgan states that he also desires to make the book suitable for "self study." In this latter respect, however, he is not completely successful, the explanations and methods not always being as clear as they might be, In the chapter on electro-chemistry, after reading the definition of the ohm, ampere, volt and coulomb, the electrical engineering student is immediately shown that he must be prepared for nomenclature and symbols that are new to him:—

> The intensity factor of electrical energy is the volt, while the capacity factor is the coulomb, *i.e.*,
>
> $$E = e\pi,$$
>
> where e is the amount of current [*sic*] in coulombs, π is the E.M.F. in volts, and E is the electrical work, the unit of which is the watt-second, equal to the volt-ampere-second. . . .

In spite of its small size, the book appears to cover the elements of the subject fairly well, but it should be administered through the medium of a teacher.

Dynamo-electric Machinery. Vol. II.: Alternating-current Machines. By Samuel Sheldon, A.M., Ph.D., and Hobart Mason, B.S.E.E. (London: Crosby, Lockwood & Son.) 1902. 12s. net.

This book has quickly followed the publication of its companion volume on "Direct-current Machines" (reviewed in *The Electrician*, Vol. XLVIII., p. 577). It is written on exactly the same lines, and is primarily intended as a text-book for use in technical colleges. The first four chapters, occupying 56 pages, deal with the elementary theory of alternate currents in circuits containing self-inductance and capacity. The mathematics employed are simple, the relations between E.M.F. and current are clearly shown, and the graphical method is also made use of. These first four chapters ought to give a fairly clear understanding of what takes place in alternating-current circuits to those previously unfamiliar with the subject.

The next four chapters deal with the construction, principles of operation and behaviour of alternators, transformers, motors and converters, both of the single and polyphase types. Chapter IX. is devoted to power transmission, and discusses the questions of frequency, voltage and number of phases in their effect on cost of line construction. It also deals with resistance, inductance and capacity of the line, and compares aluminium and copper for use in the construction of overhead power transmission lines. The last chapter deals with tests on alternating-current apparatus, and gives methods of making all the usual tests that are practically requisite. All illustrations and descriptions of machines given are those of American type. The authors throughout use the letter f to denote frequency; this may be usual in America, but in England the letter n is generally employed.

Anlasser und Regler für Elektrische Motoren und Generatoren. By Rudolph Krause. (Berlin: Julius Springer.)

This is a useful little treatise of 92 pages, dealing with the theory, construction and arrangement of starting and regulating resistances for direct-current and polyphase machines. The author assumes the reader to have a working knowledge of the theory and working of the machines themselves, and the book may be regarded as a continuation of standard treatises on the design and construction of electrical machinery which do not deal specially with these accessories.

The first chapter deals with the questions of specific resistances and temperature coefficients of the various metals and alloys used in practice for such work, and also with the question of the permissible current-density for contacts, connecting bolts, resistance spirals, &c. Although based upon German practice, which is not so stringent in certain respects as that of this country, the author's formulæ and constants should prove useful to designers. He passes on (in the second chapter) to a consideration of the breaking of the circuit, but the treatment here is not very complete. Nothing is said, for instance, of oil switches for high-pressure work, the author's remarks being confined to long-break, quick-acting switches and "flare" switches. Modern practice, however, seems to show that oil switches meet all requirements in a far more satisfactory manner than any other type of switch, except in those cases in which (owing to the nature of the circuits) large pressure rises are liable to occur; even in such cases protective devices can be frequently used in conjunction with them with considerable success.

Chapters III. and V. are the best in the book; they deal with the theory and calculation of starting and regulating resistances respectively. In the former chapter equations and curves are deduced for finding (*a*) the best number of contacts

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and best sub-division of the resistances to employ for the case of starters for shunt motors having to start with a certain maximum value of armature current; (*b*) similar information for series motors; and (*c*) similar information for three-phase motors. The calculations for (*b*) are not so simple as those for (*a*), insomuch as here, the current taken by the motor during its period of starting is not constant, but is a function of the speed; the calculations for the three-phase motors (*c*) are clear and sufficiently detailed—naturally, only those motors arranged for rheostatic (rotor) control are considered. The calculations in Chapter V. are mostly graphical, the basis being the characteristic curves of the machines.

The other two chapters of the book (IV. and VI.) deal respectively with the mechanical construction of starters and regulators; in the former the question of underload and overload attachments is adequately considered. But many of the details of construction of the starters and regulators shown would not commend themselves to designers in this country in several respects, notably on account of their light, not to say flimsy, character. It is noteworthy, on the other hand, that the starters and regulators for all ordinary purposes are almost wholly self-contained—that is, the contacts are mounted directly upon the resistances themselves, thus making the length of the connecting wires to the contacts as short as possible. There is no reason really why any other arrangement should be tolerated, for, even when considerations of space behind the switchboard do not permit of the resistances being located there, the connection from the hand-wheels on the face of the board to the contact arms of the starter or regulator can always be made indirectly—*i.e.*, by means of chain or bevel gearing or by links. Such arrangements were standardised on the Continent long before the necessity for them was recognised over here; even nowadays one finds, with many English switchboards of otherwise up-to-date design, that the contacts are mounted directly on the front of the panels, necessitating long straggling connections to the resistances at the back, the arrangement having several other obvious disadvantages as well. The substitution of mechanical, instead of electrical, connections in this respect has reached a very high state of perfection at the hands of Messrs. Brown, Boveri & Co., and in the "Bertram" system of working.

Considering the importance of car controllers and resistances nowadays, we think the author's treatment of these inadequate, for only a few remarks and a pair of developed diagrams of controllers are given. This is, however, such a special subject that it may have been thought outside the scope of this little work; certainly, to deal effectively with the problem of the electrical and mechanical design of one, two and four motor controllers, with their resistances, &c., would have increased the bulk of the volume very considerably.

While there is but little that is absolutely new in Mr. Krause's treatise, it can be recommended to all those interested in the subject of these hitherto somewhat neglected, but very important, pieces of apparatus. As a rule, they give in practice more trouble than the machines with which they are employed, while, on the other hand, users of electrical machinery mostly grudge the money invested in them; particularly with small motors the cost of the starter in any case forms an appreciable percentage of the cost of the motor. A thorough knowledge of the scientific principles involved will assist the designer to attain the desired object at a minimum of cost, and in this connection the present treatise may be recommended.

Electric Wiring. By W. C. CLINTON, B.Sc. (London: John Murray.) 1s. 6d.

This book deals, in a practical manner, with electric bell and light wiring in such a way that the average wireman ought to understand without difficulty. Ohm's law is explained and several examples worked out. The various fittings in use at the present day are described and illustrated, and the last chapter is devoted to methods of testing, including diagrams of the Wheatstone bridge. The wiring and casing tables, and a list of resistances and temperature coefficients at the end of the book are useful, as is also the information given with regard to intensity of illumination.

Induction Coils for Amateurs. Edited by PERCIVAL MARSHALL, A.I.Mech.E. (London: Dawbarn and Ward.) 6d.

The theory of induction is dealt with in a simple manner in the opening chapters, and later on there is a good deal of useful information regarding the construction and use of induction coils. The book is suitable for those who do not require more than elementary knowledge of the subject. It concludes with a description of the Wehnelt interrupter and certain experiments which it is possible to perform with a spark coil.

ATMOSPHERIC ELECTRICITY AND EARTH CURRENTS.

BY E. O. WALKER, C.I.E.

On the Nilgiri Hills, in India, Michie Smith found, on the edge of a dissolving mist, the potential to be lower than the normal, and, on the edge of a condensing mist, higher. On Ben Nevis Dickson noticed that when the summit was clear a current came up the mountain, and that the reverse was the case when the summit was enveloped in mist. Similarly, on Vesuvius, the observations of Palmieri go to show that during a fall of rain or snow the current is, in direction, downwards, and when the mountain is clear, in most instances the opposite occurs.

Beyond the probability that vapour movements alter the atmospheric potential, there are other facts which ought to be considered in this relation. Kelvin has shown that electrification of air is diminished by raising the temperature; so also has Warburg, and he thinks that the electrification is probably due to condensed water particles. He adds that air without dust is not electrified. That assertion has not been borne out by others; at the same time there is no doubt that dust profoundly modifies the electrical state. Palmieri finds that when the volcano is active the direction of current is downwards. This is contrary to what occurs in a clear sky. Elster and Geitel assert that on mountain tops the density of the negative charge of the earth is greatest, but that there is a preponderance of positively electrified particles in the air. They add that in cloudy weather the condenser action of the clouds alter the conditions. In a broad sense, Schuster found in Switzerland, at high elevations, a high degree of positive electrification in the air, and a lowering of the same when the current blew off a glacier. Perhaps it may be said that cold makes vapour negative and heat makes it positive, and it is the movement of vapour, no doubt, which renders the distribution of potential below 1,000 metres in height very obscure. Chauveau, in France, finds that a disturbing influence, due to vapour, and strongest during summer, complicates the diurnal variations of the electric potential, which would otherwise have a simple oscillation.

Elster and Geitel suppose that the atmosphere contains an equal number of plus and minus ions; that fog destroys the mobility of the ions by attaching them to water drops; in the earth's electrostatic field the free ions undergo a partial separation. The positive ions round the mountain tops produce a discharge of negative electricity from them. An unimpeded acquisition of negative electricity takes place on the earth's surface wherever the negative ions penetrate below, as they practically do under under the foliage of a forest. So the earth gets its negative charge. Cloud stops the ions and accumulates electricity, and disruption follows. Elster and Geitel appear to think with Lenard that the ionisation of the air is caused by ultra-violet light, more particularly in the highest strata of the atmosphere, which would account for conductivity in those regions and for luminous phenomena. A similar supposition is entertained by Ebert and Hoffmann. A body suspended above the surface of liquid air was found to acquire a strong negative charge, due to friction of minute particles of very cold ice in the vapour. The ice was positive to the body, especially so when cold and dry. Generalising from this experiment, they attribute the electric effects of polar snowstorms to this cause, and conjecture that, high up, where ice crystals are in suspension, the atmospheric electrification may

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be partly occasioned by friction between such crystals and cosmic dust, and that solar ionisation shares in its production.

Arrhenius, on the other hand, thinks that auroræ are cathode ray phenomena. Near the poles, where the magnetic lines are vertical, these rays can penetrate more deeply into the atmosphere. Electric discharges, occurring on the sun, produce cathode and Röntgen rays. Cosmical particles projected by the sun, carry charges to other bodies; these are arrested in the high strata of the atmosphere, and produce cathode rays when discharged by ultra-violet light.

Regarding the sign of elecrification in the upper regions, Elster and Geitel, by balloon experiments, have ascertained that negative discharge takes place quicker than positive up to 8,000 metres, and above that height the rate is more nearly equal. In dry, clear air the rate is nearly as great as near the earth, but in damp air the discharge is much reduced.

It is possible that difference in the potential gradient over land and over sea are productive of electric currents in the air and on the earth's surface. A large eddy, produced by the sun north of its path round the earth and another south, would account for the horizontal movement of the needle which is daily recorded in magnetic observatories, and would also be productive of the earth currents witnessed in telegraph lines and cables. These two phenomena are intimately connected, and it is hardly necessary to cite facts in support of such an assertion. But one not generally known may be quoted. From a number of observations made of the earth current from Belgium to Vingorla in India, some 20 years ago, it was found on quiet days that the rate of change of the force producing the current, whatever it was, varied from ¼ft. to 22ft. per hour. If the daily variation in declination be due to a slight shifting of the magnetic axis of the earth under the sun's action, the north magnetic pole would, for India, be displaced to the eastward about 739ft. in 7 hours, and then slowly return to the normal. This movement is at the rate of 106ft. per hour, and, within the limits of observation errors, the approximation in slowness of change of force in the two cases is very striking.

Adverting to the possible effect of differences in potential gradient in the atmosphere in production of currents, the figures given by several observers render this surmise significant. At Delhi the gradient is 127 volts (Mache). At Luxor, in Egypt, Exner found the maximum to be 128 volts per metre, at Bombay 64 volts, and in Ceylon 57 volts. At Jeur, in the Deccan, Ludwig found 150 volts, and made the interesting observation that the potential gradient fell from 150 to 120 as totality of the eclipse of 1898 was approaching, and went on falling to 89 volts for 80 minutes after it was over. He remarks that the potential gradient clearly does not depend primarily upon the temperature. Exner supposes that air-borne dust and vapour cause maxima and minima of potential gradient. Braun's theory that it falls with rising temperature is inconsistent with the above facts.

It was with these thoughts in mind that observations were undertaken by the writer in Ceylon. Earth currents in the telegraph lines are not present to any great degree, but the manifestations were similar to those in the south of India. Between Paumben and Manaar, where the shores are low and sandy, and the two stations connected by 16 miles of overhead wire and 85 miles of cable, no difference of potential was observed greater than ¼ volt. The atmospheric conditions of the two places seem to be too much alike to permit of any difference electrically, and the gulf waters, of considerable extent on both sides, assist to produce an electrical level. Again, with regard to any possible effect by the earth's magnetic field, as no part of the line is elevated, no such effect could be predicted, nor did it come to light. Between Colombo and Kandy the case is different. The former is on the shore and at the sea level, and the latter on the hills at an elevation of 1,700ft., distant about 70 miles east of Colombo. The end of the line, however, at Kandy is among thick and tall trees, and the town itself nestles among high hills; the Colombo end is very near the sea, but surrounded by high buildings, so that in both places effects due to atmospheric electricity would naturally be somewhat obscured. Observations of the earth current were taken between 7 and 9 a.m. It flowed generally from Kandy to Colombo, and the maximum was observed on a fine and sunny day. It would seem to have been due to a difference of potential between the two ends of the line of 1·5 volt. This was at 8:19 a.m., but, compared with other days and with different states of the sky, this difference of potential was not found to be the same. Once, when the sky was overcast at Colombo and clear at Kandy, the current flowed from the former to the latter, and showed only 0·5 volt. Between Belgaum and Vingorla, in India, where the conditions are analogous, the average maximum difference of potential was found to be 1·5 volt, and the current was down the line, from the mountain to the sea shore, in the mornings.

These figures are too high to be attributable to thermal effects at junctions of earth plates with the soil, or to electro-chemical effects at the plates, and seem to be due to an influence external to the circuit of the wire, earth plates, and intervening earth. For instance, a small model was constructed with earth plates and mould similar to that actually occurring in the localities concerned, and the temperatures at the respective ends were artificially reproduced. The highest E.M.F. obtained was 0·03 volt. Again, in view to ascertain whether the different states of the iron earths were contributing to errors, a galvanised and a plain iron earth buried a little distance apart were tested and the E.M.F. obtained was 0·1 volt. Lastly, to prevent polarisation due to signalling currents from affecting the measurements, earth connections quite distinct from the telegraph office earths were employed during the experiments.

In view to elucidate the cause of the earth current, observations were instituted at Colombo with a Kelvin quadrant electrometer kindly lent by the Technical College. The collector was a tinned disc suspended at 67ft. from the ground, on the roof of the building, and 18ft. above the latter. The lead was well insulated, and every part of the circuit insulated by blocks of paraffin where any contacts with the building were likely. The variations in the air potential were irregular. Generally, there was a slight increase of positive electricity when a gust of wind occurred. The direction of the wind at this season was south-west or west-south-west. On two occasions about 8 a.m., when heavy clouds prevailed and a light or gusty wind, sudden negative deflections due to 5 and 10 volts were respectively noticed. In fine weather, again, there have been sudden variations of 5 volts.

At Kandy, where some observations were also made, very slight variation was observed, hardly to the extent of 1 volt. The collector was also above the roof of the building. Once, in heavy rain and fitful wind, there was an increase of positive electrification of 10 volts. It would seem on the whole, in the early morning at Kandy that the air potential is more positive than that of Colombo, and has less variation at the season of observation, which was during the prevalence of the south-west monsoon. It is not impossible that on the mountains, the effect of solar radiation being greater in the less dense atmosphere, the ultra-violet rays may modify the earth's negative charge to a greater extent than at low elevations, and produce the result that is manifested in the earth current. As these rays must fall in different phases at different places there would also be present, the conditions favourable to extensive electrical eddies in the air.

THE HEATING OF TOOTHED-CORE ARMATURES.

BY FRED. W. DAVIES.

Doubtless, there are many electrical engineers who have stumbled across armatures of the toothed-core type in dynamos and continuous-current motors—especially in the latter—which heated more than their output and dimensions would lead one to expect. It is evident that the designers and manufacturers of these machines did not anticipate this overheating, otherwise the defect would not have occurred. The reason why such excessive heating occurs appears sometimes to be rather obscure, and it will not be out of place to devote a little time to the investigation of the phenomenon. As (in a well-

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designed machine) it is the heating of the armature that limits the output, it is obviously of importance that its temperature rise at full load should be as low as possible. Any reduction of the temperature rise will, of course, increase the permissible output of the machine.

Alongside of such machines there is a host of excellent ones —excellent as regards efficiency, sparkless commutation and cool running; and these are ample evidence that the question of dynamo and motor design is one that has not been studied in vain. Indeed, it may appear to some to be an impertinence, at the present time, to raise the question of armature heating at all, so thoroughly is it understood by the electrical engineers of our time. However, as already pointed out, whilst many of the machines which are now being turned out are excellent in all respects, yet there are some which certainly do not merit the use of this adjective. This being so, it will be well to consider the question of armature heating—a point in which the performance of some machines falls short of that of others. Not so much with the idea of discovering a hitherto unknown source of loss—that would be presumption, considering the advanced state of knowledge on the subject—but rather with the view of emphasising the importance of certain losses, and pointing out in what way these losses are influenced by the general design of the machine—such is the purport of the present article.

Observations made by the writer on various machines having toothed-core armatures which heated unduly, have demonstrated the following facts:—Firstly, that such overheating is more marked in machines of the multipolar than the bipolar type, especially in the smaller sizes; and secondly, that the temperature rise is not at all proportional to the load on the machine, but is more marked at light load than at full load. Now, in order to discover the root of the evil, it is necessary to analyse the possible causes of the heating of an armature. There are three principal sources of loss of energy (and, consequently, of heating) in a continuous-current armature They are the C^2R loss, the hysteresis loss, and the loss due to eddy currents in the core stampings. In addition to the foregoing, there are also the loss due to the "short circuiting" of each coil or section of the armature whilst its corresponding commutator bars are under the brush, and the loss due to eddy-currents in the active conductors themselves. Unless the design of the machine is an abnormal one, these latter will be quite negligible; and may be safely ignored as far as the present inquiry is concerned—the loss due to eddy-currents in the conductors, in particular, being always very small, and in the case of toothed-core armatures (with which we are concerned at present) practically nil. The abnormal temperature rise of the armature at light load serves to show that the C^2R loss plays but a small part in the matter.

The magnetic induction in the armature core proper is never very high, and would certainly not be likely to cause overheating of the armature—unless the stampings were of inferior quality. This, and the fact that it is in toothed cores that such cases of heating usually occur, point to the teeth as being the seat of the trouble. Armature teeth are frequently made narrow with the idea of minimising the armature reaction, and, consequently, the sparking at the brushes. This plan has little to recommend it, for it increases the hysteresis and eddy-current losses, and thus lowers the efficiency of the machine, besides involving extra care in punching out the core discs. The armature reaction may be reduced equally well by increasing the length of the air-gap—an expedient which has none of the disadvantages attendant on reducing the section of the armature teeth. It will not do, of course, to make the teeth indefinitely large, as by so doing the space required for the conductors will be encroached upon, and the self-induction of the armature coils will be increased.

Sometimes it thus occurs that overheating of the armature is brought about by an insufficiency of iron in the teeth. Frequently, however—especially in small machines of the multipolar type, which are usually run at a high speed—it is due to another, not unknown, but often unrecognised cause. The loss by hysteresis varies directly as the number of cycles of magnetisation through which the iron passes per second, and the loss by eddy-currents varies as the *square* of the number of cycles of magnetisation per second. Clearly, the periodicity must be kept as low as possible, and herein lies one of the advantages of a slow-speed machine. But it is not only by means of reducing the speed that the periodicity may be reduced. The periodicity also varies directly as the number of poles there are in the magnet. In order to keep the periodicity low, therefore, it is advisable, as far as other considerations will allow, to have as few magnet poles as possible. Many of the small four-pole enclosed motors now upon the market would certainly run much cooler if the magnets were of the bipolar type. The high periodicity involved by the use of a large number of magnet poles is a more serious matter than it may perhaps appear to be at first sight, for when the watts lost in hysteresis and eddy currents in the armature stampings amount to from 25 to 50 per cent. of the total armature losses, as they frequently do, it makes quite an appreciable difference in the permissible output of the machine to use a four-pole magnet instead of a two-pole one, or a six-pole magnet instead of a four-pole. There is no valid objection to multiplying the number of magnet poles in the larger sizes, for in such machines it is usual to run at lower speeds.

There is also another reason why the iron losses are greater the greater the number of poles in a machine for a given speed. In order to ensure a sufficient range of sparkless brush movement, the gross polar angle embraced by the poles of the magnet (that is, the sum of the angles embraced by the poles) is made less the greater the number of poles on the magnet. Thus, the polar angle embraced by one pole of a four-pole machine is slightly less than one-half of that embraced by one pole of a two-pole machine, and that embraced by one pole of a six-pole machine is slightly less than two-thirds of that of a four-pole machine, and so on. To give actual figures, it may be said that the gross polar angle embraced by the poles of a two-pole machine should be about 280deg., whilst that for a four-pole machine should be about 270deg., and for a six-pole machine 260deg. From this it will be seen that the number of teeth embraced by a magnet pole is not exactly in inverse proportion to the number of magnet poles, but is rather less than this—becoming less and less as the number of poles is increased. For this reason, the magnetic induction in the teeth becomes greater as the number of poles is increased. This will not matter much if, as should always be the case in the armatures for multipolar machines, the radial depth of the armature core, and, consequently, the radial depth of the teeth is proportionately less, for then the teeth will be proportionately wider at the roots.

The foregoing considerations serve to emphasise the necessity for carefully calculating the watts lost in the armature teeth; so that, in the event of these figuring out too high, the design of the machine may be modified before it is put in hand in the works. For the purpose of estimating these losses, it may be mentioned, in passing, that the mean average magnetic induction in the armature teeth may be taken as being equal to that at one-third the distance up the teeth, measured from the roots. As a set-off against the increased losses in this direction which accompany an increase in the number of poles, it may be pointed out that the current-density in the conductors (and therefore the C^2R loss) is usually less in the larger sizes of machines, in which an increase in the number of poles is permissible.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Handbook for the use of Electricians in the Operation and Care of Electrical Machinery and Apparatus of the United States Seacoast Defences." By G. L. Anderson. (London: Crosby, Lockwood & Co.) 21s. net.

"Electrical and Magnetic Calculations." By A. A. Atkinson. (London: Crosby, Lockwood & Son.) 9s.

"Übungsbeispiele für die Elektrolytische Darstellung Chemischer Präparate," by Dr. Karl Elbs. (Halle-a-S.: Wilhem Knapp.) 4m.

"La Telegraphie Sans Fil." Reprint from the "Revue d'Electricité." (Berne: Office Polytéchnique d'Edition et de Publicité.) 1902. 1s.

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ELECTRICITY WORKS ACCOUNTS.

Glasgow Municipal Electric Supply Works.

There is to be observed a material improvement last year in the already low cost figures exhibited by this undertaking in 1900–1. Most of the items have diminished, and both the works and total costs present most creditable figures. The fuel bill, at 0·35d. per unit, is remarkably low considering the coal prices ruling generally last year. Repairs and maintenance expenses have increased within as well as outside the station, but it is necessary to point out that included in the item of repairs and renewals of mains is £649 net expended on lamps and fittings supplied during the year to consumers consequent on change of pressure of supply. It will be remembered that in the accounts for 1900–1 there was incurred by the revenue of the undertaking a charge of £13,847 transferred from the capital account, being the amount expended during that year and the preceding two years on lamps and fittings for the higher pressure. In 1900–1 £4,110 of this charge was met by the accumulated "profits" of the undertaking, which were thus wholly swallowed up. The remainder —viz., £9,738, was carried forward as a suspense account, which has been further reduced by £2,484 out of revenue this last year, in addition to the £649 referred to above as incurred during the year.

The total revenue from all sources averaged 2·69d., or, exclusive of public lighting, attendance and renewals, 2·68d. per unit sold. This is a pleasing figure, but it is unfortunately too low for soundness. That the Electricity Committee feel some uneasiness on this score is shown by their report on the present accounts, and more particularly in their references to what they call the "surplus" of £11,431, which, in our analysis, is included (with the £2,484 reducing the suspense account) in the £18,865 allocated to depreciation out of revenue. The report states:—

> Your committee have given serious consideration as to the disposal of this surplus, and have come to the conclusion that, as it is insufficient to provide for a general depreciation of the whole capital of the undertaking, as certain plant and buildings have been disposed of at a price less than the nominal book value, and as a considerable amount of plant has been, or will shortly be, thrown out of use in Waterloo-street and Kelvinside stations, owing to the change of pressure from 100 to 250 volts (which plant will not probably realise its full book value), the wisest and most prudent course to follow is to apply this money to the reduction of the capital accounts involved.

The recommendations may be summarised as follows:—

> That the value of the accumulators of Waterloo-street station which are now out of use and not in a state to be used in any of the new stations be (less the value of the old material) written off £823, similarly with the batteries at Kelvinside which are in the same state, £2,038. That the difference between the sum realised on Claremont-street battery station and the book value be written off £80. That 7½ per cent. on £10,306, the value of the plant purchased from the Kelvinside Company be written off £773. That the difference between the sum realised and the book value of two engines and dynamos belonging to Waterloo-street station which have been sold be also written off £1,282, and that as the Waterloo-street station is expected shortly to be closed as a generating station, the capital account of the plant there be reduced by the application of the balance of the surplus, amounting to £6,435.

The report goes on to state that

> . . . . As the surplus this year is a moderate one, and as the contribution to the sinking fund, at the increased rate of 2½ per cent. upon the amount borrowed under the Glasgow Corporation (Tramways and General) Order, 1901, will begin with the year 1902-1903, they do not recommend any alteration in the rates of charge for electricity.

This employment of the term "surplus" is remarkable, and especially in view of the considerations advanced by the committee anent its disposal.

An arrangement has been entered into with the tramways department by which a supply during the heavy demand experienced in the winter afternoons may be taken from some of the spare plant of that department.

Brighton Municipal Electric Supply Works.

The accounts for the year to March 31st last indicate a continued improvement in the total costs, notwithstanding increases in the fuel and distribution charges per unit. Most creditable reductions have been effected in all the other items, and, considering Brighton's situation and its effect on the cost of coal and stores, not only are the costs very low but the total revenue from all sources at 2·91d. per unit is most moderate. The capital of this undertaking is now naturally somewhat high relatively to the output, but notwithstanding this and the nature of the receipts, the working profit in relation to the capital comes out at a sound figure, and one well calculated to cover reasonable charges on capital account. It is necessary to explain, however, the somewhat high figures appearing as the interest and redemption charges. They include those on the capital (£28,162) expended on the new power station being erected at Southwick. Included also in the charges on revenue are £150, part of the capital expended in building a new store house in Bedford-street and £400 consulting engineers' fees for superintending the erection of the Southwick works. These unusual charges on revenue had the effect of turning a profit of £1,412 into the deficit of £168 shown.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 190[0]
Accrington (Municipal)	July 25, 190[2]	Kens'gton & Knightsbr'(Co.)	Apr. 11, 190[2]
Ayr (Municipal)	Oct. 11, 1901	Kingston-upon-Hull (Mun.)	July 13, 190[0]
Barnsley (Municipal)	June 27, 1902	Kingston-on-Thames (Mun.)	June 20, 190[2]
Bath (Municipal)	April 20, 1900	Lancaster (Municipal)	July 25, 190[2]
Bedford (Municipal)	Aug. 8, 1900	Leeds (Municipal)	June 27, 1902
Belfast (Municipal)	Aug. 8, 1902	Leicester (Municipal)	Jan. 26, 190[0]
Birmingham (Company)	Sept. 15, 1899	Leith (Municipal)	May 17, 190[1]
Blackburn (Municipal)	Feb. 7, 1902	Leyton (Municipal)	Nov. 1, 190[1]
Blackpool (Municipal	Oct. 4, 1901	Liverpool (Municipal)	April 4, 19[2]
Bournemouth (Company)	April 18, 1902	London Elec. Supply Corp.	Sept. 5, 190[2]
Bolton (Municipal)	Nov. 29, 1901	Londonderry (Municipal)	Feb. 16, 190[0]
Bradford (Municipal)	July 12, 1901	Manchester (Municipal)	Aug. 29, 190[2]
Brighton (Municipal)	May 10, 1901	Metropolitan Elec. Supply Co.	Apr. 25, 190[2]
Bristol (Municipal	Aug. 8, 1902	Morley (Municipal)	July 25, 190[2]
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 189[9]
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 190[1]
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 190[1]
Burton-upon-Trent (Mun.)	July 11, 1902	Northampton (Company)	Oct. 20, 189[9]
Bury (Municipal)	July 11, 1902	Norwich (Company)	Dec. 13, 190[1]
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 190[2]
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 190[1]
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Aug. 29, 190[2]
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 15, 190[2]
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 8, 190[1]
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 190[1]
Chester (Municipal)	Aug. 22, 1902	Prescot (Company)	Dec. 8, 189[9]
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 190[0]
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 19[0]
Coventry (Municipal)	Feb. 23, 1900	Richmond (Company)	June 29, 190[0]
Crewe (Municipal)	July 11, 1902	Salford (Municipal)	Jan. 24, 190[2]
Croydon (Municipal)	Nov. 22, 1901	Scarborough (Company)	Dec. 20, 190[1]
Crystal Palace District (Co.)	Sept. 13, 1901	St. Helens (Municipal)	Jan. 10, 19[2]
Derby (Municipal)	Jan. 26, 1900	St. James' & Pall Mall (Co.)	Mar. 21, 190[2]
Dewsbury (Municipal)	Feb. 15, 1901	St. Pancras (London) (Mun.)	Sept 5, 190[2]
Dover (Company)	May 2, 1902	Sheffield (Municipal)	Feb. 1, 190[1]
Dundee (Municipal)	Dec. 6, 1901	Shoreditch (Municipal)	Jan. 31, 190[2]
Eastbourne (Municipal)	Mar. 14, 1902	Smithfield Markets, Lond. (Co.)	Mar. 8, 190[1]
Edinburgh (Municipal)	Dec. 6, 1901	South London (Company)	May 16, 190[2]
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 4, 190[2]
Folkestone (Company)	May 2, 1902	Southampton (Municipal)	Aug. 1, 190[2]
Glasgow (Municipal)	Sept. 27, 1901	Southport (Municipal)	Jan. 17, 190[2]
Gloucester (Municipal)	Aug. 30, 1901	Stafford (Municipal)	Aug. 16, 190[1]
Great Yarmouth (Mun.)	Dec. 13, 1901	Sunderland (Municipal)	Aug. 1, 190[2]
Greenock (Municipal)	Aug. 30, 1901	Taunton (Municipal)	June 16, 189[9]
Guildford (Company)	Oct. 19, 1900	Tunbridge Wells (Mun.)	Aug. 22, 190[2]
Halifax (Municipal)	Dec. 27, 1901	Wakefield (Municipal)	Dec. 1, 189[9]
Hammersmith (Municipal)	Nov. 15, 1901	Walsall (Municipal)	May 23, 190[2]
Hampstead (Municipal)	Nov. 22, 1901	Wandsworth (Company)	May 9, 190[2]
Hanley (Municipal)	Aug. 9, 1901	Westminster (Company)	April 4, 190[2]
Harrogate (Municipal)	Jan. 25, 1901	Whitehaven (Municipal)	Feb. 8, 190[1]
Harrow (Company)	Dec. 21, 1900	Winchester (Company)	June 20, 190[2]
Hastings (Municipal)	July 18, 1902	Windsor and Eton (Co.)	July 19, 190[1]
Hereford (Municipal)	Jan. 17, 1902	Woking (Company)	Dec. 22, 189[9]
Hove (Company)	July 18, 1902	Wolverhampton (Municipal)	Jan. 24, 190[2]
Huddersfield (Municipal)	May 23, 1902	Woolwich (Company)	May 31, 190[1]
Hull (Municipal)	July 4, 1902	Worcester (Municipal)	April 18, 190[2]
Isle of Wight (Company)	Dec. 20, 1901		

REMARKS.

GLASGOW.—*a* Of superintendence at works £306. *b* Buildings £386, machinery and plant £1,415, instruments £4, accumulators £354. *c* Of mains, cables, &c., £3,327, of meters, &c., £274, salaries of surveyors £817. *d* Engineers' department £1,445, after deducting £635 for new work and charged to capital treasurer's department £1,000. *e* For 10-ampere double-carbon arcs and £12 for 7·5-ampere double-carbon arcs lighted from sunset to sunrise. *f* There is a suspense account with £9,738 at debit in 1900-1 and £7,303 in 1901-2. *g* Over-expended. *h* Salaries £225. *i* Buildings £718, machinery and plant £3,605, instruments £6, accumulators £762. *j* Of mains, cables, &c., £6,673, of meters £1,071, salaries of surveyors £1,090, fittings on consumers' premises £649. *k* Engineers' department £2,360, treasurer's department £1,070. *l* Inclusive of £2,434 allocated to reduction of suspense account. *m* On November 8.

BRIGHTON.—*a* Maximum load on station. *b* Being premiums on stock. *c* Includes £1,337 to purchase of patents, £1,497 engineer's commission and £5,000 to purchase of undertaking of Brighton Electric Light Co. *d* Over-expended. *e* 1,158,147 units at 7d., 1,898,710 units at 1d.; minimum charges (under special contracts) £66, less £172 bad debts. *f* 66,591 units at 7d. and 603,275 at 1d., attendance £3,71[2], "installation works" £472. *g* Rents £21 in 1900 and £53 in 1901-2. *h* Buildings £885, plant £1,673. *i* Of mains £709, of apparatus on consumers' premises £1,013. *j* "Street lighting installations" £472. *k* Insurance £145, stock registration and stamp duty £179 and law £11. *l* On glow lamp posts—2 8 c.p. lamps generally, but a few with 2 16 c.p. and 10 with Nernst 0·25, 0·5 and 1 ampere experimental lamps. *m* Maximum demand system. *n* Maximum demand system; for traction supply 5d. (1 hour) 1d. afterwards. *o* Lands £10,673. *p* Lands £11,284. *q* 1,379,115 units at 7d., 2,407,272 units at 1d., minimum charges (under special contracts) £74, less bad debts £250. *r* 82,026 units at 7d., 727,324 at 1d., attendance £3,685, "installation works" £2,852. *s* Buildings £718, plant £2,202. *t* Of mains £712, on consumers' premises £1,829. *u* "Street lighting installations" £2,852, attendance, &c., £3,685. *v* Engineers' department £3,015, accountant, collectors, &c., £375. *w* Insurance £161, registrar of stock and stamp duty £335. *x* Transferred in aid of district rate £1,455. *y* Charged to "reserve" fund (given as the "depreciation fund" in this table).

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	GLASGOW.		BRIGHTON.	
Undertaking Worked by	Glasgow Corporation.		Corporation of Brighton.	
Date of Commencement of Supply	March, 1892.		Sept., 1891.	
System of Supply	3-wire continuous-current with batteries.		[alt.-curr. trans. sub-stations, 3-w. with batts. combined with high-tension	
Chief Engineer	W. A. Chamen.		Arthur Wright.	
YEAR ENDED	MAY 31, **1901.**	MAY 31, **1902.**	DEC. 31, **1900.**	MAR. 31, **1902.**
QUANTITIES—				
Units generated	8,254,146	11,122,606	4,391,255	5,685,435
„ **SOLD (TOTAL)**	**6,813,991**	**9,282,043**	**3,726,723**	**4,860,430**
„ sold to consumers	6,290,819	8,384,696	3,056,857	3,786,387
„ sold for public lighting, &c.	523,172	897,347	669,866	809,350
„ sold for traction	nil	nil	nil	264,693
„ used on works	626,151	829,713	180,915	360,066
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	**32·8**	**30·4**	**26·7**	**29·2**
Actual maximum supply demanded	6,308 kilowatts	7,950 kilowatts[m]	2,968 kilowatts[a]	3,393 kw. lighting only 500 kw. traction only
Load factor	12·34%	13·3%	14·3%	15·5% lighting only 6·05% traction only
Number of public lamps	348	500 arc, 34 (16 c.p.) glow	262 arc, 1,242 incan.	372 arc, 1,259 glow lamp
Number of consumers	4,031	10	2,855	3,285 [posts]
Connections to mains in 8-c.p. lamps at end of year	368,342	491,306	158,884	208,469
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	**6,900**	**12,618**	**4,710**	**5,935**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	**£900,000** / **£130**	**£1,150,000** / **£91·1**	**£754,881** / **£160**	**£824,893** / **£139**
Share	— / —	— / —	nil / —	nil / —
Loan (including Debenture charges)	900,000 / 130	1,150,000 / 91·1	754,881 / 160	824,893 / 139
RECEIVED (TOTAL)	**885,000** / **128**	**1,017,000** / **80·6**	**338,269** / **71·8**	**414,541** / **69·8**
Share	— / —	— / —	nil / —	nil / —
Loan (including Debenture charges)	885,000 / 128	1,017,000 / 80·6	338,269 / 71·8	414,541 / 69·8
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**15,000** / **2·17**	**133,000** / **10·5**	**416,612** / **88·4**	**410,352** / **69·1**
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	15,000 / 2·17	133,000 / 10·5	416,612 / 88·4	410,352 / 69·1
REPAID (TOTAL)	**27,366** / **3·97**	**36,769** / **2·91**	**9,611**[b] / **2·04**	**14,761**[b] / **2·49**
RESERVE OR SINKING FUND	—[f] / —	—[f] / —	**43,519** / **9·23**	**55,393** / **9·33**
DEPRECIATION FUND	**47,555** / **6·89**	**58,987** / **4·67**	**1,792** / **0·38**	**3,421** / **0·576**
EXPENDED (TOTAL)	**883,702** / **128**	**1,021,714** / **81·1**	**339,602** / **72·1**	**404,859** / **68·2**
Lands and buildings	156,183 / 22·6	165,563 / 13·1	42,009[c] / 8·91	68,694[p] / 11·6
Plant	265,827 / 38·5	316,625 / 25·1	136,413 / 29·0	157,136 / 26·5
Mains	458,921 / 66·5	535,569 / 42·4	151,326 / 32·1	167,108 / 28·1
Miscellaneous	2,772 / 0·402	3,957 / 0·314	9,855[c] / 2·09	11,920 / 2·01
BALANCE OF CAPITAL ACCOUNT	**1,298** / **0·188**	**−4,714**[g] / **−0·374**	**−1,333**[d] / **0·28**	**9,682** / **1·63**
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	**£79,450** / **2·800d.**	**£103.941** / **2·689d.**	**£51,717** / **3·330d.**	**£65.583** / **3·238d.**
Revenue from supply	74,524 / 2·626d.	97,051 / 2·509d.	41,584[e] / 2·677d.	50,078[q] / 2·475d.
„ meters, &c.	— / —	— / —	1,314 / 0·085d.	1,599 / 0·079d.
„ public lighting	4,925 / 0·174d.	6,890 / 0·178d.	8,640[f] / 0·557d.	11,960[r] / 0·591d.
„ supply for traction	— / —	— / —	nil / —	1,799 / 0·089d.
„ miscellaneous sources	— / —	— / —	179[g] / 0·011d.	146[g] / 0·007d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£46,647** / **1·644d.**	**£52,091** / **1·347d.**	**£32,116** / **2·067d.**	**£41,305** / **2·040d.**
TOTAL WORKS COSTS	**37,404** / **1·319d.**	**39,902** / **1·032d.**	**26,965** / **1·736d.**	**35,446** / **1·750d.**
Generation of electricity	*30,843* / *1·087d.*	*28,113* / *0·727d.*	*20,394* / *1·313d.*	*24,994* / *1·234d.*
Fuel (including cartage, &c.)	19,667 / 0·693d.	13,551 / 0·350d.	11,151 / 0·718d.	15,018 / 0·742d.
Oil, waste, water, stores	1,559 / 0·055d.	1,918 / 0·050d.	1,330 / 0·086d.	1,499 / 0·074d.
Wages at station	6,637[a] / 0·234d.	7,096[h] / 0·184d.	5,355 / 0·345d.	5,562 / 0·275d.
Repairs and maintenance at station	2,139[b] / 0·075d.	5,091[i] / 0·132d.	2,558[h] / 0·165d.	2,915[s] / 0·144d.
Distribution of electricity	*5,018* / *0·177d.*	*9,483* / *0·245d.*	*2,387* / *0·154d.*	*3,915* / *0·193d.*
Wages, &c.	5,018[c] / 0·177d.	9,483[j] / 0·245d.	665 / 0·043d.	1,082 / 0·053d.
Repairs, renewals of mains, &c.			1,722[i] / 0·111d.	2,833[t] / 0·140d.
Public lighting	*1,543* / *0·054d.*	*2,306* / *0·060d.*	*4,184*[j] / *0·270d.*	*6,537*[u] / *0·323d.*
Attendance	1,543 / 0·054d.	2,306 / 0·060d.	4,184 / 0·270d.	6,537 / 0·323d.
Renewals				
MANAGEMENT AND PROPERTY CHARGES	**9,243** / **0·326d.**	**12,188** / **0·315d.**	**5,151** / **0·332d.**	**5,859** / **0·289d.**
Net rents	*1,450* / *0·051d.*	*1,416* / *0·037d.*	nil / —	nil / —
Rates and taxes	*3,630* / *0·128d.*	*4,562* / *0·118d.*	*1,237* / *0·080d.*	*1,239* / *0·061d.*
Management	*4,163* / *0·147d.*	*6,210* / *0·161d.*	*3,914* / *0·252d.*	*4,620* / *0·228d.*
Salaries	2,445[d] / 0·086d.	3,430[k] / 0·089d.	2,977 / 0·192d.	3,390[v] / 0·167d.
Stationery, &c.	422 / 0·015d.	1,127 / 0·029d.	317 / 0·020d.	395 / 0·019d.
Establishment charges	1,296 / 0·046d.	1,653 / 0·043d.	285 / 0·018d.	339 / 0·017d.
Law charges &c.	— / —	— / —	335[k] / 0·022d.	496[w] / 0·024d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	**£32,803** / **4·26%**	**£51,850** / **5·44%**	**£19,600** / **6·22%**	**£24,277** / **6·53%**
Sum carried to Depreciation Fund	— / —	13,865[l] / 1·45%	nil / —	nil / —
Sum carried to Reserve Fund	8,663 / 1·12%	8,568 / 0·899%	10,229 / 3·24%	12,629 / 3·39%
Net interest on loans (incl. Debenture charges)	24,547 / 3·19%	29,417 / 3·09%	9,264 / 2·93%	11,816 / 3·18%
Net profit for the year	— / —	— / —	107 / 0·034%	— / —
BALANCE FROM LAST ACCOUNT	— / —	— / —	1,455 / 0·462%	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	**1,562**[x] / **0·496%**	— / —
Deficit	*407* / *0·053%*	— / —	nil / —	*168*[y] / *0·045%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	58·7%	50·1%	62·1%	63·0%
Expenditure per mean kilowatt capacity	£7. 0s. 5d.	£5. 6s. 10d.	£7. 4s. 0d.	£7. 15s. 2d.
REVENUE PER MEAN KILOWATT CAPACITY	**£11. 19s. 0d.**	**£10. 13s. 0d.**	**£11. 12s. 0d.**	**£12. 6s. 5d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**5s. 2d.**	**4s. 10d.**	**7s. 2d.**	**7s. 2d.**
Price charged for lighting, per unit	6d. to 1½d.	6d. to 1d.	7d. (1 hr.) to 1d.[m]	7d. (1 hr.) to 1d.[m]
Price charged for power, per unit	2d. to 1½d.	1½d.	7d. (1 hr.) to 1d.[m]	7d. (1 hr.) to 1d.[n]
Price charged for public lighting	—	£14 per arc per ann.[e]	7d. (1 hr.) to 1d.[m]	7d. (1 hr.) to 1d.[m]
Receipts per unit for private supply	2·84d.	2·78d.	3·29d.	3·18d.
„ „ public lighting	1·55d.	1·23d.	1·60d.	1·61d.
„ „ traction	—	—	—	1·83d.

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PROF. JOHN PERRY'S PRESIDENTIAL ADDRESS TO SECTION G OF THE BRITISH ASSOCIATION.*

This section has had 66 presidents, all different types of engineer. As each has had perfect freedom in choosing the subject for his address, and each has known of the rule† that presidential addresses are not subject to debate afterwards, and as, being an engineer, he has always been a man of originality, of course he has always chosen a subject outside his own work. An engineer knows that the great inventions, the great suggestions of change in any profession, come from outsiders. Lawyers seem like fish out of water when trying to act as law-makers. The radical change that some of us hope to see before we die in the construction of locomotives will certainly not come from a locomotive superintendent who cannot imagine a locomotive which is not somehow a lineal decendant of the "Rocket."

Hence it is that in almost every case the president of this section has devoted a small or large part of his address to the subject of the education of engineers. I grant that every president has devoted his life to the education of one engineer—himself—and it is characteristic of engineers that their professional education proceeds throughout the whole of their lives. Perhaps of no other men can this be said so completely. To utilise the forces of Nature, to combat Nature, to comprehend Nature as a child comprehends its mother, this is the pleasure and the pain of the engineer.‡ A mere scientific man analyses Nature; takes a phenomenon, dissects it into its simpler elements, and investigate these elements separately in his laboratory. The engineer cannot do this. He must take Nature as she is, in all her exasperating complexity. He must understand one of Nature's problems as a whole. He must have all the knowledge of the scientific man, and ever so much more. He uses the methods of the scientific man, and adds to them methods of his own. The name given to these scientific methods of his own or their results is sometimes "common sense," sometimes "character," or "individuality," or "faculty," or "business ability," or "instinct." They come to him through a very wide experience of engineering processes, of acquaintance with things and men. No school or college can do more than prepare a young man for this higher engineering education, which lasts through life. Without it a man follows only rule-of-thumb, like a sheep following the bell-wether, or else he lets his inventiveness or love of theory act the tyrant.

When a man has become a great engineer and he is asked how it happened, what his education has been, how young engineers ought to be trained, as a rule it is a question that he is least able to answer, and yet it is a question that he is most ready to answer. He sees that he benefited greatly by overcoming certain difficulties in his life; and, forgetting that every boy will have difficulties enough of his own, forgetting that although a few difficulties may be good for discipline many difficulties may be overwhelming, forgetting also that he himself is a very exceptional man, he insists upon it that those difficulties which were personal to himself ought to be thrown in the path of every boy. It often happens that he is a man who is accustomed to think that early education can only be given through ancient classics. He forgets the dulness, the weariness of his school-days. Whatever pleasure he had in youth—pleasure mainly due to the fact that the average Anglo-Saxon boy invents infinite ways of escaping school drudgery—he somehow connects with the fact that he had to learn classics. Being an exceptional boy he was not altogether stupefied, and did not altogether lose his natural inclination to know something of his own language; and he is in the habit of thinking that he learnt English through Latin, and that ancient classics are the best mediums through which an English boy can study anything.‖ The cleverest men of our time have been brought up on the classics, and so the engineer who cannot even quote correctly a tag from the Latin grammar, who never knew anything of classical literature, insists upon it that a classical education is essential for all men. He forgets the weary hours he spent getting off Euclid, and the relief it was to escape from the class-room not quite stupefied, and he advocates the study of pure mathematics and abstract dynamics as absolutely necessary for the training of the mind of every young engineer. I have known the ordinary abominable system of mathematical study to be advocated by engineers who, because they had passed through it themselves, had really got to loathe all kinds of mathematics higher than that of the grocer or housekeeper. They said that mathematics had trained their minds, but they did not need it in their profession. There is no profession which so much requires a man to have the mathematical tool always ready for use on all sorts of problems, the mathematical habit of thought the one most exercised by him; and yet these men insist upon it that they can get all their calculations done for them by mathematicians paid so much a week] If they really thought about what they were saying, it would be an expression of the greatest contempt for all engineering computation and knowledge. He was pitchforked into works with no knowledge of mathematics, or dynamics, or physics, or chemistry, and, worse still, ignorant of the methods of study which a study of these things would have produced into works where there was no man whose duty it was to teach an apprentice; and because he, one in a thousand, has been successful, he assures us that this pitchforking process is absolutely necessary for every young engineer. He forgets that the average boy leaves an English school with no power to think for himself, with a hatred for books, with less than none of the knowledge which might help him to understand what he sees, and he has learnt what is called mathematics in such a fashion, that he hates the sight of an algebraic expression all his life after.

I do not want to speak of boys in general. I want only to speak of the boy who may become an engineer, and before speaking of his training I want to mention his essential natural qualification—that he really wishes to become an engineer. I take it to be a rule to which there are no exceptions that no boy ought to enter a profession—or, rather, to continue in a profession—if he does not love it. We all know the young man who thinks of engineering things during office hours and never thinks of them outside office hours. We know how his fond mother talks of her son as an engineer who, with a little more family influence and personal favour, and if there was not so much competition in the profession, would do so well. It is true, family influence may perhaps get such a man a better position, but he will never be an engineer. He is not fit even to be a hewer of wood and drawer of water to engineers. Love for his profession keeps a man alive to its interests all his time, although, of course, it does not prevent his taking an interest in all sorts of other things as well; but it is only a professional problem that warms him through with enthusiasm. I think we may assume that there never yet was an engineer worth his salt who was not fond of engineering, and so I shall speak only of the education of the young man who is likely to be fond of engineering.

How are we to detect this fondness in a boy? I think that if the general education of all boys were of the rational kind which I shall presently describe, there would be no great difficulty; but as the present academic want of system is likely to continue for some time, it is well to consider things as they are. Mistakes must be made, and the parent who tries during the early years of his offspring to find out by crafty suggestion what line his son is likely to wish to follow will just as probably do evil by commission as the utterly careless parent is likely to do evil by omission. He is like the botanical enthusiast who digs up plants to see how they are getting on. But in my experience the Anglo-Saxon boy can stand a very great deal of mismanagement without permanent hurt, and it can do no kind of boy any very great harm to try him on engineering for a while. Even R. L. Stevenson, whose father seems to have been very persistent indeed in trying to make an engineer of him against his will, does not seem, to a Philistine like myself, to have been really hurt as a literary man through his attendance on Fleeming Jenkins' course at Edinburgh—on the contrary, indeed. It may be prejudice, but I have always felt that there is no great public person of whom I have ever read who would not have benefited by the early training which is suitable for an engineer. I am glad to see that Mr. Wells, whose literary fame, great as it is, is still on the increase, distinguishes the salt of the earth or saviours of society from the degraded, useless, luxurious, pleasure-loving people doomed to the abyss by their having had the training of engineers and by their possessing the engineer's methods of thinking.

It may be that there are some boys of great genius to whom all physical science or application of science is hateful. I have been told that this is so, and if so, I still think that only gross mismanagement of a youthful nature can have produced such detestation. For such curious persons engineering experience is, of course, quite unsuitable. I call them "curious" because every child's education in very early years is one in the methods of the study of physical science; it is Nature's own method of training, which proceeds successfully until it is interfered with by ignorant teachers who check all power of observation and the natural desire of every boy to find out things for himself. If he asks a question he is snubbed; if he observes Nature as a loving student, he is said to be lazy and a dunce, and is punished as being neglectful of school work. Unprovided with apparatus, he makes experiments in his own way, and he is said to be destructive and full of mischief. But however

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* Delivered at Belfast yesterday.

† The committees of Sections G and L have arranged a discussion on "The Education of Engineers," this address being regarded as opening the discussion. Thus the rule is not in force this year.

‡ Of all the unskilled labour of the present day, surely that of the modern poet is the most grotesque. How much more powerful and powerless man seems to us now; how much more wonderful is the universe than it was to the ancients! Yet our too learned poets prefer to copy and re-copy the sentiments of the ancients rather than try to see the romance which fills the lives of engineers and scientific men with joy.

‖ The very people who talk so much of learning English through Latin neglect in the most curious ways those Platt-Deutsch languages, Dutch and Scandinavian, a knowledge of which is ten times more valuable in the study of what is becoming the speech of the world. And how they do scorn Lowland Scotch!

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much we try to make the wild ass submit to bonds and the unicorn to abide by the crib, however bullied and beaten into the average schoolboy type, I cannot imagine any healthy boy suffering afterwards by part of a course of study suitable for engineers, for all such study must follow Nature's own system of observation and experiment. Well, whether or not a mistake has been made, I shall assume the boy to be likely to love engineering, and we have to consider how he ought to be prepared for his profession.

I want to say at the outset that I usually care only to speak of the average boy, the boy usually said to be stupid—95 per cent. of all boys. Of the boy said to be exceptionally clever I need not speak much. Even if he is pitchforked into works immediately on leaving a bad school, it will not be long before he chooses his own course of study and follows it, whatever course may have been laid down for him by others. I recollect that when in 1863 I attended an evening class held in the Model School, Belfast, under the Science and Art Department, on practical geometry and mechanical drawing, there was a young man attending it who is now well known as the Right Hon. William J. Pirrie. He had found out for himself that he needed a certain kind of knowledge if he was to escape from mere rule-of-thumb methods in shipbuilding work; it could at that time be obtained nowhere in the north of Ireland except at that class, and of course he attended the class. For 42 years the Science and Art Department, which has recently doubled its already great efficiency, has been giving chances of this kind to every clever young man in the country, from long before any physical science was taught in any English public school.* The one essential thing for the exceptional boy is that he shall find within his reach chances to take advantage of; chances of learning; chances of practice; and over and above all, chances of meeting great men. It takes me off my subject a little, but I should like here to illustrate this matter from my own personal experience.

I had already been an apprentice for four years at the Lagan Foundry when I entered Queen's College for a course of civil engineering. I suppose that there never was on this earth a college so poorly equipped for a course of engineering study. Even the lecture room—this lecture room in which you are now sitting—was borrowed from the physics professor. There was a narrow passage, ironically called a "drawing room," and this was the only space reserved for engineering in a town whose engineering work was even then very important. There were some theodolites and levels and chains for surveying, but nothing else in the way of apparatus. But there was as professor a man of very great individuality; he acted as president of this section 28 years ago. I can hardly express my obligations to Prof. James Thomson. It was my good fortune to be a pupil both of this great man and of his younger brother Lord Kelvin, as well as of Dr. Andrews. It is not because these three men were born in Belfast that we here call them great. It is not because Tait, late of Edinburgh, and Purser, now the president of Section A, were professors at this college that we call them great. All the scientific men of the world are agreed to call these men very great indeed. To come in contact with any of them, even for a little while, as a student, altered for ever one's attitude to Nature. It was not that they gave us information, knowledge, facts. The syllabuses of their courses of study were nothing like so perfect as that of the smallest German polytechnic. And yet if a youth with a liking for physical science had gone to a German gymnasium to the age of 19, and had become a walking encyclopædia on leaving one's polytechnic at the age of 24, the course of that life-study would not have done for him as much good as was done by a month's contact with one of these men. People call it "personal magnetism," and think there is something occult about it. In truth, they revealed to the student that he himself was a man, that mere learning was unimportant, that one's own observation of some common phenomenon might lead to important results unknown to the writers of books. They made one begin to think for oneself for the first time. Let me give an example of how the thing worked.

James Thomson was known to me as the son of the author of my best mathematical books, but more particularly as the man who had first used Carnot's principle in combination with the discovery of Joule, and I often wondered why Rankine and Clausius and Kelvin got all the credit of the discovery of the second law of thermodynamics. Men think of this work of his merely as having given the first explanation of regelation of ice and the motion of glaciers. He was known to me as the inventor of the Thomson turbine and centrifugal pump and jet pump. His name was to be found here and there in all my text-books, always in connection with some thoroughly well-worked-out investigation, as it is to be found in all good text-books now; for wherever he left a subject, there that subject has remained until this day; nobody has added to it or found a mistake in it. He was to me a very famous man, and yet he treated me as a fellow-student. One of his early lectures was about flowing water, and he told us of a lot of things he had observed, which I also had observed without much thought; and he showed how these simple observations completely destroyed the value of everything printed in every text-book on the subject of water flowing over gauge-notches, even in the otherwise very perfect Rankine. I felt how stupid I had been in not having drawn these conclusions myself, but, in truth, till then I had never ventured for a moment to criticise anything in a book. I have been a cautious critic of all statements in text-books ever since. If any engineer wants to read what is almost the most instructive Paper that has ever been written for engineers, let him refer to the latest Paper written by James Thomson on this subject.* The reasoning there given was given to me in lectures in this very room in 1868, and had been given to students for many years previous.

Again, soon afterwards, he let me see that although I had often looked at the whirlpool in a basin of water when the central bottom hole is open, and although I had read Edgar Allen Poe's mythical description of the Maëlstrom, I had been very much too careless in my observation. Among other things, Thomson had observed that particles of sand gradually passed along the bottom towards the hole. When he found out the cause of this, it led him at once to several discoveries of great importance. Indeed, the study of this simple observation gave rise to all his work on (1) what occurs at bends of pipes and channels, and why rivers in alluvial plains bend more and more; (2) the explanation of the curious phenomena that accompany great forest fires; (3) the complete theory of the great wind circulation of the earth, published in its final form as the Bakerian Lecture of the Royal Society in 1892.

But why go on? He taught me to see that the very commonest phenomenon had still to reveal important secrets to the understanding eye and brain, and that no man is a true student unless he is a discoverer. And so it was with Kelvin and Andrews. Their names were great before the world, and yet they treated one as a fellow-student. Is any expenditure of money too large if we can obtain great men like these for our engineering colleges? Money is wanted for apparatus, and more particularly for men, and we spend what little we have on bricks and mortar!

The memory of a man so absolutely honest as Prof. James Thomson was, compels me to say here that I was in an exceptionally fit state to benefit by contact with him, for I hungered for scientific information.† I do not think that there was so much benefit for the average student, whose early education had almost unfitted him for engineering studies. To work quantitatively with apparatus is good for all students, but it is absolutely necessary for the average student, and, as I said before, there was no apparatus. Also, the average student cannot learn from lectures merely, but needs constant tutorial teaching, and the professor had no assistant.

Anybody who wants to know what kind of engineering school there ought to be in such a college as this can see excellent specimens (sometimes several in one town) in Glasgow, Birmingham, Liverpool, London, Manchester, Leeds, Bristol, Nottingham, Edinburgh and other great cities. There the fortunate manufacturers have given many hundreds of thousands of pounds for instruction in applied science (engineering). In America the equipment of such schools is much more thorough, and there are large staffs of teachers, for fortunate Americans have contributed tens of millions of pounds for this kind of assistance to the rising generation. Germany and Switzerland compete with America in such preparation for supremacy in manufacture and engineering, and nearly every country in the world is more and more recognising its importance as they see the great inventions of Englishmen like Faraday and Perkin and Hughes and Swan developed almost altogether in those countries which believe in education. Even £100,000 would provide Queen's College, Belfast, with the equipment of an engineering school worthy of its traditions and position, and Belfast is a city in which many large business fortunes have been made.

It is interesting to note that the present arrangements of the Royal University of Ireland, with which this college is affiliated, are such that most of the successful graduates in engineering of Queen's

* I once stated that my workshop at Clifton College in 1871 was the first school workshop in England. I understand that this is a mistake; there had been a workshop at Rossall for some years. But I believe I am right in saying that my physical laboratory at Clifton was the first school laboratory in England. These ideas were not mine; they were those of the headmaster, now the Bishop of Hereford.

* Brit. Assoc. *Report*, 1876, pp. 243–266.

† Some of our most successful graduates went direct to works from the Model School, Belfast, and afterwards attended this college. No school in the British Islands could have given better the sort of general education which I recommend for all boys. English subjects were especially well taught, so that boys became fond of reading all manner of books. There were good classes in freehand and machine drawing, classes in chemistry and physics (at that time I believe that there were no such classes in any English public school), and the teaching of mathematics was good. Some of the masters started classes also under the Science and Art Department. Some of the masters had much individuality, and there was no outside examination to restain it; there was only encouragement. Evidence has been given before a committee of the London School Board as to the excellence of the teaching at this school 40 years ago. Foreign languages were not in the regular curriculum, but they could be studied by boys inclined that way; and, in my opinion, this is the position that all languages other than English ought to take in any British school. With such preparation a boy was eager and able to understand what went on in engineering works from his first day there

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University would now be debarred from taking the degree. Even in London University, latin is not a compulsory subject for degrees in science; Ireland has taken a step backward towards the Middle Ages, at the very time when other countries are stepping forward.

Well-equipped schools of applied science are getting to be numerous, but I am sorry to say that only a few of the men who leave them every year are really likely to become good engineers. The most important reason for this is that the students who enter them come, usually, from the public schools; they cannot write English; they know nothing of English subjects; they do not care to read anything except the sporting news in the daily papers; they cannot compute; they know nothing of natural science; in fact, they are quite deficient in that kind of general education which every man ought to have.

I am not sure that such ignorant boys would not benefit more by entering works at once than by entering a great engineering school. They cannot follow the college courses of instruction at all, in spite of having passed the entrance examination by cramming. Whereas after a while they do begin to understand what goes on in a workshop; and if they have the true engineer's spirit, their workshop observation will greatly correct the faults due to stupid schoolwork.*

Perhaps I had better state plainly my views as to what genera education is best for the average English boy. The public schools of England teach English through Latin, a survival of the time when only special boys were taught at all, and when there was only one language in which people wrote. Now the *average* boy is also taught Latin, and when he leaves school for the army or any other pursuit open to average boys he cannot write a letter, he cannot construct a grammatical sentence, he cannot describe anything he has seen. The public-school curriculum is always growing, and it is never subtracted from or re-arranged. There is one subject which ordinary schoomasters can teach well—Latin † The other usual nine subjects have gradually been added to the curriculum for examination purposes; they are taught in water-tight compartments—or, rather, they are only crammed. and not taught at all. Our school system resembles the ordinary type of old-established works, where gradual accretion has produced a higgledy-piggledy set of shops which one looks at with stupefaction, for it is impossible to get business done in them well and promptly, and yet it seems impossible to start a reform anywhere. What is wanted is an earthquake or a fire—a good fire—to destroy the whole works and enable the business to be reconstructed on a consistent and simple plan. And for much the same reason our whole public-school system ought to be "scrapped." What we want to see is that a boy of 15 shall be fond of reading, shall be able to compute, and shall have some knowledge of natural science; or, to put it in another way, that he shall have had mental training in the study of his own language, in the experimental study of mathematics, and in the methods of the student of natural science. Such a boy is fit to begin any ordinary profession, and whether he is to enter the Church, or take up medicine or surgery, or become a soldier, every boy ought to have this kind of training. When I have advocated this kind of education in the past I have usually been told that I was thinking only of boys who intend to be engineers; that it was a specialised kind of instruction. But this is very untrue. Let me quote from the recommendations of the 1902 Military Education committee (Report, p. 5):—

"The fifth subject which may be considered as an essential part of a sound general education is experimental science; that is to say, the science of physics and chemistry treated experimentally. As a means of mental training, and also viewed as useful knowledge, this may be considered a necessary part of the intellectual equipment of every educated man, and especially so of the officer, whose profession in all its branches is daily becoming more and more dependent on science." When statements of this kind have been made by some of us in the past, nobody has paid much attention; but I beg you to observe that the headmaster of Eton and the headmaster of St. Paul's School are two of the members of the important committee who signed this recommendation, and it is impossible to ignore it. Last year, for the first time, the President of the Royal Society made a statement of much the same kind, only stronger, in his annual address. I am glad to see that the real value of education in physical science is now appreciated; that mere knowledge of scientific facts is known to be unimportant compared with the production of certain habits of thought and action which the methods of scientific study usually produce.

As to English, the committee say: "They have no hesitation in insisting that a knowledge of English,* as tested by composition, together with an acquaintance with the main facts of the history and geography of the British Empire, ought in future to hold the *first* place in the examination and to be exacted from all candidates." The italics are mine. It will be noticed that they say nothing about the practical impossibility of obtaining teachers. As to mathematics, the committee say: "It is of almost equal importance that every officer should have a thorough grounding in the elementary parts of mathematics. But they think that elementary mechanics and geometrical drawing, which under the name of practical geometry is now often used as an introduction to theoretical instruction, should be added to this part of the examination, so as to ensure that at this stage of instruction the practical application of mathematics may not be left out of sight." As Sir Hugh Evans would have said, "It is a very discretion answer—the meaning is good"; but I would that the committee had condemned abstract mathematics for these army candidates altogether.

This report appears in good time. It would be well if committees would sit and take evidence as to the education of men in the other professions entered by our average boys. It is likely that when an authoritative report is prepared on the want of education of clergy-

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* When I was young I remember that there were many agricultural colleges in Ireland; they have all but one been failures. Why? Because the entering pupils were not prepared by early education to understand the instruction; this had done as much as possible to unfit them.

† Only one subject—Latin—is really educational in our schools. I do not mean that the average boy reads any Latin author after he leaves school, or knows any Latin at all 10 years after he leaves school. I do not mean that his Latin helps him even slightly in learning any modern language, for he is always found to be ludicrously ignorant of French or German, even after an elaborate course of instruction in these languages. I do not mean that his Latin helps him in studying English, for he can hardly write a sentence without error. I do not mean that it makes him fond of literature, for of ancient literature or history he never has any knowledge, except that Cæsar wrote a book for the third form, and on English literature his mind is a blank. But I do mean that as the ordinary public-school master is really able to give a boy easy mental exercises through the study of Latin, this subject is in quite a different position from that of the others. If any proof of this statement is wanted, it will be found in the published utterances of all sorts of men—military officers, business men, lawyers men of science, and others—who, confessedly ignorant of "the tongue," get into a state of rapture over their school experiences and the efficiency of Latin as a means of education. All this comes from the fact, which schoolboys are sharp enough to observe, that English schoolmasters can teach Latin well, and they do not take much interest in teaching anything else. It is a power inherited from the Middle Ages, when there really was a simple system of education. I ask for a return to simplicity of system. English (the King's English; I exclude Johnsonese) is probably the richest, the most complex language, the one most worthy of philologic study; English literature is certainly more valuable than any ancient or modern literature of any one other country, yet admiration for it among learned Englishmen is wonderfully mixed with patronage and even contempt. At present, is there one man who can teach English as Latin is taught by nearly every master of every school? Just imagine that English could be so taught by teachers capable of rising to the level of our literature.

I have often to give advice to parents. I find the average parent exceedingly ignorant of his son's character or inclinations or ability. He pays a schoolmaster handsomely for taking his son off his hands except during holidays. During the holidays, so terrible to a parent, he sees his son as little as possible. One question always asked is: Do you think it better to have "theoretical" instruction (they always call it by this absurd name) before or after an actual apprenticeship in works? Of course, such a question cannot be answered offhand. You tell the parent, to his great astonishment, that you must see the boy himself. When at length you see him, the chances are that you will find him to be what the schoolmasters are making of all our average boys. No part of his school work has been a pleasure to him, and, although he has had to work hard at his books, not one of the above three powers is his—power to use books and to write his own language; the language of his nurse, his mother, his mistress that is to be, his enemies and friends; the only language in which he thinks—power to compute and a liking for computation—power to understand a little of natural phenomena. Honestly I practically never find that such a boy has had any education at all except what he has obtained at home or from his school companions or from his sports. Even his sports are to keep him healthy of body only and not at all to cultivate his mental powers. Those old games like "Prisoners' Base," which really developed in a wonderful way not only all the muscles of the body, but also the thinking power, are scorned in the public schools. Think now how such a boy is handicapped if we pitchfork him into works where it is nobody's duty to teach him anything, or send him to college, where he cannot understand the lectures. Of course, if he is very eager to be an engineer he will, by hook or by crook, get to understand things. I have met some such men—clever, successful engineers in spite of all sorts of adverse circumstances—but the best of them are willing to admit that they are, and have always been, greatly hurt by the absence of the three powers which I have specified. And if this has been so in the past, when the scientific principles underlying engineering have been simple, how much more so is it now, when every new discovery in physics is producing new branches of engineering!

* This committee recommends for the Woolwich and Sandhurst candidates a reform that has already been carried out by London University. No dead language is to be compulsory, but unfortunately some language other than English is still to be compulsory. Those boys, of whom there are so many, who dislike and cannot learn another language are still to be labelled "uneducated." Must there, then, be national defeat and captivity before our chosen race gives up its false academic gods? We think of education in the most slovenly fashion. The very men who say that *utility* is of no importance are the men who insist on the usefulness of a knowledge of French or German. They say that a man is illiterate if he knows only English, although he may be familiar with all English literature and with other literatures through translations. The man who has passed certain examinations in his youth and never cares to read anything is said to be educated. The men of the city of the Violet Crown, were they not educated? And did they know any other than their own language!

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men, for example, exactly the same statements will be made in regard to the general education which ought to precede the technical training; but perhaps a reference may be made in the report to the importance of a study of geology and biology as well as physical science. Think of the clergyman being able to meet his scientific enemies in the gate!

Thanks mainly to the efforts of a British Association committee, really good teaching of experimental science is now being introduced into all public schools, in spite of most persistent opposition wearing an appearance of friendliness. In consequence, too, of the appointment of a British Association committee last year, at what might be called the psychological moment, a great reform has already begun in the teaching of mathematics.* Even in the regulations for the Oxford locals for 1903 euclid is repudiated. It seems probable that at the end of another five years no average boy of 15 years of age will have been compelled to attempt any abstract reasoning about things of which he knows nothing; he will be versed in experimental mathematics, which he may or may not call mensuration; he will use logarithms, and mere multiplication and division will be a joy to him; he will have a working power with algebra and sines and cosines: he will be able to tackle at once any curious new problem which can be solved by squared paper; and he will have no fear of the symbols of the infinitesimal calculus. When I insist that a boy ought to be able to compute, this is the sort of computation that I mean. Five years hence it will be called "elementary mathematics." Four years ago it was an unorthodox subject called "practical mathematics," but it is establishing itself in every polytechnic and technical college and evening or day science school in the country. Several times I have been informed that on starting an evening class, when plans have been made for a possible attendance of 10 or 20 students, the actual attendance has been 200 to 300. Pupils may come for one or two nights to a class on academic mathematics, but then stay away for ever; a class in practical mathematics maintains its large numbers to the end of the winter.†

Hitherto the average boy has been taught mathematics and mechanics as if he were going to be a Newton or a Laplace; he learnt nothing and became stupid. I am sorry to say that the teaching of mechanics and mechanical engineering through experiment is comparatively unknown. Cambridge writers and other writers of books on experimental mechanics are, unfortunately, ignorant of engineering. University courses on engineering—with one splendid exception, under Prof. Ewing at Cambridge—assume that undergraduates are taught their mechanics as a logical development of one or two axioms; whereas in many technical schools under the Science and Art Department apprentices go through a wonderfully good laboratory course in mechanical engineering. We really want to give only a few fundamental ideas about momentum and the transformations of energy and the properties of materials, and to give them from so many points of view that they become part of a student's mental machinery, so that he uses them continually. Instead of giving a hundred labour-saving rules which must be forgotten, we ought to give the one or two ideas which a man's common-sense will enable him to apply to any problem whatsoever and which cannot be forgotten. A boy of good mathematical attainments may build on this experimental knowledge afterwards a superstructure more elaborate than Rankine or Kelvin or Maxwell ever dreamt of as being possible. Every boy will build some superstructure of his own.

(To be concluded.)

* Discussion last year and report of committee, published by Macmillan.

† To many men it will seem absurd that a real working knowledge of what is usually called higher mathematics, accompanied by mental training, can be given to the average boy. In the same way it seemed absurd 500 years ago that power to read and write and cipher could be given to everybody. These general beliefs of ours are very wonderful.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) and St. Marylebone Borough Council.

ARBITRATION.

Following is a continuation of the examination of Mr. George Conacher by Mr. Cripps, on behalf of the Metropolitan Electric Supply Co. (Ltd.), in the arbitration proceedings before Mr. C. A. Russell, K.C. (umpire), and Mr. Robert Vigers and Mr. W. C. Ryde (arbitrators), at the Surveyors' Institution, Westminster:—

Mr. CRIPPS: Now, as to working expenses and their proportion to gross revenue up to Dec. 31, 1901, for the company's entire undertaking. We can ask the question about Marylebone later. In the tables relating to these matters there is no estimate, and the actual figures have been supplied to the Marylebone Borough Council?—Yes; the total revenue from all sources in 1901 was £235,474, the revenue from the sale of current being £228,173.

Now working expenses under the heads of coal, generating expenses, distribution, rents, rates and taxes, are the actual figures appearing in the company's published accounts?—Yes; in 1901 coal was higher in price than ever it was before in the history of the company. In 1900 it was much above the average, so that the expenses for the last two years have been disturbed somewhat by these excessive prices. I give in the table £59,505 as the difference between the actual cost of coal in the year 1901 and what it would have been if the cost average had been the average price during the 12 years of the company's operations.

You have been able from your experience to introduce what will become sources of income in the future, and we have reduced your figure of £59,505 to £53,029, and you have made adjustments leaving other figures normal, so that you reduce the £144,681, the total of your working expenses, to £124,193?—Yes.

Then we have the units sold from 1893 over your whole system, then the rate of working expenses in proportion to total revenue from the beginning of the company's operations. As regards generating expenses other than coal, you had substantially a constant increase in proportion to the size of your business, distribution and management going down as business increased?—Yes.

Rents, rates and taxes did not always go down?—No; there is some disturbance every quinquennial valuation, and in the 1901 valuation a large increase was shown in this item.

Anyway, the cost per unit of current sold, with the various adjustments, seems to have been brought down from 5·05d. to 2·67d., showing a gradual advantage as the business has grown?—Yes, that is distinctly shown under all the headings except coal.

Some portion of your economies have been brought about by the adoption of water softening, condensing, and heating apparatus?—Yes, we have introduced various types of this apparatus at all our town stations, and find that these help materially to bring down generation expenses, and from alterations and improvements that we have in hand we expect to save a still further sum on this head at Willesden and elsewhere.

Now, as to the economy in introducing the continuous-current system. What was the amount you expended before introducing the system in Marylebone?—Up to the end of 1901 £52,399, which we estimate will ultimately be increased to £140,000.

Your mains are now sufficient for a double number of consumers?—Yes, a large part of our current expenditure is, therefore, for the benefit of future years.

There is great economy, is there not, in the cost of connecting up new consumers compared with the old system?—Yes; it cost nearly £18 to connect on the house transformer system, while on the continuous current system it is only a little over £4.

You suffered great loss from leakage of current from the use of house transformers on the alternate high-tension system, and you say that for every 100 units sold to a consumer on that system the company had to deliver 175 units, so that 75 units were entirely lost?—Yes.

Will you tell us what is meant by the expression "banked transformers," the system which caused so great a loss of generated current?—"Banked transformers" are the transformers erected by the company in their sub-stations at Manchester-square, Marylebone, outside Norfolk-crescent and at Brook's-mews, for the purpose of transforming electric energy from 1,000 to 200 volts, so that each of these sub-stations should transmit this transformed current to the consumer, instead of the transformation being done in detail on the consumers' premises. The "banked transformer" system is, therefore, alternative to the house transformer, and very much minimises the loss of current. By reference to the table which has been prepared it will be seen that for the first four years, before any change took place in the company's system—that is, when it was wholly alternating high-tension (with the exception of the small portion at Whitehall, which has always been continuous)—we lost 72 units for every 100 units we sold—that is, there were 3,956,228 units of current actually generated and 1,492,886 units wasted.

Mr. MOULTON: What do you mean by current?—Units.

But you are using alternating currents?—Yes, certainly.

Do you mean you measure it by energy?—It is computed on the volt-ampere basis.

Then it is not energy?—You mean not measured by instrument?

Mr. CRIPPS: It is energy, is it not?—It is energy.

Mr. MOULTON: I want to know whether it is volt-ampere, or whether it is energy.

Mr. CRIPPS: It is true watts, is it not?—Yes, I understand so; it is our ordinary method of computing the generation of alternating current in units.

Mr. MOULTON: Would you find out whether this is volt-ampere or energy, because I should like to know?

Mr. CRIPPS: It is energy. I should think it would be more accurate to say energy lost in house transformers rather than current. It was that which misled my friend?

Mr. MOULTON: Is it taken in your ordinary method of measurement?—It is.

Mr. MOULTON: Then I am told that is volt-ampere.

Mr. CRIPPS: I am told the contrary, but you will ask him by-and-bye what he says about it. To Witness: We take in the element of time, which gives energy?—Yes.

Mr. MOULTON: No, it does not give energy necessarily, but, of course, you take in the element of time.

WITNESS: But we deduct 13 per cent. in order to get at the actual number of units.

Mr. CRIPPS: It is more an engineering question, of course, but that is the figure. That is the method of arriving at the units which we believe we generate. We have worked it out through our engineers, and we think it quite accurate. Now, I do not know whether the percentage of loss to sales is dealt with. I do not know whether that is the right expression, but you say it averaged in these years 74½ per cent.?—That is to say, for every 100 units we sell of alternating high-tension current we lost 74½ per cent. (74½ units).

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Is not it this, if I may put it in another way—that out of every 174½ generated, and allowing for what I may call a proper loss for distribution, you only mark it at the 100 units?—Yes, that is so. Putting it in that way it is about 58 per cent. I think that is more accurate?

Mr. MOULTON: 58 per cent sold?—Yes, sold.

Mr. CRIPPS: You mean that the difference between 100 and what you actually had to generate under the conditions of loss is as 100 is to 174½?—Yes.

The UMPIRE: Mr. Ryde suggests that you lose three out of every seven?—Yes, three out of seven we send out. We lose three as compared with every four we sell.

Mr. CRIPPS: We come now to what is called loss during 1901?—By that time the company had introduced certain changes, and, therefore, the method of arriving at the loss in the banked transformers had to take into account the changes which had taken place. The table shows the amount of continuous current sold, first in Marylebone and then in the other areas, making altogether 3,567,876 units. The next column shows the low-tension alternating-current sold as 1,051,854 units in Marylebone and 684,702 units in the other areas, or altogether 1,736,556 units. In the same way the high-tension sales are divided between Marylebone and the other areas, and the total is shown bringing out 11,122,022 units as sold altogether. Then, as all these descriptions of current were subject to some loss for current used at stations and in distribution, an addition is made for that current under each head at the same rate—*i.e*, 16 per cent., bringing out a total generation, apart from certain other losses, of 13,240,501 units.

WITNESS: Then a new source of loss which did not exist prior to 1897 has to be dealt with, and that is the loss in the banked transformers which in the interval had been introduced. It will be seen that 1,736,556 units had been sold under that system, so that in addition to the common sources of loss we have to make allowance for the current or energy used in the banked transformers and in the additional distribution which banked transformers entail. That accounts for another loss of 179,767 units. Then in 1901 the company were converting alternating current into continuous current in Marylebone, and that process absorbed 125,125 units, leaving total current required to supply the quantity sold, apart from house transformers, 13,545,393 units. To compare that with the current generated we have to deduct from what was generated at Willesden the losses which take place in bringing the Willesden current from the generators to the town stations. These losses consist of three. At present the current is generated at Willesden at a voltage of 500 volts. Then they transform through the large transformers at Willesden at a pressure of 10,000 volts, and that entails a loss of 2 per cent. From those generators it is sent in the extra high trunk mains to the town stations, where it is subject to a further loss of 6 per cent., and it is then transformed down to 1,000 volts, by which another 2 per cent. is lost, making altogether a loss of 10 per cent. as between the generators at Willesden and the 1,000 volts at the transformers in the town stations. In order, therefore, to ascertain the quantity of energy produced at or delivered into the town stations, we have to deduct for the energy produced at Willesden 10 per cent. The total energy was 10,934,601 units, from which you deduct the 10 per cent. shown, and you get 9,841,141 units as the energy received at the town stations from Willesden. There was generated at the town stations themselves 8,068,854 units, making altogether 17,909,995 units, or 4,364,602 units more than the quantity which would have been necessary but for the house transformer loss. That loss is practically 75 units for every 100 units sold under the house transformer system.

Mr. CRIPPS: It really means that out of every 175 units generated 75 are lost through the house transformers?—Yes.

Now, you are either putting down plant, or you have already put down plant, to change from the alternating to the low-pressure system. The object of that expenditure is to get rid of this waste?—Yes.

When that is done, do you expect to get rid of the whole of this waste in the Marylebone area?—67 per cent. of the whole of the Marylebone system will then have become continuous current; 23 per cent. will remain, as at present, supplying on the alternating low-tension system, leaving 10 per cent. remaining on this wasteful system.

I do not know whether you have left it for the electrical engineer to estimate the figure as regards the amount saved?—Yes, I do leave it, although I have to take a figure for the purpose of subsequent calculations. But this waste goes on continuously during the whole 24 hours, whether consumers are taking current or not, and it entails, no doubt, a very great expenditure in coal, water and other expenses. We believe the saving which would have been effected last year if the change had been then in operation upon the business of last year would have been not less than £5,000.

You have had taken out the working expenses as regards other metropolitan areas where they have had the continuous system of supply?—Yes, of the St. James' and Pall Mall and the Westminster Companies. Taking these figures for last year, and adjusting their coal to the average price as we have done, their expenses work out practically to 45 per cent. against our 61·44 per cent.

You say that the working expenses, as far as you have gone, have only worked down to 61·44, or after the adjustment down to 52·74?—Yes.

But to what length do you estimate your working expenses will go down?—If we take £5,000 as the minimum saving, as before mentioned, that would have brought it down to the expense as adjusted in the table. It stands at 52·74, and this would have brought it down to about 47½ per cent. Our view is that when these economies have been introduced, and taking coal at an average price, also when the rest of the company's system has been changed to the continuous current, and allowing for the growing business, the time will come when we might allow for a rate of 40 per cent. compared with 45, which the adjoining electricity supply companies obtain on their present business.

That is an admixture of increased economy of production and increased output?—Yes, and increased proportionate use at Willesden.

When you come to the higher figures, or the higher output which you have estimated, and bring into the calculation these economies at Willesden, you think you will ultimately get down to 40 per cent.?—We think so.

Of course, the business you are transferring to the Marylebone Borough Council is partly in respect of current which is generated at Willesden?—Yes.

But no part of Willesden comes within the terms of the transfer to Marylebone?—No.

Therefore you have to make a calculation, of course, in favour of Marylebone, as to the plant they will want in order both to give the supply you are selling to them, and also as regards future supply?—Yes.

I think Dec. 18, 1901, was the day of maximum demand last winter. The total supply given on that day by the continuous system throughout the various areas measured at the switchboard was 9,925kw.?—Yes.

You give the maximum demand on Dec. 18, 1901, in Marylebone at 4,386kw.?—Yes.

Now, the first problem we have is what allowance we are to make to Marylebone because the equipment you are going to hand over is not sufficient to generate the electrical energy for which you are asking to be paid?—Yes. The deficiency of generating plant in Marylebone, as measured by the boiler capacity, is given at 2,051kw., but that included the plant needed to supply the waste through house transformers. That plant will, of course, be set free after this year for ordinary purposes. The supply of 2,051 units and 1,063 units of waste implies the running continuously, from the beginning of the year to the end of the year, of something like 234kw. of plant—a little more no doubt at times of maximum load, but we put that roundly as representing 250kw. So that by the time the undertaking passes into the hands of the Borough Council that deficiency would be reduced by the stoppage of the waste which took up the working of, say, 250kw. of the local plant. The deficiency is measured by the capacity of the boilers, but the engines and dynamos are much more than the boilers. They are represented by 2,925kw. Now, it is quite possible to put in the Manchester-square station additional boilers to enable the Council to utilise to the full extent the plant for which there are no boilers at present; and we have had an estimate prepared of the cost of providing 500kw. more of boilers, which comes to £11,000. When that money is spent, and when the waste ceases, the deficiency of 2,051kw. which existed last winter will have been reduced by 250kw. and 500kw. respectively, or 750kw. in all, bringing it down to 1,301kw. as the ultimate deficiency of plant in Marylebone.

Now, starting with that deficiency of 1,301kw., we have to find out what the equivalent plant at Willesden would be, because in view of the loss in current from the Willesden generators to the town stations, it is obvious that the generation at Willesden instead of at the town stations implies the employment of a larger amount of plant. That is to say, only 90 per cent. of the current generated at Willesden is available for distribution. Therefore you have to add to any deficiency which is brought out in the local area, one-ninth, to ascertain the power or capacity of the equivalent plant required at Willesden. One-ninth of 1,522kw. (the deficiency of the alternating current in the borough) is 169kw., which, if added to the 1,301, gives the equivalent at Willesden of 1,470kw. In our table we divide the cost of Willesdon up to the completion of 4,500kw., and plant in the proportion of 1,470 to 4,500 parts, bringing out the sum of £101,977 as representing the portion of the plant at Willesden which had to do the work which would otherwise have been done in Marylebone if the local plant had been sufficient for the demand of last winter?—Yes.

How do you deal with the transforming plant in Marylebone in order to make up the current required from Willesden as regards the deficiency of generating plant?—Of course the generators at Willesden do not fulfil all the functions of generators in the town areas. In the case of Willesden we have to add the mains by which the current is brought, and also the transformers to the town sub-stations, by means of which the voltage is reduced from 10,000 to 1,000. Therefore, to make the allowance complete, regard has to be had to the amount of that subsidiary or complementary plant, which already exists in the area, or which will be there when the low-tension scheme has been completed.

And you show in the table, as the result of the expenditure of £11,000, what you call a surplus of 221kw?—Yes, I show that there are motor generators representing 520kw. already at work in the area, and that we have installed, or will have installed when the new sub-station is ready, 3,730kw. of motor generators, or a surplus of 3,210kw. over and above what was required for the supply of the Marylebone area last winter.

Mr. MOULTON: It is absolutely necessary I should know how these amounts are made up. I may point out that all the expenses in Marylebone are lumped together, and the boilers are put in one item and the engines and dynamos in another. For instance, supposing all the boilers were at one place, and all the engines and dynamos at another, it would be not a very profitable arrangement.

WITNESS: But that is not so.

Mr. MOULTON: I do not know what engines and dynamos you are putting together to give this particular figure.

WITNESS: The continuous-current generators at Manchester-square are six in number, of a capacity of 350kw. each, equal 2,100kw.; at Rathbone-place there are six 120kw. generators, equal 720kw., and three 35kw. generators, equal 105kw., making 825 at that station; or, at both places, 2,925kw.

Mr. MOULTON: But when you say, Mr. Conacher, that there are these generators there, you mean they will be?—No, they are there now. They are in course of construction and will be completed. They are there now, but those at Manchester-square are being altered from alternating to continuous, but the existing generators are the same.

Mr. MOULTON: You do not distinguish what type of supply these dynamos can give or how anyone can find out. You say that some give continuous and some alternating.

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WITNESS: No, by the time the transfer takes place they will all be continuous, and we are going on that basis.

Mr. MOULTON: You are taking figures here for the boilers which depend on what you say these have done, but these figures appear on no table, and they are not calculable from the figures given in the tables?—They are calculable from the heating surface itself, and so on, but that is an engineering question. I state it as a fact, that this is what these stations have done, and having done that already, we say they are capable of doing that again.

Therefore, it is not from the description, but it is from the history you get it?—The description must have some bearing upon it. The description is actually as we say it is; and we say, that description being accurate, that is the work these boilers have done. It is an engineering question whether we have done what is fair by the boilers, but that is what they have done.

Mr. CRIPPS: Now, these calculations give the Marylebone proportion of the Willesden plant as £101,977?—The proportion of the Willesden generators and mains.

The UMPIRE: There is one point arises here. I have only got the 4,500kw. of plant, not the denominator of the fraction?—4,500kw. is the capacity of three 1,500kw. engines which we worked at Willesden last year. There were five altogether. The fourth one was used as a spare one, and the fifth, or latest one, was provided for future requirements. Although we had actually 6,000kw. of generators at Willesden, with 5,360 of boilers, we rate the stations at 4,500 to provide for spare—that is to say, we keep at Willesden our spare for all our areas.

Mr. CRIPPS: As you put it, the 4,500kw. really are three times 1,500kw.?—Quite so.

Then the 1,470, what is that?—That is the equivalent at Willesden of the Marylebone deficiency arrived at by the process which I have described. In another statement I show the transforming and converting plant in the local area, which shows a considerable surplus over actual requirements last year, a surplus of that description of plant of 2,900kw.

Now, having shown the surplus as regards this requirement, you come to the amount that is to be allowed in respect of the deficiency in the generating plant in Marylebone as at Dec. 31, 1901?—Yes.

How do you work that out?—I start with the £11,000 which we allow to the Borough Council in respect of the deficiency of boilers in Manchester-square. We also include the allowance of £101,997 as the portion of the Willesden plant which was employed in making good the local deficiency last winter, and then we add one-half the cost of the Norfolk-crescent-mews sub-station, which, of course, they cannot purchase from us; but as they were using that station last winter we have allowed one-half the sum it has cost us, making altogether £118,773. That sum is subject to a deduction of £62,686 by reason of the excess of transforming and converting plant in Marylebone. This was the cost of the North-street sub-station, which was entirely surplus last winter, and the 2,900kw. of static transformers above mentioned.

In a further table you seek to arrive at the relation between capital expenditure on the one side and the amount of current sold. Have you got the actual results from 1893?—We have.

You show the capital expenditure in Marylebone up to 1897?—Yes, we stop at 1897 with Marylebone, because after that we are beginning to expend money at Willesden for the benefit of Marylebone and the other areas, and therefore you cannot make the comparison for Marylebone alone for any later year than 1897.

The UMPIRE: You give it for the entire undertaking after that?—Yes.

Mr. CRIPPS: But we get that estimate in another statement—that is, for the entire undertaking. Also the units sold in Marylebone and the units sold in the entire undertaking, and also the capital expenditure per 1,000 units sold?—Yes. We have taken that as a convenient measure of capital expenditure in connection with a growing business, and the figures show that in 1893 the capital represented £291 for every 1,000 units sold in Marylebone, and that that rate of capital expenditure fell from year to year until in 1897 it became £147. For the entire undertaking, from 1893 to 1901, the fall was from £266 to £145. Very little drop took place in the entire undertaking after 1898, because so much capital was being expended at Willesden for the future, and a large amount of capital was being expended in the last two years in Marylebone which is not yet remunerative.

That shows that at the present time you have really a large amount of dead capital on your hands of which you are just expecting to get the fruit?—Yes.

Now, in another statement you have an estimate of the total capital required for the business of Marylebone up to 1904?—Yes, we have taken that in some detail, because the date is not far off, and we are able to put accurate figures upon our estimate for those three years. The figure is, up to Dec. 31, 1901, £646,009, which the company has spent or is spending in Marylebone, or has spent at Willesden, for the Marylebone business.

Then the proportion for 1902?—£35,000 for connecting new consumers and £12,000, making altogether an estimated expenditure by the end of 1902 for Marylebone of £693,009.

Taking that on the estimated number of units sold means £131 per 1,000 units sold?—Yes, which is, of course, a reduction upon the figure shown in the later years. So that as our business increases we get a diminishing amount of capital expenditure per 1,000 units sold. This in 1904 comes to £117. The decrease is more rapid in those years because we are bringing into the earnings the capital which is now largely or entirely unremunerative. That is a very large factor in your operations. We have only to estimate for additional capital required for the business of Marylebone to the end of our term. We have based that upon the opinion given us by our engineers that on our ultimate output, having regard to the proportion of that output which is represented by motor power, the capital per 1,000 units sold should, by that time, work out to about £75, and the amount which is shown for the year 1931 for the total capital required—namely, £2,443,000—is 3,300,000 units. We expect it will be multiplied by £75 for every 1,000 units.

Then you have got to take the capital which we have actually provided, which is £646,009, and the additional capital required each year?—Yes.

And, finally, you show the charge on the undertaking, which means taking 3½ per cent. per annum as the capital charge involved, and 1 per cent. for depreciation?—Yes. This figure for 1902 is £2,613, and for 1931 is £81,353.

The UMPIRE: As to the Willesden deficiency?—We hand over £48,837, which the Borough Council would have to lay out in plant to maintain the business as it was at the end of 1901, and they ought, of course, to have to bear the depreciation upon that plant.

Mr. CRIPPS: That is the difference between the plant required and the excess plant which they will take over. When we come, by-and-bye, to the net profit, we shall have to make an allowance to Marylebone of that amount in each year?—Yes.

The Witness here said that the capital expenditure in relation to units generated for the past four years had been practically constant, owing to their capital expenditure having been unremunerative in some measure. But for that they would have maintained the decrease, because that was the experience of all the electric supply companies. He had gone into the maintaining expenditure of the principal companies in London, and they all exhibited the same tendency to decrease the capital required in proportion to the business done.

(To be continued.)

Tramway Bye-Laws.—Overcrowding.

In *The Electrician* for Aug. 29., p. 766, we reported the proceedings before the stipendiary magistrate at Leeds (Mr. C. M. Atkinson) against a tramcar conductor for overcrowding his car. In that case a conviction followed and a nominal penalty of 5s. was enforced, Mr. Atkinson consenting to state a case. We understand that the appeal in that case is not to be proceeded with. In agreeing to the withdrawal of the appeal, Mr. Atkinson said:—"There appears to have been some misapprehension between that case and the case tried here last week [reported below.] In the first case the charge was preferred under a bye-law which related to the carrying of passengers in excess of the number that the licence stipulated for. There was raised a question as to the powers of the authorities to limit that number, and that was the question raised for appeal. In the case before me last week the circumstances were of a wholly different character, and it was brought under an entirely different bye-law. It had no relation whatever to the first case, and was for permitting a person to stand in the car, but no legal question was raised, and, so far as I know, none could be raised. No application was made for a case for appeal, and if there had been any I should not have granted it. No legal question was raised or could be raised on that information. There was no connection between the two cases, and any attempt to confuse them was either owing to ignorance or something else."

At Leeds, on Friday last, before Mr. Atkinson, a second charge of a similar character to that mentioned above was heard. A conductor was summoned for allowing a passenger to stand in the interior of a car belonging to the Corporation, in contravention of the municipal bye-laws. From the evidence it appeared that up to three months ago the conductors of the Leeds cars were not allowed to carry more than the regulation number of passengers, but since that date orders had been given them to permit eight passengers to stand inside during wet weather and on holidays. The legality of this instruction has been frequently questioned, with the result that the present summons was issued at the instance of a local solicitor (Mr. J. S. Marriner) in order to test the point. Mr. Marriner conducted his own case, and defendant was represented by Mr. W. Wright, instructed by local officials of the Gasworkers and General Labourers' Union.

In the course of his evidence Mr. MARRINER stated that just after six o'clock on the evening of 28th ult. he was going up Woodhouse-lane, when a crowded car passed him, in which he could see several people standing. He waited until the next car arrived, and boarded it. He then saw that three people were standing inside. At Blackman-lane one man left the car, but another entered and continued the journey. He did not actually get inside the car, but boarded the platform and travelled a couple of hundred yards to count the number of people inside.

The MAGISTRATE: Have you on other occasions been inside the cars when people have been standing?

Mr. MARRINER: On numerous occasions.

And you have been inconvenienced?—Yes. He told defendant that he was overcrowding his car. There were 11 persons on each side (the licensed number) and three standing. Defendant counted the number, and agreed that he had three too many, and, when asked what his orders were, replied that his instructions, given by the inspector only that morning, were to "overcrowd the cars till further notice."

In cross-examination, Mr. MARRINER agreed that he got on to the car for getting information.

Then, you were not a passenger in the ordinary sense of the word?—I paid my fare. It was not raining at the time. The conductor was perfectly civil, and gave his name and number readily.

Mr. WRIGHT submitted that defendant was simply a passive agent, acting under instructions. His neglect to prevent the extra passengers entering was, unquestionably, the result of his instructions.

The MAGISTRATE: Does defendant substantiate the statement that he had instructions to do this?

DEFENDANT, in reply, said he was instructed to admit extra passengers on wet days and holidays—that was, on Saturdays after 12, on Sundays and on Bank Holidays.

Were you told what a wet day or a holiday was?—It was left to our discretion, and is so still.

If it is wet in the morning, do you allow them to ride inside in the after noon?—No, only during the rain.

Your instructions were on wet days, but you took that to mean during

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actual rain. Do you turn them out when the rain is over?—No; they would not go.

Defendant admitted that some conductors had refused to carry out the order. The bye-laws told the men to prevent overcrowding as far as they could, but they had been precluded from doing so by the express orders of their superiors.

Mr. WRIGHT said he could not suggest there had been no breach of the bye-laws, but he thought justice would be done if defendant were bound over.

Mr. MARRINER said he had brought the proceedings in order that public attention might be drawn to the fact that officials of the Corporation had actually instructed the conductors of the municipal tramcars to disobey the law.

In giving judgment, Mr. ATKINSON expressed his sympathy with defendant under the circumstances. He appeared to have behaved with perfect propriety. He (the magistrate) was not concerned with the somewhat vague nature of the instructions given to these men, but he was concerned with their admitted lawlessness. Their city, like all great English cities, was governed largely by local acts and bye-laws, which had legislative sanction. It was in this case alleged that officials of the local authority had deliberately directed those over whom they exercised control to violate the very laws of which a printed copy had been supplied for their instruction and guidance. If that were so, it seemed to him that no language could be too strong to condemn the action of those who had incited—nay, directed—the men to commit open and flagrant breaches of the law. "Municipal government, forsooth!" he continued: "If such a state of things were to be tolerated we should have a combination or blend of municipal government with municipal trading which might, I think, then be aptly described as municipal chaos!" He then bound defendant in £5 to come up for judgment within six months, but if he repeated the offence he would be fined the full penalty.

In re Mazarron Electric Light Co. (Ltd.)—Richard v. the Company.

This case came before Mr. Justice Swinfen Eady in the Vacation Court on Wednesday on a motion by plaintiff for the appointment of a receiver and manager and for an account. Plaintiff is holder of five debentures in the company of £20 each and a judgment creditor, the judgment debt being unsatisfied. In the result the motion was ordered to stand over till next Wednesday.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Poplar (London) Borough Council require a general clerk to keep cost accounts of electricity supply undertaking. Applications to town clerk (Mr. Leonard Potts), Council offices, High-street, Poplar, by Sept. 29. See advertisement.

An experienced electrical engineer is required for the calculation, designing and cost estimating of new types and sizes of polyphase and monophase generating and distributing machinery and accessories. Applications to works manager, Crompton & Co. (Ltd.), Arc Works, Chelmsford. See advertisement.

An assistant lecturer in electrical engineering is required for Hartley College, Southampton. Further particulars may be obtained from the principal, Dr. S. W. Richardson, to whom applications by Sept. 24. See advertisement.

An assistant lecturer in physics is also required at Hartley College, Southampton. Applications by 24th inst.

An assistant lecturer is required at Huddersfield Technical College. Applications by September 24th.

Doncaster Electricity committee require a chief assistant electrical engineer. Applications to chairman by 16th inst.

An assistant mains engineer is required for the Bristol electricity department. Applications to city electrical engineer by Sept. 16.

Maidenhead Corporation have vacancy for a pupil at their electricity works. Applications to resident electrical engineer by Sept. 20.

Mr. H. B. Phillimore, of Warrington, has been appointed assistant electrical engineer at Southend.

Mr. W. Frisby, of Stockport, has been appointed chief assistant engineer at the Colchester Corporation electricity works.

Batley Council on Thursday last confirmed the appointment of Mr. S. Jones, of Doncaster, as electrical clerk of works.

EDUCATIONAL NOTICES.

University College, Liverpool.—Complete courses of instruction are given in civil, mechanical and electrical engineering at this college. The 1902–3 session commences Oct. 2, and prospectuses can be obtained from the secretary.

Battersea Polytechnic.—The new session opens on Sept. 22. Day and evening courses of instruction are given for the matriculation (new regulations) and degree examinations of the new faculty of engineering of the University of London. Day courses in preparation for the mechanical, electrical and constructional work, and evening courses are held in all engineering and science subjects. Prospectus from the secretary, Mr. Joseph Harwood. See also advertisement.

Borough Polytechnic Institute.—A special course of lectures and laboratory work on electrical engineering and magnetic measurements will be given on Friday evenings by Dr. John Henderson, commencing Oct. 3. Detailed syllabus of course can be obtained from the principal, Mr. C. T. Millis. See also advertisement.

City of London College.—The Michaelmas term commences on Sept. 29. Classes are held in magnetism and electricity, sound, heat, light, mathematics, chemistry and other science subjects. There are laboratories for practical work. Prospectuses from the secretary, Mr. David Savage.

East London Technical College.—A special course of lectures on the most recent developments of electro-chemistry will be given by Prof. Lehfeldt at East London Technical College, Mile End-road, London, E., on Thursday evenings from 8:45 to 9:45. See also advertisement.

Northampton Institute.—The calendar of this Institute, containing the educational and social announcements for the session 1902-3, is to hand, and contains full details of the courses of instruction in the electro-technical branches of study which at this institution have, with mechanical engineering and horological engineering, special prominence. It may be mentioned that special classes are provided for postal telegraph officers in the electrical engineering and applied physics department, which is presided over by the principal (Dr. R. Mullineux Walmsley), the chief assistant and senior lecturer being Dr. C. V. Drysdale. Mr. E. Kilburn Scott is also a lecturer in this department. There are well-equipped electrical engineering laboratories and instrument rooms, and opportunities for study in all branches of electrical work are provided. The evening courses and classes in all technological subjects commence on Monday, 22nd inst., and the day classes in engineering on Monday, 29th inst. Some further particulars are given in an advertisement.

Airdrie.—The application of the Airdrie and Coatbridge Tramways Co. for an extension for laying the first portion of their lines in Coatbridge has been refused by the Board of Trade, but they have been allowed an extension of time for beginning the work. Airdrie and Coatbridge Corporations lodged objections to the application. The company have, therefore, to complete the tramway within the time specified in the provisional order.

Ashford (Kent).—Further discussion on the proposal to borrow £15,000 for electric lighting took place at the Council meeting last week. The chairman said the Electric Light committee would lay before the Council a proposal which would relieve them from any possibility of spending the ratepayers' money on the proposed electric lighting scheme for at least 25 years. The decision to apply for the loan was confirmed.

Ayr.—The annual report of the burgh electrical engineer (Mr. A. J. Fuller) states that the number of units of electric current sold for private lighting was 102,553, yielding a revenue of £3,765; for public lighting, 330,560 units, giving £2,147; and for traction, 132,105 units, yielding £827. The total revenue was £6,973, and the expenditure £4,483. There is a deficit of £756 after allowing for interest and sinking fund. The capital expended to date was £78,999, an increase during the year of £22,841. The accounts of the tramways department covered eight months. The total income was £4,974, and the working expenses £2,852, leaving credit balance of £2,121. After paying interest, sinking fund instalment, and allowing for depreciation, there was a credit of £242, which has been carried to reserve.

Bradford-on-Avon.—The Somerset and District Electric Power Syndicate intends applying for Parliamentary powers to supply current in this district.

Brechin.—The Police Commission are obtaining estimates for the electric lighting of the Council chambers, the surveyor's and town chamberlain's offices and the lobby at the municipal buildings.

Brentwood.—At a recent conference of representatives of adjoining parishes, a resolution was passed pledging support to the Brentwood Council's application for electric lighting powers.

Caerphilly.—Mr. R. H. Fletcher has been appointed consulting electrical engineer to the Council.

Colwyn Bay.—By the casting vote of the chairman (Mr. Bevan) it was decided on Tuesday to apply for a loan of £2,500 for extensions of the electricity undertaking.

Cromer.—An inquiry was held here last week into the application of the Council for sanction to borrow £25,000 for electricity supply. The application was supported by the clerk (Mr. J. K. Frost). A provisional order was obtained in 1899. A site for the station was obtained in 1901, and an agreement had been entered into with Edmundsons' Electricity Corporation for operating and maintaining the works, which were estimated to cost £21,258. The company would also pay the Council an annual sum equal to the interest and sinking fund instalment on the loan. The agreement was for 25 years, terminable at stated periods. If terminated at seven or 10 years a premium was to be paid to the company, but not

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after that period. Technical details were supplied by Mr. E. H. Cozens-Hardy (Messrs. O'Gorman and Cozens-Hardy, consulting engineers to the Council.)

Companies to be Struck Off Register.—The following will be struck off the register of joint-stock companies in three months, unless cause is shown to the contrary :—

A.B.C. Electric Arc Lamp and Incandescent Mantle Co.
Auto-motors.
Carbide of Calcium Supply Co.
Cardiff and Penarth District Light Railway Co.
Cotsworth Arc Lamp and Electric Lighting Co.
Electrical Development Syndicate.
Engineering and Electric Works Co.
French Improved Electric Glow Lamp Syndicate.
Gas and Electric Light Consumers' Protection Association.
International Telephone Mfg. Co.
Marine Propulsion and Electrical Generation Syndicate.
National Light Railway Construction Syndicate.
New Electro-chemical Manufacturers' Association.
Railway Developments.
Self-charging Electrical Traction Co.
Telephone and Switchboard Syndicate (Continental).
Woodward's Electrical Storage Battery Co.

Dorchester.—A committee has been appointed to visit electricity works to collect information in connection with the proposed municipal electric lighting scheme.

Dudley.—On Tuesday, the Council formally decided to purchase the whole of the tramways within the borough from the Dudley and Stourbridge and District Electric Traction Co. and the British Electric Traction Co.

East Barnet.—A communication has been received by the Council from the North Metropolitan Electrical Power Distribution Co. notifying that, as the Metropolitan Electric Tramways Co. (an associated concern) are taking over the construction and working of the Hertfordshire light railways, some of which would run in East Barnet, they would be able to supply electric current for lighting. The Electric Lighting committee are considering the matter. Some progress has already been made with the municipal electricity scheme, and plans are being prepared by the Council's consulting engineer, Mr. Adams.

Eastbourne.—The Council contemplate providing a service of motor 'buses, and the Electric Lighting committee has been instructed to obtain information as to the most suitable vehicle in the market. This step has been taken on the ground that electric tramways are considered to be impracticable from a financial point of view.

Edmonton.—On the recommendation of the Electric Lighting committee the Council, on Tuesday, decided to invite three electrical engineers to submit reports and estimates of the cost of schemes for carrying out the terms of the electric lighting order, including (1) generating station and plant, and (2) mains and distribution system, and also an estimate of annual expenses and revenue. The North Metropolitan Electric Power Supply Co. and other companies are to be invited to submit terms (1) for supplying electrical energy in bulk, and (2) for supply and distribution complete for all purposes.

Epsom.—Sanction to a further loan of £10,900 for electric lighting extensions has been obtained.

Eton.—The Council's consulting engineer (Mr. E. Baily Denton) recommends the erection of electrical plant for the pumping station, effecting an estimated saving of £100 per annum.

Exeter.—The City Council are about to serve notice on the local tramways company requiring the latter to sell their lines to the Council.

Felixstowe.—A committee has been formed to report upon the proposal to acquire the local electricity works for £7,000.

Golborne.—The Council are in communication with Mr. W. M. Beckett as to preparing a report on electric lighting.

Halifax—In his report on the suggested adoption of the Bell punch method of collecting tram fares, the tramway manager (Mr. F. Spencer) states that the system would incur an extra annual cost of £724. 10s. He enumerates 22 objections to the system, some of which can be overcome by efficient supervision.

The Tramways committee recommend the Council to extend the electric tramways from Stump Cross to Hipperholme, at a cost of £8,365. 12s. 6d., and from Salterhebble to West Vale at a cost of £3,253.

Hampton Wick.—Messrs. Christian and Phipps having asked for permission to carry electric light wires under the High-street, the Council have replied that they could not give consent unless a provisional order were obtained.

Harrogate.—The borough surveyor has been instructed to prepare plans of the routes, &c., for electric tramways in Harrogate and district.

Hartlepool.—The Council have refused the terms of the Hartlepool Electric Tramway Co. for the supply of electric current for lighting, but are considering a further communication from the company on the subject.

Hawick.—The Council have decided to grant wayleaves for electric tramways in the burgh.

Infirmary Lighting.—At the next meeting of the Montrose Asylums Board a resolution will be moved that the tender of the Angus Electric Light and Power Co. for the supply of electric current for lighting the Montrose infirmary at 4d. per unit be accepted, and that £120 be expended in wiring the building.

International Patents Convention—Messrs. Edward Evans & Co., patent agents, inform us that on 15th inst. amendments of importance will take effect in all the States of the Convention (Belgium, Denmark, France, Italy, Japan, Netherlands, Norway, Portugal, Sweden, Switzerland, Tunis and United States) as follows :—

(*a*) The priority granted to applicants for patents, designs, or trade mark in any of the States of the Convention shall be 12 months for patents and four months for designs or trade marks, reckoned from date of application in the State in which applicant is domiciled.

(*b*) Patents applied for in any of the States of the Convention by persons entitled to the privileges thereof shall be independent in duration of patents obtained for the same invention in other States whether parties to the Convention or not.

(*c*) No patent applied for under the Convention shall incur forfeiture for non-working until the expiration of a minimum period of three years from the date of application.

The extended period for priority given to applicants under the Convention has been granted in Great Britain since January last by the amending Act of 1901.

Islington (London).—The report of the chief electrical engineer (Mr. Albert Gay) on the recent fire at the electricity works has been issued :—

Mr. Gay states that the fire occurred in the cable trench containing the main cables from and to the switchboard, resulting in the burning of a number of short lengths of cable, slight damage to the building, and covering with smoke and soot the switchboard, which had to be entirely dismantled and cleaned, as well as the destruction of two or three instruments at the back of the board, and some small transformers. It was fortunate (continues the report) that the fireproofing of the switchboard had been completed, but it would have been more fortunate if the fireproofing of the cables, which had been commenced, had also been completed. The actual origin of the outbreak would probably remain unknown, as it was now impossible to give a definite opinion. Whether a light was dropped by a man working at or near the conduit, or whether by some means spontaneous combustion caused the fire could only remain a matter of conjecture. One thing, however, was absolutely certain—viz, that whatever else might have been the cause, it was not due to self-ignition or to any defect in the electric cables, apparatus, plant, or system. The electrician's report was that the first suspicion he had of anything wrong was a slight smell of hot rubber about 7.30 p.m. He felt absolutely certain that no short-circuit occurred. No fuses blew until after the fire was well alight, there were no kicks on the ammeters, no unusual grunting of alternators, and all the machines were running steadily. Nothing abnormal happened until some time after he discovered the fire, which made itself shown through keyholes and edges of the culvert cover in corridor. As regards the whole of the cables being in one trench, those cables were all double steel armoured, and no ordinary fire such as that produced by self-ignition could have brought about the disaster. There was no doubt whatever, not only that the fire was due to some outside cause, but that it had obtained a considerable hold upon the cables before it was discovered. The principle of laying the cables together in a conduit could not, therefore, be condemned, and it was with the object of preventing damage by fire from any source whatever that the fireproofing of the cables was proceeding.

Mr. Gay expresses his high appreciation of the way in which the members of the staff acted throughout the trying ordeal, and they had been exceedingly fortunate in being able to resume supply so promptly, and with comparatively little secondary trouble. Everything had been reinstated in a temporary manner, but it would take a considerable time to get everything absolutely straight. No fatal accident had resulted, either from the fire or the subsequent urgent repairing work, but two cases of shock—one trivial and one serious—have had to be dealt with. Otherwise they had escaped with the minimum of inconvenience to consumers and o expense to the department.

Keighley.—Mr. R. C. Quin, who is promoting a scheme for constructing an electric tramway between Shipley and Keighley, had an interview on Tuesday with members of Keighley Council, when the scheme was considered. Terms have practically been agreed upon between the promoter and the Shipley and Bingley authorities, and it is anticipated that the negotiations with Keighley will have a successful issue. Mr. Quin bears the cost of obtaining Parliamentary powers.

Kilmarnock.—The Council resolved on Wednesday to ask Prof. Kennedy to furnish a report on the establishment of electricity works

Leeds.—The Tramways committee are considering the advisability of constructing extensions to 10 tramway routes, and the general manager (Mr. J. B. Hamilton) has been instructed to prepare detailed plans.

Leeds Tramway Overcrowding Case.—We report fully on another page the proceedings before the Leeds stipendiary magistrate (Mr. Atkinson) in the charges against tramway conductors for overcrowding. The defence in these cases was that the conductors charged

with the offences were acting upon the express instructions of their superiors and in accordance with the terms of a bye-law approved by the Leeds Corporation. The bye-law particularly in question is as follows :—

FULL NUMBER OF PASSENGERS.

14. When any car contains in the interior thereof the full number of passengers for which seating accommodation, according to the notice thereof attached to the car is provided in such interior no person beyond such number shall enter, mount or remain therein, except by the express permission of the conductor first obtained.

When any car contains on the outside thereof the full number of passengers for which seating accommodation, according to the notice thereof attached to the car, is provided on such outside, no person beyond such number shall enter, mount or remain thereon.

It will be seen that the conductor is permitted under this bye-law to allow excess passengers inside but not outside a tramcar. Owing to the decision of the magistrate, twice expressed, the Tramways committee have reconsidered the position, and Mr. J. B. Hamilton, the tramways general manager, has issued the following order to the tram conductors and drivers in the employ of the Corporation :—

Until the new bye-laws, sanctioned by the City Council, which will regulate the maximum number of passengers to be allowed on a car, have received the approval of the Board of Trade, conductors and motormen will not allow any passengers in excess of the seating capacity to remain in or upon any car.

Should any person in excess of the number desire to ride, it must be courteously explained that conductors are instructed not to permit this, pending bye-laws being obtained under which certain additional passengers may be allowed.

The Tramways committee have approved the action of the chairman (Mr. Smithson) and the general manager (Mr. Hamilton) in withdrawing permission to allow excess passengers at certain times on the tramcars.

It may be added that the bye-laws (23 in number, including the above have been submitted to the Board of Trade for approval, and the decision of the Board is awaited, in Leeds especially, with some interest.

Leek.—Gas and electric lighting interests are in future to be under the control of the Gas and Electricity committee, and under the superintendence of one person.

Leopoldville (Congo Free State).—Public electric lighting was inaugurated here on July 1.

Light Railways.—The Clacton-on-Sea and St. Osyth Light Railways Order has been lodged with the Board of Trade for confirmation. Objections by 27th inst.

The Light Railway Commissioners will resume the holding of local inquiries on 24th inst. From the passing of the Light Railways Act to Dec. 31 last 379 applications for orders were received, representing a total length of 3,659 miles, and an estimated cost for construction of nearly £27,500,000. The commissioners approved 201 schemes, with an aggregate length of 1,479 miles, and estimated to cost over £10,000,000. Eighty-one applications were rejected, representing a total mileage of 983 and an estimated expenditure of £7,750,000. The remaining schemes were withdrawn, or left over to be dealt with during the ensuing session.

Bridlington Council will oppose the application of the promoters of the Flamborough and Bridlington light railway for another extension of the order.

The Cheltenham and District Light Railways (Extensions No. 2) order has been submitted to the Board of Trade for confimation. Objections by Oct. 1.

At the meeting of the Worcestershire County Council on Monday the chairman (Mr. J. W. Willis Bund) referred to the Hales Owen Light Railway extensions, and said that arrangements were made between the Council and the Hales Owen District Council for the inclusion of certain conditions in the order, which had not been inserted, and the Board of Trade now refused to incorporate them in the order as finally settled. The Board of Trade, in his opinion, was a most meddlesome and, he was about to say, impertinent authority. After an arrangement had been made between the two authorities the Board allowed the Hales Owen Council to get out of its promises. The sooner the Board of Trade had its light railway powers taken away the better for the country. (Loud applause followed these remarks !)

Liverpool.—Sanction to a further loan of £300,000 for electricity supply extensions has been received by the Council.

The tramways general manager (Mr. C. R. Bellamy) has devised a method of protection for passengers on the outside of the cars on the Liverpool Corporation tramways, and a trial car was recently run which is said to have given great satisfaction.

Llanelly.—So great is the dissatisfaction with the present public lighting arrangements that, one evening recently, some of the inhabitants illuminated one of the main thoroughfares with candles in order to shame the authorities into action. The result was that crowds congregated, and the police were kept busy clearing the pavement, and the Council now contemplate taking proceedings against the owners of the candles for causing obstruction.

London-Dover Monorail Scheme.—The promoters of this scheme are canvassing the various municipal authorities en route and the Rochester, Chatham and Gillingham Councils are according support to the project. In the preliminary surveys it is proposed to include two routes—one through Maidstone and the other through Chatham. The consulting engineers to the promoting syndicate are Mr. F. B. Behr and Mr. R. Elliott Cooper.

Manchester.—The Council are recommended to apply for further powers in regard to construction and equipment of additional tramways.

Mirfield.—The British Electric Traction Co. is willing to take over the powers of Huddersfield Council, and to commence the extension of the electric tramways to Mirfield forthwith.

Motor Car Industry.—The Society of Motor Manufacturers and Traders has recently been formed "for the protection, encouragement and development of the automobile industry in the United Kingdom." The first president is Mr. F. R. Simms, and the council is composed of representatives of 21 firms. The vice-presidents are Messrs. J. E. Thornycroft and S. F. Edge. Mr. T. F. Woodfine is secretary.

Municipal Telephony.—At Glasgow last week the chairman of the Telephone committee (Mr. Alexander) said they had now 6,310 instruments connected up, and had still orders on hand for 1,600. That was after one year's working. Bailie Ferguson referred to statements which had appeared in the *Glasgow Herald* to the effect that the telephone department was being worked at a loss of £10,000, and that although skilful bookkeeping might keep that off the rates for some time, it was bound to come. He asked if there was the slightest foundation for that alarming statement. Mr. Alexander said he was surprised that such a statement should go forth without better information. Instead of being worked at a loss, there was not the slightest doubt that within a short time there would be a profit of £10,000. They were not carrying on the enterprise for a large profit, but for the benefit of the ratepayers. If they wanted to make money, it would be an easy matter to raise the charge from £5 to £16. So far as it had gone, that was one of their best municipal enterprises. It was not long since the tramway enterprise received the same criticism from the same source, and when they received criticism of that sort it was a proof to him that they were on the right lines. Mr. Bruce Murray thought there was an explanation of this matter. He considered the statement referred to was warranted.

Sheffield City Council, on Wednesday, considered a report recommending the establishment of a municipal telephone service :—

Mr. COLVER proposed an amendment that the matter be referred back to ascertain the amount of support likely to be given to the enterprise. There were, he said, about 3,200 subscribers to the telephone in Sheffield at present, and it seemed to him absurd that public funds should be used for the exploitation of any competitive system. The chief point was, would the service pay, and on that they had several object lessons. In Glasgow there had been an outlay of £200,000, and the gross increment was about £395. The experience of Tunbridge Wells was still more disastrous. The National Telephone Co. only paid a dividend of about 4 per cent. The area of the Sheffield telephonic district was about 230 miles, yet if the system proved a failure all the loss would fall upon the inhabitants of Sheffield alone. He thought Sir William Preece should have been consulted.

Mr. FISHER, who seconded the amendment, said the experiment was a risky one. Only some 3,000 or 4,000 inhabitants could be benefited by it, and he was there to represent the other 396,000. To have two telephones was bewildering and expensive, and he urged the Council to wait for the reply of the National Company as to whether they were willing to sell their undertaking.

Mr. CROWTHER thought every business man would deny that the National Company had served the city well.

Mr. W. T. WHEATLEY humorously recounted his telephonic experiences, and supported the municipal scheme.

Ultimately the Council approved the scheme by 32 votes to 14.

Chapel-en-le-Frith Council will support the Sheffield municipal telephone scheme, and Sheffield Corporation has been requested to include Bamford and Ashopton in its area.

The Town Councils of Burnley, Nelson, Colne and Todmorden are considering the establishment of municipal telephone service for the Burnley exchange area.

Portsmouth Finance committee propose that, instead of borrowing £25,000 for municipal telephony, the amount should be taken from the loans funds, thus avoiding the issue of further stock.

Northfleet.—Offers from the Kent Electric Power Syndicate and the Gravesend Town Council have been received for the supply of electricity in bulk in the district. The matter is under consideration by the Works committee.

Oldham.—There has been a joint meeting of the Water, Gas and Electricity committees to discuss the question of non-rate-aided committees paying for water supplied to them by the Water committee, and it has been decided to recommend the Council to authorise a charge of 4d. per 1,000 gallons being made to the Gas and Electricity committees for water. After discussion the minutes were withdrawn, and it was agreed that the question of payment for water by all committees be considered by a special body composed of the chairman and vice-chairman of each committee.

Romford.—The Council is in negotiation with the United Electric Light and Power Co. for the transfer of the Romford provisional

order for the erection of electricity supply works and the construction of electric tramways. Mr. W. C. C. Hawtayne is advising the Council.

Sheffield.—The Corporation are recommended by the Electric Light committee to obtain powers to purchase and let electric motors on hire, and to wire premises on hire-purchase terms; also to postpone operation of sinking fund on the capital expended on the new generating station for five years, &c.

The chairman of the Sheffield Gas Co. (Sir F. Mappin, M.P.), at the meeting on Tuesday, animadverted on the tendency to municipalise business undertakings. The City Council was to discuss the desirability of establishing a municipal telephone service. They had already the National Telephone Co. in the city and a Government telephone. Were there to be three? How were they to have any profit left for their capital expenditure if they followed such advice? A councillor was to move that steps be taken to establish a municipal savings bank. What should they do next? He hoped the Council would not follow such advice, and that someone would point out the folly of it. Another member was to move that steps be taken by the Tramways committee to institute for Walkley a service of cars of not less than 20 journeys per hour. The City Council and the councils of other places were undertaking so many duties that they could not find time to consider the various subjects that were placed before the members; nor could they find the men of experience who had large undertakings to manage to give the time necessary for so many and varied occupations that had to be dealt with by the councils.

South London Tramways.—On Oct. 1 the last of the South London lines will come under the control of the London County Council, which will then own and work over 40 miles of line.

Sunderland.—The Electricity committee have submitted a scheme for the extension of the electricity undertaking, so as to give supply for motive power to manufacturers. The estimated outlay is £74,000. The matter was adjourned to a special meeting.

The Marylebone Inquiry.—In connection with the prolonged arbitration proceedings as to the amount to be awarded to the Metropolitan Electric Supply Co., in the event of the purchase by the Marylebone Borough Council of that portion of the company's undertaking which lies within that borough, a question has been raised as to extensions of mains, &c., in the district. Pending the award the company considers it necessary to make certain extensions of mains to meet the increasing demand for current. On the other hand, the Council urges that this will materially increase the amount which the Council would ultimately have to pay to the company, and on this account the Council objects to the proposed extensions. The matter has been argued before Mr. A. P. Trotter at the Board of Trade, and Mr. Trotter will probably give his decision in a few days. Mr. Barlow (Messrs. Barlow and Barlow) appeared for the company and Mr. Caine for the Council. In connection with this matter, if we may judge by the views expressed in one of the Marylebone local journals, it appears to be the prevailing idea that the Council enters into possession of the Metropolitan Company's Marylebone undertaking at the end of 1902, but this is by no means the case. Before the Council come into possession, the arbitration now dragging its slow length along has to be terminated, the arbitrators' award to be given and the necessary moneys to be borrowed, and these preliminaries to the purchase will involve a considerable period of time before completion. These may be accepted as the lines upon which the company's operations are being conducted in the Marylebone district, and it remains to be seen whether this view will be accepted by Mr. Trotter in his decision.

Walton-on-the-Naze.—Mr. H. R. Spence, manager director of the Coast Development Co., has been requested by the Council to prepare an electric lighting scheme, as the local gas company has given notice of intention to terminate its contract in November.

Whitefield (Lancs.).—An agreement has been entered into with the Bury Corporation for the supply of electricity at the following rates for five years: Private lighting, 6d. per unit for first hour's maximum demand per day, and 3d. after; domestic supply, 4½d., and motor power 3d. for first hour's maximum demand, and 1d. after. After five years the charges are to be the same at Bury, and Whitefield is to participate in the net profits during the first five years pro rata to Bury.

Wigan.—An inquiry has been held into the application of the Council to borrow £11,000 for electric lighting extensions. There was no opposition.

Yarmouth.—The salary of the borough electrical engineer (Mr. Gordon Bryant, has been increased by £50 per annum.

The number of passengers carried by the electric tramways since the start of the service has been 712,887, and the receipts amounted to £3,692. 15s. 5d., the mileage to 59,850. The receipts per car-mile worked out at 14 8d., the average fare per passenger 1·2d., and the average number of passengers carried per car-mile 11·9.

Yeovil.—The Gas committee are to ascertain the terms upon which a company will establish electricity works and take a transfer of the Yeovil provisional order.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Blackburn Town Council invite tenders for the supply, delivery and erection of an electrically-driven travelling crane. Specifications, &c, from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, and copies may be seen at (but not obtained from) 78, King-street, Manchester. An advertisement contains further particulars. Tenders to the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by noon Sept. 22.

Stafford Gas and Electricity committee invite offers for six battery regulating switches and 19 contacts. Further particulars from the engineer and manager (Mr. Hubert Pooley), Gas and Electricity offices, Stafford, to whom offers. See advertisement.

The Directors of the *Commercial Gas Co.* invite tenders by 17th inst. for the present stock and for the production of retort carbon for 12 months from Sept. 30. Some further particulars will be found in an advertisement.

Grimsby Corporation invite tenders for the supply of continuous-current motors for letting on hire. Specification from the borough electrical engineer (Mr. W. A. Vignoles), to whom tenders by Sept. 20. See advertisement.

Dundee Gas Commissioners invite tenders for the supply and erection of water-tube boilers, with mechanical stokers and superheaters and induced draught apparatus. Further particulars are given in an advertisement. Specifications, &c., from the city electrical engineer, Mr. Walter H. Tittensor, and tenders to the clerk (Sir Thomas Thornton, LL D.), City Chambers, Dundee, by Sept. 24.

Dundee Gas Commissioners also invite tenders for the supply of carbons for public lamps. Specifications from city electrical engineer (Mr. Walter H. Tittensor), and tenders to Sir Thomas Thornton, LL.D., by Sept. 24. See advertisement.

Messrs. Preece and Cardew are authorised by the *Shanghai* Municipal Commissioners to receive tenders for the supply and delivery (c.i.f.) of two 500kw. steam alternators, switchboards, two condensers and circulating water pumps. Specifications, &c., from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, to whom tenders by noon Oct. 30. An advertisement contains further particulars.

Reading Corporation invite tenders for the supply, delivery, drawing in and connecting up of all feeder cables, rail return cables, test wires, &c., with joint boxes and jointing, and the carrying out of tests; also the supply, delivery, erection and connecting up of all poles, brackets, wires, cables, insulators, switch-boxes and other fittings, and the carrying out of tests, for their electric tramways department. Tenders to chairman of Tramways committee by noon Sept. 18.

By command of the *Postmaster-General* tenders will be received until 10 a.m. of Sept. 29 for the supply of Swedish, Norwegian or Finland red fir telegraph poles, and for creosoting same. All particulars of Mr. S. C. Hooley, controller of stores, G.P.O., London, E.C.

Aston Manor Urban District Council invite tenders for steel coal bunkers and a coal conveyor for their electricity generating station. Tenders to chairman of Electric Lighting and Tramways committee by noon Sept. 19.

The directors of the *North-Eastern Railway Co.* invite tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders to secretary, York, by noon Oct. 7.

King's Norton and Northfield Urban District Council are prepared to lease their powers under their electric lighting order of 1898. Offers to Mr. E. Docker, 10, Newhall-street, Birmingham, by Sept. 18.

Swindon Corporation invite tenders for a complete lighting switchboard, with all instruments and accessories. Tenders to town clerk by Sept. 19.

Burton-on-Trent Corporation invite tenders for supply and laying of electric mains, conduits, junction boxes, &c. Tenders to town clerk before noon Sept. 30.

The managers of the *West London School District* invite tenders for the electric lighting, &c., of their schools at Ashford, Middlesex. Tenders to managers at the schools, Ashford, by 6 p.m. 25th inst.

Dublin Lighting committee invite tenders for erection of underground transformer sub-station building in Sackville-street. Tenders to chairman by noon Sept. 23.

Bradford Corporation invite tenders for electric lighting and bell fitting at the Market Tavern and Trevelyan Hotel. Tenders by noon 17th inst.

Bristol Electrical committee require two 750kw. single-phase steam alternators. Tenders to city electrical engineer by noon Sept. 16.

Southampton Corporation invite tenders for electrical plant for street alarms, steam fire engine, &c. Tenders by 24th inst.

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Dungannon (Ireland) District Council require tenders for electricity generating plant, mains, &c. Tenders by Sept. 24.

Aylesbury District Council invite tenders for erection and maintenance of electricity works for a term of years. Tenders by Oct. 8.

St. Petersburg (Russia) Town Council require tenders for the reconstruction of the existing three horse-drawn tramways in the city to electric traction, and for the construction and equipment of an electric power station. Conditions of tender, &c., can be obtained (by post or telegraph) from the Stadt-Amt., St. Petersburg, where projects have to be lodged and tenders sent by the 1st (14th) Nov.

At 11 a.m. on 18th inst. tenders will be opened at *Spezia*, Italy, for the supply to the Italian navy of electric lamps and lamp holders of the total value of 40,000 lire. The lamps are to be delivered to the Royal Arsenals at Spezia, Naples, Venice and Taranto. Conditions of the contract can be obtained at the Ministry of Marine (Rome), at the Royal Arsenals above mentioned, and of the principal Chambers of Commerce in Italy. A deposit of 10 per cent. has to be made to qualify a tender.

TENDERS RECEIVED AND ACCEPTED.

Amsterdam Municipal Council have received the following tenders for the delivery and laying of cables for the municipal electric lighting scheme :—

		About
Kabelwerk Rheydt A.G. (Rheydt, Germany)	fr.1,003,865.38	£40,156
Société Française des Cables Electriques (Lyons)	1,001,957.50	40,076
Société Industrielle des Téléphones (Paris)	999,451.66	39,976
Siemens and Halske A.-G. (Berlin)	949,218.75	37,968
Siemens Brothers & Co. (London)	946,060.55	37,840
British Insulated Wire Co. (Prescot)	938,781	37 548
Felten and Guilleaume Carlswerke A.G. (Mulheim-on-Rhine)	936,473.75	37,350
	941,777.50	37,672
Allgemeine Elektricitäts-Gesellschaft (Berlin)	915,145.75	36,604
	910,468.25	36,416
Land- und Seekabelwerke A.G. (Cologne)	901,306.25	36,052
Dr. Cassirer & Co. (Berlin)	865,752.60	34,628
W. T. Henley's Telegraph Works Co. (London)	845,087.15	33,800
	817,794.70	32,712
St. Helens Cable Co. (Warrington)	860,399.24	34,416
	844,502.22	33,780
Callender's Cable and Construction Co. (London)	813,853.50	32,152
W. T. Glover & Co. (Manchester)	812,354	32,492
Western Electric Co. (London)	795,925.75	31,836
Kabelfabrik A.G. (Vienna)	775,136	31,004
Deutsche Kabelwerke A.G. (Berlin)	773,400.20	30,936

The following tenders have been received by the Metropolitan Asylums Board for an electric fire alarm installation at the Orchard Small Pox Hospital, near Dartford :—

Cox-Walkers (*accepted*)	£295	0	0
Jackson Bros.	697	14	6
Julius Sax & Co.	475	0	0
J. Bakewell & Co.	455	15	6
Electric Installation and Maintenance Co.	438	1	5
Scholes & Son	423	0	0
Private Wire and Telephone Installation Co.	419	0	0

The following tenders have been received by the West Ham Electric Tramways committee for tramway track construction :—

J. Ewart	£77,121	19	7	Dick, Kerr & Co.	£59,535	15	7
J. J. Robson	67,537	12	0	Thos. Adams	58,631	2	11
W. L. Meredith & Co.	65,593	13	0	W. Griffiths (Ltd.)	55,901	8	4
E. Nuttall	63,226	2	5	F. Osman	55,092	0	0
J. G. White & Co.	62,139	6	2				

The West Ham municipal works manager also tendered at £54,298. The tenders will be considered by the Tramways and Highways committees.

Stockport Town Council have accepted the following tenders :—

Dick, Kerr & Co. (10 tramcars complete)	£5,900	0	0
Lorain Steel Co. (reconstructing tramway route)	598	17	6
Electrical Power Storage Co. (renewal of 101 cells).	445	14	0
Babcock and Wilcox (feed water pipes)	115	0	0

Bury (Lancs.) Town Council have accepted the tender of Walter Scott (Ltd.) for 2,500 tons of tramway rails and 80 tons of fish plates; that of Ibbotson Bros. & Co. for 22 tons of fish bolts and nuts ; and that of the Cooper Patent Anchor Rail Joint Co. for anchor plates and fixing.

The following contracts have been placed with Messrs. Belliss and Morcom (Ltd.), Ledsam-street Works, Birmingham :—

One 150 H.P. engine, with Mavor and Coulson dynamo, for Mexborough.

Steam engines for condensing plant and Siemens dynamos for the Bournemouth and Poole Electricity Supply Co.

Engine for coupling a Mather and Platt dynamo for Shanghai.

Messrs. Pritchetts and Gold (Ltd.), Feltham, Middlesex, have obtained an order from Edmundsons' Electricity Corporation (Ltd.) for a storage battery of 240 cells for Market Drayton electricity station.

Andover Town Council have accepted the tender of the General Post Office to carry out the system of electric calls for firemen and telephones at the fire station and other public buildings. The National Telephone Co. also tendered.

Sheffield Corporation have accepted the tender of their electric supply department for wiring and fitting up the Norfolk Market Hall at £230.

Brighton Town Council have accepted the tender of Messrs. Sattin and Evershed for making additions to the motor room and offices in Bread-street to adapt them for the extension of the tramway generating plant at £949.

Messrs. Babcock and Wilcox have obtained an order from the Underground Electric Railways Co. of London (Ltd.) for 128 chain grate stokers, to be used in connection with 64 of the firm's boilers which are being erected at the company's generating station at Lot's-road, Chelsea. This is the largest order ever booked at one time for stokers.

Darlington Corporation have placed an order for 100 meters for the ensuing 12 months with Ferranti Limited.

The Bengal Iron and Steel Co. have placed a further order with Messrs. Crompton & Co. for two dynamos for direct coupling to Willans engines of 300 H.P.

The Wheldale Iron and Coal Co. are installing a 200 H.P. Willans engine for direct coupling to a Holmes dynamo for electric power work at their colliery.

Motherwell Town Council have accepted the tender of Veritys Limited for switchboard extension at £104, and that of the Wheeler Condenser and Engineering Co. for condensing plant at £3,594.

Dartford District Council have accepted the tender of Messrs. T. Ledward & Co. for the supply and erection of an atmospheric condenser with tank, &c., at £1,579. 10s.

Salford Corporation have accepted the tender of the British Electric Car Co. for a tower waggon at £90.

Broadstairs Council have accepted the tender of Messrs. Attwaters & Co. for electric light fittings for the Council offices at £19.

Essex County Council have accepted the tender of Messrs. T. H. P. Dennis & Sons for wiring the Shire Hall at £38. 15s.

BUSINESS NOTICES.

For some months past extensive additions and reconstructions have been in progress at the Arbroath works of the James Keith and Blackman Co. which will double the capacity of these works. The large extensions of the company's business and operations will necessitate still further extensions, and to provide for these a large piece of land adjoining the present works has been secured. Considerable extensions are also completing at the works of the company at Holloway, London.

Reed's Electrical Engineering and Supply Co., 83, Cannon-street, London, E.C., require agents to take up sale of Edison-Reed incandescent lamps and other specialities.

We have received the following circular from Messrs. Macarthur and Cheverton, solicitors, 33, King-street, London, E.C. :—

We are instructed by the directors of Hands Limited, Garlick-hill, Cannon-street, E.C., to inform you that the trustees for the debenture-holders have, for reasons the directors are unable to appreciate and without formal notice, taken possession of the properties belonging to the company, and until their claim is satisfied or matters arranged with them, the claims of the trade creditors will have to stand aside. The directors, having regard to the financial position of the company, have every reason to believe that all the creditors will be paid in full, but they deem it advisable to at once put the true state of affairs before you, and for this purpose the directors would be glad to meet creditors at room No. 8, Guildhall Tavern, Gresham-street, London, E.C., on Tuesday, Sept. 23, at 3 o'clock, to explain matters more fully, and the whole position can then be informally discussed.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of creditors of G. H. Stutfield was held on Wednesday. The debtor returned his liabilities at £1,243, assets £37, doubtful debts £323, and an interest in certain patents. Debtor attributed his insolvency to liability in connection with the underwriting of certain shares of the British Drying Co. (Ltd.). Mr. Weldon, for debtor, asked for an adjournment to enable an arrangement to be made for payment of creditors in full. Debtor was interested in certain patents, and negotiations for the sale of one of them were pending, and it was anticipated that a deposit of £2,500 or £3,000 would shortly be made. This particular patent was for making ozone and doing away with cold storage. Adjourned to 31st inst.

The Newhaven and Seaford Electric Lighting Co. (Ltd.) is being wound up voluntarily. Mr. E. T. Wellsted is liquidator.

A meeting of the British Electric Meter Co. (Ltd.) will be held at 146A, Queen Victoria-street, London, E.C., on Oct. 5 to receive an account of the winding up.

Winding-up Petitions.—A petition for winding up the British Power, Traction and Lighting Co. (Ltd.) has been presented in the High Court and will be heard on Sept. 17.

A petition for winding up the Electromotion Corporation (Ltd.) has been presented and will be heard in London on Oct. 28.

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Plant for Sale.—Two complete Parsons steam turbine generating sets are for sale. Particulars from Mr. F. Stobart, Lambton Office, Fence Houses, Co. Durham. See also advertisement.

Messrs. Whittaker Bros. (Ltd.), Dudley, have for sale a 16kw. compound-wound dynamo (230 volts) and a watt-hour meter. See advertisement.

Messrs. Carr Bros., Darlington, have for sale a 150kw. three-phase B.T.-H. dynamo; a 60kw. three-phase motor and two spare armas tures; also three nearly new Babcock and Wilcox water-tube boilers. Further particulars in advertisements.

Particulars of some electric lighting plant for sale are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold Battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

Tractors for Military Purposes.—The War Office competition for tractors for military purposes, which was announced for the spring of 1903, will be postponed until October, 1903. Intending competitors should apply on Oct. 1 for forms of entry for the competition to the Secretary, Mechanical Transport, War Office, Horse Guards, Whitehall, S.W., which should be returned by Jan. 1, 1903.

Catalogues.—A useful illustrated hanging card sheet of "Ark" lamps, lamp parts, posts, brackets, projection fittings, reflectors, &c., is issued by Messrs. Johnson and Phillips, and can be obtained by the trade on application.

Nernst Electric Light (Ltd.) is introducing the Nernst lamp into the whole of Asia, Africa, Central and South America and all British Colonies, and a new illustrated catalogue and price-list is now ready for those countries. The catalogue is in English, and is nicely illustrated. Copies can be obtained from the offices, 82, Victoria-street, Westminster, London, S.W.

The Howard Conduit Co., Trafford Park, Manchester, have issued an extra leaf to their main catalogue dealing with the latest development in the Howard system of asphalt troughing, namely, "Bends," and the method of making them. Special troughs are made and supplied by the company similar to the ordinary asphalt trough, except that the inside sheet-iron casing is treated with a substance that allows the trough (when made slightly flexible by warming) to be removed by the aid of a knife. The trough can be bent at any place where warmed into any shape that may be required. A considerable saving of labour at times and places where such work is either difficult to be done or would occupy considerable time is thus provided for by a simple method, and the company claims that it is impossible with any other kind of troughing but that on the Howard system for this simple and effective bend to be made.

Mr. P. Pitman, of Halifax, has some lists ready of the new Hector water motor and Pelton wheels. The list can be obtained on application.

The British Thomson-Houston Co. have ready pamphlet No. 133, dealing with twin-carbon enclosed arc lamps.

Imports of Electrical Goods.—The value of the electrical goods imported into this country during August was £57,388, against £42,096 in August, 1901, and £148,317 in August, 1900. The total value for the eight months ended August 31 was £464,667, compared with £637,169 and £697,592 in the corresponding periods of 1901 and 1900 respectively.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Sept. 3 to 9, with the ports of destination:—

Africa—Cape Town, £370; East London, £395. *Argentina*—Buenos Ayres, £430; Rosario, £62. *Australasia*—Fremantle, £112; Melbourne, £660; Sydney, £811; Wellington, £48. *Ceylon*—Colombo, £175. *Channel Islands*, £317. *Chili*—Valparaiso, £100. *China*—Shanghai, £192. *Denmark*—Copenhagen, £284 (telegraph material). *Holland*—Amsterdam, £103. *India*—Bombay, £730 (including £710 telegraph wire); Calcutta, £218 (including £163 telegraph cable). *Norway*—Christiania, £400 (telegraph cable). *Spain*—Malaga, £102 (telegraph cable). *Sweden*—Gothenburg, £543; Stockholm, £598 (telegraph cable). Total £6,650, against £8,319 in the corresponding week last year (Sept. 4 to 10).

CITY AND SURREY ELECTRIC RAILWAY CO. (LTD.)—In connection with the flotation of this company (referred to in our issues for July 18 and Aug. 15 last), we have received the following communication:—"At a meeting of the above-named company, held on Aug. 8 last, we were asked whether we would join the board of the National Electric Traction Co. (Ltd.) with which it was proposed to amalgamate. We have consequently endeavoured to obtain as much information as possible as to the position and prospects of both companies, but the situation, as disclosed by the materials which have been furnished, does not, in our opinion, justify us in accepting office. The National Electric Traction Co. (Ltd.) has been officially informed of our decision, but as we have failed to obtain any list of applicants for shares of the City and Surrey Company, we trust that you will insert this letter, as we have no other means of carrying our decision to them.—(Signed) S. P. Braun, W. T. Holmes, A. Howell."

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 29, 1902.

16,837. SIEMENS BROS. & Co. Framing of dynamos, electromotors. (Siemens and Halske A.G., Germany.)
16,839. SIEMENS BROS. & Co. and F. LYDALL. Polyphase induction motors.*
16,843. J. BUTCHER. Liverpool. Electric clocks.*
16,850. H. BERGNER. Electric igniters for gas burners.
16,852. J. GELL. Perforators for automatic telegraph transmitters.

July 30, 1902.

16,858. R. PAULSON. Hove. Transmitting and utilising electricity.
16,861. W. A. PURDON, J. EDMONDSON, J. W. DAWSON, and EDMONDSON AND PURDON. Halifax. Magnetic device for indicating a current of a given amount traversing a conductor and closing or opening a switch or contact, specially applicable to indicating leakages and cutting off main current in such cases.
16,874. M. SMALL and C. KERR. Glasgow. Trolley poles. (G. J. Thomas, U.S.)
16,887. J. T. ARMSTRONG and A. ORLING. Detectors of electromagnetic waves and actuating one or more relays.
16,896. SIEMENS BROS. & Co. Electric semaphore signals for railways. (Siemens and Halske A.G., Germany.)*
16,902. W. D. WATKINS. Telephone systems.*
16,904. H. H. LAKE. Regulating devices for dynamos. (G. E. Co., U.S.)
16,905. H. H. LAKE. Contact fingers for electric controllers. (G. E. Co., U S.)
16,906. H. H. LAKE. Electric circuit-breakers. (G. E. Co., U.S.)
16,923. H. H. LAKE. Manufacture of incandescent lamps. (G. E. Co., U.S.)
16,924. H. H. LAKE. Electromagnetic switches. (G. E. Co., U.S.)
16,925. H. H. LAKE. Control of electric motors. (G. E. Co., U.S.)
16,927. H. H. LAKE. Starting devices for induction motors. (G.E. Co., U.S.)
16,928. H. H. LAKE. Counters, or tell-tales for electric circuit-breakers. (G. E. Co., U.S.)
16,939. J. LAGARDE. Electric transmission, adapted for operating and controlling automatic type-setting and composing machines.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each

1901.

18,110. J. BROWN & Co. (LTD.), TRESIDDER and JONES. Electric cranes.
18,273. CAWLEY. Vehicle for electric traction on railways.
18,400. REICHWALD (Fried. Krupp). Controlling apparatus for electrically operated or driven ammunition rammers.
18,652. VON ZWEIGBERGK. Breaking arcs.
18,691. SMITH. Electric switches.
18,732. ELECTRIC LIGHTING BOARDS (Lefebre). Contacts for glow lamps.
18,797. DAWE. Trolley-line switches.
18,962. GOWLLAND. Prepayment electricity meters.
19,377. HARTNELL. Fixing carbons for dynamos and motors.
19,461. DUCRÉTET. Transmitting and receiving Hertzian waves.
19,554. ESTLER. Overhead fittings for tramways.
19,657. KINGSLAND. Communicating step-by-step motions for controlling and for encasing and mounting electric switches.
20,019. TIRMANN and TIRMANN. Fuses for explosive charge holders.
20,462. EARLE. Electromagnetic clutches.
20,651. SCHMIDT. Arc lamps.
23,294. IMMICH. Earth conductors for lightning conductors.
24,096. BYNG and BELL. Attaching cases of apparatus to telegraph, telephone and tramway poles or the like.
25,146. ANDREWS. Switching apparatus.
25,201. NEWTON (Keiley). Recording apparatus for electric meters and speed indicators.
25,318. EVANS (A.E.G.) Electricity meters.
26,634. RABBIDGE. Connecting an alarm bell in a local system to the telephone exchange.
26,700. HENRY. Electric lighting of railway trains.

COMPANIES' MEETINGS AND REPORTS.

Drake and Gorham (Ltd.).

The first annual meeting was held yesterday, Mr. B. M. DRAKE presiding.

The SECRETARY (Mr. A. C. Read) read the notice convening the meeting, and the auditors' report.

The CHAIRMAN then said that the net profits for the period covered by the accounts amounted to £12,081 after payment of managing directors' salaries, directors' fees, and writing off the whole of the preliminary expenses. The greater portion of the expenses of the formation of the company was payable by the vendors, but the company were liable for

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sundry charges. It was proposed to pay a dividend at the rate of 7 per cent. per annum. The amount to be distributed as dividend did not agree with 7 per cent. on the capital, owing to the fact that the dividend on the vendors' shares were due from May 23, and that on the subscribed capital from the time of allotment and payment of calls. The directors recommend that the sum remaining after the dividend had been paid should be dealt with by placing £2,000 to reserve and carrying forward £1,246 to next account. This £2,000, it should be explained, had no reference to the compulsory reserve mentioned in the prospectus, as that only came into operation when a dividend of 10 per cent. had been paid. Since the report was published the board's attention had been called to the fact that the company's articles did not, apparently, make provision for the formation of an ordinary reserve. It was, therefore, proposed to add that £2,000 to the amount carried forward pending the receipt of legal advice as to the desirability of altering the articles. The work carried out during the period under review included many considerable installations. At the present time the company had contracts in hand at Cape St. Vincent for the Western Telegraph Co. and at Aden for the Eastern Telegraph Co., and they were also carrying out a number of important installations for the aristocracy, and the outlook generally was promising. He then moved the adoption of the report and accounts.

Mr. J. C. FORSTER seconded the resolution.

A SHAREHOLDER asked if the board had made any arrangements to extend the company's business abroad. They hoped to do so, apparently, by a paragraph in the report.

The CHAIRMAN replied that during his recent visit to the United States he was engaged on behalf of this company in working out an agency for American goods which could be introduced into the United Kingdom. As the result of this visit they had now an agency established for some electrical devices which they hoped to introduce into mills, and others in connection with electric lighting. He also looked into the question of electrical vehicles and electrical machinery which, it was thought, were made cheaper and better in the States, and could be sold to advantage in this country.

The resolution was carried unanimously.

The retiring director (Mr. R. P. Sellon, M.I.E.E.) was re-elected and the proceedings terminated with a vote of thanks to the chairman and directors.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 24d. per oz. (Sept. 11). Consols (2¾ per cent.) 93 1/16—93 1/8 for money, 93 1/8—93 1/8 for account; 2½ per cent. 93¾—94¼ (Sept. 11). Consols Pay day, Oct. 2; Stocks and Shares Continuation Days, Sept. 24 and Oct. 13; Ticket Days, Sept. 25 and Oct. 10; Pay Day, Sept. 26; Mining Share Carry-over Days, Sept. 23 and Oct. 10.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD).—At a meeting held on Tuesday resolutions were passed enabling the company to raise further capital. The chairman (Mr. R. M. Horne Payne) said that since 1897 their profits had risen from £20,000 to £45,000 per year, and that the equivalent number of 8 c.p. lights had increased from 19,000 to 69,000, with a prospect of a further large increase, both in earnings and in number of lights. It was essential that further capital should be raised in order to provide the machinery necessary for supplying further demands for current.

BRITISH INSULATED WIRE CO. (LTD.)—An extraordinary meeting was held at Liverpool on Wednesday to authorise the change of the name of the company to the British Insulated and Helsby Cables (Ltd.) and other purposes. The chairman (Mr. E. K. Muspratt) said it had been agreed, on the amalgamation with the Telegraph Mfg. Co., of Helsby, that the name of the combined companies should be changed. The changes proposed in the articles of association had been carefully considered, and were now submitted to the shareholders for sanction. If passed, a further meeting would be necessary for the purpose of confirming. He proposed a resolution that the name of the company be changed to the British Insulated and Helsby Cables (Ltd.). This was seconded by Mr. James Taylor, and carried unanimously. Resolutions were also adopted approving the alterations in the articles of association required by the Companies Acts.

The chairman, referring to the progress of the joint companies, said everything was going on well. They naturally had met some little difficulties, inevitable in a reconstruction or amalgamation of that kind, but the difficulties were not of any unusual nature. They had found it necessary to appoint a general manager. The business had grown enormously during the last few years, and the amalgamation rendered it absolutely necessary, in order to co-ordinate the work, to have someone to superintend the whole. A business of that kind could not be carried on without a general manager. They had been fortunate in securing the services of Mr. Dane Sinclair, who was acquainted with a business of that kind, having been chief engineer of the National Telephone Co. for a very long period. He believed that that step would be a great improvement, and that Mr. Sinclair would carry on the business to the satisfaction both of the directors and the shareholders. As the result of the amalgamation they now had the advantage of having on the board several gentlemen who had great business experience, and, moreover, experience of the kind of business in which the company was engaged. He trusted that in the result the company would be in the future as prosperous as in the past.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—The directors' report for the year ended June 30 states that the progress of the business has been maintained. During the year the directors have dealt with the reduction and adjustment of the capital and assets, with the unanimous co-operation of all classes of shareholders. The directors congratulate the shareholders on the high class of business for which they continue to receive orders, showing the undoubted value of the Chloride battery. The company keeps itself abreast of all advances that are being made in technical knowledge with reference to the construction and use of storage batteries. The balance-sheet shows a trading profit for the financial year of £12,901. 7s. 5d. After providing for interest, other expenditure and depreciation, amounting to £5,753. 12s. 6d., there remains £7,147. 14s. 11d., which the directors propose to deal with in paying the dividend (from April 14, 1902, the date of the reduction of capital) to the end of the financial year on the 6 per cent. preference shares (less income tax) and on the ordinary shares of 8 per cent. (tax free), carrying forward £5,801. 6s. 7d.

YORK TRAMWAYS CO. (LTD.)—At the meeting last week the chairman (Mr. J. Kincaid) said that the company had delayed doing the work of relaying their lines, as they had entered into an agreement with the Corporation for handing them over, and while Parliamentary powers were being obtained the Corporation was to keep the road in repair. The Corporation possessed the right after 21 years to purchase the trams at periods of seven years, so that, unless a special agreement was entered into, the Corporation had no right to purchase for six years at least. In the meantime he hoped an agreement would be come to whereby they could substitute electric traction for horse haulage.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Aug. 30	1,291	+ 443	13	15,230	+ 3,695
Ayr Corporation	Sept. 6	295	...	16	6,383	...
*Birmingham Tramways.	„ 6	5.136	+ 310	9	44,761	+ 1,412
*Blackburn Corporation..	„ 5	987	+ 210	24	20,175	+ 3,643
Blackpool Corporation...	„ 4	2,072	+ 130	23	26,993	+ 539
Blackpool and Fleetwood	„ 6	1,655	- 78	10	13,780	- 932
Bolton Corporation	„ 7	1,731	+ 266	23	37,957	+ 2,446
Bradford Corporation ...	„ 7	3,692	+2,501	23	78,392	+53,184
Brighton Corporation ...	...	...	...	...	...	...
Brisbane Tramways.....	July 23	2,199	+ 380	4	9,295	+ 1,897
*Bristol Trams & Carriage	Sept. 5	4,977	+1,073	9	46,722	+ 9,274
*Buenos Ayres & Belgrano	Aug. 10	3,041	+ 469	6	17,019	+ 1,267
Burnley Corporation ...	Sept. 6	755	+ 400	‡23	15,490	+ 6,353
Calcutta Tramways Co...	„ 8	R28.128	+R9,196	10	R250,163	+R46,658
Cardiff Corporation	„ 6	1,624	...	23	31,909	...
Carlisle Tramways Co....	„ 6	210	+ 16	†36	6,379	+ 425
Central London Railway	„ 6	5,662	+ 130	10	62,876	+ 5,316
Chatham & Dist. Lt. Rys	„ 4	561	...	¶11	6,127	...
City & South London Ry.	„ 7	2,657	+ 823	10	27,335	+ 8,940
Cork Elec. Tramways Co.	„ 4	872	+ 346	§35	20,121	+ 3,361
Devonport & Dist. Trams	Aug. 29	498	+ 36	34½	14,913	+ 508
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	Sept. 6	300	+ 10	23	5,725	- 144
Dublin & Lucan Railway	„ 7	148	+ 17	10	1,420	- 52
Dublin Southern Dist....	„ 5	1,210	+ 94	†10	12,481	- 230
Dublin United	„ 5	4,481	+ 276	†10	39,819	
Dudley—Stourbridge ...	Aug 29	923	+ 163	34½	25,778	+ 3,396
*Dundee Corporation ...	Sept. 3	891	+ 137	§15	12,200	+ 1,138
East Ham Council	„ 6	531	+ 102	11	5,880	+ 820
Gateshead & Dist. Trams	Aug. 29	898	+ 252	34½	25,146	+ 4,098
Glasgow Corporation ...	Sept. 6	12,585	- 851	14	166,816	- 4,459
Gravesend	Aug. 29	200	...	4	915	...
Greenock & Port Glasgow	„ 29	609	+ 393	34½	17,228	+10,457
Hartlepool Tramways ..	„ 29	376	+ 84	34½	8,880	+ 1,108
Hull Corporation	Sept. 6	1.783	+ 118	23	40,646	+ 1,709
Isle of Thanet Co.	„ 6	1,701	+ 210	10	15,402	+ 609
Kidderminster & Dist....	Aug. 29	160	+ 6	34½	4,336	+ 5
Leeds Corporation	Sept. 6	5,329	+ 882	23	124,682	+20,773
*Liverpool Corporation...	Aug. 30	10,668	+1,211	35	338,211	+27,367
Liverpool Overhead Rly.	Sept. 7	1,608	+ 3	‡10	16,296	- 1,063
Manchester Corporation	„ 6	5,812	+3,591	64	185,329	...
Merthyr.....	Aug. 29	221	+ 7	34½	7,035	- 1,325
Middleton	„ 29	396	...	22½	7,124	...
Newcastle-on-Tyne Corp	Sept. 6	2,927	...	...	...	...
Oldham, Ashton & Hyde.	Aug. 29	571	+ 73	34½	18,159	+ 771
Perth (W.A.) Elec. Trams	Sept. 5	990	+ 190	¶35	37,473	+ 6,293
Poolé & Dist.....	Aug. 29	379	+ 27	34½	8,865	- 143
*Portsmouth Corporation	Sept. 6	2,103	+ 935	...	...	...
Potteries	Aug. 29	1,535	+ 46	34½	50,253	+ 1,900
Rothesay	„ 29	349	...	1½	560	...
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ..	Sept. 7	4,374	+ 713	10	43,306	+10,401
Southampton Corp.	„ 4	1,180	...	...	...	...
Southend Corporation...	„ 3	430	+ 66	22	7,067	...
Southport Tramways ...	Aug. 29	349	+ 175	34½	8,850	+ 3,099
*S. Staffordshire Trams...	„ 29	776	- 89	34½	26,645	+ 34
Sunderland Corporation.	Sept. 7	1,321	+ 128	23	28,724	+ 2,510
Swansea Trams.....	Aug. 29	590	+ 43	34½	16,370	+ 1,148
Taunton Trams.....	„ 29	85	- 57	34½	2,315	- 81
Tynemouth & Dist.	„ 29	506	+ 147	34½	10,183	+ 1,038
Weston-super-Mare	„ 27	383	...	16½	4,020	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 29	326	+ 203	34½	6,323	+ 4 203

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

PRESENT AMOUNT.	AMOUNT OF SHARE.	LAST DIVIDEND.	NAME.	PREVIOUS WEEK'S PRICE, SEPT. 3.		PRICE WEDNESDAY, SEPT. 10.		RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS DONE DURING WEEK ENDING SEPT. 10.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	½	½	½	½				
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103	106	103	106	4 6 0			
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11½	12½	5 12 0			
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9			
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101	104	101	104	4 6 7			
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord	10	10½	10½	10⅝	3 14 5			
20,000	5	3/6	Do. 7 per Cent. Preference	10	10½	10½	10⅝	3 5 1	March and September	10½	10 7/16
30,000	5	3/6	Calcutta Elec. Supply Ord. (1 to 30,000)	7	8	7	8	3 15 0		7⅞	
10,000	5	...	Do. (30,001 to 40,000)	7	8	7	8				
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	106	108	105	108	3 14 8			
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	9½	9	9⅛	5 5 3	February and August	9⅛	
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9				
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	6⅜	5⅝	5⅝	3 18 3	" "	5⅝	5⅝
40,000	5	..	Do. City Undertaking 4½% Cum. Pref.	4⅜	5⅛	4⅜	5⅛			4 13/16	4⅞
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9			
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½	5⅝	5¼	5⅜	2 12 2	March		
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December		
70,595	10	10/0	City of London Electric Lighting Ord.	9	10	9	10	5 0 0	February and August	9½	
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12	13	12⅛	13⅛	4 8 11	January and July	13	
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December		
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 5 10			
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½	9½	8½	9½	4 4 3			
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12⅝	11½	12⅝	4 16 0	March and September	12½	
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	109	112	110	113	4 0 4			
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5⅝	6⅛	5⅝	6⅛	3 12 0			
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105				
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0			
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10½	11½	10½	11½	4 6 11			
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6⅝	6⅝	6⅝	6⅝	4 8 11	January and July		
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11			
£115,000	Stock	4%	Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105	108	105	108	3 15 0			
£111,000	3	...	London Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛				
49,840	5	2/6	Do. 6 per Cent. Preference	4⅝	5⅛	4⅝	5⅛	5 4 9		4⅝	
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	96	99	96	99	4 1 2	Mar., June, Sept., Dec.		
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15	16	15	16	4 7 6	April and October	15⅛	
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	108	112	109	113	4 0 1	June and December		
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99	102	99	102	3 9 2			
10,852	10	6/0	Notting Hill Electric Ordinary	13½	14⅜	13⅜	14⅜	4 2 9	March		
12,194	5	5/0	Oxford Electric Ordinary	5	6	5	6	4 3 4	"		
£50,000	Stock	4%	Do. 4% Debenture Stock	97	100	97	100	4 0 0			
300,000	1	...	Rand Electric	⅜	⅝	⅜	⅝				
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75		January and July		
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 7 0	April and October		
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	14½	15½	14⅜	15⅜	4 13 7	February and August	15⅜	
20,000	5	3/6	Do. 7 per Cent. Preference	8⅜	9⅛	8⅜	9⅛	3 13 8	" "		
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97	100	97	100	3 10 0			
13,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛				
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11			
65,000	5	...	South London Electric Supply Ordinary	2½	3	2⅛	3				
30,000	5	..	Urban Electric Supply Ord. (£3 paid)	2⅞	3⅛	2⅞	3⅛				
30,000	5	..	Do. 5% Cum. Pref.	2⅞	3⅛	2⅞	3⅛				
110,000	1	..	Westminster Electric Supply Ordinary	11	12	11	12	4 11 8	March and September	11⅜	11½
28,141	5	5/6	Do. 5 per Cent. Cum. Pref.	5⅝	6⅛	5⅝	6⅛	4 0 0		6⅛	5⅞
			TELEGRAPHS.								
67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98	102	98	102	3 18 5	January and July		
25,000	10	...	Amazon Telegraph	3⅞	4⅛	3⅞	4⅛		June and December		
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80				
£788,840	Stock	15/0	Anglo-American	47	50	47	50	5 17 0	Feb., May, Aug., Nov.	48½	
£3,105,580	Stock	30/0	Do. Preferred	92	94	93	95	6 1 3	" "	94⅝	92½
£3,105,580	Stock	2/0	Do. Deferred	7⅛	8	7⅛	8	1 5 0	" "	7⅞	7 1/16
13,333,300	$100	$12½	Commercial Cable Capital Stock	160	170	160	170	4 14 2	Jan., Apr., July, Oct.		
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	95	97	95	97	4 2 6	" "	97½	93
16,000	10	4/0	Cuba Submarine Ordinary	5	6	5½	6½	6 3 1	February and August		
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 6	" "	13½	
13,000	5	2/0	Direct Spanish Ordinary	2½	3½	2½	3½	5 14 4	April and October		
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7	8	7	8	6 5 10	" "		
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞	103⅞	99⅞	103⅞	4 7 8	January and July		
60,710	20	4/0	Direct United States Cable	10½	10⅝	10½	11	5 18 2	Jan., Apr., July, Oct.	10⅝	10 7/16
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	100	103	100	103	4 7 10	June and December		
£4,000,000	Stock	65/0	Eastern Ordinary .. xd & bonus .. [to 1,200) (red.)	121	126	124	129	5 8 6	Jan., Apr., July, Oct.	12 ½	125
£1,955,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	90	93	90	93	3 15 8	" "	93	90½
£1,634,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108	111	108	111	3 13 0	May and November	109½	
300,000	10	2/6	Eastern Extension	12	12½	19⅛	12⅝	5 9 10	Jan., Apr., July, Oct.	12½	12½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 0	February and August	109	
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 18 7	February and August		
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞	104⅛	101⅞	104⅞	3 17 6	May and November		
150,000	10	5/0	Great Northern of Copenhagen	25	27	25	27	5 11 1	January and July		
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (w th n Nos	99	102	99	102	4 8 1	June and December		
17,000	25	37/6	Indo-European [1 to 1,200) (red.	38	42	38	42	5 19 1	May and November		
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	101	105	101	105	5 14 3	March and September		
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 5	June and December		
15,609	10	...	*West African Telegraph Shares	3⅞	4⅛	3⅞	4⅛				
30,008	2½	...	West Coast of America	⅜	⅝	⅜	⅝				
£150,000	100	4%	* Do. 4 per Cent. Debentures	97	100	97	100	4 0 0	January and July		
88,321	10	...	West India and Panama	¼	½	¼	½		May and November		
34,563	10	6/0	Do. 6 per Cent. 1st Pref.	4½	5½	4½	5½	11 8 6	" "		
4,669	10	...	Do. 6 per Cent. 2nd Preference	3	4	3	4		" "		
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	January and July		
207,930	10	3/0	Western Telegraph (late Br gill'n Submarine)	11¾	12½	11¾	12½	5 14 3	Mar., June, Oct., Dec.	12 1/16	11⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1908)	102	105	102	105	4 15 10	June and December		
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	97	100	98	101	3 19 9			
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3½	4	3½	4	5 11 1	August		
224,850	10/0	8%	Consolidated Telephone Con. and Manfg.	1/0	2/0	1/0	2/0	15 0 0	April and October		
72,680	1	2½%	Monte Video Telephone Ordinary	½	½	½	½	5 0 0	November		
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"		
£1,983,333	Stock	6%	National Co. Preferred Stock	93	96	93	95	6 6 4		94	93
£1,966,667	Stock	4½%	Do. Deferred Stock	55	57	55	57	7 17 10		55	
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	13	12	13	4 12 4	February and August		
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11	12	11	12	4 12 4	" "		
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	4⅞	5⅛	5 0 1	" "		
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	96	99	96	99	3 10 10	June and December	96⅛	
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6			
171,504	1	0/8½	Oriental	1 1/8	1 1/16	1 1/8	1 1/16	5 12 11	April and October		
58,000	5	4/6	United River Plate	4⅜	5⅛	4⅜	5⅛	6 13 4	July		
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	4 15 3	June and December		
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 16 2	June and December		
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅜	6	5⅜	6	5 0 0			
180,237	10	4/9	Globe Telegraph and Trust	9⅛	9⅜	9⅜	10	5 5 0	Jan., Apr., July, Oct	9⅞	9½
80,042	10	3/0	Do. 6 per Cent. Preference	13⅜	13⅝	13⅜	14	4 5 9	" "	13⅝	13½
11,329	8	4/0	Reuter's	6½	7	6½	7	5 14 3	April and October		
8,303	£100 Cert	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "		

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Shares.	Last Dividend.	Name.	Previous Week's Price, Sept. 3.	Price Wednesday, Sept. 10.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 10. Highest	Lowest
			ELECTRIC RAILWAYS, TRAMWAYS, &c.			£ s. d.			
160,000	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4½ 4⅝	4½ 4⅝	9 8 11	April and October	4⅝	4⅝
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125 130	125 130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9 11	9 11	2 14 7	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	8¼ 9¼	9 10	5 0 0	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95 100	95 100	4 10 2	...	...	...
15,000	10	4/0	Blackpool and Fleetwood Tramways	13 14	13 14	4 12 10	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3⅜ 4⅛	3⅜ 4⅛	...	...	3⅜	...
75,000	5	2/6	Do. 5% Cum. Pref.	4⅛ 5	4⅛ 5	5 0 0	...	4⅛	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	103 106	103 106	4 5 0	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	20½ 21½	20½ 21½	3 14 2	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10 10½	10 10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106 108	106 08	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7 7½	7 7½	2 13 4	...	7⅛	7
20,000	10	5/0	Do. 5% Preference	9½ 9⅝	9 9½	5 5 3	May and November	9⅛	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	103⅝ 105⅞	103⅝ 105⅞	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12⅜ 13⅛	12⅛ 13⅛	6 13 4	...	13	12⅞
100,000	10	6/0	Do. 5% Cum. Pref.	12¼ 12⅝	12¼ 12⅝	4 14 1	February and August	12⅝	...
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	126	126
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅜ 1⅝	1⅜ 1⅝	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	5 5½	5 5½	5 9 1	...	5⅝	5⅝
27,500	5	10/0	Do. "B"	5 5½	5 5½	5 9 1	...	...	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103 106	103 106	4 14 9	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97 100	97 100	5 0 11	...	...	...
70,00	10	6/0	Calcutta Tramways	7 7½	7 7½	4 0 0	...	7⅜	7⅜
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107 109	107 109	4 3 1	...	107	...
480,000	1	1/2⅞	Cape Electric Tramways Shares	2⅛ 2⅜	2⅛ 2⅜	6 14 9	...	...	...
£1,860,014	Stock	4%	Central London Ordinary Stock	103 106	103 106	3 15 6	June and December	104½	104
£494,093	Stock	4%	Do. 4% Preferred Stock	104 107	105 108	3 14 4	...	107½	...
£494,993	Stock	4%	Do. Deferred Stock	103 106	103 106	3 15 6	...	106	105
£698,201	100	4%	Do. 4% Deb.	115 118	115 118	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	5 5⅛	5 5¼	4 15 3	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101 104	101 104	3 16 11	...	...	...
£1,330,000	Stock	3%	City and South London Railway Con. Ordinary	72 74	72 74	3 11 7	February and August	73⅛	72
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	... ...	... ...	...	...	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	... ...	... ...	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128 131	128 131	3 16 6	...	...	...
£300,000	Stock	5%	Do. (1896)	126 129	126 129	3 17 6	...	...	...
£150,000	Stock	5%	Do. (1901)	121 125	121 125	4 0 0	...	124½	123⅝
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115 118	115 118	3 9 7	May and November	...	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛ 12⅛	11⅛ 12⅛	4 8 0	...	...	...
59,987	10	6/0	Do. 6 per Cent. Preference	14⅝ 15⅛	14⅝ 15⅛	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96 99	96 99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4 4½	4⅛ 4¾	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99 102	99 102	4 18 0	...	...	...
78,600	10	8/0	Great Northern and City Railwy Pref. Ord. (4%)	8 9	8 9	3 6 8	...	8⅛	...
20,000	10	8%	†Imperial Tramways Ordinary ..... Xd	23 24	23 24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½ 13⅝	13½ 13⅝	4 7 3½	,, ,,	...	...
£300,000	Stock	4½2	† Do. 4½ per Cent. Debenture	108 110	108 110	4 1 9	January and July	...	...
30,000	5	0/9	Isle of Thanet Electric Trams and Light'g 5% Pref.	4⅛ 5	4⅛ 5	5 0 0	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4⅜ 4⅝	4⅜ 4⅞	2 4 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	9⅞ 10⅛	9⅞ 10⅛	4 17 7	,, ,,	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	99 101	99 1 1	3 9 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	10⅜ 11⅛	11⅛ 11⅜	4 5 1	...	11⅛	11⅛
30,999	10	2/3	Do. (£7, 10s. paid)	8¼ 8⅛	8⅛ ⅝	4 ⅛ 0	...	...	...
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	108 110	10 110	3 12 9	...	110	03⅛
£169,659	Stock	18 0	Do. Prov. Certs. (£75 paid)	81 83	81 83	...	...	...	...
$3,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112 117	112 117	4 5 7	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	104 106	104 106	4 14 3	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	108 110	108 110	4 2 2	...	...	...
24,000	5	4/0	New General Traction Ordinary	2 3	2 3	6 13 4	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3½ 4½	3 4	7 10 0	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93 98	93 98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100 103	100 103	4 17 5	...	102	100½
3,334	10	8/0	Potteries Electric Traction Ordinary	8½ 9⅛	8½ 9⅛	4 4 8	...	...	...
10,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 0 1	February and August	...	...
220 000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108 111	108 111	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord	... ...	... ...	...	...	...	...
51,182	1		Do. 6% Preference (14/0 paid)	... ...	... ...	...	April and October	...	...
50,000	1		Do. 6% Preference (fully paid)	... ...	... ...	...	,, ,,	...	...
600,000	Stock	...	Do. 4½% Debenture Stock (70% paid)	... ...	... ...	...	January and July	...	...
£540,800	Stock	8%	Waterloo and City Ordinary	90 93	90 93	3 4 6	June and December	91	...
			ELECTRIC MANUFACTURING &c.						
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛ ¼	⅛ ¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	⅛ ¼	1/16 1/16	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	¼ ⅜	¼ ⅜	12 0 0	March and September	...	...
70,000	5	4/0	British Insulated Wire Ordinary	7¼ 7⅝	7¼ 7⅝	5 16 2	July and February	7½	...
80,000	5	3/0	Do. 6 per Cent. Preference	5⅛ 6	5⅛ 6	5 0 0	January and July	...	...
£250,000	Stock	4 %	Do. 4½% 1st Mort. Deb. Red.	101 104	101 104	4 6 1	...	104	102⅝
200,000	1	3/0	British Westinghouse 6% Preference	5⅞ 6⅛	5⅞ 6⅛	4 18 0	...	6⅛	6
£500,000	Stock	14,0	Do. 4 per cent. Mortgage Deb. Stock	103 105	103 105	...	...	1 4½	103
105,731	1	...	Brush Electrical Engineering	1⅜ 1⅝	1 1½	...	March	1 1/16	...
150,000	1	...	Do. 6 per Cent. Pref. Non-Cum.	1½ 2	1½ 1⅝	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	100 103	100 103	4 7 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	93 98	93 98	4 11 6	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15⅝ 16½	15½ 16½	4 10 11	,, ,,	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅜ 6⅛	5⅜ 6⅛	4 0 0	,, ,,	6 1/16	6
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109 113	109 113	3 19 8	November and May	...	...
450,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	⅛ 1⅜	⅛ 1⅜	5 6 8	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	94 99	94 99	4 11 0	...	...	...
60,000	1	1/0	Chadburn's Ship Telegraph Ordinary	¾ 1	¾ ⅞	9 2 0	March	...	...
85,000	3	1/9¾	Crompton and Co. (Nos. 1 to 54,000)	2½ 2⅝	2½ 3	6 0 0	January and July	2⅝	...
£100,000	00	5%	Do. 5 per Cent. First Mortgage Deb. (red.)	101⅝ 106⅝	101⅞ 106⅞	4 14 4	...	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜ ⅝	⅜ ⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1⅜ 2⅛	1⅜ 2⅛	...	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	74 78	74 78	5 3 0	June and December	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	78 83	78 83	6 2 10	...	...	...
50,000	5	4/6	Edmundson's Electricity Corporation Ord.	6½ 6⅝	6½ 6⅝	5 3 8	Half-yearly	6⅞	6⅝
30,000	5	3/0	Do. 6% Cumulative Preference	6 6⅛	6 6⅛	4 12 4	...	6⅞	6⅝
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107 110	107 110	4 2 1	...	108⅝	107½
112,100	5	1/2½	Electric Construction Co.	1⅝ 2⅛	1⅝ 2⅛	5 6 8	January and July	1⅝	1⅝
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2½ 3	2⅜ 3	4 13 4	July	2⅝	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99 102	99 102	3 19 1	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾ 1	¾ 1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾ 1½	¾ 1½	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	10 10½	10 10½	4 15 3	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	100 103	100 103	3 18 11	...	...	...
35,000	5	6/0	Henley's Telegraph Works Ordinary	16 17	16 17	4 14 2	February and August	16⅝	16⅜
35,000	5	2/3	Do. 4½ per Cent. Preference	5½ 5⅝	5½ 5⅝	3 18 3	,, ,,	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	109 113	109 113	3 19 8	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	4 13 0	,, ,,	21	20 1/16
£300,000	00	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½ 15½	14½ 15½	6 9 0	July	...	...
37,350	12	12/0	Telegraph Construction and Maintnce.	38 41	38 41	5 17 0	March and July	39½	38⅝
£150,000	00	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	January and July	...	...
45,000	5	8/0	Do. Manufacturing Ordinary	... ...	... ...	5 14 3	...	...	...
20,000	5	4/6	Do. 5 per Cent. Cumulative Preference	... ...	... ...	4 8 4	...	...	...
66 666	5	5/0	Willans and Robinson Ordinary	... ...	... ...	...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	... ...	... ...	...	,, ,,	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

IT has always been the custom of the British Association to "forecast the years" some time in advance, though it has not always been able "to find in loss a gain to match." Next year the Association will meet at Southport; and it was resolved at the meeting of the General Committee on Friday last that the meeting place in 1904 shall be at Cambridge, a resolution which, we are sure, will meet with general approval. Rumour has it that the Association in 1905 may visit Cape Colony, and it has been hinted by the president that the invitation from the colony may next year be formally considered. There are, however, several difficulties in the way of a visit to Cape Colony. In the first place, not only has Cape Town sent an invitation, but there are also pressing invitations from Johannesburg and Kimberley, and the railway companies are offering splendid facilities for the Association to visit these northern cities of the colony. It looks as if the British Association, in the event of its going to the southern hemisphere, would have to undertake a sort of South African campaign. This would occupy a serious amount of time, and might act as a deterrent upon a large number of its best members. Another difficulty might be the time required for the voyage there and back. Possibly, however, by 1905 we may have turbine steamers running to the Cape in much less time than at present. As regards next year's meeting at Southport, the president-elect is Sir NORMAN LOCKYER.

PROF. EDWARD DIVERS' presidential address to the chemical section last week had the somewhat ambitious title of "The Atomic Theory Without Hypothesis." The title is reminiscent of the "Religion without Dogma" which is sometimes advertised. As a matter of fact, there cannot be a complete atomic theory that is devoid of hypothesis until the time shall have arrived when we know all there is to know about atoms. What Prof. DIVERS has aimed at in his address has been to show that "the exposition of even advanced chemistry . . . . is independent of any hypothesis as to the mechanically and chemically differentiated structure of substances, and that chemistry can be studied and still further developed without reference to such a structure." This fact involves no new discovery: it has never been disputed that chemical phenomena in the mass can be studied apart from atomic hypothesis. But though the student of pure chemistry may be content to be ignorant of the inner nature of the processes he is studying, the physical chemist will insist on asking questions as to the why and the wherefore—in other words, he will not be content with a cut-and-dried theory—he will demand a working hypothesis in addition.

MUNICIPAL traders are evidently aspiring to develop their trading in electricity supply over a larger field than hitherto. Not content with securing for themselves almost the whole of the electric lighting industry in the provinces, and a large proportion of the electric tramway undertakings, they are now seeking to acquire the business of which the electric power companies have been the pioneers. If other Corporations in the industrial districts follow in the footsteps of Sunderland, not only shall we have to depend on municipal authorities for our electric light and our means of local travel, but we shall also have to go to them for the power required to drive our works and factories. The arguments in favour of this development are most plausible, once the principle of municipal trading is granted. The load-factor of the Sunderland electricity works during the year of working completed last March was 16½ per cent.—that is to say, that roughly six times the present output could be given by the same generating stations if the plant, instead of having to supply a variable load, was fully loaded continuously. Although the tramways are already good all-day consumers, if contracts could be obtained to supply power to works in addition, the load-factor could be still further improved, and, as a result, the cost of generating the current would be cheapened. It is, of course, argued that

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the present consumers would benefit by this, and that an electricity works being once started, everything should be done to increase the profits and thus ultimately cheapen the supply.

But let us go a step further. The greater the output of machinery made by the engineering works supplied with power by the Corporation, the greater will be the power taken by them. Thus it will be to the Corporation's interest to order their new plant from the works whenever possible. But, as the works buy power from the municipal electricity department with which to manufacture plant for the Corporation, there is a sort of partnership, except for the fact that the manufacturing company makes a profit out of its sales to the Corporation. It would, therefore, be cheaper for the Corporation itself to acquire these works and save this profit; and as the "load-factor" of the engineering works would be a low one if its only business is to make machinery for the Corporation, it must continue to supply elsewhere in the ordinary way of trade to maintain the works on a profitable basis. Continuing the argument in the same way, it could be shown that a municipal corporation should be a universal provider, and that nothing should be left in the hands of private manufacturers or traders—which is absurd.

We give in another column the scheme drawn up by Mr J. F. C. Snell for the power supply which it is proposed that the Sunderland Corporation electricity works should give. While we have no doubt that, in the able hands of their borough electrical engineer, the undertaking would be a successful one, we feel bound to protest against this endeavour to extend the bounds of municipal trading so far as it affects the electrical engineering industry. The supply of power for the driving of works and factories is no more a business for the ratepayers' money to be invested in than would be the business of municipal drapers, ironmongers or bootmakers, and the plea that it would, if undertaken, slightly cheapen the price of electric light is not sufficient reason for embarking upon a distinctly new phase in municipal trading enterprise.

The annual congress of Joint Postal and Telegraph Associations was held at the Holborn Town Hall, London, on Saturday last, Mr. C. H. Garland presiding. Naturally, the grievances of the employés of that service had the lion's share of attention in the presidential address. Naturally, also, he took advantage of his "joint" position to point to the huge profits of the postal system in proof that the Telegraph staff was underpaid, omitting to mention that the telegraph branch of the service shows a deficit now amounting to very nearly £1,000,000 annually. Perhaps Mr. Garland does not believe in this deficit any more than we do; but, if so, his Association could not better employ its time than by exposing the methods by which the alleged deficit is made to appear. As to the president's examples of ill-usage, and the cited instances of "sweating," the worst case is that of the sub-offices, where the hours of attendance are usually not less than twelve and often more. Bad as this is, however, it is not so bad as represented, the wages quoted being generally supplemented by board and lodging. As to the telephone girls, whose hours are much shorter and who enjoy a rising scale of pay, we suppose the remuneration is based upon that which prevails in the National Telephone Company, against whom, in this respect, we have heard no serious complaint. Moreover we are able to correct Mr. Garland's figures. Although, we believe, the telephone operators' scale of wages is not absolutely standardised, 26s. and not 20s. per week is the maximum to which an ordinary operator can attain in the Post Office telephone service, and the post of chief supervisor, to which there is no reason that an intelligent and well-educated operator should not aspire, may command a salary of more than twice this figure.

A much more substantial case for inquiry is the so-called dual system of sorter-telegraphists, an attempt having been made to overawe the telegraphists proper by creating a reserve among the postal sorting clerks. From all we can hear, this extraordinary experiment has proved a most costly and ludicrous failure, succeeding only in exasperating the telegraphists and humiliating the sorters. Mr. Garland was justified in adding that the service, once so attractive, is now most unpopular, there being considerable difficulty in recruiting it except from the very lowest grades inside the service—a method which is not likely to raise its tone or increase its efficiency.

Effect of Tramway Competition on Railways.—It is reported that owing to the severe competition of the Glasgow Corporation electric tramways, the Glasgow and South-Western Co. have announced the withdrawal of their suburban service to Govan and Springburn on and after October 1st, with the exception of the early morning workmen's trains.

Telegraphy in Alaska.—It is stated that the telegraph system in Alaska will be complete within the next year; this will enable communications to be made between certain parts of the country at small expense and with great rapidity, whereas at the present time it is only possible to exchange letters about twice or three times a year.

Electricity in Mines.—At the annual meeting of the Mining Institute at Newcastle-on-Tyne on Wednesday, the secretary (Mr. M. Walton Brown) in the course of his annual report to the Council stated that the ventilation of mines was now obtained by means of fans on the surface instead of by underground furnaces. Mechanical haulage had replaced horses, machine holding was taking the place of human labour, and electricity had been introduced as a motive power for all classes of machinery.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899	—
St. Lucia—St. Vincent	May 9, 1902	Sept. 18, 1902
St. Lucia—Grenada	May 9, 1902	—
Dominica—Martinique	May 9, 1902	—
St. Lucia—Martinique	May 9, 1902	—
Guadeloupe—Martinique	May 9, 1902	—
Santa Cruz—Teneriffe	July 7, 1902	—
Puerto Plata—Martinique	July 10, 1902	—
Anjer—Kalianda	Aug. 2, 1902	—
Guantanamo—Mole St. Nicholas	Aug. 5, 1902	—
Cayenne—Pinheiros	Aug 13, 1902	—

Lightning Fatality.—During the storm which passed over mid-Kent on Wednesday last week, an agricultural labourer was killed by lightning in a hop field at Hunton. According to the medical evidence at the inquest on Friday, the lightning had passed through his head and burnt his right shoulder as if a hot iron had been placed on it. As the result of a post-mortem examination it was found that the membranes of the brain were congested and the heart was affected. Another man working near the deceased at the same time was also struck. There were more external marks of violence on his body, but his head was not affected, and it is expected that he will recover.

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Electric Railway Traction in America.—It is stated by *Electricity* of New York that the Manhattan Railway Co. of New York is making preparations to dispose of rolling stock which they no longer require, owing to the successful tests which they have lately carried out with electricity as a motive power for their trains. All the locomotives formerly employed on the line mentioned have been withdrawn from service, as the entire East Side elevated system extending to Pelham Avenue is now being operated exclusively with electricity. Work is being hurried on the Sixth and Ninth Avenue lines, and the first electric trains on these may be started about October 1st.

A Long Cable Span.—According to the *Electrical Review* of New York, a long span of telephone cable has just been swung across the Susquehanna river. The total distance is 3,200ft. from pole to pole. Cables of steel, hard-drawn copper and aluminium had previously been tried but were all unsuccessful. The present one consists of 10 pairs of No. 19 B. and S. conductors, rubber covered and weighing about 880lb. per 1,000ft. This is fastened to a suspension wire composed of seven strands of No. 12 B. W. G. ($\frac{5}{16}$in. in diameter) weighing 211b. per 100ft., and having a guaranteed tensile strength of 25,000lb. per square inch. The poles are not on the same level, one being 270ft. and the other 100ft. above the surface of the river. The sag is, therefore, not exactly in the middle, but about two-thirds of the way across, and amounts to no less than 122ft. or about 4 per cent. of the total length of the span. The poles are of heavy chestnut, 12in. in diameter at the top, and the anchorages are connected to two poles on either side.

Wireless Telegraphy in America.—The *Western Electrician* states that a preliminary report in regard to the first experiments with space telegraphy by the board of naval officers has been submitted to the Navy department. The board reported that it tried the Rochefort system with some success, messages having been received and sent with accuracy. It is now proposed to test in turn a French and two German systems. Information received by Rear-Admiral Bradford in regard to the experiments of foreign countries with wireless telegraphy shows that the United States is a long way behind other nations in this work. Italy has over a dozen naval officers conducting separate experiments. France has three boards of officers at work and several ships fitted with instruments. England has 80 ships equipped with the Marconi system, and Germany has at least 10 vessels thus provided. In the United States, on the other hand, but a single officer, Lieut. Hudgins, so far has been detailed exclusively to this subject. The lack of progress along these lines in the navy, however, is not to be charged to Admiral Bradford, who believes that a number of capable naval officers should be assigned to the work of equipping themselves thoroughly by investigation and experiment in this important field, and who has already recommended that such assignments could be made.

Superheated Steam for Turbines.—The current number of the *Engineering Magazine* contains an abstract of an article on the above subject recently published in the *Engineering Record* in which the results of tests on a turbine of 300 B.H.P. by Messrs. Dean and Main are given. The machine under notice was manufactured by the De Laval Company at Trenton, N.J., and was directly coupled to a dynamo. It was not possible to measure the steam consumption by weighing the whole of the exhaust steam owing to a Worthington jet condenser being used, and, therefore, the boiler feed water was weighed and the necessary corrections made. The boiler pressure was 200lb. per sq. in., and when testing with saturated steam the entrained water was removed by a separator and deducted from the evaporation to determine the true volume of steam going to the turbine. For the superheating trials, the steam was raised to about 84°F. above the temperature due to the pressure. The efficiencies of the generators were known and all instruments calibrated, so that the readings obtained were a correct indication of the output. At full load, ranging from 333 to 352 B.H.P., the steam consumption for saturated steam was 15·17lb. per H.P., while, with steam superheated to 84°F., the consumption was reduced to 13·94lb., a saving of 8·8 per cent. With superheating of 200deg. or more, the steam consumption should be brought down very close to the record for engines of the piston type, and many inherent disadvantages in connection with carbonising of the lubricant, distortion of valve seats, &c., by unequal heating, entirely eliminated by the use of turbines.

The Late Sir Frederick Abel.—The funeral of Sir Frederick Abel, which took place at Nunhead Cemetery on Thursday last week, after a service at St. Martin-in-the-Fields, London, W.C., was largely attended by representatives of the numerous scientific societies with which he was connected. Prof. Silvanus P. Thompson, F.R.S., Mr. Alexander Siemens, Mr. W. H. Patchell and Mr. W. G. McMillan attended on behalf of the Institution of Electrical Engineers, a wreath of flowers being sent by that body. The Royal Society were represented by Sir William Huggins (president) and Mr. A. B. Kempe, and amongst the other societies and institutions which sent representatives were the Institution of Mechanical Engineers, the Imperial Institute, the Chemical Society, the Board of Trade, the Society of Chemical Industry, the Iron and Steel Institute, the Society of Arts, and the Senate of the University of London. ——At a meeting of the executive council of the Imperial Institute, presided over by Lord James of Hereford, the following resolution was passed unanimously:—

> The members of the council of the Imperial Institute desire to express their sense of the great loss sustained by the death of Sir Frederick Abel. For 16 years he devoted all his great ability and energy to the service of the Imperial Institute, for which he quitted all other pursuits, and in which he sacrificed time, emoluments and health. Every member of the council had learned to value the worth of a great friendship, the loss of which is now sincerely mourned.

The Electrolytic Recovery of Tin from Scrap and Cuttings.—Recent issues of the *Zeitschrift für Elektrochemie* contain a lengthy memoir by Dr. H. Mennicke upon this industry. According to the author 80,000 tons of tin scrap are treated annually by the electrolytic processes in Germany alone, and tin scrap of good quality is now difficult to obtain in that country. Works are reported to be in operation at Essen, Kempen, Uerdingen, Nuremberg, Ludwigshafen, Emmerich and Flushing (Holland), the largest of these being that located at Essen. A new works of this character has recently been erected at Pfaffstatten, near Vienna. The cuttings and scrap are drawn chiefly from England, France and Switzerland, and the average value of the scrap does not exceed 3·5 per cent. of tin. The author treats his subject in a most exhaustive manner, and discusses various practical details of the technical process under ten sectional headings. He is of opinion that the alkaline process yields the best results, as the metallic (tin and iron) residues obtained from the sodium stannate solutions are best adapted for the further smelting operations required to yield the tin and iron in commercial form. The addition of sodium chloride to the alkaline electrolyte he regards as unwise, since it leads to the increase of impurities in the final products of the electrolysis. The maximum recovery of tin possible by the alkaline process, according to the author, is 88 per cent., and recovery of the remaining 12 per cent. present in the scrap is only possible at the cost of the electrical and economic efficiency of the process. The author estimates that a works for the treatment of 9,000 tons of tin scrap yearly by the alkaline process would require 60 cells of about 3 cubic metres capacity, each cell containing, when fully charged, three baskets of cuttings, or 150kg. scrap. The author has carried out a large number of experiments relating to the conditions necessary for obtaining the best results from the alkaline process, and the results of these are given in the original paper, which is well worth the study of all interested in the subject.

The Manufacture of Litharge from Electrolytic Lead-sponge.—A Paper read by P. Salom before the recently-formed American Electrochemical Society contains some details of the process used at Niagara by the Electrical Lead Reduction Co. for the production of litharge and white lead from spongy lead. Galena is employed as the raw material of this manufacture, and, after removal of earthy impurities by careful washing, it is ground so as to pass a sieve of 40 to 50 mesh, and is charged into the cells, where it is reduced by the

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action of electrolytic hydrogen. The cells are constructed of hard lead, and have the form of an abbreviated cone, the dimensions being 15cm. × 60/70cm. diameter, above and below respectively. These cells are constructed to sit one upon the other, and 10 or 12 are piled up in this manner after charging with 5½kg. of the ore, and filling to two-thirds of their height with dilute sulphuric acid. 48 of these cells are electrically connected in series, and require an E.M.F. of 125 to 130 volts, with a current of 2 amperes per kilogramme of ore. The reduction lasts five days, and the electrical efficiency of the process very closely approaches the theoretical figure of 1 E.H.P. hour per kilogramme of ore. Sulphuretted hydrogen gas is evolved during the reduction process, and some trouble has been caused in the past by the effects of this gas upon the workers. The spongy lead obtained from the cells is washed to remove the free acid, and is pressed at once into bars or is employed to manufacture litharge and white lead. The conversion into litharge is effected by heating in specially-designed furnaces, and requires only one and a-half to two hours. In the second half of 1901 106,000kg. of litharge were produced at the Niagara works. Recent reports in the financial columns of New York papers seem to indicate, however, that the process is not an economic success, and possibly, although electrical power is exceptionally cheap at Niagara, it may have been found that the electrical reduction process cannot compete in cost with the older methods of converting galena into litharge and white lead.

Criticisms of the British Association.—Our lay contemporaries do not wish to appear too grateful to the British Association for affording them interesting matter with which to fill their columns at a period when the "silly season" is not quite over and the newspaper reader's interest in big gooseberries, sea serpents and correspondence over indeterminate abstract questions may be supposed to flag. This year their criticisms on the Association's proceedings are more outspoken than usual, but, strange to say, they answer one another's objections so completely that one is almost forced to the conclusion that no reform is needed. A correspondent signing himself "F. R. C. S.," fills half a column of Monday's *Times* complaining that the addresses and Papers read before the British Association are too technical in character, and regretting that they are no longer "calculated to promote that general growth of enlightenment, concerning the methods and the value of science, which it was once understood to be the function of the Association to bring about." This correspondent and yesterday's *Truth*, which contains some notes criticising the proceedings at the British Association meeting, both quote the following passages from sectional addresses:—

On the removal of the ophthalmite of certain crustacea it was found that on regeneration it assumes a uniramous multi-articulate form; and it is an interesting circumstance that in the common crayfish the biramous condition normal to the antennule may occur—an example this of a fact which no other method could explain.

Instead of the coefficients of molecules, necessitated by having to consider many chemical changes as being cases of two or more single interactions occurring together, there are the valency coefficients of the polyvalent radicals, called out also by such a compound interaction. Thus, whilst the single interaction between hydrogen sulphide and calcium hydroxide shows calcium hydroxyl as one of the radicals, the succeeding interaction between the calcium hydroxhydrosulphide, &c.

Possibly *Truth* suspects that the reference to the valency coefficient of polyvalent radicals, called out by compound interactions occurring together, may well have a veiled political significance. The correspondent of *The Times* also complains:—"I also read a good deal about "ions," the word not being used in the sense of violets, nor with any reference either to the Chian poet or to the hero of Talfourd's tragedy." On the other hand, a leading article in Wednesday's *Standard* says:—

In too many cases neither the subject, the author, nor the manner of treatment could be called scientific. In its anxiety to become popular—in other words, to attract the attention of the half-educated—the Association, in recent years, has exercised little discrimination in its choice either of the topics or the persons on whom it bestows its still respectable countenance. Some of its "sections" have become convenient hunting grounds for the faddist, and for the superficial amateur, and occasionally for the mere seeker after notoriety. The investigator occupied with genuine research in organic chemistry, pure mathematics, astronomy, physics and biology must, we should imagine, be not a little annoyed by the irresponsible chatter which goes on around him at th conferences.

THE BRITISH ASSOCIATION AT BELFAST.

The seventy-second annual meeting of the British Association for the Advancement of Science, and its third meeting at Belfast, was inaugurated on Wednesday, the 10th inst. The inaugural meeting, which was attended by a large audience, including many persons of distinction and note, was held in the Grosvenor Hall, where, at 8:30 p.m., the retiring president, Sir Arthur Rücker, introduced as the new president Prof. James Dewar, professor of chemistry at the Royal Institution, London. Although of exceptionally great length and occupying far more than the allotted time, this brilliant address was listened to with marked interest by the audience. Inasmuch as the interest proceeded *crescendo* towards the close, the long duration of the address was scarcely heeded by the intent hearers. A portion of a lengthy abstract of Prof. Dewar's address appeared in our last issue, the abstract being concluded this week. It is unnecessary, therefore, to refer to the details of the address in this article.

Thursday, September 11th.

The various sections commenced proceedings at times ranging from 10 a.m. to 11:30 a.m., this arrangement allowing of a visitor hearing more than one president's address, although naturally it was impossible to hear more than two. The fact that all the sections met within the same group of buildings at Queen's College, enabled members also to move about quickly from one section to another, a great convenience to those who—like electrical members—are interested in several sections.

Section A (mathematical and physical science) met in the college natural philosophy class room at 10 a.m. to hear the address of Prof. John Purser. The subject of this address was a historical review of the Irish school of mathematicians and physicists, commencing at the end of the eighteenth century. The summary, although of no great direct interest to electricians, naturally brought forward many names with which the electrical profession is familiar. Sir William R. Hamilton was mentioned for his monumental work in mathematical science, Lord Rosse for his researches in astronomy, and among physicists were noticed James Thomson, G. F. Fitz-Gerald, Thomas Preston, and many others less well known than these. After a hearty vote of thanks had been given to Prof. Purser for his address, some seven Papers were read and discussed. These, however, not being of electrical interest we may pass them over.

In Section B (chemistry) Prof. Edward Divers, of the University of Tokio, Japan, delivered his presidential address at 11:30 a.m., taking as his subject "The Atomic Theory without Hypothesis." The author, in adopting this somewhat curious title, has aimed at showing how "the exposition of even advanced chemistry, in its symbolic, equally as in its ordinary language and nomenclature, is independent of any hypothesis as to the mechanically and chemically differentiated structure of substances, and that chemistry can be studied and still further developed without reference to such a structure." We refer to this address in an editorial note.

Section G (engineering) met at 11:30 a.m. in the college library to listen to Prof. John Perry's long looked-for address on "The Education of Engineers." A large audience, including many leading engineers, assembled on this occasion. We conclude in our present issue the reprint of this address commenced last week. Our readers will, therefore, have an opportunity to read the address for themselves, and to form their own opinions on the important question of the education of boys for the engineering profession. In proposing a vote of thanks to Prof. Perry, Mr. Hawksley, President of the Institution of Civil Engineers, observed that the opinions advanced in the address were such as "ordinary mortals in the engineering world" generally held, but it was surprising to hear such views advanced by—a professor. As seconder of the vote, the ever-humorous Sir Frederick Bramwell referred to himself as the "fearful example," and observed that in his boyhood all subjects, save those useful in engineering, glided off his mind like water off a duck's back. He spoke fondly,

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however, of Euclid, and deplored the modern tendency to oust Euclid from school curricula.

Upon the conclusion of Prof. Perry's address, Section G adjourned to the logic room, where the desks were so heavily covered with a kind of bitumen that visitors desirous of retiring experienced a measure of physical difficulty in making a start. Thus much, it would appear, is necessary to make the Hibernian youth stick to his logic lectures. The first, and indeed the only Paper taken was a useful contribution by Mr. H. A. Humphreys on "Recent Progress in Large Gas Engines." By the aid of numerous lantern slides the author contrived to make interesting a lengthy Paper filled to a large extent with statistical matter and numerical data. The author stated that the last few years have seen a development in large gas engines which has but few parallels in the history of engineering enterprise. Gas engines of 1,200 H.P. and 1,500 H.P. are already working, and others of 2,000 H.P. to 4,000 H.P. are being constructed. In the Paris Exhibition of 1900 the 600 H.P. Cockerill gas engine created much surprise, but now the makers have in hand an engine of 2,500 H.P., and are quite prepared to build a 5,000 H.P. gas engine. In this country, the first gas engines above 400 H.P. were started in 1900 and ran with Mond gas, but at the present time the two leading English manufacturers have delivered or have under construction 51 gas engines of between 200 H.P. and 1,000 H.P. Of these Messrs. Crossley Brothers, of Manchester, supply 28 engines, having an aggregate of 8,300 H.P., or an average of 296 H.P. per engine, and the Premier Gas Engine Co., of Nottingham, supply 23 engines with a total of 9,300 H.P., giving an average of 404 H.P. per engine. These two makers collectively supply 17,600 H.P., and of this power 12,500 H.P. is for driving dynamos. This is a striking proof of rapid progress, but we have to look abroad for the great achievements in this direction. Neglecting all engines below 200 H.P., the author finds that Messrs. Körting Bros. and their licensees have made or have under construction 32 gas engines, with a total of 44,500 H.P., averaging 1,390 H.P. per engine. The Société Anonyme John Cockerill, of Seraing, and their licensees come next with 59 engines, having an aggregate of 32,950 H.P., so that the average size of the engines built by this firm is 558 H.P. The Gasmotoren Fabrik Deutz take the third place with 51 engines, developing collectively 20,655 H.P.; and are followed by the Deutsche Kraftgas Gesellschaft and licensees, working under the Oechelhaueser patents, with engines numbering 28, and giving 16,900 H.P. Although America has lagged somewhat behind the Continent in adopting large gas engines, there is evidence that this state of affairs will not long remain. The Snow Steam Pump Works, of Buffalo, New York, have only recently started the manufacture of gas engines, yet they have already put to successful work six gas engines of 1,000 H.P. each, and are now constructing two enormous gas-engine gas compressors of 4,000 H.P. each, the first to be running next November, and the second by January, 1903. The Westinghouse Machine and Mfg. Co., of Pittsburgh, have made gas engines of 1,500 H.P., and are prepared to build sizes up to 3,000 H.P., either horizontal or vertical. The principal engines mentioned above were described by the author, and illustrated by lantern slides. Improvements in construction were then dealt with, the points touched upon being concerned respectively with the framework, the cylinder and piston, the valves, ignition apparatus, governing devices, and self-starting mechanism. Types of engines were briefly considered with a view to show upon what lines the development is progressing, and to indicate the kind of machine which may be expected to prove the most successful gas engine in the future. Some advances in the theory of the gas engine were mentioned. The last few years have shed some light on what takes place in a gas engine cylinder, and the author mentioned the questions of temperature gradients, the effect of increased specific heats of gases at high temperatures, and the effect of high pressures on the mode of heat transference to the cylinder walls. The heat efficiency of gas engines received attention, and some figures were given as to the relative efficiencies of gas and steam engines. It was admitted that the future of gas engines for central station purposes depends on the ability of gas engines to drive alternators in parallel. Numerous instances were given in which gas-driven alternators are regularly at work in parallel, giving good results. The permissible cyclic variation of gas engines intended for driving alternators was discussed, and other matters relating to successful parallel working were dealt with. It is greatly to be regretted that time did not allow of any discussion on this important Paper, though members were promised an opportunity to discuss it at a later period in the session.*

In the afternoon, members of the engineering section visited Belfast harbour works in ss. "Musgrave." In the evening the Association was entertained by the Lord Mayor of Belfast at a conversazione in the Exhibition Hall and grounds.

Friday, September 12th.

Section A, meeting at 10:30 a.m., was faced by a heavy list of astronomical Papers; it therefore offered no attraction to the electrical engineer. Section B, meeting still earlier, at 9:30, had no electrical Papers on its day's list of chemical topics; and even the new educational science section offered nothing for the electrical student. So there was a big muster of electrical men, and a large number of others, at 10:30, in the logic room, to hear the Hon. C. A. Parsons read his Paper on "Steam Turbines." The bitumened seats, by-the-way, had by now been overlaid with red cloth—a decided improvement. The early part of Mr. Parsons' Paper gave data as to the size and power of the steam turbines now manufactured by the various Continental and other makers, and particulars of the various uses to which this engine has been successfully put. Messrs. Brown, Boveri & Co., of Baden, it would appear, have manufactured the largest single steam turbine of the Parsons type, this being an engine of some 5,000 H.P. Naturally, in a city famous for shipbuilding, as is Belfast, the use of steam turbines in the mercantile and naval marine occupied the premier place in the Paper. Some attention, however, was also devoted to the success which has been achieved recently in driving the steam turbine as a reversed apparatus—*i.e.*, as a rotatory pump for water or for compressing air.

An interesting discussion followed the reading of Mr. Parsons' Paper. Prof. W. C. Unwin expressed satisfaction at the great success attained by Mr. Parsons in the economical utilisation of steam, also in the successful use of the turbine as a pump. Mr. R. E. Crompton stated that electrical engineers would welcome the Parsons turbine as a pump, inasmuch as it gave them a high-speed rotatory pump which they could couple direct to an electric motor. Prof. Hele-Shaw spoke on the adoption of parallel flow in preference to radial flow, as being demonstrated experimentally to be the most economical plan. He also asked Mr. Parsons how he succeeded in using the steam turbine to reverse the direction of motion of a ship. Replying to an enquiry as to the use of superheated steam in turbines, Mr. Parsons stated that the approximate improvement in economy of heat is 1 per cent. for each 10deg. of superheat, up to 200deg. superheat. One of the difficulties in the use of very high degrees of superheat was the unequal expansion of the turbine chamber when the steam was turned on. Replying to Prof. Hele-Shaw, Mr. Parsons said that in order to reverse the direction of a turbine steamer he adopted two turbines, one for each direction. For pumping purposes, Parsons turbines could be used in series where a single pump would be inadequate.

Later in the morning a Paper by Dr. Vaughan Cornish on "Regular Undulations Produced in a Road by the Use of Sledges," was read by the recorder of the section. Dr. Cornish has observed that the continual passage of a number of sledges in one direction along a road, the sledges being of similar construction and equally loaded, gives rise to a series of sine-wave undulations in the road surface. The phenomenon is of considerable scientific interest, and the Paper gave rise to a good discussion. It has no bearing, however, on electrical matters, except in so far as it goes to show the advantage of using rails for vehicles wherever possible.

One of the Papers in the day's programme, in Section G, was entitled "An All-Stations Express," and was read by

* This, however, was never granted, owing to lack of time.—ED. *E.*

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Mr. J. Brown. Happily this Paper and the ensuing discussion gave rise to much mirth, which helped to relieve the monotony of the proceedings. Mr. Brown's system of railroading has in contemplation an express train running without a single stop from end to end of the line. In order to serve intermediate stations, it is proposed that, on the approach of an express to any one of these stations, passengers desirous of joining the express should enter a railway carriage standing still at the platform, on the same track as that on which the express is approaching. The system of traction being electrical, the guard on this stationary carriage, on the near approach of the express, will start the carriage in motion in the same direction as the express is moving, gradually getting up speed. In time the express will catch up to the single carriage, and, coming into contact without a jolt, will be automatically coupled to it. This operation is to be repeated at every station. There is further provided means by which a passenger on the train may alight at any desired station, for the rear coach on the train is detached and brought to a standstill as each station is passed. The whole train being of the vestibule type, it is assumed that passengers on entering the train will sort themselves out as necessary. A working model of this curious electric railway was to be seen within the precincts of the college. The discussion on this Paper was opened by Sir Frederick Bramwell, whose eyes twinkled merrily as he said that he, for one, would prefer not to be in a standing coach with an express train approaching it on the same track. He would prefer to be on a siding. Prof. Perry described his own invention in this form of railroading, in one modification of which the station platforms are made to spin round until they have the same velocity as the passing train. Passengers merely step from platform to train without ado.

It often happens at meetings of the British Association that the event of greatest interest occurs, not within the sectional meetings, nor even in the president's address, but in one or other of the evening discourses which are delivered to the Association by eminent men of science. An example of this was to be found in the lecture which Prof. J. J. Thomson delivered in the evening, at the Grosvenor Hall, on "Becquerel Rays and Radio-activity." An account of this discourse will be found in our leading article this week.

Saturday, September 13th.

All sections of the Association took a holiday on Saturday, many of the members—in spite of the inclement weather—visiting places of interest around Belfast.

Monday, September 15th.

Monday's *Journal* was bulky with the long lists of Papers to be read. Section A contemplated the discussion of no less than 30 Papers, and divided itself into three sub-sections for the accomplishment of this feat. Section G had a good muster of engineers and commenced its day's programme with a Paper by Mr. J. E. Kingsbury on "The Future of the Telephone in the United Kingdom." The Paper deals with this important question from a political point of view. It sketches in clear and succinct language the history of the telephone in the United Kingdom, from its first introduction in 1876, by Sir William Thomson, now Lord Kelvin, down to the present time. The author demonstrates, convincingly, the errors of working telephone systems competitively, and arrives at the conclusion that the only rational and satisfactory telephone system is a monopoly controlled by the State. We hope to reprint this timely Paper in an early issue. In opening the discussion, Sir William Preece stated that it was he who, in 1877, brought the first working telephone to England, and not Sir William Thomson in 1876, for Sir William Thomson's import would not work. He himself had always advocated telephone monopoly, and he believed that the State should take in hand whatever affects the nation as a whole. The telephone was a *national*, and not a parochial matter. To illustrate this, he told a story of his son, who, the other day, had just arrived at the country house in Wales, Sir William Preece being at the time at his house at Wimbledon. At dinner time, soon after his arrival, Mr. Preece rang up over a distance of 270 miles, and pathetically asked "what had been done with the key of the cellar." Col. R. E. Crompton said that as reference had been made to the control of railways by the State, he might, perhaps, say something about what he was doing to further the State control of roads in the interests of bicyclists and motor-car riders. He then gave a detailed account of the Highways bill in which he is interested, concluding with the remark that the connection between this topic and telephones lay in the fact that market gardeners could use the telephone in connection with the loads of garden produce they had to send along the roads to market. Thus does each speaker speak out of the fulness of his heart. Mr. Kingsbury, in reply, regretted that the discussion had drifted from the main question, and combated the statements of one of the speakers who advocated municipal telephony as practised at Glasgow. The essential question, Mr. Kingsbury said, was not as to the profits to be made by shareholders, it was as to what is the best system for the community. He believed a monopoly worked on a national scale to be the most satisfactory in this respect.

Mr. F. Holden then described "A New Magnetic Testing Machine," which is designed for the commercial testing of iron. The instrument was well received by the speakers, including Prof. Perry, Dr. Glazebrook, Prof. Baily and others. It is impossible, however, to give an adequate description of it in these brief notes and without reference to diagrams. We hope to publish an account of it in an early issue.

Prof. E. Wilson next read his Paper on "The Electrical Conductivity of Certain Aluminium Alloys as affected by Exposure to London Atmosphere." We reprint this Paper in full elsewhere this week. In the brief discussion, Sir William Preece spoke of the importance of using aluminium conductors in the colonies, especially where the cost of native labour was great for carriage of the material up-country. Dr. Glazebrook observed that the curious effect noted by Prof. Wilson in connection with the nickel-copper-aluminium alloy was not what might be expected on theoretical grounds, and he hoped it would be further inquired into.

Mr. M. B. Field read a Paper describing several ingenious instruments for use in electric tramway power stations. We hope to describe these in an article shortly.

Owing to lack of time the following Papers were taken as read, and were not discussed—viz., "The Importance of Minor Details in Engineering Work," by Mr. Holroyd Smith, and "The Specific Utilisation of Materials in Dynamo Construction," by Prof. Silvanus P. Thompson.

In the afternoon the engineering and educational sections joined forces in order to discuss the question of "The Education of Engineers." There was a large attendance, including many well-known engineers and a large number of professors and teachers. There should have been a good and useful debate, but in reality the discussion was disappointing and inconclusive. Many speakers appear to have come prepared with set speeches, and thus ignored the issues raised by fellow-speakers. A large number of speakers wandered greatly, giving little biographical sketches of their own boyhood instead of sticking to the point. Prof. Perry opened the debate with a summary of his address to Section G. Sir Philip Magnus, in a rather lengthy speech on the history of the Finsbury movement, proposed as a tangible point for discussion the question as to the best period for a student to go to works. He advocated "the half-time system"—*i.e.*, alternations of six months at technical college and six months at works. Col. Crompton said he was a Harrow boy; all the Cromptons were Harrow boys—he was proud of the fact and believed in public school education. In South Africa he had led into action the first corps that ever existed that comprised only educated men. Their education gave them the nerve and discipline of veterans, although they had never been in action before. Mr. Hawksley, President of the Institution of Civil Engineers, spoke in favour of the half-time system. Sir William Preece, in a lengthy speech, gave an address on the general question and its numerous side issues. He stated his disapproval of the half-time system, and thought a student ought to complete his college training before entering works. Principal Griffiths, of the University of South Wales, gave some amusing experiences as a Cam-

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bridge coach. At public schools, science subjects were collectively known by the boys as "stinks"; the study of these subjects was generally considered "bad form" and young fellows coming up to Cambridge with a little knowledge of science generally confessed it apologetically. He had once induced a young Cambridge student to enter and pass a science examination, with the result that the fond father wrote an indignant letter, protesting that "he wished his son to be educated as a gentleman." As long as the subjects known as "stinks" were regarded as bad form by public school youths, it would be difficult to get science and scientific methods introduced into education. Mr. C. M. Stuart, principal of St. Dunstan's College, Catford, said that he also was a Harrow boy, but he had succeeded *in spite of that fact*. He believed that all the good which boys got at Harrow was picked up in the cricket-field and at sports, not in the class room. Fond parents, in nine cases out of 10, imagined that their little sons were engineering prodigies. It was just the same in Athens 3,000 years ago. Mr. Mark Barr, in a thoroughly common-sense and practical speech, ably brought the debate to a close. He insisted that what is needed is to inculcate in youths a synthetic mode of thinking as opposed to a mere analytic mode of studying by the aid of memory only. Imagination, not memory, was what was chiefly needed. The young student should be taught to put ideas together for himself—to combine them together inventively and in an original manner.

Tuesday, September 16th.

Electrical engineers assembled in Section G to hear and discuss a number of Papers of engineering interest. The proceedings commenced with a verbal interim report from Sir William Preece as to the work of the Small Screw Gauge committee. The final report will not be presented this year; the committee will be re-appointed, and it is hoped to bring out the final report at the next meeting. The entire matter will thereafter be transferred to the National Physical Laboratory.

Three Papers were now read and discussed conjointly. The first of these was a Paper on "Combustion of Bituminous Fuel," by Mr. W. H. Booth. Mr. Booth's Paper, however, contains nothing new or that has not been advocated in our columns for the past seven or eight years. Succinctly, it advocates the design and setting of boilers so that the furnace gases shall not have their heat abstracted until combustion is complete. Mr. Booth made some unnecessarily severe criticisms of the best modern practice in boiler construction. Mr. J. S. Raworth contributed a short Paper on "The Prevention of Smoke," in which he gave some account of the Wilson process now in use at Messrs. Gallahers tobacco factory in Belfast. This process consists in spraying a solution of nitrate of soda on to the fuel in the boiler furnace, and it is stated that it improves the steaming in the ratio of 1 to 1·22. The third Paper was on "The Solignac Boiler," and was read by Mr. W. H. Booth. This boiler is of the tubular type arranged for complete evaporation of the water in the tubes, which are worked nearly red hot. The lower end of each tube communicates with a water drum through a finely-perforated nozzle, and the upper end connects with the steam drum. We shall give further particulars of this boiler in a later issue.

A discussion on these three Papers was nominally invited, but the first speaker was permitted to occupy nearly an hour with a lantern demonstration on the general subject of water-tube boilers for the navy. Sir Frederick Bramwell followed with characteristic reminiscences of boilers he had had to do with some 60 years ago. Col. R. E. Crompton then rose to speak. He said that all these boilers they had been talking about, all the boilers that had been tried for the navy, were useless. He knew of the one boiler that would soon put all other steam generators into the shade. It was the invention of "a young American," named, we believe, Mr. White. Col. Crompton had investigated that boiler—it was marvellous; it was, in fact, miraculous; we quote Col. Crompton's own words. The inventor had employed his boiler on a motor car; he brought his car round to take Col. Crompton for a ride. For two hours they rode about, and all the while Col. Crompton was not aware there was a boiler on the car. They went down to Aldershot, and rode about for a fortnight, covering over 1,000 miles. Only once in all that time was Col. Crompton aware that it was to a boiler—an American boiler—he owed his locomotion. The motor car had stopped and would not budge; examination showed that the water tank, the boiler, everything in the car, was destitute of water. You cannot blame even an American boiler for stopping if you don't supply it with water. The young American who was driving the motor car was equal to the emergency; he had met it before, more than once. Seizing a bucket lying handy somewhere on the car, he ran to a ditch and brought up a bucketful of a fluid, 75 per cent. water 25 per cent. mud. The contents of the bucket were tipped into the tank and the car ran on as smoothly as ever. Once more it was as if no boiler existed. Subsequently Col. Crompton had this boiler taken to pieces and the tubes cut open. They were perfectly clean—not a trace of the 25 per cent. of mud. Col. Crompton himself described this narrative as "a fairy tale"; we incline to agree with him. The efficiency of this marvellous boiler was stated to be higher than that of the internal combustion engine. In this connection it is important to observe that the steam is generated at 800°F. A thermostat in the lowermost tubes keeps the oil firing regulated for this temperature, whatever the load on the boiler.

Owing to lack of time, a Paper on "The Making of a Dynamo," by Mr. H. A. Mavor had to be curtailed. It consisted of a popular demonstration by means of a number of lantern slides showing photographs, taken in the workshops, of the stages in the making of a continuous-current dynamo. Owing also to lack of time, a Paper by Mr. H. E. Wimperis entitled "A Preliminary Note on Gas Engine Explosions," was taken as read. Prof. Perry had intended to read a note on this Paper, bringing forward the researches of two of his students, Messrs. Bairstow and Horsley, but there was no time, and the section adjourned until next year.

Wednesday, September 17th.

A large number of the sections, including Sections A, B and G, did not sit on Wednesday, and no electrical Papers were read in any of the sections. At the concluding annual general meeting, the session of the British Association was adjourned until next year, when the Association will meet at Southport under the presidency of Sir Norman Lockyer.

ELECTRICALLY-PROPELLED MOTOR CARS.

The question of the suitability of electricity as a motive power for self-propelled cars and carriages is a much-discussed and exceedingly important one. That electrical driving can be used, and that it possesses certain considerable advantages over other methods, there is no doubt, but at the present time we fear that a number of counterbalancing disadvantages have prevented the electric motor car from acquiring the same popularity as its rivals. True, an electrical vehicle makes far less noise than one driven by petrol or even steam; it emits no unpleasant vapours or odours; it runs much easier, is more comfortable, and, last but not least, its manipulation is decidedly more simple. On the other hand, it cannot be driven for such a great distance without recharging, and, generally, its initial cost is much in excess of cars propelled by other means. For country use, therefore, it is entirely unsuited, unless within a reasonable distance of a charging station, whereas petrol and water can be obtained at almost any small town or village in the United Kingdom. For racing purposes, or, indeed, in any case where extreme speed is necessary, it is again quite out of the question; but there is every prospect of automobile racing coming to a speedy termination, so that this deficiency will not be of much consequence.

While, however, for certain purposes the electric motor car has a large field before it, the time is certainly not yet ripe for the introduction of public electrical vehicles with a view to superseding those worked on existing lines. The most modern accumulator omnibus can accommodate fewer

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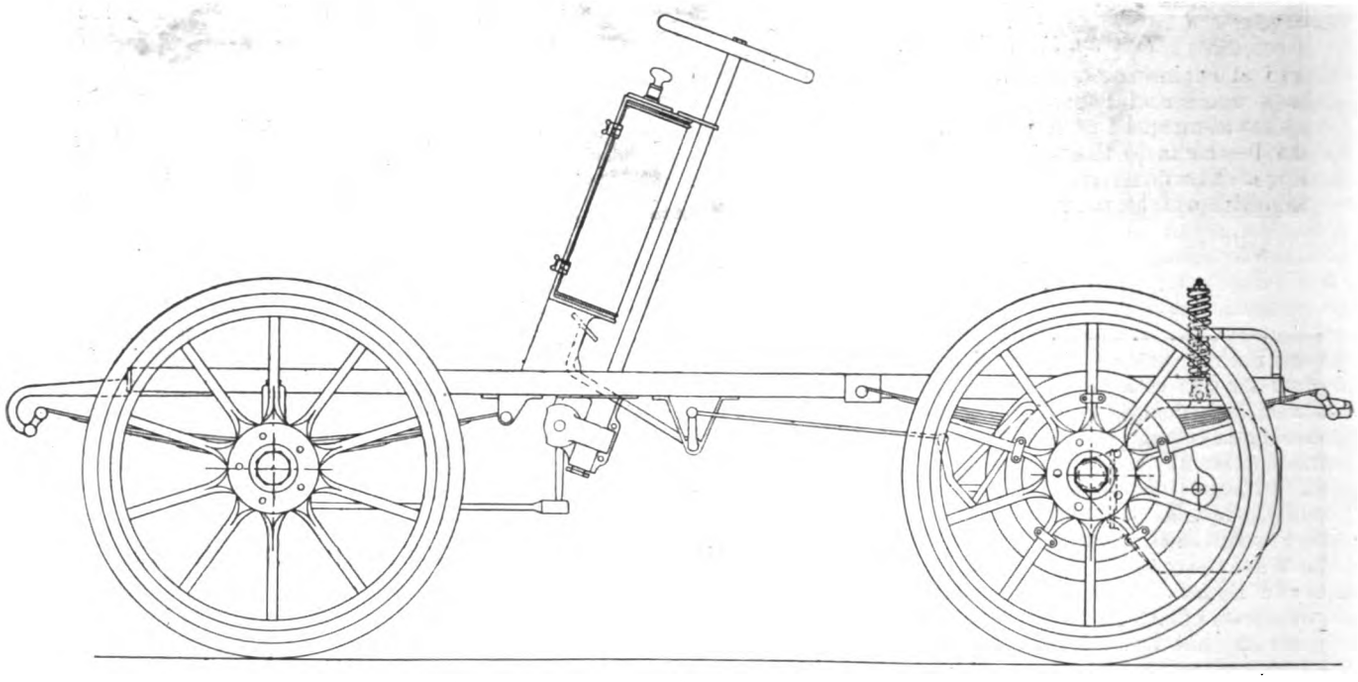
passengers than the tramcar, and yet requires as many attendants to look after it, who should at the same time be more highly trained and skilled than the ordinary tramway motorman and conductor. Even if these difficulties are not insuperable at present, we still have the question of the high cost of working and depreciation to contend with. When the accumulator tramway is a success we may turn our attention to the accumulator omnibus.

To return to private motor cars, however. It would appear that the comfort and ease with which these cars are manipulated have been considered of paramount importance by many users of motor cars, for manufacturers declare that orders for private carriages are coming in faster than they can deal with them, and that the electric car for certain classes of work has a great future. It is greatly to be regretted that, notwithstanding these good reports, the trials for electrical vehicles promoted by the Automobile Club have had to be repeatedly postponed. Only two vehicles were entered, and those by one firm. But these were entered weeks ago, when the trials were originally to have taken place, and, in the hope that more would come in, the club decided to postpone the trials. Unfortunately that hope was not realised. More entries did not come in; our inquiry among the makers of motor cars to ascertain the cause of this has been somewhat inconclusive. Some makers stated that they knew nothing about the trials, others that they had no time to build a special car, and others, again, are of opinion that such trials would not repay for the expense and trouble they entailed. The fact remains that the trials have been, of necessity, abandoned for the present, and it cannot be denied that a valuable opportunity has been lost of showing to the world at large the exact state of the electric motor-car industry.

Most of the difficulties attendant upon the construction of a car for short distance work have been overcome, but the primary disadvantage still exists in the short life of the storage battery. Those who have had experience with accumulators that are never moved from the time they are first put in until they are "scrapped," will appreciate the difficulties encountered when dealing with cells of high capacity that have to stand the wear and tear inseparable from a motor car. Even in the case of a stationary battery, frequent examinations have to be made and scrupulous care taken if it is to be maintained in anything like good condition. The plates of which the battery is composed have a capacity of few watt-hours per pound as compared with traction cells, and yet the makers—with some exceptions—will seldom accept a maintenance contract under 10 per cent. per annum, despite the accurate log kept and the frequent inspections made by the purchasers and the contractor's engineers. The plates of a traction cell cannot possess that mechanical strength found in the stationary cell, and having to stand more ill-use must go to pieces sooner. Notwithstanding all this, accumulator cars have made extraordinary progress during the past few years. It is now possible to buy a car, weighing less than 10cwt., capable of running 100 miles without its battery requiring an additional charge.

There is a lamentable lack of willingness displayed by manufacturers to impart any information regarding the technical details of their cars. They are for the most part reticent as to the size and capacity of the cells used in them, the discharge rate of the cells, the controller connections and similar particulars—information upon which one would think the purchaser would insist on having imparted to him. Even the mileage the car will do on one charge is often given grudgingly, and any description of the construction of the car itself is usually confined to a carriage-builder's specification, which has only an indirect bearing upon the motor equipment. The one firm which has shown itself anxious to prove to us the capabilities of the electric motor car is the British Electromobile Co. This firm, which it should be mentioned was the single one which entered cars for the Automobile Club trials this year, has made us acquainted with the more important features in the design of its carriages, and has taken us for a ride on one of its phaetons to enable us to compare the behaviour of this car with that of cars propelled by steam and petrol. We are able to confirm that there is an entire absence of jerking when starting, the car going forward with a gliding motion, although the acceleration is rapid.



British Electromobile Co.'s Standard Chassis.

Starting from the company's office at Bloomsbury, we drove through some of the thickest traffic in London, where the driver, who has had the honour of driving the King on various occasions, amply demonstrated with what ease an electric car can be controlled. When running at about 12 miles per hour on the level, with four passengers, the ammeter indicated about 25 amperes at 100 volts, or nearly 3½ H.P. On the top notch, when travelling at over 30 miles per hour, the ammeter reading was below 70, and the volts naturally fell to less than 100.

The following is a description of the car on which the above trial run was made:—It is of the "double-phaeton" type, with raised skeleton back seat, and its weight, exclusive of occupants, is 29 cwt., of which 15 cwt. is accounted for by the battery. This consists of 48 "Leitner" traction cells, each of 150 ampere-hours capacity, giving the car a mileage of about

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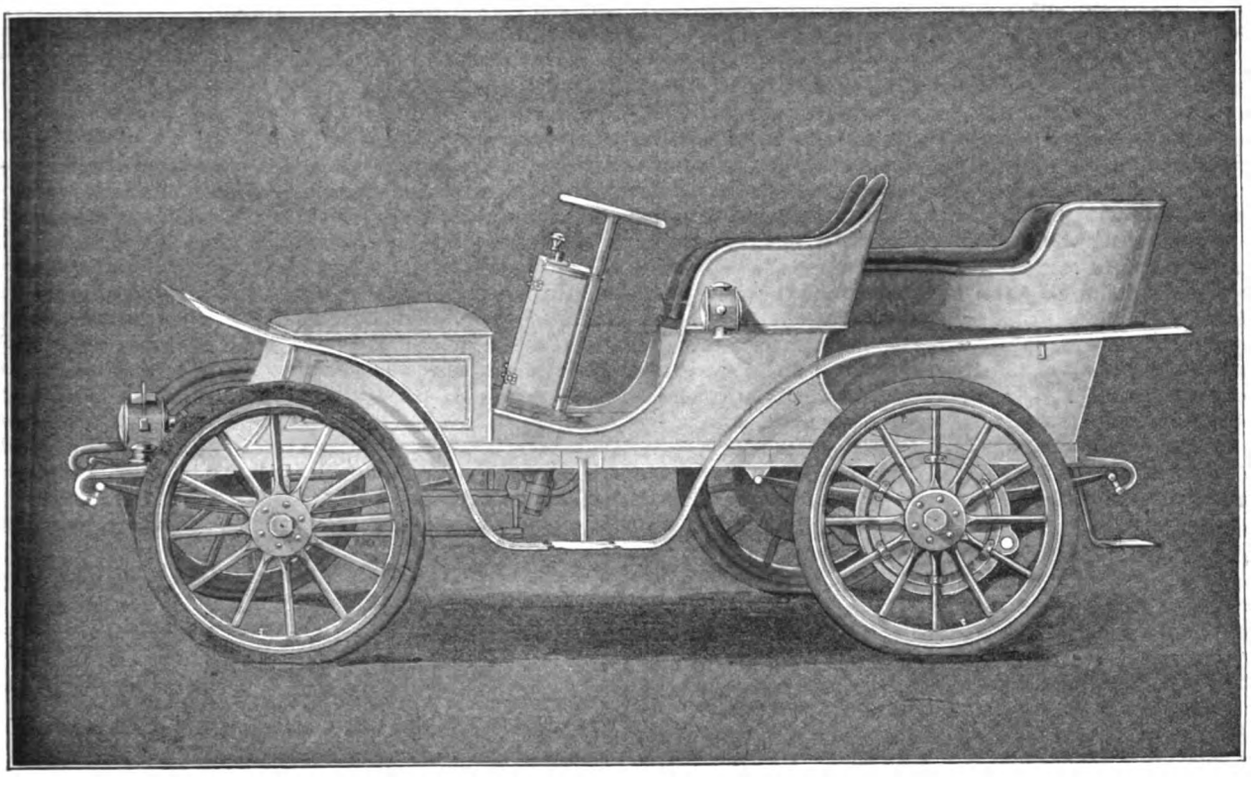
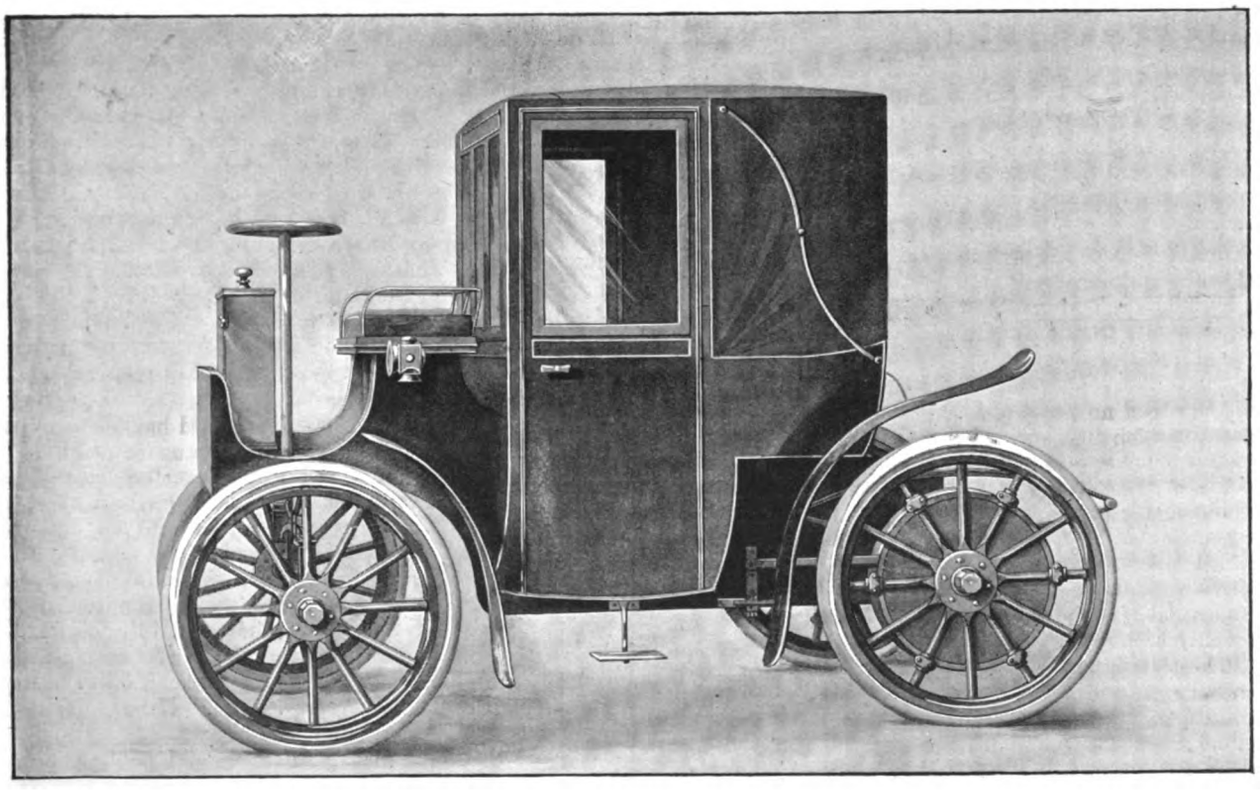
50 miles, at an average speed of 15 miles per hour. Each cell has five positive and six negative plates of the pasted grid type, with ebonite separators. The containers are of ebonite, and are packed in groups in wooden nesting-boxes, which prevent the containers bulging. The cells have lids, sealed on and provided with rubber bungs for filling, so that splashing is impossible. Sixteen cells are carried in a bonnet in front, and the rest beneath the seats. The seats are hinged, so as to swing forward when two wing nuts are slacked back, and the rest of the battery space has hinged lids, giving complete access to the top of every cell for examination and filling, as well as thorough ventilation whilst charging. Connections between cells in the same nesting-box are of lead, burnt solid, and those between nesting-boxes are insulated



BRITISH ELECTROMOBILE CO.'S "DOUBLE-PHAETON."



BRITISH ELECTROMOBILE CO.'S "LANDAULET."

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copper cables ending in fixed terminals. Special attention has been paid to insulating the nesting-boxes from the frame and to draining the bottom of condensed moisture.

There are two motors driving the rear wheels independently through single reduction toothed gearing, which is completely enclosed in aluminium gear cases and runs in oil. Each motor is capable of giving out 4 B.H.P. continuously when running at 1,800 revs. (corresponding to 24 miles per hour of the car), and weighs 150lb. The motors are four-pole enclosed, and have plain bearings, with wool lubrication. They are compound wound, the proportions being such that the series field coils give ample starting torque, while the shunt coils provide a field whose polarity is constant for either direction of current in the armature, enabling the motors to act as dynamos and return current to the battery when driven above their speed as motors by the momentum of the car. The armatures are slotted drum, with former-wound coils. In corresponding positions on opposite sides of the armature the coils are in series, so that only two brushes at 90deg. with one another are necessary. The motors are swung radially behind the rear axle, being suspended from the frame of the car by spiral springs. This position gives the greatest accessibility possible, the commutators being easily exposed by the removal of covers.

The controller is of the usual barrel type with sunken contacts of brass and phosphor-bronze brushes tipped with copper. It is enclosed in a watertight aluminium casing provided with a door which can be removed by slacking four wing nuts, exposing the entire interior. It is placed in front of the driver to the left of the steering wheel, so that the latter can be brought close in for convenience in steering, while the controller can be manipulated by the left hand, without taking the right hand off the steering wheel. The controller gives five forward speeds, one reverse speed and an electric brake; these, with the "Stop" position (at which the car is charged), divide the controller dial into eight points equally spaced at 45deg. interval. This arrangement, combined with an effective quick-break mechanism, renders it quite easy to work the controller by touch without risk of lingering between positions, though a glance at the numbers engraved on the dial is an additional safeguard. In the system of control adopted, as in the equipment itself, the designers claim no striking departures from the best existing practice, but can point to several improvements in detail which have suggested themselves in the course of continual use on the road, and which have contributed more than may be supposed to ease of manipulation and efficiency.

The running speeds are produced by series-parallel combinations of the two motors and grouping of cells, and intermediate speeds by field weakening. Attached to the foot lever which applies the band brake is a switch by which the circuit can be interrupted and closed again without use of the controller or application of the band brake. However, a further movement of the same foot lever applies the band brake, the circuit remaining broken until the lever is almost completely raised. This switch consists of a radial arm passing over contacts connected by resistance coils, so that the current may be admitted suddenly or gradually according to the rapidity with which it is released. A powerful spring brings the lever against a stop when the foot is withdrawn, ensuring that good contact is made in the switch and no resistance left in. The contacts can be renewed with less trouble and cost than those of the controller, the life of which is considerably prolonged by avoiding the necessity for continually changing positions. In fact, this foot switch is almost analogous in its functions to the clutch of a petrol car. On all the running speeds the series field coils are in circuit, whether the shunt coils are excited or not, but when it is desired to run the motors as shunt-wound generators for returning current to the cells on a down grade, a small pedal is depressed by the left foot, actuating a switch which short-circuits the series coils. The same switch short-circuits the foot switch mentioned above, so that the band brake can be applied without losing the benefit of the check due to "recuperation," as would be the case if the circuit was broken as usual. As soon as the small pedal is released the motors commence to drive again at the same speed as before. By an interlocking device, it cannot be depressed except on those positions of the controller in which the shunt field coils are excited. These positions, by the way, give sufficient recuperative effect to enable a novice to keep the car well in hand on a hill before he has learnt the use of the pedal.

A combined ammeter and voltmeter is placed on a bracket in full view of the driver, and all accessory fittings, such as the charging and running plug sockets, fuses and lamp switches are mounted on one board in an accessible but protected position. The band brake is especially powerful, and acts equally well both forwards and backwards. The wheels are fitted with Goodyear pneumatic tyres 82in. by 4in. in front and 86in. by 5in. behind.

The "landaulet" illustrated on p. 861 also has two motors of the same type as those on the phaeton, driving the rear wheels independently. The controller and connections are identical with those described above, but the gear ratio is lower. Perhaps the most novel feature consists in the position of the battery, which is carried entirely in one box under the seat and forward of the rear axle. When in position, the battery box follows the lines of the frame and hangs no lower than the body; but by removing four nuts and working a ratchet-jack on each side it can be rapidly lowered on to the ground or elsewhere, and the car can be run backwards clear of it. This capability of being lowered by jacks does not preclude the use of a lift where this is available, but is a distinct advantage when such is not the case, and is a decided advance on the usual plan of hauling out from behind or taking out the seats to get at the cells. The battery, consisting of 42 four-plate "Leitner" cells of 120 ampere-hours capacity, weighs 10 cwt. All four wheels are of equal size—namely, 3ft. diameter—and are fitted with 3in. solid tyres as a precaution against side-slip in London streets.

The body can be removed completely from the chassis, which can be run about as a complete vehicle with temporary seats. The weight of the chassis, complete with battery, is 23 cwt. and the body weighs 4 cwt. Its mileage on average roads is from 30 to 40 miles at an average speed of about 12 miles per hour.

A voiturette by the same makers has already become most popular, and though there is only seating accommodation for two, it is of a luxurious nature, and there is ample room for luggage, while the long wheel base gives unusual ease of motion and safety at high speeds. Its total weight is 22 cwt., of which 10 cwt. is accounted for by the battery. The latter consists of 42 cells of 185 ampere-hours capacity, giving a 50-mile run at a good average speed, and is carried partly in a bonnet in front and partly under the seats. The ease with which this car can be handled is largely due to this perfect distribution of weight. It is driven by a single motor and differential gear mounted on a live rear axle, the main reason being to benefit by the higher efficiency of one large motor as compared with two smaller ones. The position of the differential gear is novel and effective, and enables a continuous live axle to be employed instead of one broken in the middle. The case containing all the gearing is on one side of the car and partly hidden within the brake drum, and by removing one road wheel every tooth is exposed. This arrangement permits the body to be brought much lower than would be the case if it were directly over the differential box, and at the same time allows of a single reduction of ample proportions. This car has climbed the Farquhar-road hill to the Crystal Palace at a minimum speed of 9 miles an hour on a maximum current of 70 amperes. The wheels are all 32in. in diameter and have "Continental" tyres.

BURNAND TRANSFORMERS.

The Burnand Transformer Co. is issuing an interesting description of the transformers which it is now placing on the market. These embody one or two interesting departures in transformer design. One of the first features that will be noticed in the transformer is that the coils are of triangular cross-section, and are on four sides of an iron square built up of stampings. The company contends that the advantage of this lies in the large surface exposed, the small radial depth

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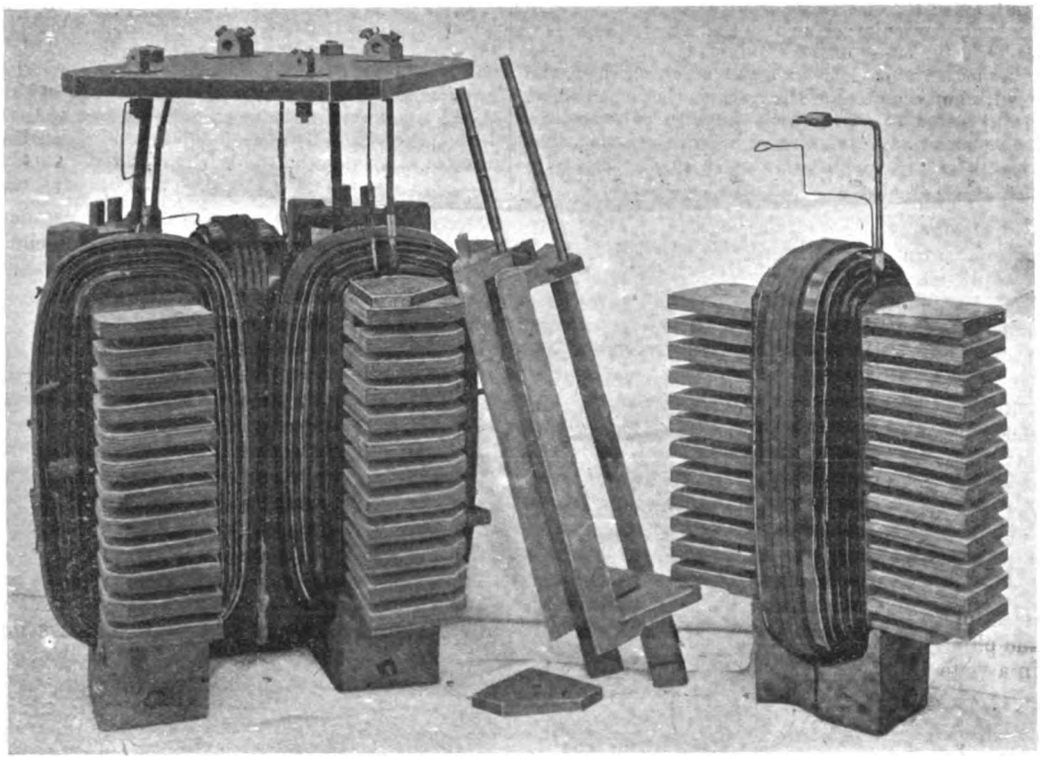

FIG. 1.—COIL REMOVED FOR INSPECTION.

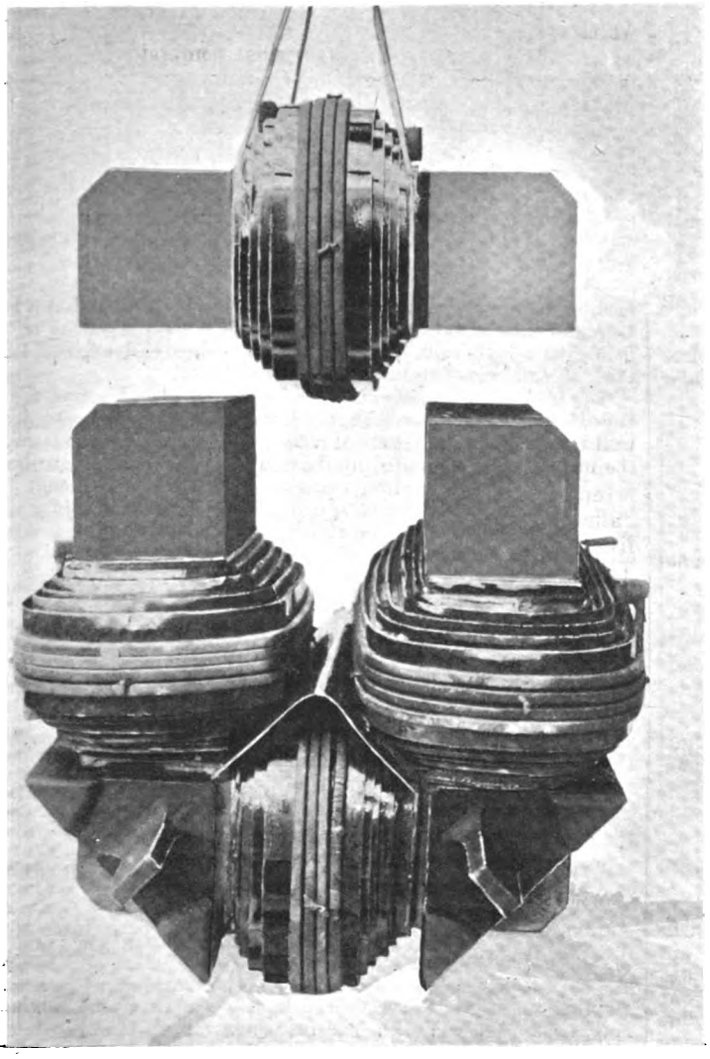

FIG. 2.—50KW. BASE WITH COIL LIFTED.

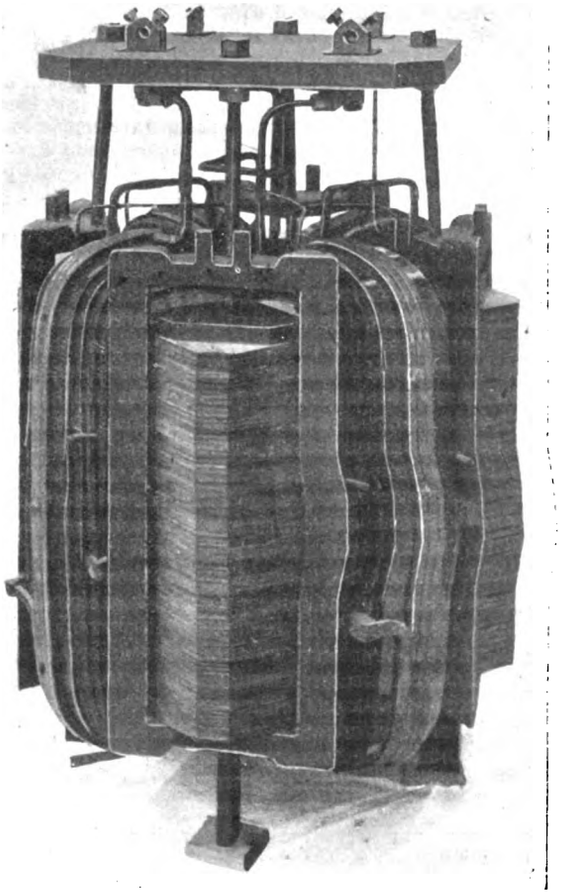

FIG. 3.—50KW. BASE COMPLETE BUT WITHOUT CASE.

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of coil, and the shortness of the electrical circuit without increase in the length of the magnetic circuit, and explains this as follows :—

It is well known that the effect of the windings is simply proportional to the number of turns enclosing a given magnetic flux, and has nothing to do with the diameter of the coils, so that the shorter the length of wire required to get a given number of turns, the smaller will be the resistance, and the energy lost in the coils. The reduction in the length of wire required to get a given effect with the Burnand transformers is shown in the diagrams Figs. 4 to 7.

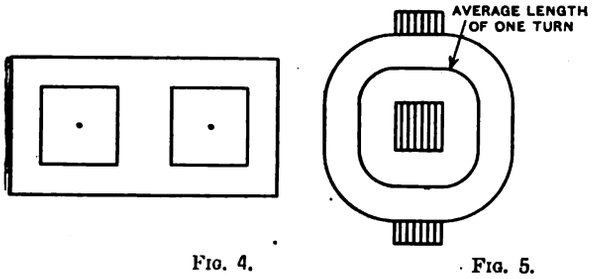

Fig. 4.

Fig. 5.

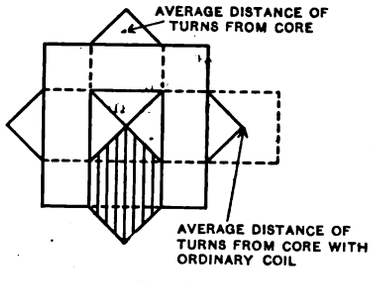

Fig. 6.

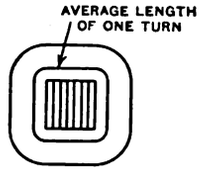

Fig. 7.

Fig. 5 shows a coil with parallel sides round a core having a divided return path, the diagram showing the shortest possible electrical circuit combined with the shortest possible magnetic circuit. Fig. 4 shows one of the stampings. The average length of one turn of the winding is shown in Fig. 5. The only way in which this can be reduced is by increasing the height of the stampings (Fig. 4), but to do this would be to increase the length of the magnetic circuit—*i.e.*, to save copper loss at the expense of the iron loss. Adding more stampings only has the effect of further increasing the length of wire per turn, so increasing the copper loss and drop on load. Fig. 6 shows exactly the same core arranged as in the Burnand transformer with single magnetic circuit and coils of triangular cross-section. As shown in Figs. 3, 6 and 9 every turn of wire on the coil is very close to the core on which it is wound, and also, owing to the triangular

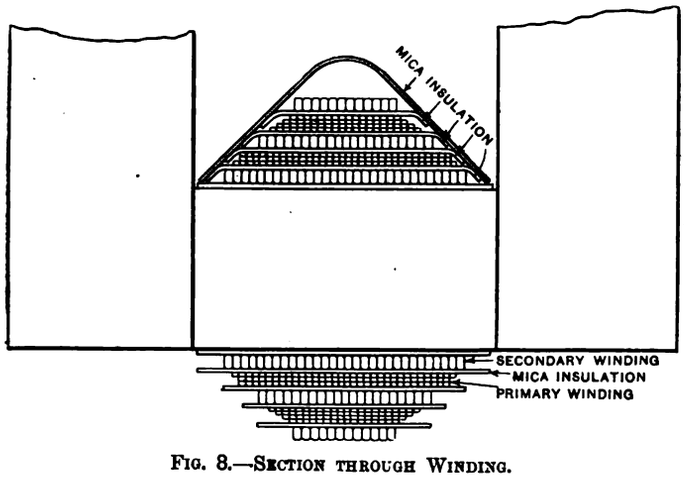

Fig. 8.—Section through Winding.

cross-section, nearly all the turns are in the bottom layers, the turns becoming fewer as the distance from the core increases. The net result of this is that the average length of the turns is reduced to that shown in Fig. 7. This means that with exactly same core as before and exactly same number of turns round the core, it is possible to reduce the length of wire in the proportion shown in Figs. 5 and 7, the copper loss and drop in volts being reduced in the same proportion.

It is further claimed for these transformers that they possess a much greater radiating surface than the average, which, in conjunction with the small radial depth of the coil, ensures that the middle of the coil is little hotter than the outside, and prevents slow charring, which has sometimes been observed with the old types of large capacity transformers even when comparatively cool on the outside of the coil. It is also claimed that the regulation on motor loads is in every case as close as on non-inductive load. A test recently made by an electric supply works gave a drop of 2·25 per cent. on full load whether

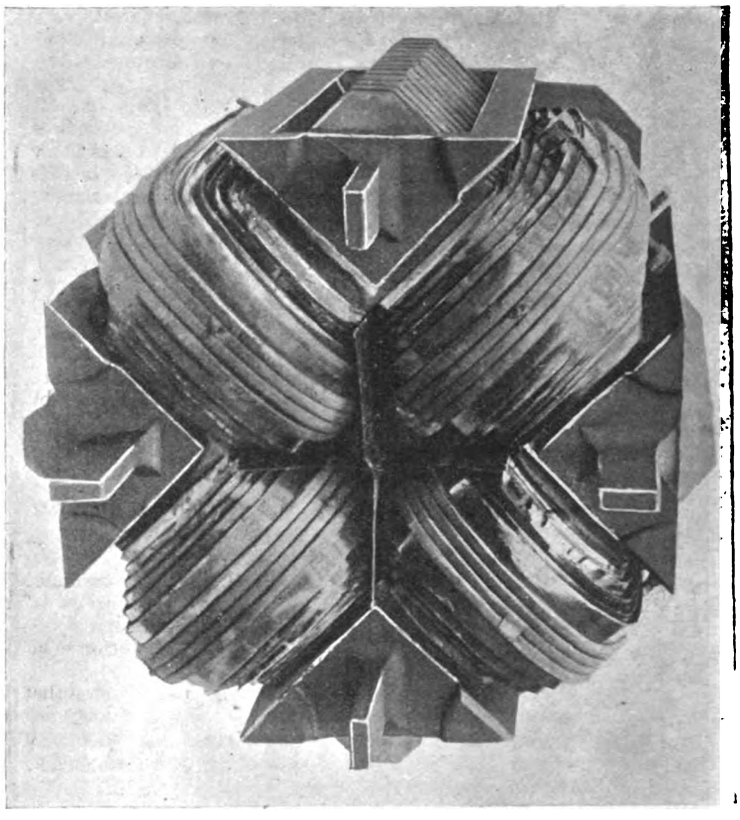

Fig. 9.—50kw. Base.

feeding lamps or motors, or both. It is also stated that a larger Burnand transformer made for specially low regulation for another firm gave 1·7 per cent. drop on full non-inductive load, and 1·6 per cent. on full inductive load of 0·7 power-factor.

The insulation consists of micanite simply placed round the core and windings like a postal wrapper, the edges of insulation projecting well beyond the windings. Movement of the winding sideways on the insulation is prevented by the mutual support between the triangular coils inside the iron square. With this construction every layer is visible after the coil is completed. In case of injury whilst in use, any section of the transformer can be replaced without disturbing any other section.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Aufgaben aus der Elektrotechnik nebst deren Lösungen." By Dr. E. Müllendorff. (Berlin : Georg Siemens). 2.50m.

"Calendar for the Session 1902–1903 of the Durham College of Science, Newcastle-upon-Tyne." (London and Newcastle : Andrew Reid & Co.)

"The Amateur Electrician's Workshop." By S. R. Bottone. (London : Guilbert Pitman.) 1s. 6d.

"Jahresbericht des Physikalischen Vereins zu Frankfurt-am-Main für das Rechnungsjahr 1900-1901." (Frankfort-on-the-Main : C. Naumann.)

"Transactions of the American Institute of Electrical Engineers," May, 1902 (New York : The Institute.) 2s. 3d.

"Encyclopædia Britannica." Vol. V. of the new volumes. (London : *The Times*)

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PROF. JAMES DEWAR'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION.*

(*Concluded from page 829.*)

But supposing all difficulties to be overcome, and the experimenter to be able to reach within a few degrees of the zero, it is by no means certain that he would find the near approach of the death of matter sometimes pictured. Any forecast of the phenomena that would be seen must be based on the assumption that there is continuity between the processes studied at attainable temperatures and those which take place at still lower ones. Is such an assumption justified? It is true that many changes in the properties of substances have been found to vary steadily with the degree of cold to which they are exposed. But it would be rash to take for granted that the changes which have been traced in explored regions continue to the same extent and in the same direction in those which are as yet unexplored. Of such a breakdown, low-temperature research has already yielded a direct proof at least in one case. A series of experiments with pure metals showed that their electrical resistance gradually decreases as they are cooled to lower and lower temperatures, in such ratio that it appeared probable that at the zero of absolute temperature they would have no resistance at all and would become perfect conductors of electricity. This was the inference that seemed justifiable by observations taken at depths of cold which can be obtained by means of liquid air and less powerful refrigerants. But with the advent of the more powerful refrigerant liquid hydrogen it became necessary to revise that conclusion. A discrepancy was first observed when a platinum resistance thermometer was used to ascertain the temperature of that liquid boiling under atmospheric and reduced pressure. All known liquids, when forced to evaporate quickly by being placed in the exhausted receiver of an air pump, undergo a reduction in temperature, but when hydrogen was treated in this way it appeared to be an exception. The resistance thermometer showed no such reduction as was expected, and it became a question whether it was the hydrogen or the thermometer that was behaving abnormally. Ultimately, by the adoption of other thermometrical appliances, the temperature of the hydrogen was proved to be lowered by exhaustion as theory indicated. Hence it was the platinum thermometer which had broken down; in other words, the electrical resistance of the metal employed in its construction was not, at temperatures about minus 250°C., decreased by cold in the same proportion as at temperatures about minus 200deg.

This being the case, there is no longer any reason to suppose that at the absolute zero platinum would become a perfect conductor of electricity; and in view of the similarity between the behaviour of platinum and that of other pure metals in respect of temperature and conductivity the presumption is that the same is true of them also. At any rate, the knowledge that in the case of at least one property of matter we have succeeded in attaining a depth of cold sufficient to bring about unexpected change in the law expressing the variation of that property with temperature, is sufficient to show the necessity for extreme caution in extending our inferences regarding the properties of matter near the zero of temperature. Lord Kelvin evidently anticipates the possibility of more remarkable electrical properties being met with in the metals near the zero. A theoretical investigation on the relation of "electrions" and atoms has led him to suggest a hypothetical metal having the following remarkable properties: Below 1deg. absolute it is a perfect insulator of electricity, at 2deg. it shows noticeable conductivity, and at 6deg. it possesses high conductivity. It may safely be predicted that liquid hydrogen will be the means by which many obscure problems of physics and chemistry will ultimately be solved, so that the liquefaction of the last of the old permanent gases is as pregnant now with future consequences of great scientific moment as was the liquefaction of chlorine in the early years of the last century.

The next step towards the absolute zero is to find another gas more volatile than hydrogen, and that we possess in the gas occurring in clevite, identified by Ramsay as helium, a gas which is widely distributed, like hydrogen, in the sun, stars and nebulæ. Although the liquefaction of the gas is a problem for the future, this does not prevent us from safely anticipating some of the properties of the fluid body. It would be twice as dense as liquid hydrogen, with a critical pressure of only 4 or 5 atmospheres. The liquid would possess a very feeble surface-tension, and its compressibility and expansibility would be about four times that of liquid hydrogen, while the heat required to vaporise the molecule would be about one-fourth that of liquid hydrogen. Heating the liquid 1deg. above its boiling point would raise the pressure by $1\frac{3}{4}$ atmospheres, which is more than four times the increment for liquid hydrogen. The liquid would be only 17 times denser than its vapour, whereas liquid hydrogen is 65 times denser than the gas it gives off. Only some 3deg. or 4deg. would separate the critical temperature from the boiling point and the melting point, whereas in liquid hydrogen the separation is respectively 10deg. and 15deg. As the liquid refractivities for oxygen, nitrogen and hydrogen are closely proportional to the gaseous values, and as Lord Rayleigh has shown that helium has only one-fourth the refractivity of hydrogen, although it is twice as dense, we must infer that the refractivity of liquid helium would also be about one-fourth that of liquid hydrogen. Now hydrogen has the smallest refractivity of any known liquid, and yet liquid helium will have only about one-fourth of this value—comparable, in fact, with liquid hydrogen just below its critical point. This means that the liquid will be quite exceptional in its optical properties, and very difficult to see. This may be the explanation of why no mist has been seen on its adiabatic expansion from the lowest temperatures.

Taking all these remarkable properties of the liquid into consideration, one is afraid to predict that we are at present able to cope with the difficulties involved in its production and collection. Provided the critical point is, however, not below 8deg. absolute, then from the knowledge of the conditions that are successful in producing a change of state in hydrogen through the use of liquid air, we may safely predict that helium can be liquefied by following similar methods. If, however, the critical point is as low as 6deg. absolute, then it would be almost hopeless to anticipate success by adopting the process that works so well with hydrogen. The present anticipation is that the gas will succumb after being subjected to this process, only, instead of liquid air under exhaustion being used as the primary cooling agent, liquid hydrogen evaporating under similar circumstances must be employed. In this case the resulting liquid would require to be collected in a vacuum vessel, the outer walls of which are immersed in liquid hydrogen. The practical difficulties and the cost of the operation will be very great; but on the other hand, the descent to a temperature within 5deg. of the zero would open out new vistas of scientific inquiry, which would add immensely to our knowledge of the properties of matter. To command in our laboratories a temperature which would be equivalent to that which a comet might reach at an infinite distance from the sun would indeed be a great triumph for science. If the present Royal Institution attack on helium should fail, then we must ultimately succeed by adopting a process based on the mechanical production of cold through the performance of external work. When a tubine can be worked by compressed helium, the whole of the mechanism and circuits being kept surrounded with liquid hydrogen, then we need hardly doubt that the liquefaction will be effected. In all probability gases other than helium will be discovered of greater volatility than hydrogen. If amongst the unknown gases possessing a very low critical point some have a high critical pressure instead of a low one, which ordinary experience would lead us to anticipate, then such difficultly liquefiable gases would produce fluids having different physical properties from any of those with which we are acquainted. Again, gases may exist having smaller atomic weights and densities than hydrogen, yet all such gases must, according to our present views of the gaseous state, be capable of liquefaction before the zero of temperature is reached.

The Upper Air and Auroras.

The present liquid ocean, neglecting everything for the moment but the water, was at a previous period of the earth's history part of the atmosphere, and its condensation has been brought about by the gradual cooling of the earth's surface. This resulting ocean is subjected to the pressure of the remaining uncondensed gases, and as these are slightly soluble they dissolve to some extent in the fluid. The gases in solution can be taken out by distillation or by exhausting the water, and if we compare their volume with the volume of the water as steam, we should find about one volume of air in 60,000 volumes of steam. This would then be about the rough proportion of the relatively permanent gas to condensable gas which existed in the case of the vaporised ocean. Now let us assume the surface of the earth gradually cooled to some 200deg. below the freezing-point; then, after all the present ocean was frozen, and the climate became three times more intense than any arctic frost, a new ocean of liquid air would appear, covering the entire surface of the frozen globe about 35ft. deep. We may now apply the same reasoning to the liquid air ocean that we formerly did to the water one, and this would lead us to anticipate that it might contain in solution some gases that may be far less condensable than the chief constituents of the fluid. In order to separate them we must imitate the method of taking the gases out of water. Assume a sample of liquid air cooled to the low temperature that can be reached by its own evaporation, connected by a pipe to a condenser cooled in liquid hydrogen; then any volatile gases present in solution will distil over with the first portions of the air, and can be pumped off, being uncondensable at the temperature of the condenser. In this way, a gas mixture, containing, of the known gases, free hydrogen, helium and neon, has been separated from liquid air. It is interesting to note in passing that the relative volatilities of water and oxygen are in the same ratio as those of liquid air and hydrogen, so that the analogy between the ocean of water and that of liquid air has another suggestive parallel. The total uncondensable gas separated in this way amounts to about one fifty-thousandth of the volume of the air, which is about the same proportion as the air dissolved in water.

* Delivered at Belfast on September 10th.—*Abstract.*

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That free hydrogen exists in air in small amount is conclusively proved, but the actual proportion found by the process is very much smaller than Gautier has estimated by the combustion method. The recent experiments of Lord Rayleigh show that Gautier, who estimated the hydrogen present as one five-thousandth, has in some way produced more hydrogen than he can manage to extract from pure air by a repetition of the same process. The spectroscopic examination of these gases throws new light upon the question of the aurora and the nature of the upper air. On passing electric discharges through the tubes containing the most volatile of the atmospheric gases, they glow with a bright orange light, which is specially marked at the negative pole. The spectroscope shows that this light consists, in the visible part of the spectrum, chiefly of a succession of strong rays in the red, orange and yellow, attributed to hydrogen, helium and neon. Besides these, a vast number of rays, generally less brilliant, are distributed through the whole length of the visible spectrum. The greater part of these rays are of, as yet, unknown origin. The violet and ultra-violet part of the spectrum rivals in strength that of the red and yellow rays. As these gases probably include some of the gases that pervade interplanetary space, search was made for the prominent nebular, coronal, and auroral lines. No definite lines agreeing with the nebular spectrum could be found, but many lines occurred closely coincident with the coronal and auroral spectrum. But before discussing the spectroscopic problem it will be necessary to consider the nature and condition of the upper air.

According to the old law of Dalton, supported by the modern dynamical theory of gases, each constituent of the atmosphere while acted upon by the force of gravity forms a separate atmosphere, completely independent, except as to temperature, of the others, and the relations between the common temperature and the pressure and altitude for each specific atmosphere can be definitely expressed. If we assume the altitude and temperature known, then the pressure can be ascertained for the same height in the case of each of the gaseous constituents, and in this way the percentage composition of the atmosphere at that place may be deduced. Suppose we start with a surface atmosphere having the composition of our air, only containing two ten-thousandths of hydrogen, then at 37 miles, if a sample could be procured for analysis, we believe that it would be found to contain 12 per cent. of hydrogen and only 10 per cent. of oxygen. The carbonic acid practically disappears; and by the time we reach 47 miles, where the temperature is minus 132deg., assuming a gradient of 3·2deg. per mile, the nitrogen and oxygen have so thinned out that the only constituent of the upper air which is left is hydrogen. If the gradient of temperature were doubled, the elimination of the nitrogen and oxygen would take place by the time 37 miles was reached, with a temperature of minus 220deg. The permanence of the composition of the air at the highest altitudes, as deduced from the basis of the dynamical theory of gases, has been discussed by Stoney, Bryan and others. It would appear that there is a consensus of opinion that the rate at which gases like hydrogen and helium could escape from the earth's atmosphere would be excessively slow. Considering that to compensate any such loss the same gases are being supplied by actions taking place in the crust of the earth, we may safely regard them as necessarily permanent constituents of the upper air. The temperature at the elevations we have been discussing would not be sufficient to cause any liquefaction of the nitrogen and oxygen, the pressure being so low. If we assume the mean temperature as about the boiling-point of oyxgen at atmospheric pressure, then a considerable amount of the carbonic acid must solidify as a mist, if the air from a lower level be cooled to this temperature; and the same result might take place with other gases of relatively small volatility which occur in air. This would explain the clouds that have been seen at an elevation of 50 miles, without assuming the possibility of water vapour being carried up so high.

The temperature of the upper air must be above that on the vapour pressure curve corresponding to the barometric pressure at the locality, otherwise liquid condensation must take place. In other words, the temperature must be above the dew-point of air at that place. At higher elevations, on any reasonable assumption of temperature distribution, we inevitably reach a temperature where the air would condense, just as Fourier and Poisson supposed it would, unless the temperature is arrested in some way from approaching the zero. Both ultra-violet absorption and the prevalence of electric storms may have something to do with the maintenance of a higher mean temperature. The whole mass of the air above 40 miles is not more than one seven-hundreth part of the total mass of the atmosphere, so that any rain or snow of liquid or solid air, if it did occur, would necessarily be of a very tenuous description. In any case, the dense gases tend to accumulate in the lower strata, and the lighter ones to predominate at the higher altitudes, always assuming that a steady state of equilibrium has been reached. It must be observed, however, that a sample of air taken at an elevation of 9 miles has shown no difference in composition from that at the ground, whereas, according to our hypothesis, the oxygen ought to have been diminished to 17 per cent., and the carbonic acid should also have become much less. This can only be explained by assuming that a large inter-mixture of different layers of the atmosphere is still taking place at this elevation. This is confirmed by a study of the motions of clouds about 6 miles high, which reveals an average velocity of the air currents of some 70 miles an hour; such violent winds must be the means of causing the intermingling of different atmospheric strata. Some clouds, however, during hot and thundery weather, have been seen to reach an elevation of 17 miles, so that we have direct proof that on occasion the lower layers of atmosphere are carried to a great elevation. The existence of an atmosphere at more than 100 miles above the surface of the earth is revealed to us by the appearance of meteors and fireballs, and when we can take photographs of the spectrum of such apparitions we shall learn a great deal about the composition of the upper air. In the meantime, Pickering's solitary spectrum of a meteor reveals an atmosphere of hydrogen and helium, and, so far, this is corroborative of the doctrine we have been discussing.

It has long been recognised that the aurora is the result of electric discharges within the limits of the earth's atmosphere, but it was difficult to understand why its spectrum should be so entirely different from anything which could be produced artificially by electric discharges through rarefied air at the surface of the earth. Writing in 1879, Rand Capron, after collecting all the recorded observations, was able to enumerate no more than nine auroral rays, of which but one could with any probability be identified with rays emitted by atmospheric air under an electric discharge. Vogel attributed this want of agreement between Nature and experiment, in a vague way, to difference of temperature and pressure; and Zollner thought the auroral spectrum to be one of a different order, in the sense in which the line and band spectra of nitrogen are said to be of different orders. Such statements were merely confessions of ignorance. But since that time observations of the spectra of auroras have been greatly multiplied, chiefly through the Swedish and Danish Polar Expeditions, and the length of spectrum recorded on the ultra-violet side has been greatly extended by the use of photography, so that, in a recent discussion of the results, M. Henri Stassano is able to enumerate upwards of 100 auroral rays, of which the wave-length is more or less approximately known, some of them far in the ultra-violet. Of this large number of rays he is able to identify, within the probable limits of errors of observation, about two-thirds as rays, which Prof. Liveing and myself have observed to be emitted by the most volatile gases of atmospheric air unliquefiable at the temperature of liquid hydrogen. Most of the remainder he ascribes to argon, and some he might, with more probability, have identified with krypton or xenon rays, if he had been aware of the publication of wave-lengths of the spectra of those gases, and the identification of one of the highest rays of krypton with that most characteristic of auroras. The rosy tint often seen in auroras, particularly in the streamers, appears to be due mainly to neon, of which the spectrum is remarkably rich in red and orange rays. One or two neon rays are amongst those most frequently observed, while the red ray of hydrogen and one red ray of krypton have been noticed only once. The predominance of neon is not surprising, seeing that from its relatively greater proportion in air and its low density it must tend to concentrate at higher elevations. So large a number of probable identifications warrants the belief that we may yet be able to reproduce in our laboratories the auroral spectrum in its entirety. It is true that we have still to account for the appearance of some, and the absence of other, rays of the newly-discovered gases, which in the way in which we stimulate them appear to be equally brilliant, and for the absence, with one doubtful exception, of all the rays of nitrogen. If we cannot give the reason of this, it is because we do not know the mechanism of luminescence—nor even whether the particles which carry the electricity are themselves luminous, or whether they only produce stresses causing other particles which encounter them to vibrate; yet we are certain that an electric discharge in a highly rarefied mixture of gases lights one element and not another, in a way which, to our ignorance, seems capricious.

The Swedish North Polar Expedition concluded from a great number of trigonometrical measurements that the average above the ground of the base of the aurora was 50km. (34 miles) at Cape Thorsden, Spitzbergen; at this height the pressure of the nitrogen of the atmosphere would be only about one-tenth of a millimetre, and Moissan and Deslandres have found that in atmospheric air at pressures less than 1mm. the rays of nitrogen and oxygen fade and are replaced by those of argon and by five new rays which Stassano identifies with rays of the more volatile gases measured by us. Also Collie and Ramsay's observations on the distance to which electrical discharges of equal potential traverse different gases explosively throw much light on the question; for they find that, while for helium and neon this distance is from 250mm. to 300mm., for argon it is 45½mm., for hydrogen it is 39mm., and for air and oxygen still less. This indicates that a good deal depends on the very constitution of the gases themselves, and certainly helps us to understand why neon and argon, which exist in the atmosphere in larger proportions than helium, krypton, or xenon, should make their appearance in the spectrum of auroras almost to the exclusion of nitrogen and oxygen. How much depends not only on the constitution and it

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may be temperature of the gases, but also on the character of the electric discharge, is evident from the difference between the spectra at the cathode and anode in different gases, notably in nitrogen and argon, and not less remarkably in the more volatile compounds of the atmosphere. Paulsen thinks the auroral spectrum wholly due to cathodic rays. Without stopping to discuss that question, it is certain that changes in the character of the electric diecharge produce definite changes in the spectra excited by them. It has long been known that in many spectra the rays which are inconspicuous with an uncondensed electric discharge become very pronounced when a Leyden jar is in the circuit. This used to be ascribed to a higher temperature in this condensed spark, though measurements of that temperature have not borne out the explanation.

Schuster and Hemsalech have shown that these changes of spectra are in part due to the oscillatory character of the condenser discharge, which may be enhanced by self-induction, and the corresponding change of spectrum thereby made more pronounced. Lightning we should expect to resemble condensed discharge much more than aurora, but this is not borne out by the spectrum. Pickering's recent analysis of the spectrum of a flash obtained by photography shows, out of 19 lines measured by him, only two which can be assigned with probability to nitrogen and oxygen, while three hydrogen rays most likely due to water are very conspicuous, and 11 may be reasonably ascribed to argon, krypton and xenon, one to more volatile gas of the neon class, and the brightest ray of all is but a very little less refrangible than the characteristic auroral ray, and coincides with a strong ray of calcium, but also lies between, and close to, an argon and a neon ray, neither of them weak rays. There may be some doubt about the identification of the spectral rays of auroras because of the wide limits of the probable errors in measuring wave-lengths so faint as most of them are, but there is no such doubt about the wave-lengths of the rays in solar protuberances measured by Deslandres and Hale. Stassano found that these rays, 44 in number, lying between the Fraunhofer line F and 3,148 in the ultra-violet agree very closely with rays which Prof. Liveing and myself measured in the spectra of the most volatile atmospheric gases.

It will be remembered that one of the earliest suggestions as to the nature of solar prominences was that they were solar auroras. This supposition helped to explain the marvellous rapidity of their changes, and the apparent suspension of brilliant self-luminous clouds at enormous heights above the sun's surface. Now, the identification of the rays of their spectra with those of the most volatile gases, which also furnish many of the auroral rays, certainly supports that suggestion. A stronger support, however, seems to be given to it by the results obtained at the total eclipse of May, 1901, by the American expedition to Sumatra. In the *Astrophysical Journal* for June last is a list of 339 lines in the spectrum of the corona photographed by Humphreys, during totality, with a very large concave grating. Of these no fewer than 209 do not differ from lines we have measured in the most volatile gases of the atmosphere, or in krypton or xenon, by more than one unit of wave-length on Armstrong's scale, a quantity within the limit of probable error. Of the remainder, a good many agree to a like degree with argon lines, a very few with oxygen lines, and still fewer with nitrogen lines; the characteristic green auroral ray, which is not in the range of Humphrey's photographs, also agrees within a small fraction of a unit of wave-length with one of the rays emitted by the most volatile atmospheric gas. Taking into account the Fraunhofer lines H, K, and G, usually ascribed to calcium, there remain only 55 lines of the 339 unaccounted for to the degree of probability indicated. Of these, considerably more than half are very weak lines which have not depicted themselves on more than one of the six films exposed, and extend but a very short distance into the sun's atmosphere. There are, however, seven which are stronger lines, and reach to a considerable height above the sun's rim, and all have depicted themselves on at least four of the six films. If there be no considerable error in the wave-lengths assigned (and such is not likely to be the case), these lines may perhaps be due to some volatile element which may yet be discovered in our atmosphere. However that may be, the very great number of close coincidences between the auroral rays and those which are emitted under electric excitement by gases of our atmosphere almost constrains us to believe, what is indeed most probable on other grounds, that the sun's coronal atmosphere is composed of the same substances as the earth's, and that it is rendered luminous in the same way—namely, by electric discharges.

This conclusion has plainly an important bearing on the explanation which should be given of the outburst of new stars and of the extraordinary and rapid changes in their spectra. Moreover, leaving on one side the question whether gases ever become luminous by the direct action of heat, apart from such transfers of energy as occur in chemical change and electric disturbance, it demands a revision of the theories which attribute more permanent differences between the spectra of different stars to differences of temperature, and a fuller consideration of the question whether they cannot with better reason be explained by differences in the electric conditions which prevail in the stella atmosphere.

If we turn to the question what is the cause of the electric discharges which are generally believed to occasion auroras, but of which little more has hitherto been known than that they are connected with sun spots and solar eruptions, recent studies of electric discharges in high vacua, with which the names of Crookes, Röntgen, Lenard, and J. J. Thomson will always be associated, have opened the way for Arrhenius to suggest a definite and rational answer. He points out that the frequent disturbances which we know to occur in the sun must cause electric discharges in the sun's atmosphere far exceeding any that occur in that of the earth. These will be attended with an ionisation of the gases, and the negative ions will stream away through the outer atmosphere of the sun into the interplanetary space, becoming, as Wilson has shown, nuclei of aggregation of condensable vapours and cosmic dust. The liquid and solid particles thus formed will be of various sizes; the larger will gravitate back to the sun, while those with diameters less than one and a-half thousandths of a millimetre, but nevertheless greater than a wave-length of light, will, in accordance with Clerk-Maxwell's electromagnetic theory, be driven away from the sun by the incidence of the solar rays upon them, with velocities which may become enormous, until they meet other celestial bodies, or increase their dimensions by picking up more cosmic dust or diminish them by evaporation. The earth will catch its share of such particles on the side which is turned towards the sun, and its upper atmosphere will thereby become negatively electrified until the potential of the charge reaches such a point that a discharge occurs, which will be repeated as more charged particles reach the earth.

This theory not only accounts for the auroral discharges, and the coincidence of their times of greatest frequency with those of the maxima of sun spots, but also for the minor maxima and minima The vernal and autumnal maxima occur when the line through the earth and sun has its greatest inclination to the solar equator, so that the earth is more directly exposed to the region of maximum of sun spots, while the 26 days period corresponds closely with the period of rotation of that part of the solar surface where faculæ are most abundant. J. J. Thomson has pointed out, as a consequence of the Richardson observations, that negative ions will be constantly streaming from the sun merely regarded as a hot body, but this is not inconsistent with the supposition that there will be an excess of this emission in eruptions, and from the regions of faculæ. Arrhenius' theory accounts also, in a way which seems the most satisfactory hitherto enunciated, for the appearances presented by comets. The solid parts of these objects absorb the sun's rays, and as they approach the sun become heated on the side turned towards him until the volatile substances frozen in or upon them are evaporated and diffused in the gaseous state in surrounding space, where they get cooled to the temperature of liquefaction and aggregated in drops about the negative ions. The larger of these drops gravitate towards the sun and form clouds of the coma about the head, while the smaller are driven by the incidence of the sun's light upon them away from the sun and form the tail. The curvature of the tail depends, as Bredichin has shown, on the rate at which the particles are driven, which in turn depends on the size and specific gravity of the particles, and these will vary with the density of the vapour from which they are formed and the frequency of the negative ions which collect them. In any case, Arrhenius' theory is a most suggestive one, not only with reference to auroras and comets, and the solar corona and chromosphere, but also as to the constitution of the photosphere itself.

Various Low-Temperature Researches.

We may now summarise some of the results which have already been attained by low-temperature studies. In the first place, the great majority of chemical interactions are entirely suspended, but an element of such exceptional powers of combination as fluorine is still active at the temperature of liquid air. Whether solid fluorine and liquid hydrogen would interact no one can at present say. Bodies naturally become denser, but even a highly expansive substance like ice does not appear to reach the density of water at the lowest temperature. This is confirmatory of the view that the particles of matter under such conditions are not packed in the closest possible way. The force of cohesion is greatly increased at low temperatures, as is shown by the additional stress required to rupture metallic wires. This fact is of interest in connection with two conflicting theories of matter. Lord Kelvin's view is that the forces that hold together the particles of bodies may be accounted for without assuming any other agency than gravitation or any other law than the Newtonian. An opposite view is that the phenomena of the aggregation of molecules depend upon the molecular vibration as a physical cause. Hence, at the zero of absolute temperature, this vibrating energy being in complete abeyance, the phenomena of cohesion should cease to exist, and matter generally be reduced to an incoherent heap of cosmic dust. This second view receives no support from experiment.

The photographic action of light is diminished at the temperature of liquid air to about 20 per cent. of its ordinary efficiency, and at the still lower temperature of liquid hydrogen only about 10 per cent. of the original sensitivity remains. At the temperature of liquid air or liquid hydrogen a large range of organic bodies and

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many inorganic ones acquire under exposure to violet light the property of phosphorescence. Such bodies glow faintly so long as they are kept cold, but become exceedingly brilliant during the period when the temperature is rising. Even solid air is a phosphorescent body. All the alkaline earth sulphides which phophoresce brilliantly at the ordinary temperature lose this property when cooled, to be revived on heating; but such bodies in the first instance may be stimulated through the absorption of light at the lowest temperatures. Radio-active bodies, on the other hand, like radium, which are naturally self-luminous, maintain this luminosity unimpaired at the very lowest temperatures, and are still capable of inducing phosphorescence in bodies like the platino-cyanides. Some crystals become for a time self-luminous when cooled in liquid air or hydrogen, owing to the induced electric stimulation causing discharges between the crystal molecules. This phenomenon is very pronounced with nitrate of uranium and some platino-cyanides.

In conjunction with Prof. Fleming a long series of experiments was made on the electric and magnetic properties of bodies at low temperatures. The subjects that have been under investigation may be classified as follows:—The thermo-electric powers of pure metals, the magnetic properties of iron and steel, dielectric constants, the magnetic and electric constants of liquid oxygen, magnetic susceptibility.

The investigations have shown that electric conductivity in pure metals varies almost inversely as the absolute temperature down to minus 200deg., but that this law is greatly affected by the presence of the most minute amount of impurity. Hence the results amount to a proof that electric resistance in pure metals is closely dependent upon the molecular or atomic motion which gives rise to temperature, and that the process by which the energy constituting what is called an electric current is dissipated essentially depends upon non-homogeneity of structure and upon the absolute temperature of the material. It might be inferred that at the zero of absolute temperature resistance would vanish altogether, and all pure metals become perfect conductors of electricity. This conclusion, however, has been rendered very doubtful by subsequent observations made at still lower temperatures, which appear to point to an ultimate finite resistance. Thus the temperature at which copper was assumed to have no resistance was minus 223deg., but that metal has been cooled to minus 253deg. without getting rid of all resistance. The reduction in resistance of some of the metals at the boiling-point of hydrogen is very remarkable. Thus copper has only 1 per cent., gold and platinum 3 per cent. and silver 4 per cent. of the resistance they possessed at zero C., but iron still retains 12 per cent. of its initial resistance. In the case of alloys and impure metals, cold brings about a much smaller decrease in resistivity, and in the case of carbon and insulators like gutta-percha, glass, ebonite, &c., their resistivity steadily increases. The enormous increase in resistance of bismuth when transversely magnetised and cooled was also discovered in the course of these experiments. The study of dielectric constants at low temperatures has resulted in the discovery of some interesting facts. A fundamental deduction from Maxwell's theory is that the square of the refractive index of a body should be the same number as its dielectric constant. So far, however, from this being the case generally, the exceptions are far more numerous than the coincidences. It has been shown in the case of many substances, such as ice and glass, that an increase in the frequency of the alternating E.M.F. results in a reduction of the dielectric constant to a value more consistent with Maxwell's law. By experiments upon many substances it is shown that even a moderate increase of frequency brings the large dielectric constant to values quite near to that required by Maxwell's law. It was thus shown that low temperature has the same effect as high frequency in annulling the abnormal dielectric values. The exact measurement of the dielectric constant of liquid oxygen as well as its magnetic permeability, combined with the optical determination of the refractive index, showed that liquid oxygen strictly obeys Maxwell's electro-optic law even at very low electric frequencies.

In magnetic work the result of greatest value is the proof that magnetic susceptibility varies inversely as the absolute temperature. This shows that the magnetisation of paramagnetic bodies is an affair of orientation of molecules, and it suggests that at the absolute zero all the feebly paramagnetic bodies will be strongly magnetic. The diamagnetism of bismuth was found to be increased at low temperatures. The magnetic moment of a steel magnet is temporarily increased by cooling in liquid air, but the increase seems to have reached a limit, because on further cooling to the temperature of liquid hydrogen hardly any further change was observed. The study of the thermo-electric relations of the metals at low temperatures resulted in a great extension of the well-known Tait thermo-electric diagram. Tait found that the thermo-electric power of the metals could be expressed by a linear function of the absolute temperature, but at the extreme range of temperature now under consideration this law was found not to hold generally; and, further, it appeared that many abrupt electric changes take place, which originate probably from specific molecular changes occurring in the metal. The thermo-electric neutral points of certain metals, such as lead and gold, which are located about or below the boiling point of hydrogen, have been found to be a convenient means of defining specific temperatures in this exceptional part of the scale.

The effect of cold upon the life of living organisms is a matter of great intrinsic interest, as well as of wide theoretical importance. Experiment indicates that moderately high temperatures are much more fatal, at least to the lower forms of life, than are exceedingly low ones. A similar persistence of life in seeds has been demonstrated even at the lowest temperatures. Bacteria are minute vegetable cells, the standard of measurement for which is the "micron." Yet it has been found possible to completely triturate these microscopic cells when the operation is carried out at the temperature of liquid air, the cells then being frozen into hard breakable masses. The typhoid organism has been treated in this way, and the cell plasma obtained for the purpose of studying its toxic and immunising properties. It would hardly have been anticipated that liquid air should find such immediate application in biological research. A research by Prof. Macfayden, just concluded, has shown that many varieties of micro-organisms can be exposed to the temperature of liquid air for a period of six months without any appreciable loss of vitality, although at such a temperature the ordinary chemical processes of the cell must cease. At such a temperature the cells cannot be said to be either alive or dead, in the ordinary acceptation of these words. It is a new and hitherto unobtained condition of living matter—a third state.

And now, to conclude an address which must have sorely taxed your patience, I may remind you that I commenced by referring to the plaint of Elizabethan science, that cold was not a natural available product. In the course of a long struggle with Nature, man, by the application of intelligent and steady industry, has acquired a control over this agency which enables him to produce it at will, and with almost any degree of intensity, short of a limit defined by the very nature of things. But the success in working what appears, at first sight, to be a quarry of research that would soon suffer exhaustion, has only brought him to the threshold of new labyrinths, the entanglements of which frustrate, with a seemingly invulnerable complexity, the hopes of further progress. In a legitimate sense all genuine scientific workers feel that they are "the inheritors of unfulfilled renown." The battlefields of science are the centres of a perpetual warfare, in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of Nature. To serve in the scientific army, to have shown some initiative, and to be rewarded by the consciousness that in the eyes of his comrades he bears the accredited accolade of successful endeavour, is enough to satisfy the legitimate ambition of every earnest student of Nature. The real warranty that the march of progress in the future will be as glorious as in the past lies in the perpetual reinforcement of the scientific ranks by recruits animated by such a spirit, and proud to obtain such a reward.

THE ELECTRICAL CONDUCTIVITY OF CERTAIN ALUMINIUM ALLOYS AS AFFECTED BY EXPOSURE TO LONDON ATMOSPHERE.*

BY ERNEST WILSON.
(Professor of Electrical Engineering, King's College, London.)

The physical properties of certain light aluminium alloys have formed the subject of a communication,† and, as stated therein, a specimen of each alloy was placed on the roof of King's College, London, in order to investigate the effect of exposure to London atmosphere. The specimens are in the form of wire, 0·126in. (3·2mm.) diameter, supported on a wooden frame, and were placed on the roof on June 11, 1901. They have been tested after about 13 months' exposure, and have revealed some interesting facts. In order that the chemical analysis may be inspected it is again given in the following table, which gives the results of the tests. It is assumed that the observed effects are principally due to pitting at the surface, but exposure might also affect the structure of these alloys.

The position of aluminium in the electro-chemical series with respect to the other substances in the analysis is as follows:—Al, Mn, Zn, Fe, Ni, Cu, Si. We should expect to find that copper, widely separated as it is, would be effective in the production of corrosion. This is found to be the case (specimens 16, 4, 13, 14, 15), the effect increasing with the percentage of copper. Nickel is well separated from aluminium in the series, and alone (specimen 20) has considerable effect, but if alloyed with copper (specimen 22) the conductivity has slightly increased during exposure. This specimen is specially

* Paper read at the British Association, Section G, Belfast, 1902.

† See *Journal* Institute of Electrical Engineers, 1902, Part 154, Vol. XXXI.; also British Association *Report*, 1901; also *Journal* of the Society of Arts, December 13, 1901.

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No. of specimen.	Analysis.						Specific resistance in 10^{-6} ohms before exposure on June 11, 1901.	Percentage variation of resistance as found on July 23, 1902.
	Si.	Fe.	Cu.	Ni.	Mn.	Zn.		
16	0·31	0·37	0·11	...	...	...	2·92	1·81
4	0·38	0·25	0·16	...	...	...	2·88	1·83
13	0·38	0·25	1·58	...	...	...	3·34	4·50
14	0·40	0·31	1·86	...	...	...	3·25	6·18
15	0·40	0·40	2·61	...	...	...	3·34	8·07
1	0·38	0·22	0·17	...	...	0·62	2·86	1·98
2	0·43	0·28	0·30	...	...	1·20	2·94	1·30
5	0·43	0·39	0·09	...	...	2·04	3·07	2·30
7	0·37	0·25	0·05	0·75	...	...	3·05	1·21
8	0·35	0·29	0·09	1·19	...	...	3·24	2·07
20	0·37	1·10	0·06	2·25	...	...	3·18	1·64
24	0·35	1·16	0·09	...	...	...	2·97	0·60
3	0·37	0·28	0·59	...	...	0·59	3·06	2·49
6	0·39	0·31	0·63	...	...	1·20	3·12	2·00
17	0·35	0·53	0·10	0·83	...	0·90	3·03	0·99
12	0·31	0·59	0·19	1·09	...	0·73	3·33	1·21
18	0·43	0·40	0·21	1·13	...	1·94	3·24	2·59
19	0·35	0·29	0·11	2·01	...	1·77	3·26	3·21
11	0·39	0·56	0·24	2·31	...	0·38	3·48	1·93
22	0·37	0·43	1·08	1·29	...	...	3·41	-1·41
21	0·39	2·57	0·10	1·39	...	...	3·24	-0·80
10	0·32	0·54	0·02	...	0·05	...	3·09	0·62
9	0·31	0·35	0·03	...	0·35	...	3·30	1·92
23	0·44	0·56	0·09	...	1·78	...	3·49	2·20

promising, as it has a breaking load of 45,900lb., and limit of elasticity 36,600lb. per square inch. It has, comparatively, a low percentage extension (0·146 with 16,250lb. per square inch), a high coefficient of expansion (0·0000252), and a low temperature coefficient for electrical resistance (0·00178 per 1°C. between 0°C. and 100°C.). Again, iron in the presence of nickel (specimen 21) has slightly increased conductivity. This specimen has a comparatively high-breaking load of 42,200lb. per square inch, and its conductivity is slightly larger than in specimen 22. Silicon is the most widely separated of all the substances in the above series, and it should be remembered that all commercial aluminium contains traces of silicon and iron. Since these alloys were supplied the purity of commercial aluminium has been greatly improved, so that further research may yield results from which more definite deductions may be made. For exposed light aluminium alloys it appears that copper alone should not be used in the alloy; the presence of equal amounts (about 1 per cent.) of nickel and copper certainly reduces conductivity to a small extent, but the gain in mechanical and corrosive properties is great.

PROPOSED MUNICIPAL POWER DISTRIBUTION SCHEME AT SUNDERLAND.

At a special meeting of the Sunderland County Borough Council, held on Wednesday, the following recommendations of the Electricity and Lighting committee were agreed to:—

That the scale of charges to motor consumers as set forth in the electrical and tramways engineer's report be adopted; that, in accordance with the same report, application be made to the Board of Trade for sanction to adopt three-phase high-tension electrical transmission, and that the town clerk and the electrical and tramways engineer be authorised to take the requisite steps to obtain such sanction; that the Finance committee be directed to take the requisite steps for obtaining the sanction of the Local Government Board to the borrowing of £74,000 in respect of such scheme.

The report by Mr. J. F. C. Snell, referred to above, recommends that shipbuilders and engine builders should be offered the supply of electricity for driving workshop tools on such terms as would render it unprofitable for each firm to instal its own plant. Such a supply, the report states, would react favourably both on the Corporation's own electricity department and also on the general trade output of the town.

Up to the present, it is stated, the demand for current and the output have grown steadily. The cost per unit has compared favourably with that prevailing in other towns, and, in spite of the extremely low price of gas, the concern has been able to pay sinking fund and interest, leaving a small net profit balance. But the cost of production is still about 1½d. per unit, to which must be added 1d. for interest and sinking fund, making the total cost about 2½d. The cost of supply depends most largely on the load-factor—*i. e.*, the proportion of units actually generated to the number of units that could be generated with the plant working at full capacity all the year. The greater the number of units generated the less the cost. Shipyards and engine works have as high a load-factor as 30 per cent., whereas ordinary lighting consumers are as low as 9 per cent., and hotels and public-houses 18 per cent.

Mr. Snell goes on to state that he has ascertained that the cost to a shipyard for providing its own energy varies from 1½d. to 1d. per unit. In order, therefore, to supply these consumers, the Corporation must be prepared to supply at about this figure. Not only can this be done without unfairness to other classes of consumers, but, Mr. Snell states, unless this class of power consumer can be obtained the minimum charges to all classes can never be reached, and it would be hurtful to the interests of everybody concerned. If the demand for power for motors were received, the tramways department, which now pays 2d. would, he says, be able to look forward to the time when a price only a little higher than that proposed for the shipyards would be charged to them. Otherwise, they would never be able to reduce the cost to the trams below 1¼d. or 1⅛d.

The scale of charges proposed for motors is:—

0 to	500 units	per quarter	.....	5 per cent.	=2⅜d.
501 to	1,000	ditto	.....	10 do.	=2¼d.
1,001 to	1,500	ditto	.....	16 do.	=2⅛d.
1,501 to	2,500	ditto	.....	20 do.	=2d.
2,501 to	5,000	ditto	.....	25 do.	=1⅞d.
5,001 to	7,500	ditto	.....	30 do.	=1¾d.
7,501 to	10,000	ditto	.....	35 do.	=1⅝d.
10,001 to	25,000	ditto	.....	40 do.	=1½d.
25,001 to	50,000	ditto	.....	45 do.	=1⅜d.
50,000 to	100,000	ditto	.....	50 do.	=1¼d.
100,001	and over	ditto	.....	55 do.	=1⅛d.

At the present moment, continues the report, satisfactory negotiations are in progress with six of the large works in the borough, besides a large number of smaller power consumers, who, Mr. Snell thinks, would be prepared to enter into agreements upon the above basis and covering a term of years. The combined output to these works would reach 2½ million units, or more than the total output of the Sunderland electricity works in 1901. This refers to only six shipyards out of a possible 21.

The supply has hitherto been by low-pressure continuous current, but Mr. Snell recommends that the transmission in future should be by the three-phase high-pressure current, generated at a pressure of 5,500 volts and a frequency of 50 cycles per second. The current so generated at Hylton-road would be transmitted by high-pressure cables to certain sub-stations, at which there would be motor-generators, furnishing low-pressure continuous current to the distributing network. The formal sanction of the Board of Trade to the scheme has still to be obtained; but Mr. Snell has already interviewed Mr. Trotter, the electrical adviser to the Board of Trade, who, he says, has unofficially intimated that the proposal would be confirmed. It is proposed that additional sub-stations should be created at the South Docks, Hendon, Pallion and Monkwearmouth.

The estimate for carrying out the scheme is as follows:—Two 300kw. three-phase generators, two 700kw. three-phase steam generators, three Lancashire boilers, high-tension switchboard and cable connections, £27,920; Monkwearmouth sub-station, two 275kw. motor-generators, battery switchboards, land and buildings, £7,975; South Docks sub-station, two 250kw. motor-generators, one 500kw. motor-generator and building, £6,820; Hendon sub-station, two 250kw. motor-generators, switchboards, land and building, £5,170; Pallion sub-station two 250kw. motor-generators, switchboards and buildings, £4,455; high-pressure transmission mains, £18,308; total £70,648.

It will also be necessary sooner or later to lay additional low-tension mains, estimated at £3,000, making a grand total of £73,648.

As the first requirements will be at the South Docks and Monkwearmouth, Mr. Snell states that it will only be necessary to instal the following plant at the outset:—At Hylton-road station, one 700kw. steam three-phase generator, two 300kw. three-phase generators, one Lancashire boiler, high-tension switchboard, &c., £11,000; South Docks station, two 250kw. motor-generators, switchboards, buildings, &c., £9,800; Monkwearmouth sub-station, two motor-generators, switchboards, &c., £9,835; total £30,335.

The estimate for 1903–4 shows an output of 3,610,000 units. The cost of generation, &c., is put down at £19,045, and the revenue £35,575, leaving a gross profit of £16,530; and after paying sinking fund and interest amounting to £15,000 there is a net balance of £1,530.

It is stated that the North Eastern Marine Engineering Works have already applied for power, and will require about 600,000 units per annum.

This report gave rise to considerable discussion at the meeting of the Council on Wednesday. Alderman Bruce, chairman of the Electricity committee, and Mr. Snell, explained the nature of the recommendations, and Mr. D. Bell seconded the resolution for their adoption. Mr. T. Summerbell thought it unfair that the tramways should be charged more per unit than other power consumers, and Alderman Ranken criticised the whole principle of the scheme. The report and recommendations were ultimately adopted, 27 members voting for them, one against, and seven not voting.

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PROF. J. J. THOMSON ON RADIO-ACTIVITY.

Exactly 50 years ago, at the first meeting of the British Association in the city of Belfast, Sir GEORGE GABRIEL STOKES delivered, as one of the evening discourses, his famous lecture on "Recent Discoveries in Light." At that time the attention of physicists was closely directed to the curious action of certain bodies in emitting light at ordinary temperatures, and the main subject of Sir GEORGE STOKES' address was the then little understood phenomenon of fluorescence It is a remarkable coincidence that the British Association, meeting after half a century in the same Irish city, should listen at one of the usual two evening discourses to a lecture by Prof. J. J. THOMSON on the most recent researches tending to throw light on the true nature and cause of phosphorescence—viz., "Becquerel Rays and Radio-Activity." It is worthy of note, moreover, as Lord RAYLEIGH pointed out when proposing a vote of thanks to Prof. THOMSON for his brilliant lecture, that the series of discoveries which were described in that lecture, and formed the clue to phosphoresence and much besides, have all been made within the past five years. Thus, although the essential phenomena of radio-activity have been known to physicists for at least 50 years, it is only within the last half-decade that there has been any clue to their real cause. Doubtless much of this tardiness has been produced by too close an adherence to the undulatory theory of radiation, or, rather, from an unwillingness to perceive the consistency between this theory and the scorned emission theory in certain circumstances. It is indeed true, as Prof. THOMSON observed during his lecture, that had the researches connected with radio-activity which have been made recently actually been made before the triumph of the undulatory theory, that theory would have had a very much harder fight for recognition.

Prof. THOMSON traced the developments in radio-action research from the discovery of Röntgen rays down to the present time. It was the Röntgen ray which first gave the clue to the true action of uranium and other phosphorescent bodies, and it was Prof. BECQUEREL who first followed up this clue to a successful conclusion. Hence, the radiations or luminous emanations from uranium and other radio active bodies were now called Becquerel rays. The chance event of a photographic plate, wrapped in light-proof material, being put away for several days in a dark drawer, in company with a piece of phosphorescing uranium salt, was the starting point of Prof. BECQUEREL'S research. The phosphorescence had produced its effect on the plate, in spite of the darkness and the light-proof envelope. This pointed strongly to a resemblance between the phosphorescence and Röntgen rays, or some kindred emanation. Nevertheless, the actual piece of uranium salt used, having previously been exposed to ordinary light—in fact, to bright sunlight—was under suspicion of producing its photographic effect by

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virtue of this prior charging with luminous radiation. In other words, conclusive evidence was lacking that the uranium salt developed a self-originating radiation, and not a radiation due to previous exposure to light. Accordingly, Prof. BECQUEREL set about manufacturing some uranium salt which should never in the entire course of its existence be exposed to light. It was dissolved amidst darkness; and in black darkness the crystals were formed and deposited. Undiminished in consequence, the phosphorescence still occurred, and the sensitive plate was affected as vigorously as if the uranium salt had been previously bathed in light. This experiment conclusively proved that the luminous emanations were self-originating and independent of any previous influence on the radio-active material.

Passing quickly in review, by the aid of a few well-selected experiments, the most salient properties of radio-active bodies, Prof. THOMSON was able towards the end of the hour allotted for his lecture to deal with some of the most recent researches and calculations. Unfortunately, the Grosvenor Hall, in which the discourse was given, although an admirable lecture hall from an acoustic point of view, is not well adapted to the exhibition of delicate experiments, and more than one of Prof. THOMSON'S elaborate and well-arranged experiments had to be abandoned in consequence. Little, however, was lost to the audience on this account, for the lecturer invariably made so clear what should be expected to take place that it was even as if it had actually happened. The dielectrification by the presence of radio-active matter was exhibited in a variety of forms, one experiment—which was quite a success—being Mr. C. T. R. WILSON'S well-known fog experiment. The experiments of RUTHERFORD in the deviation of this form of radiation by a magnetic field were also described. The lecturer then passed on to the important work accomplished by Prof. and Madame CURIE, whose patient and laborious researches have imparted an immense stimulus to systematic inquiry into radio-active phenomena. These experiments are familiar to those of our readers who follow the records of radio-active research in these pages: the discovery that the Becquerel rays carry an electric charge, the detection of radio activity in an immense number of rare earths and other bodies, notably—as being of such marked character—in pitchblende. Many of these bodies were found to exhibit a higher degree of radio-activity than even uranium, yet only so when they were in their natural state. Their artificial synthesis always yielded a substance possessing no marked radio-activity as compared with uranium. Suspicion at once naturally arose that there was some unknown substance present to which these minerals, in common with the uranium salts, owe their radio-active properties. Yet the spectroscope gave no indication whatever of the presence of any such substance. Long and patient research, with the pertinacity of a SHERLOCK HOLMES, at length not only put Prof. and Madame CURIE upon the track of the real substances giving rise to radio-action, but also allowed of their concentrating these substances. Three such substances have been detected—(1) the well-defined and isolable substance radium, (2) a less well-defined and but slightly recognisable substance called polonium, and (3) a vague and elusive substance called actinium. Of these three essentially radio-active substances, polonium and actinium have never been obtained in a sufficiently high degree of concentration to make their presence visible in the spectroscope. Only by the evidence of radio-activity can their existence be detected. Thus, as Prof. THOMSON remarked, it is seen how much more delicate than chemical analysis, or even than spectroscopy, is radio-activity, as a test of the presence of these substances: "It is millions of times more sensitive than chemical analysis, and thousands of times more sensitive than the spectroscope." The percentage of radio-active matter in many substances in which these properties have been detected is "far less than the percentage of gold in sea water." Indeed, after Prof. and Madame CURIE had detected radio-activity in pitchblende it became necessary to concetrate the essential radio-active constituent, radium, to no less than 5,000 times higher a degree of concentration, before even the spectroscope would give evidence of its presence. With such inconceivably minute traces of matter are we thus dealing, in the refinements of this fascinating research.

The question raises itself as to what is the rate, in measurable units, at which these self-originating emanations are constantly going on. There are two rates to be considered: first, the rate at which matter is being projected from the surface of the radio-active material; secondly, the rate at which energy is being given off in the process. Prof. THOMSON'S answers to these two questions caused his audience much astonishment. So slowly, in the case of pure radium for instance, is matter being thrown off by the radio-activity, that it would occupy one square centimetre of surface a million years to throw off only one-thousandth of a milligramme of the substance. Yet visible, not to say vigorous emanations are proceeding uninterruptedly from that surface. The energy thrown off is at a far more rapid rate, being sufficient, within the million years, to melt a layer of ice a quarter of a mile thick. It remains yet to be explained how the radium maintains its supply of intrinsic energy. Is it by virtue of the heat energy of its environment—some peculiar atomic constitution enabling it to absorb and transform that energy into Becquerel radiation? Or, is it by virtue of the normal electrification of its environment—the fact, in other words, that the earth and all upon it is negatively charged? Prof. THOMSON, remarking on this latter point, mentioned that Messrs. ELSTER and GEITEL have found that a negatively charged wire or pointed piece of metal is radio-active. In virtue of the earth's negative charge, moreover, all leaf tips and other points connected with earth are found to be radio-active. Another recondite matter in connection with radio activity is its curious infectiousness, and the recovery in course of time of the infected bodies. Placed in contact with barium or thorium—or, indeed, almost any substance—a piece of radium will gradually impart to the neighbouring substance its own radio-active properties, and, still more wonderful to relate, it will itself lose those properties. If now the two substances be separated for a time, it will be found that the barium will gradually lose the properties which contagion imparted to it, while, at exactly the same rate, the depleted radium will restore itself to its normal radio-activity. The entire series of operations may then be repeated many times over. Herein is a mystery which physical research is as yet unable to fathom. Prof. THOMSON illustrated it in a homely manner. Imagine, he said, that all babies were radio-active from the moment they were born to the moment when they were 12 months old. Then, although there would be a continual supply of fresh babies, the radio-activity of the community would not, on the whole, greatly increase, for as many babies would pass out of the radio-active state as would be born into it. Now imagine that all the radio-active babies in the community at any given moment were to be removed to some place apart from the community. Then the community would for a time lose its radio-activity; but the *crèche* to which the infants had been removed would glow with its newly-acquired radiation. In time, however, the old community would gradually acquire its lost radio-activity, for new

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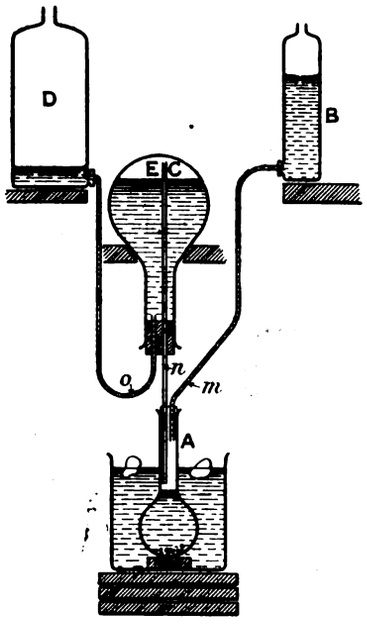
babies would be born and cast their glow around; while, in exactly the same process of time the *crèche* would gradually lose its radio-activity, for the infants would pass the age limit. The community is the radium, and the *crèche* is the infected barium; but Prof. THOMSON did not venture any further with his analogy. He refrained from giving any hint as to whether we are to infer therefrom that, like poets, "electrons are born, not made."

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

An Acetylene Generator.—H. A. Rands has devised a simple and convenient arrangement for laboratory use where a small quantity of acetylene is desired, free from air and as pure as the carbide will permit. It is shown in the diagram. Flask C is filled with water, preferably recently boiled, from D, inverted and placed in a rest provided for it. Aspirator bottle B is partly filled with water, and both it and tube E are connected with stopper of flask A, stopper not being in the flask. To insure absolute expulsion of air, valves *m*, *n* and *o* are fastened slightly open, so as to leak a very little. Flask A is then filled to the very top of neck with 95 per cent. alcohol, into which are dropped a few pieces of calcium carbide, after which



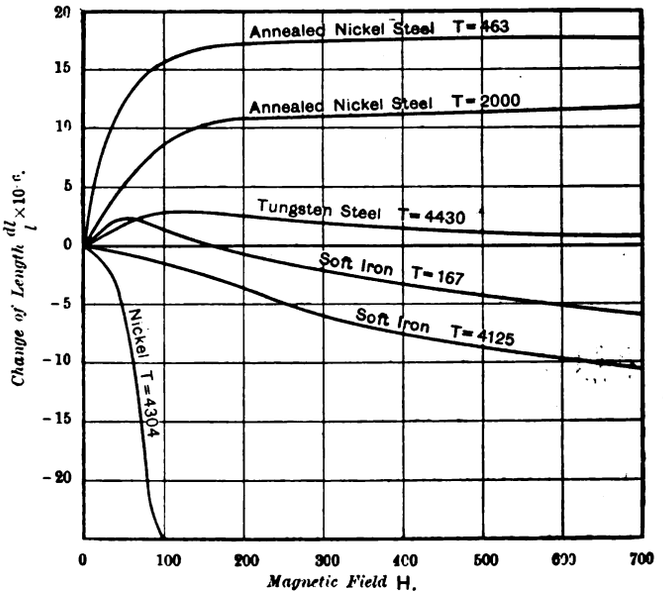
the flask is raised, the stopper pressed tightly in place, and flask supported at desired height on convenient blocks. Valve *m* is then closed tightly, and *o* and *n* opened full. The reaction will be very slow at first, and the gas first formed will collect at top of A, the pressure gradually forcing some of the liquid up into C. This will continue until foot of E is reached, when bubbles will pass up into C, forcing some of the water out, as shown. The reaction may be hastened at any time by opening *m* for an instant, allowing water to replace some of the alcohol. Should the reaction become very rapid, so that the small amount of liquid in A becomes heated, the blocks may be removed, and a beaker containing water and a few bits of ice may be raised up under it, as shown, which will insure coolness. When a sufficient quantity of acetylene has been obtained *n* is closed, A removed, and the water about stopper will form a perfect seal.

[H. A. RANDS, *Phys. Review*, September, 1902.]

Empirical Formulæ.—The method of least squares, now accepted as the best method for determining the constants of an empirical formula, becomes unwieldy when powers higher than the second are introduced. E. G. Brown points out that it practically prevents the analytical application of all sorts of formulæ which it might be easily possible to apply by other means. He develops a class of formulæ involving Taylor's series, which he calls "power expansion formulæ." First, he introduces a new variable x, such that for the given experiments its range shall be as nearly as practicable from 0 to 1. Then, instead of simple-power terms, he uses "standard" terms made up of sums of terms, and compounded of the factors x, $(1-x)$, $(1-2x)$, $(1-4x)$, $(3-4x)$, and so on. The first of these factors is the negative of the parabola used by Callendar in platinum thermometry. Curves of experimental data should be traced as bands having twice the experimental error for their width. In the graphic process the first term is the initial value of the dependent variable as given by the graph; the second is the average rate of charge for the whole experimental range; the third is the average curvature for the whole scale expressed in terms of a parabola; the fourth is the difference in curvature of the first and second half of the range expressed as a cubic standard formula. Formulæ and curves are given for as many as nine terms.

[E. G. BROWN, *Trans. New Zealand Inst.*, 34, 1902.]

Length of Magnetised Wires under Tension.—K. Honda and S. Shimizu have repeated Bidwell's experiments with an improved apparatus, which allows of the tension being made very small, and thus brings out the characteristic difference between nickel, iron, and nickel-steel shown in the diagram. T is the tension in grammes per square millimetre. In soft iron there is a distinct elongation in weak fields, but this gives



way to a reduction as the field is increased. When the tension is increased, the initial elongation disappears, and the effect of the field is larger than it was. When the tension is considerable—*i.e.*, when a large proportion of molecules are pulled out of their positions of equilibrium under molecular attraction—the effect of magnetisation is to reduce the length of the wire, as might be expected from the attraction of the molecular currents. The elongation under feeble tension, and the uniform elongation of nickel-steel must be due to some unexplained cause, which urges the molecules apart, while the tension and the field is feeble. The behaviour of nickel-steel is all the more remarkable, as nickel by itself shows a uniform reduction in length even with the feeblest field.

[HONDA and SHIMIZU, *Phil. Mag.*, September, 1902.]

Electric Currents in Plants.—In Waller's experiment, a leaf is placed on a glass plate between zinc electrodes, and one half of it is illuminated, while the other half is covered with black paper. An electric current then passes from the illuminated portion to the dark portion, especially under the red rays which are absorbed by chlorophyll. Waller believes this current to be due to a direct photo-electric action of the light upon the leaf. C. Ries gives a number of reasons for believing that it is a photo-chemical current of a non-physiological nature. In the first place it is not necessary that the leaves

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be green to show the effect. Then, no current is indicated when the electrodes themselves are covered. The effect also depends upon the material of the electrodes. When copper or silver electrodes are substituted for the zinc electrodes the current is reversed, and it is greatly reduced by carefully cleaning the electrodes. The effect is practically the same when the electrodes are dipped into the juice of the leaves instead of being in contact with them. The author believes the phenomenon to be identical with the photo-chemical currents observed by Hankel, Schmidt, Luggin, Pellat, and others, and to be mainly due to the sodium, potassium, and calcium compounds contained in the plants. The effect is enhanced by chlorophyll, just as it is by a variety of other dies and pigments.

[C. Ries, *Physikal. Zeitschr.*, August 15, 1902.]

Atmospheric Electricity.—W. Caspari has made some valuable observations of the dissipation of electricity at Brienz, on the Rothorn, and on Monte Rosa. Some of the observations are very characteristic of Föhn weather, with its strong precipitations alternating with clear periods of very limpid air. During those periods there is great ionisation of the air and large prevalence of positive ions. Thus, on the Rothorn, on August 27th, the coefficient of dissipation of positive electricity was 6·84, and of negative electricity 20·98. On the Col d'Olen, Monte Rosa, the coefficients were 4·69 and 8·56 respectively on a foggy day, and 18·86 and 17·11 respectively on a clear day. On Monte Rosa, between September 4th and September 8th, there was a regular alternation between snowstorms and sunny weather, always marked by a similar change from prevalent negative and positive ions respectively. There is a close connection between ionisation and mountain sickness. A bad place for mountain sickness was the Lyssjoch, altitude 4,000 metres, at the edge of a vast ice cleft. The coefficients of positive and negative dissipation at that place were 18·16 and 51·44 respectively, probably the highest ever observed. The high ionisation was probably due to the same cause as that which produces it in a cellar. An excess of free ions evidently acts as a poison.

[W. Caspari, *Physikal. Zeitschr.*, August 15, 1902.]

Generation of Röntgen Rays.—T. Tommasina formulates the following novel view of the formation of Röntgen rays: The electric flux starting from the anode follows the lines of electric force, forming its own conductors, which consist of polarised alignments of radiant matter, as is the case in the production of electric phantoms by conducting powders in liquid dielectrics. The flux being of an oscillating character gives rise to a periodical destruction of the contacts, and thus produces vibrations which become visible in the form of luminescence. The cathode is not the only source of cathode or X-rays, as these may also be generated at the walls of the tube, and generally at any point where the anode flux is reflected. It is not necessary, as alleged by Semenov, that the anticathode be insulated. Cathode rays can be produced in a conical tube in which an electrode is placed at the top of the cone, and another in a side tube, by joining the former electrode to the positive pole of an induction coil through a water resistance, and leaving the other electrode and the other pole insulated. This would apparently mean that the impact of positive ions is sufficient to elicit negative ions and produce Röntgen rays. The production of the latter, which require a high velocity of impact, could hardly be due to the impact of slow positive ions.

[T. Tommasina, *Comptes Rendus*, August 11, 1902.]

LIST OF THE ELECTRICAL PAPERS READ AT THE BRITISH ASSOCIATION MEETING AT BELFAST.

The following is a complete list of electrical Papers read and reports presented at the Belfast meeting of the British Association, September 10 to 16, 1902:—

Section A.—Mathematical and Physical Science.

Presidential address by Prof. John Purser.

"On the Question as to the Accurate Conservation of Weight in Chemical Reactions," by the Right Hon. Lord Rayleigh, F.R.S.

"Motion of a Detached Thread of Liquid in a Capillary Tube," by Prof. W. B. Morton and W. Hawthorn.

"Further Experiments by the Thermal Method on the Variation of the Critical Velocity of Water with Temperature," by Dr. H. T. Barnes.

"A New Bolometer for Recording the Total Daily Amount of Solar Radiation," by Dr. W. E. Wilson, F.R.S.

"On the Variation of the Specific Heat of Mercury with Temperature, by the Continuous Flow Method," by Dr. H. T. Barnes.

"Some Experiments on Radiation and Absorption: a Preliminary Study for a Standard of Light," by J. E. Petavel.

"Animal Thermostat," by the Right Hon. Lord Kelvin, F.R.S.

"On the Application of the Method of Entropy to Radiant Energy," by Dr. J. Larmor, Sec. R. S.

"The Relation of Voltaic Potential to Temperature," by Dr. J. Larmor, Sec. R. S.

"Does Motion Through the Ether Cause Double Refraction?" by the Right Hon. Lord Rayleigh, F.R.S.

Report of the Committee on Electrical Standards.

"Magnetic Detectors in Space Telegraphy," by Prof. E. Wilson, F.R.S.

"A New Receiver for Hertzian Oscillations," by Prof. G. M. Minchin, F.R.S.

"A Graphical Method of Determining the Discharge of a Condenser Through a Variable Self-induction," by Dr. E. W. Marchant.

"Luminosity and the Kinetic Theory," by J. Butler-Burke.

"Seamless Aluminium Tube," by H. F. Nalder.

Section B.—Chemistry.

"The Atomic Theory Without Hypothesis," by Prof. E. Divers, F.R.S. (presidential address).

Section G.—Engineering.

"Recent Progress in Large Gas Engines," by A. Humphrey.

"Steam Turbines," by the Hon. C. A. Parsons.

"Undulations Produced in a Road by the Use of Sledges," by Vaughan-Cornish, D.Sc.

"An Elastic Wheel," by J. Brown, F.R.S.

"An All-Stations Express," by J. Brown, F.R.S.

"Water Power in Ireland," by F. J. Dick.

"The Future of the Telephone in the United Kingdom," by J. E. Kingsbury.

"A New Magnetic Testing Instrument," by F. Holden.

"Alloys of Aluminium," by Prof. E. Wilson.

"Some Electrical Instruments," by M. B. Field.

"The Science of the Workshop," by W. Taylor.

"The Importance of Minor Details in Engineering Work," by M. Holroyd Smith.

"On the Specific Utilisation of Materials in Dynamo Construction," by Prof. Silvanus P. Thompson, F.R.S.

Report of the Committee on the Small Screw Guage.

"Combustion of Bituminous Fuel," by W. H. Booth.

"The Prevention of Smoke," by J. S. Raworth.

"The Solignac Boiler," by W. H. Booth.

"The Making of a Dynamo," by H. A. Mavor.

"A Preliminary Note on Gas Engine Explosions," by H. E. Wimperis.

Section L.—Educational Science.

Report on "Teaching of Mathematics," by Prof. Forsyth.

ELECTRICITY WORKS ACCOUNTS.

Norwich Electricity Co.

A distinct improvement in the position of this undertaking is to be discerned in the accounts for 1901. Following a reduced fuel bill, the generating costs show a slight diminution, which would have been more pronounced had it not been for the continued rise in the expenditure on repairs at the station. It is noteworthy that while this latter item exhibits an abnormally high figure, the item of wages at the station is correspondingly low, so that the two items jointly compare very well indeed with the average of company-owned undertakings of similar character. Another generating item which has remained steady and at a very low figure is that of oil and stores, and it is, therefore, not surprising that now the fuel charge has fallen to the relatively moderate amount of 0·85d. per unit that the total generating and works costs are well below the average. Though they have increased, the management and property charges are still low, and consistently share in the credit of the low total costs figure of 2·4d. per unit sold.

Amongst company stations the total revenue, from all sources, of 4d. per unit is especially creditable when studied in relation to a working profit of 7·12 per cent. of the mean capital expended. In fact, it is to a combination of low working costs and low capital expenditure relatively to the output that the gratifying financial results shown are due.

A provisional agreement with the Norwich Town Council had been entered into for the acquisition by the latter of the undertaking from December 31st last subject to the payment of a dividend of 6 per cent. free of income tax for 1901.

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	NORWICH.		SCARBOROUGH.	
Undertaking Worked by	The Norwich Electricity Co.		The Scarborough Electric Supply Co. (Ltd.).	
Date of Commencement of Supply	October, 1893.		September, 1893.	
System of Supply	3-wire continuous-current with batteries.		Alt.-curr. transformer sub-stations and partly [house transformers.	
Chief Engineer	F. M. Long.		F. G. Holden.	
YEAR ENDED	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	—	—	—	589,728
,, **SOLD (TOTAL)**	1,183,675	1,332,109	321,676	379,743
,, sold to consumers	1,183,675	1,332,109	321,676	379,743
,, sold for public lighting, &c.	—	—	nil	nil
,, sold for traction	—	—	nil	nil
,, used on works	—	—	3,590	4,422
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	26·5	21·1	15·2	13·8
Actual maximum supply demanded	1,170 kilowatts	1,367 kilowatts	382 kilowatts	442 kilowatts
Load factor	11·5%	11·1%	9·62%	9·81%
Number of public lamps	nil	nil	nil	nil
Number of consumers	1,858	2,266	592	702
Connections to mains in 8-c.p. lamps at end of year	75,742	87,670	33,343	40,197
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	1,600	2,431	675	1,085
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£200,000 / £125	£200,000 / £82·2	£100,000 / £148	£100,000 / £92·1
Share	100,000 / 62·5	100,000 / 41·1	100,000 / 148	100,000 / 92·1
Loan (including Debenture charges)	100,000 / 62·5	100,000 / 41·1	— / —	— / —
RECEIVED (TOTAL)	118,000 / 73·7	123,900 / 51·0	50,995 / 75·6	63,995 / 59·0
Share	70,000 / 43·7	87,500 / 36·0	50,995 / 75·6	63,995 / 59·0
Loan (including Debenture charges)	48,000 / 30·0	36,401 / 10·9	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	82,000 / 51·2	76,100 / 31·3	49,005 / 72·6	36,005 / 33·2
Share (unissued)	30,000 / 18·7	12,500 / 5·14	40,000 / 59·3	30,000 / 27·6
Share (uncalled)	— / —	— / —	9,005 / 13·4	6,005 / 5·53
Loan (including Debentures)	52,000 / 32·5	63,600 / 26·2	nil / —	nil / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	10,000[a] / 6·25	17,004[l] / 6·99	— / —	— / —
DEPRECIATION FUND	13,899 / 8 69	17,399[o] / 7·16	2,000 / 2·96	2,648 / 2·44
EXPENDED (TOTAL)	129,993 / 81·1	146,284[o] / 60·2	53,854 / 79·8	67,990 / 62·7
Lands and buildings	22,496[b] / 14·1	24,047[m] / 9·89	10,521[g] / 15·6	13,135[g] / 12·1
Plant	55,658[c] / 34·3	64,582[n] / 26·6	24,584[h] / 36·4	31,564[i] / 29·1
Mains	49,584 / 31·0	55,106 / 22·7	17,730 / 26·3	22,264 / 20·5
Miscellaneous	2,254 / 1·41	2,549 / 1·05	1,020 / 1·51	1,028 / 0·947
BALANCE OF CAPITAL ACCOUNT	−11,993[d] / −7·50	−22,384[d] / −9·21	−2,859[a] / −4·24	−3,995[a] / −3·68
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£20,118 / 4·075d.	£22,646 / 4·080d.	£7,750 / 5·780d.	£8,753 / 5·533d.
Revenue from supply	19,372 / 3·925d.	21,665 / 3·903d.	7,482 / 5·580d.	8,408 / 5·313d.
,, meters, &c.	724 / 0·147d.	831 / 0·150d.	248 / 0·185d.	306 / 0·193d.
,, public lighting	— / —	— / —	— / —	— / —
,, supply for traction	— / —	— / —	— / —	— / —
,, miscellaneous sources	22 / 0·004d.	150 / 0 027d.	19 / 0·014d.	38 / 0·024d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£12,278 / 2·487d.	£13,315 / 2·397d.	£4,263 / 3·178d.	£4,623 / 2 920d.
TOTAL WORKS COSTS	9,094 / 1·840d.	9,552 / 1·721d.	3,414 / 2·546d.	3,578 / 2·262d.
Generation of electricity	*8,161* / *1·653d.*	*8,694* / *1·566d.*	*3,302*[b] / *2·463d.*	*3,379*[b] / *2·135d.*
Fuel (including cartage, &c.)	4,745 / 0·961d.	4,719 / 0·850d.	2,002 / 1·493d.	2,079 / 1·314d.
Oil, waste, water, stores	287 / 0·058d.	323 / 0·058d.	123 / 0 092d.	105 / 0·066d.
Wages at station	1,455[e] / 0·295d.	1,649[p] / 0·297d.	796[j] / 0·594d.	858[l] / 0·542d.
Repairs and maintenance at station	1,650[f] / 0·334d.	1,982[q] / 0·357d.	318[k] / 0·237d.	282[m] / 0·178d.
Distribution of electricity	*933* / *0·189d.*	*858* / *0·154d.*	*112* / *0·084d.*	*199* / *0·126d.*
Wages, &c.	184[g] / 0 037d.	170[r] / 0·031d.	70[n] / 0·052d.	87[n] / 0·055d.
Repairs, renewals of mains, &c.	749[h] / 0·152d.	688[s] / 0·124d.	42[o] / 0·031d.	112[o] / 0·071d.
Public lighting	— / —	— / —	nil / —	nil / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	3,184 / 0·645d.	3,761 / 0·678d.	849 / 0·633d.	1,045 / 0 661d.
Net rents	— / —	— / —	*47* / *0·035d.*	*73* / *0·046d.*
Rates and taxes	*982* / *0·199d.*	*1,217* / *0·219d.*	*248* / *0 185d.*	*330* / *0 209d.*
Management	*2,202* / *0·446d.*	*2,544* / *0·458d.*	*554* / *0 413d.*	*642* / *0·406d.*
Salaries	1,731[i] / 0·351d.	1,889[t] / 0·340d.	262[e] / 0·195d.	354[e] / 0·224d.
Stationery, &c.	125 / 0·025d.	135 / 0·024d.	61 / 0 045d.	90 / 0·057d.
Establishment charges	156 / 0·032d.	198 / 0·036d.	57 / 0·043d.	66 / 0·042d.
Law charges &c.	190[j] / 0·039d.	322[u] / 0·058d.	174[d] / 0·130d.	132[p] / 0·083d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£8,627[k] / 7·05%	£9,836 / 7·12%	£3,488 / 7·09%	£4,130 / 6·78%
Sum carried to Depreciation Fund	3,000 / 2·45%	3,500 / 2·53%	530 / 1·08%	600 / 0·985%
Sum carried to Reserve Fund	— / —	— / —	— / —	— / —
Net interest on loans (incl. Debenture charges)	1,306 / 1 07%	1,451 / 1·05%	11 / 0·022%	46 / 0·076%
Net profit for the year	4,321 / 3·53%	4,885 / 3·54%	2,947 / 5·99%	4,018[q] / 6·60%
BALANCE FROM LAST ACCOUNT	125 / 0·102%	229 / 0·166%	158 / 0·321%	102 / 0·168%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	4,446 / 3·63%	5,114 / 3·70%	3,191[c] / 6·48%	4,119[q] / 6·76%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	6% / —	6% / —	6½% / —	7% / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	61%	58·8%	55·0%	52·8%
Expenditure per mean kilowatt capacity	£8. 11s. 5d.	£6. 12s. 2d.	£6. 6s. 5d.	£5. 5s. 0d.
REVENUE PER MEAN KILOWATT CAPACITY	**£14. 0s. 10d.**	**£11. 3s. 10d.**	**£11. 9s. 7d.**	**£9. 18s. 10d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	**6s. 1d.**	**5s. 6d.**	**5s. 1d.**	**4s. 9d.**
Price charged for lighting, per unit	5d.	5d.	6½d. to 5½d.[f]	6½d. to 5½d.[f]
Price charged for power, per unit	3d. to 1½d.	3d. to 1d.	2½d.	2½d.
Price charged for public lighting	—	—	—	—
Receipts per unit for private supply	3·93d.	3·90d.	5·58d.	5·31d.
,, ,, public lighting	—	—	—	—
,, ,, traction	—	—	—	—

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Interest at 3½ per cent. was to be paid by the Corporation on the purchase money from the beginning of the year to date of completion of purchase.

Scarborough Electric Supply Co.

In the case of the Scarborough undertaking all the items of generating costs have been reduced, but the fuel and the wages at the station are both still too high. Management and property charges have slightly increased but are not excessive. On the whole the costs of working, while lower than last year, still offer opportunities for further improvement, as the favourable financial results shown are due mainly to the moderate capital expenditure relatively to the output and to the somewhat high total revenue. The latter condition must operate to check the desirable expansion of the concern. The allocation for depreciation continues to be meagre, and the net profits shown include £534 from premiums.

REMARKS.

NORWICH.—*a* "Reserve fund"; includes £6,764 premiums on shares. *b* Lands £5,193, buildings £17,301. *c* Machinery £35,502, accumulators £2,620, meters £14 642, electrical instruments £2,889. *d* Over-expended. *e* Proportion of salaries of engineers and officers £342. *f* Buildings £66, engines and boilers £490, dynamos, exciters, transformers and motors £511, accumulators and accessories £166, other plant and tools £418. *g* Proportion of salaries of officers. *h* Of mains £406, of apparatus on consumers' premises £343. *i* Directors £568, salaries of managing engineers, secretary, &c., £1,162. *j* Auditing £60, law £18, insurance £ 13. *k* Including rents on wiring £335, profit on installation work £453. *l* "Reserve fund"; includes £7,004 net from premiums. *m* Buildings £18,855. *n* Machinery (including £297 written off for depreciation) £42,074, accumulators £2,620, meters (including £1,663 written off for depreciation) £16,533 and instruments £3,355. *o* Includes £1,960 written off meters and machinery. *p* Proportion of salaries of engineers and officers £563. *q* Buildings £90, engines and boilers £875, dynamos, exciters and motors £322, accumulators £169, other plant and instruments £525.

SCARBOROUGH.—*a* Over-expended. *b* £63 lighting of works in 1900 and £55 in 1901. *c* Directors £100, salaries of managing engineers, secretary, &c., £162 in 1900 and £254 in 1901. *d* Insurance £76, law £62, auditing £36. *e* Including £36 premium on shares. *f* Accounts over £75 on Wright system, 7d. (1 hour) to 3d. *g* Lands £1,625. *h* Machinery £17,067, transformers and motors £3,731, meters £3,142, instruments £653. *i* Machinery £22,915, transformers and motors £4 187, meters £3,783, instruments £679. *j* Proportion of salaries of engineers and officers £111. *k* Buildings £2, plant £317. *l* Proportion of salaries of engineers and officers £116. *m* Buildings £96, plant £184. *n* Proportion of salaries of officers. *o* Of mains £1 in 1900 and £53 in 1901; of apparatus on consumers' premises £3 in 1900 and £15 in 1901; of apparatus at distributing stations £36 in 1900 and £45 in 1901. *p* Auditing £43, law £3, insurance £95. *q* After adding £534 from premiums.

PROF. JOHN PERRY'S PRESIDENTIAL ADDRESS TO SECTION G OF THE BRITISH ASSOCIATION.*

(*Concluded from page 841.*)

I must not dwell any longer on the three essential parts of a good general education which lead to the three powers which all boys of fifteen ought to possess; power to use books and to enjoy reading; power to use mathematics and to enjoy its use; power to study Nature sympathetically. English Board School boys who go to evening classes in many technical schools after they become apprentices are really obtaining this kind of education. The Scotch Education Board is trying to give it to all boys in primary and secondary schools. It will, I fear, be some time before the sons of well-to-do parents in England have a chance of obtaining it.

When a boy or man of any age or any kind of experience enters an engineering college and wishes to learn the scientific principles underlying a trade or profession, how ought we to teach him? Here is the reasonable general principle which Profs. Ayrton and Armstrong and I have acted upon, and which has, so far, led us to much success. Whether he comes from a bad or a good school, whether he is an old or young boy or man, approach his intelligence through the knowledge and experience he already possesses. This principle involves that we shall compel the teacher to take the pupil's point of view† rather than the pupil the teacher's; give the student a choice of many directions in which he may study; let lectures be rather to instruct the student how to teach himself than to teach him; show the student how to learn through experiment and how to use books, and, except for suggestion and help when asked for, leave him greatly to himself. If a teacher understands the principle he will have no difficulty in carrying it out with any class of students. I myself prefer to have students of very different qualifications and experience in one class, because of the education that each gives to the others. Usually, however, except in evening classes, one has a set of boys coming from much the same kind of school, and, although perhaps differing considerably as to the places they might take in an ordinary examination, really all of much the same average intelligence. Perhaps I had better describe how the principle is carried out in one case—the sons of well-to-do parents such as now leave English schools at about 15 years of age.

* Delivered at Belfast September 11th.

† Usually it is assumed that there is only one line of study. In mathematics it is assumed that a boy has the knowledge and power and past experience and leisure of an Alexandrian philosopher. In mechanics we assume the boy to be fond of abstract reasoning, that he is a good geometrician who can do the most complex things in geometrical conics, but cannot possibly take in the simplest idea of the calculus.

It was for such boys that the courses of instruction at the Finsbury Technical College (the City and Guilds of London Institute) were arranged 22 years ago. It was attempted to supply that kind of training which ought already to have been given at school, together with so much technical training as might enable a boy at the end of a two-years' course to enter any kind of factory where applied science was important, with an observing eye, an understanding brain and a fairly skilful hand. The system, in so far as it applies to various kinds of mechanical engineering, will be found described in one of a small collection of essays called "England's Neglect of Science," pp. 57-67.* I am sure that any engineer who reads that description will feel satisfied that it was the very best course imaginable for the average boy of the present time. A boy was taught how he must teach himself after he entered works. If after two or three years in the works he cared to go for a year or so to one of the greater colleges, or did not so care, it was assumed that he had had such a training as would enable him to choose the course which was really the best for him.

Old Finsbury students are to be found everywhere in important posts. The experiment has proved so successful that every London polytechnic, every municipal technical school in the country, has adopted the system, and in the present state of our schools I feel sure that all important colleges ought to adopt the Finsbury system. It hardly seems appropriate to apply the word "system" to what was so plastic and uncrystallised and had nothing to do with any kind of ritual.

The professors were given a free hand at Finsbury, and there were no outside examiners. I need not dwell upon the courses in chemistry and physics—some critics might call the subjects *rational* chemistry and applied physics—they were as different from all other courses of study in these subjects as the courses on rational mathematics and mechanics differed from all courses elsewhere. The course on mechanics was really one on mechanical engineering. There were workshops in wood and iron, not to teach trades, but rather to teach boys the properties of materials. There were a steam engine and a gas engine, and shafting and gearing of many kinds, and dynamos which advanced students in turn were allowed to look after under competent men. There was no machine which might not be experimented with occasionally. Elementary and advanced courses of lectures were given; there was an elaborate system of tutorial classes, where numerical and squared paper exercise work was done; there were classes in experimental plane and solid geometry, including much graphical calculation; boys were taught to make drawing-office drawings in pencil only, and tracings and blue prints, such as would be respected in the workshop, and not the ordinary drawing-class drawings, which cannot be respected anywhere; but the most important part of the training was in the laboratory, in which every student worked, making quantitative experiments. An offer of a 100-ton testing machine for that laboratory was made, but refused; the advanced students usually had one opportunity given them of testing with a large machine, but not in their own laboratory. I consider that there is very little educational value in such a machine; the student thinks of the great machine,† and not of the tiny specimen.

* The ideas in this Address have been put forward many times by Professor Ayrton and myself. See the following, among other publications:—"England's Neglect of Science" (Fisher Unwin); "Practical Mechanics," 1881 (Cassell); "Applied Mechanics," 1897 (Cassell); "The Steam Engine, &c.," 1898 (Macmillan); "The Calculus for Engineers," 1897, (Arnold); "Recent Syllabuses and Examination Papers of the Science and Art Department in Subjects I., VII., Vp and XXII."; "Summary of Lectures on Practical Mathematics (Board of Education); "The Work of the City and Guilds Central Technical College" (*Journal* of the Society of Arts, July 9, 1897); "Inaugural Lecture at Finsbury," 1879; "Address at the Coventry Technical Institute," February, 1898; "Education of an Electrical Engineer" (*Journal* of the Society of Telegraph Engineers and of Electricians, September, 1882); "Presidential Address," Institution of Electrical Engineers, January, 1892; "The Best Education for an Engineer" (*Nature*), October 12, 1899; "Address at a Drawing-room Meeting," March, 1887.

† These great testing machines, so common in the larger colleges, seem to have destroyed all idea of scientific experiment. There is so much that the engineer wants to know, and yet laboratory people are persistently and lazily repeating old work suggested and begun by engineers of 60 years ago. For example, men like Fairbairn and Robert Napier would long ago have found out the behaviour of materials under combined stresses. We do not even know the condition of strength of iron or steel in a twisted shaft which is also a beam. The theory of strength of a gun or thick tube under hydraulic pressure is no clearer now than it was 50 years ago. The engineer asks for actual information derived from actual trial, and we offer him the "cauld kail het again" stuff falsely called "theoretical," which is found in all the text-books (my own among others). These great colleges of university rank ought to recognise that it is their duty to increase knowledge through the work of their advanced students. The duty is not neglected in the electrical departments of some of the colleges. Perhaps the most instructive reference is to the work done at the Central Technical College of the City and Guilds Institute at South Kensington, as described by Prof. Ayrton in some of the Papers already referred to. I cannot imagine a better development of the Finsbury idea in the work of the highest kind of engineering college.

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Junior students loaded wires and beams, or twisted things with very visible weights, and saw exactly what was happening, or they studied vibrating bodies. Many hours were devoted to experiments on a battered, rusty, old screw-jack or some other lifting machine, its efficiency under many kinds of load being determined, and students studied their observations, using squared paper, as intently as if nobody had ever made such experiments before. There was one piece of apparatus—an old flywheel, bought at a rag-and-bone shop—to which kinetic energy was given by a falling weight, which, I remember, occupied the attention of four white-headed directors of electric companies in 1882 (evening students) for many weeks. A casual first measurement led on to corrections for friction and stiffness of a cord, and much else of a most interesting kind. At the end of six weeks these gentlemen had gained a most thorough computational acquaintance with every important principle of mechanics, a knowledge never to be forgotten. They had also had a revelation such as comes to the true experimenter—but that is too deep a subject.

Perhaps teachers in the greater colleges will smile in a superior way when they hear of this kind of experimental mechanics being called engineering laboratory work. True, it was elementary mechanics; but is not every principle which every engineer constantly needs called a mere elementary principle of mechanics by superior persons? I find that these elementary principles are very much unknown to men who have passed through elaborate mathematical studies of mechanics. Students found out in that laboratory the worth of formulæ; they gained courage in making calculations from formulæ, for they had found out the extent of their own ignorance and knowledge.

I have never approved of elaborate steam engines got up for students' laboratory exercise work. A professor who had devoted much thought for a year to the construction of such a four-cylinder engine showed a friend how any one or any two or any three or all four cylinders, with or without jacketing, could be used in all sorts of ways. The friend ventured to say: "This engine will be used just once and never after." The professor was angry, but his friend proved to be right. The professor made experiments with it once himself with a few good students. Unfortunately, it was not a sufficiently elaborate investigation for publication. Afterwards he never had time personally to superintend such work; his assistants were busy at other things; his students could not be trusted with the engine by themselves, and to this day it stands in the laboratory a beautiful but useless piece of apparatus. At Finsbury there was an excellent one-cylinder engine with vapourising condenser. It drove the workshops and electric generators. On a field-day it drove an electric generator only, and perhaps 30 students made measurements. Each of them had already acted as stoker and engine driver, as oiler and tester of the machinery, lighting fires, taking indicator diagrams, weighing coals, opening and closing cocks from 7 in the morning to 10 at night, so that everything was well known to him. They maintained three different steady loads for trials of three hours each. They divided into groups, one from each group ceasing to take a particular kind of observation every 10 minutes and removing to another job. All watches were made to agree, and each student noted the time of each observation. These observations were: Taking indicator diagrams, checking the speed indicator, taking temperature of feed-water, quantity of feed by meter (the meter had been carefully checked by gauge-notch, and every other instrument used by us had been tested weeks before), taking the actual horse-power passing through a dynamometer coupling on the shaft, taking boiler and valve-chest pressures and vacuum pressures on the roof and in the engine-room, weighing coals (the calorific value had already been tested), taking the horse-power given out by the dynamo, counting the electric lamps in use, and so on. Each student was well prepared beforehand. During the next week he reduced his own observations, and some of the results were gathered on one great table. One lesson that this taught could never be forgotten—how the energy of 1lb. of coal was disposed of. So much up the chimney or by radiation from boiler or steam-jacket and pipes; in condensation in the cylinder; to the condenser; in engine friction; in shaft friction, &c. I cannot imagine a more important lesson to a young engineer than this one taught through a common working engine. The students had the same sort of experience with a gas engine. I need hardly say how important it was that the professor himself should take charge of the whole work leading up to, during and after such a field-day.

The difficulty about all laboratory exercise work worth the name is that of finding demonstrators and assistants who are wise and energetic. Through foolishness and laziness the most beautiful system becomes an unmeaning routine, and the more smoothly it works the less educational it is. In England just now the curse of all education is the small amount of money available for the wages of teachers—just enough to attract mediocre men. I have been told, and I can easily imagine, that such men have one talent over-developed—the talent for making their job softer and softer—until at length they just sit at a table, maintaining discipline merely by their presence, answering the questions of such students as are earnest enough to come and worry them. In such cases it is absolutely necessary to periodically upset their clockwork arrangements. After such an artificial earthquake one might be reminded of what occurred at the pool of Bethesda, whose waters had their healing property restored when the angel came down and troubled them. But for a permanently good arrangement there ought to be very much higher wages all round in the teaching profession.

No kind of engineering has developed so rapidly as the electrical. Why, it was at the meeting here in Belfast 28 years ago (I remember, for I was a secretary of Section A that year, and took the machine to pieces afterwards in Lord Kelvin's laboratory) that there was exhibited for the first time in these islands a small Gramme machine. This handmaid of all kinds of engineering is now so important that every young engineer may be called uneducated who has not had a training in that kind of mechanical engineering which is called electrical engineering. Prof. Ayrton's laboratory at Finsbury is the model copied by every other electrical engineering laboratory in the world. He and I had the same notions; we had both been students of Lord Kelvin; we had worked together in Japan since 1875; but whereas I was trying to make my system of teaching mechanical engineering replace an existing system, or want of system, there was no existing system for his to replace. Thus it will be found that in every electrical engineering laboratory the elementary principles are made part of a pupil's mental machinery by many quantitative experiments, and nobody suggests that it is mere elementary physics which is being taught—a suggestion often enough made about the work in my mechanical laboratory. When students know these elementary principles well, they can apply their mathematics to the subject. As they advance in knowledge they are allowed to find out by their own experiments how their simple theories must be made more complex in real machines. Their study may be very complete, but, however much mathematics and graphical calculation may come in, their designs of electrical machinery are really based upon the knowledge acquired by them in the electrical and mechanical laboratories.

The electrical engineer has an enormous advantage over other engineers; everything lends itself to exact calculation, and a completed machine or any of its parts may be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by other engineers, do not destroy the body tested. But for this very reason, as a finished product, the electrical engineer cannot have that training in the exercise of his judgment in actual practical work after he leaves a college that some other engineers must have. In tunnelling, earthwork, and building, in making railways and canals, the engineer is supremely dependent on the natural conditions provided for him, and these conditions are never twice the same. There are no simple laws known to us about the way in which sea and river currents will act upon sand and gravel, and engineers who have had to do with such problems are continually appealing to Nature, continually making observations and bringing to bear upon their work all the knowledge and habits of thought that all their past experience has given them. I do not know that there is any job which a good teacher would have greater pleasure in undertaking than the arrangement of a laboratory in which students might study for themselves such problems as come before railway, canal, river, harbour and coast-protection engineers; there is no such laboratory in existence at the present time, and in any case it could only be of use in the way of mere suggestion to an engineer who had already a good knowledge of his profession.

It was a curious illustration of mental inertia that the usual engineering visitor, even if he was a professor of engineering, always seemed to suppose that the work done at Finsbury was the same as that done in all the great engineering colleges. As a matter of fact, no subject was taught there in the same manner as it was taught elsewhere.*

Most of the students were preparing for electrical or mechanical engineering, and, therefore, we thought it important that nearly every professor, or demonstrator, or teacher should be an engineer. I know of nothing worse than that an engineering student should be taught mathematics, or physics, or chemisty by men who are ignorant of engineering, and yet nothing is more common in colleges of applied science.† The usual courses are only suitable for men who are preparing to be mere mathematicians, or mere physicists, or mere chemists. Each subject is taken up in a stereotyped way, and it is thought quite natural that in one year a student shall have only a most elementary knowledge of what is to the teacher such a great subject. The young engineer never reaches the advanced parts which might be of use to him; he is not sufficiently grounded in general principles; his whole course is only a preliminary course to a more advanced one which there is no intention of allowing him to

* It is really ludicrous to see how all preachers on technical education are supposed by non-thinking people to hold the same doctrine. The people asking for reform in education differ from one another more than Erasmus and Luther, and John of Leyden and Knipperdoling.

† At the most important colleges the usual professor or tutor is often ignorant of all subjects except his own, and he generally seems rather proud of this; but surely in such a case a man cannot be said to know even his own subject.

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pursue, and, not being quite a fool, he soon sees how useless the thing is to him. The professor of chemistry ought to know that until a young engineer can calculate exactly by means of a principle, that principle is really unknown to him. For example, take the equation supposed to be known so well,

$$2H_2+O_2=2H_2O.$$

It is never understood by the ordinary elementary chemical student who writes it down so readily. Every one of the six cunning ways in which that equation conveys information ought to be as familiar to the young engineer as they are, or ought to be, to the most specialised chemist. Without this he cannot compute in connection with combustion in gas and oil engines and in furnaces. But I have no time to dwell on the importance of this kind of exact knowledge in the education of an engineer.

Mathematics and physics and chemistry are usually taught in watertight compartments, as if they had no connection with one another. In an engineering college this is particularly bad. Every subject ought to be taught through illustrations from the professional work in which a student is to be engaged. An engineer has been wasting his time if he is able to answer the questions of an ordinary examination paper in chemistry or pure mathematics. The usual mathematical teacher thinks most of those very parts of mathematics which to an ordinary man who wants to *use* mathematics are quite valueless, and those parts which would be altogether useful and easy enough to understand he never reaches; and, as I have said, so it is also in chemistry. Luckily, the physics professor has usually some small knowledge of engineering; at all events he respects it. When the pure mathematician is compelled to leave the logical sequence which he loves to teach mechanics, he is apt scornfully to do what gives him least trouble—namely, to give as "mechanics" that disguised pure mathematics which forms 90 per cent. of the pretence of theory to be found in so many French and German books on machinery. As pure mathematical exercise work it is even meaner than the stupid exercises in school algebras; as pretended engineering it does much harm, because a student does not find out its futility until after he has gone through it, and his enthusiasm for mathematics applied to engineering problems is permanently hurt. But how is a poor mathematical professor who dislikes engineering, feeling like Pegasus harnessed to a common waggon—how is he to distinguish good from evil? He fails to see how worthless are some of the books on "Theoretical Mechanics" written by mathematical coaches to enable students to pass examinations. An engineer teaching mathematics would avoid all futilities; he would base his reasoning on that experimental knowledge already possessed by a student; he would know that the finished engineer cannot hope to remember anything except a few general principles, but that he ought to be able to apply these, clumsily or not, to the solution of any problem whatsoever. Of course he would encourage some of his pupils to take up Thomson and Tait, or Rayleigh's "Sound," or some other classical treatise as an advanced study.*

Not only do I think that every teacher in an engineering college ought to have some acquaintance with engineering, but it seems to me equally important to allow a professor of engineering, who ought, above all things, to be a practical engineer, to keep in touch with his profession. A man who is not competing with other engineers in practical work very quickly becomes antiquated in his knowledge: the designing work in his drawing office is altogether out of date; he lectures about old difficulties which are troubles no longer; his pupils have no enthusium in their work because it is merely academic and lifeless; even when he is a man distinguished for important work in the past his students have that kind of disrespect for his teaching which makes it useless to them. If there is fear that too much well-paid professional work will prevent efficiency in teaching, there is no great difficulty in applying a remedy.

One most important fact to be borne in mind is that efficient teachers cannot be obtained at such poor salaries as are now given. An efficient labourer is worthy of his hire: an inefficient labourer is not worthy of any hire, however small. Again, there is a necessity for three times as many teachers as are usually provided in England. The average man is in future to be really educated. This means very much more personal attention, and from thoughtful teachers. Is England prepared to face the problem of technical education in the only way which can lead to success—prepared to pay a proper price for the real article? If not, she must be prepared to see the average man remaining uneducated.

Advocacy of teaching of the kind that was given at Finsbury is often met by the opposition not only of pure mathematicians and academic teachers, but I am sorry to say also of engineers. The average engineer not merely looks askance at, he is really opposed to the college training of engineers, and I think, on the whole, that he has much justification for his views. University degrees in engineering science are often conferred upon students who follow an academic course, in which they learn little except how to pass examinations. The graduate of to-day, even, does not often possess the three powers to which I have referred. He is not fond of reading, and therefore he has no imagination, and the idea of an engineer without imagination is as absurd as Teufelsdröch's notion of a cast-iron king. He cannot really compute, in spite of all his mathematics, and he is absurdly innocent of the methods of the true student of Nature. This kind of labelled scientific engineer is being manufactured now in bulk because there is a money value attached to a degree. He is not an engineer in any sense of the word, and does not care for engineering, but he sometimes gets employment in technical colleges. He is said to teach when he is really only impressing upon deluded pupils the importance of formulæ, and that whatever is printed in books must be true. The real young engineer, caught in this eddy, will no doubt find his way out of it, for the healthy experience of the workshop will bring back his common-sense. For the average pupil of such graduates there is no help. If he enters works, he knows but little more than if he had gone direct from school. He is still without the three qualifications which are absolutely necessary for a young engineer. He is fairly certain to be a nuisance in the works and to try another profession at the end of his pupilage. But if it is his father's business he can make a show of knowing something about it, and he is usually called an engineer.

Standardisation in an industry usually means easier and cheaper and better manufacture, and a certain amount of it must be good even in engineering, but when we see a great deal of it we know that in that industry the true engineer is disliked. I consider that in the scholastic industry there has been far too much standardisation. Gymnasien and polytechnic systems are standardised in Germany, and there is a tendency to import them into England; but in my opinion we are very far indeed from knowing any system which deserves to be standardised, and the worst we can copy is what we find now in Germany and Switzerland. What we must strive for is the discovery of a British system suiting the British boy and man. The English boy may be called stupid so often that he actually believes himself to be stupid; but of one thing we may be sure, he will find in some way or other an escape from the stupefying kind of school work to which the German boy submits. And if it were possible to make the average English boy of 19 pass such a silly school-leaving examination as the German boy,* and to pass through a polytechnic, I am quite sure that there would be little employment among common-sense English engineers for such a manufactured article. But is it possible that British boys could be manufactured into such obedient academic machines, without initiative or invention or inviduality, by teachers who are none of them engineers? No, we must have a British system of education. We cannot go on much longer as we have done in the past without engineering education, and, furthermore, it must be such as to commend itself to employers. Of my Finsbury students I think I may say that not one failed to get into works on a two or three years' engagement, receiving some very small wage from the beginning, and without paying a premium. To obtain such employment was obviously one test of fitness to be an engineer, because experienced men thought it impossible. One test of the system was the greater ease with which new men obtained employment in shops which had already taken some of our students. It is certainly very difficult to convince an employer that a college man will not be a nuisance in the shops. In Germany and France, and to a less extent in America, there is among employers a belief in the value of technical education. In England there is still complete unbelief. I have known the subscribers of money to a large technical college in England (the members of its governing board) to laugh, all of them, at the idea that the college could be of any possible benefit to the industries of the town. They subscribed because just then there was a craze for technical education due to a recent panic. They were ignorant masters of works (sons of the men who had created the works), ignorant administrators of the college affairs, and ignorant critics of their mismanaged college. I feel sure that if the true meaning of technical education were understood it would commend itself to Englishmen. Technical education is an education in the scientific and artistic prin-

* One sometimes finds a good mathematician brought up on academic lines taking to engineering problems. But he is usually *stole* and unwilling to go thoroughly into these practical matters, and what he publishes is particularly harmful, because it has such an honest appearance. When we do get, once in 40 years, a mathematician (Osborne Reynolds or Dr. Hopkinson) who has common-sense notions about engineering things, or a fairly good engineer (Rankine or James Thomson) who has a common-sense command of mathematics, we have men who receive the greatest admiration from the engineering profession, and yet it seems to me that quite half of all the students leaving our technical colleges ought to be able to exercise these combined powers if mathematics were sensibly taught in school and college. We certainly have had enough of good mathematicians meddling with engineering theory and of engineers with no mathematics wasting their time in trying to add to our knowledge.

* The following is, I understand, a stock question at certain gymnasien: "Write out all the trigonometrical formulæ you know." I asked my young informant, "Well, how many did you write?" "Sixty-two," was the answer. This young man informed me that a boy could not pass this examination unless he knew "*all* algebra and *all* trigonometry and *all* science." Strassburg geese used to be fed in France; now they are fed in Germany. German education seems to be like smothering a fire with too much fuel o wet slack which has the appearance of fuel;

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ciples which govern the ordinary operations in any industry. It is neither a science, nor an art, nor the teaching of a handicraft. It is that without which a master is an unskilled master, a foreman an unskilled foreman, a workman an unskilled workman, and a clerk or farmer an unskilled clerk or farmer. The cry for technical education is simply a protest against the existence of unskilled labour of all kinds.*

To have any good general system the employers must co-operate. Much of the training is workshop practice, and it cannot be too often said that this is not to be given in any college. The workshop in a college serves a quite different purpose. Now, how may the practice best be given? I must say that I like the Finsbury plan very much indeed, but there are others. When I attended this college in winter I was allowed to work in the Lagan foundry in summer. In Japan the advanced students did the same thing; they had their winter courses at the college, and the summer was spent in the large Government workshops; the system worked very well indeed.† In Germany recently the great unions of manufacturers made facilities for giving a year of real factory work to the polytechnic students, but it seems to me that these men are much too old for entrance to works, and, besides, a year is too short a time if the finished product is to call itself a real engineer. Possibly the British solution may be quite different from any of these. A boy may enter works at 14 on leaving a primary school, or not later than 16 on leaving a secondary school. In either case he must have the three powers to which I have already referred so often. It will be recognised as the duty of the owners of works to provide, either in one large works or near several works, in a well-equipped school following the Finsbury principle, all that training in the principles underlying the trade or profession which is necessary for the engineer.

No right-thinking engineer has been scared by the newspaper writers who tell us of our loss of supremacy in manufacture, but I think that every engineer sees the necessity for reform in many of our ways, and especially in this of education. People talk of the good done to our workmen's ideas by the strike of two years ago; it is to be hoped that the employers' ideas were also expanded by their having been forced to travel and to see that their shops were quite out of date.‡ In fact, we have all got to see that there is far too much unskilled labour among workmen and formen and managers, and especially in owners. The may be some kinds of manufacture so standardised that everything goes like a wound-up clock, and no thought is needed anywhere; but certainly it is not in any branch of engineering. Many engineering things may be standardised, but not the engineer himself. Millions of money may build up trusts, but they will be wasted if the unskilled labour of mere clerks is expected to take the place of the thoughtful skilled labour of owners and managers. I go further, and say that no perfection in labour-saving tools will enable you to do without the skilled, educated, thoughtful, honest, faithful workmen with brains. I laugh at the idea that any country has better workmen than ours, and I consider education of our workmen to be the corner-stone of prosperity in all engineering manufacture. It is from him in countless ways that all hints leading to great inventions come. New countries like America and Germany have their chance just now; they are starting, without having to "scrap" any old machinery or old ideas, with the latest machinery and the latest ideas. For them also the time will come when their machines will be getting out of date and the cost of "scrapping" will loom large in their eyes. In the meantime they have taught us lessons, and this greatest of all lessons—that unless we look ahead with much judgment, unless we take reasonable precautions, unless we pay some regard to the fact that the cleverest people in several nations are hungering for our trade and jealous of our supremacy, we may for a time lose a little of that supremacy. In the last 23 years I have written a good deal about the harm done to England by the general dislike that there is among all classes for any kind of education. I do not say that this dislike is greater than it used to be in England; I complain that is about as great.* But I have never spoken of the decadence of England. It is only that we have been too confident that those manufactures and that commerce and that skill in engineering, for which Napoleon sneered at us, would remain with us for ever. Many writers have long been pointing out the consequences of neglecting education, prophesying those very losses of trade, that very failure of engineers to keep their houses in order, which now alarms all newspaper writers. Panics are ridiculous, but there is nothing ridiculous in showing that that we can take a hint. We have had a very strong hint given us that we cannot for ever go on with absolutely no education in the scientific principles which underlie all engineering. There is another important thing to remember. Should foreigners get the notion that we are decaying, we shall no longer have our industries kept up by an influx of clever Uitlanders, and we are much too much in the habit of forgetting what we owe to foreigners—Fleming and German, Hollander, Huguenot and Hebrew—for the development of our natural resources. Think of how much we sometimes owe to one foreigner like the late Sir William Siemens.

But I am going too far; there is, after all, not so very much of the foolishness of Ishbosheth among us, and I cannot help but feel hopeful as I think lovingly of what British engineers have done in the past. We who meet here have lived through the pioneering time of mechanical and electrical and various other kinds of engineering. Our days and nights have been delightful because we have had the feeling that we also were helping in the creation of a quite new thing never before known. It may be that our successors will have a better time; will see a more rapid development of some other applications of science. Who knows? In every laboratory of the world men are discovering more and more of Nature's secrets. The laboratory experiment of to-day gives rise to the engineering achievement of to-morrow. But I do say that, however great may be the growth of engineering, there can never be a time in the future history of the world, as there has never before been a time, when men will have more satisfaction in the growth of their profession than engineers have had during the reign of Queen Victoria.

And now I want to call your attention to a new phenomenon. Over and over again has attention been called to the fact that the engineer has created what is called "modern civilisation"—has given luxuries of all kinds to the poorest people, has provided engines to do all the slave labour of the world, has given leisure and freedom from drudgery, and chances of refinement and high thought and high emotion to thousands instead of units. But it is doing things more striking still. Probably the most important of all things is that the yoke of superstitions of all kinds on the souls of men should be lifted. The study of natural science is alone able to do this, but education through natural science for the great mass of the people, even for the select few called the distinguished men of the country, has been quite impossible till recently. I say that it is to engineers that the world owes the possibility of this new study becoming general. In our country nearly all discoveries come from below. The leaders of science, the inventors, receive from a thousand obscure sources the germs of their great discoveries and inventions. When every unit of the population is familiar with scientific ideas our leaders will not only be more numerous, but they will be individually greater. And it is we, and not the schoolmasters, who are familiarising the people with a better knowledge of Nature. When men can hardly take a step without seeing steam engines and electromotors and telegraphs and telephones and steamships, with drainage and water works, with railways and electric tramways and motor-cars; when every shop-window is filled with the products of engineering enterprise, it is getting rather difficult for people to have any belief in evil spirits and witchcraft.

All the heart-breaking preaching of enthusiasts in education would produce very little effect upon an old society like that of England if it were not for the engineer. He has produced peace. He is turning the brown deserts lands of the earth into green pastures. He is producing that intense competition among nations which compels education. If England has always been the last to begin reform, she has always been the most thorough and steadfast of the nations on any

* I have pointed out how natural it is that business men should feel somewhat antagonistic to college training. Poorly paid unpractical teachers, with no ideas of their own, have in the past taught in the very stupidest way. They have called themselves "scientific" and "theoretical" till these words stink in the nostrils of an engineer. When I was an apprentice, and no doubt it is much the same now, if an apprentice was a poor workman with his hands he often took to some kind of study which he called the science of his trade. And in this way a pawkiness for science got to be the sign of a bad workman. But if workmen were so taught at school that they all really knew a little physical science, it would no longer be laughed at. When a civil or electrical engineer is unsuccessful because he has no business habits, he takes to calculation and the reading of so-called scientific books, because it is very easy to get up a reputation for science. The man is a bad engineer in spite of his science, but people get to think that he is an unpractical man because of his scientific knowledge. I do believe that the unbelief in technical education so very general has this kind of illogical foundation. Four hundred years ago if a layman could read or write he was probably a useless person who, because he could not do well otherwise, took to learning. What a man learnt was clumsily learnt; usually he learnt little with great labour and made no use of it; therefore, reading and writing seemed useless. Now that everybody is compelled to read and write, it is not a usual thing to say that it hurts a man to have these powers.

† It was the idea of Principal Henry Dyer.

‡ Not only is there an enormous improvement in the use of limit-gauges and checking and tools, and the careful calculation of rates of doing work by various tools and general shop arrangement, but attention is being paid to the comfort of workmen. There are basins and towels, and hot and cold water for them to wash in. In the old days it would have been called faddy philanthropy. Now, owners of works who scorn all softness of heart provide perfect water-closets for their men; their workshops are kept at a uniform temperature; the evil effect of a bad draught in producing colds, or a bad light in hurting the eyes, is carefully considered. In some of these works it is actually possible for a workman or a member of his family to get a luxurious hot bath for a penny. Will this really pay? Some clever hard-headed men of my acquaintance say they already see that it does pay very well indeed.

* The old apprenticeship system of training men has broken down, and this is the cause of most of our industrial troubles. An apprenticeship system suited to modern conditions is described fully on pages 68–88 of "England's Neglect of Science."

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reform when once she has started on it. Education, pedagogy, is a progressive science; and who am I that I should say that the system of education advocated by me is that which will be found best for England? In school education of the average boy or man England has as yet had practically no experience, for she has given no real thought to it. Yet when she does, I feel that although the Finsbury scheme for engineers may need great improvement, it contains the germ of that system which must be adopted by a race which has always learnt through trial and error, which has been led less by abstract principles or abstract methods of reasoning than any race known in history.

ON THE SPECIFIC UTILISATION OF MATERIALS IN DYNAMO DESIGN.*

BY PROF. SILVANUS P. THOMPSON, F.R.S.

In comparing together different dynamos designed by different engineers, one finds very considerable differences between them with respect to the specific utilisation of the materials employed. This remark applies even to machines of kindred type and magnitude, and intended to work under similar conditions. One designer will so design his machine that the iron cores or the iron teeth are subjected to a much higher degree of magnetic saturation than those in the design of a different engineer. One engineer will employ a higher density of current in his copper conductors than another employs. Another will contrive by choice of insulating material to get more copper into an equal space in the slots. Even between machines of identical type, output and efficiency, there may be differences; for, though the net efficiency may be alike, the inevitable losses of energy may be differently allocated; one machine having greater heat losses in the copper, another greater heat losses in the iron.

In the present note the specific utilisation of the materials is considered solely in relation to the armature. But the armature in which the material is utilised to the greatest advantage will be the one requiring least material in proportion to its output, and therefore in general the smallest. Hence it will require also in general the smallest size of field-magnet.

In a Paper read before the electrical section of the Engineering Congress at Glasgow in 1901, Mr. Mavor introduced the conception of the "active belt," meaning by this term the entire mass of the peripheral structure of the armature down to the roots of the armature teeth, and consisting of iron, copper, and insulation. It is in this active belt that the whole inductive generation of E.M.F.s takes place; and it is also on this active belt that the whole of the mechanical forces, as between armature and field, are exerted. Mr. Mavor discussed the energy spent in this active belt, and in order to obtain figures that could be compared with one another for different machines, he calculated down the relation between the output of the machine and the volume of the active belt, not under the actual conditions of use, but on the supposition that in all machines the field was equally strong and the peripheral speed alike. In other words, he ascertained, for a number of different machines, the number of ergs per second per cubic centimetre of active belt at unit velocity in unit field. He found the number, though varying from one machine to another, to be about five. Now, the work done per magnetic line in moving a current across a field is simply proportional to that current, so that Mr. Mavor's coefficient is simply a measure of the current-density (or a number of C.G.S. units of current per square centimetre) in the *gross* section of the active belt. As 10 amperes equal one C.G.S. unit, his result is equivalent to 50 amperes per square centimetre, or 322 amperes per square inch of the gross section. Consider the copper conductors that run through the active belt parallel to the shaft. In their net section the current density at full load may vary in different machines. In modern ventilated armatures designers work with current densities of from 1,200 to 1,800 amperes per square inch. But the copper occupies only from 0·4 to 0·5 of the slot, and as the slots are about of equal width with the teeth, or often slightly wider, one may take it that the gross section (transverse to the direction of flow of the current) of the active belt will be roughly about four times as great as the net copper section. Hence, on this view, the gross density should be from 300 to 450 amperes per square inch, or from 46·5 to 70 amperes per square centimetre, equivalent to 4·65 to 7 ergs per cubic centimetre at unit speed in unit field. Mr. Mavor's figure of 5 is nearer the lower of these limits.

Now we may extend still further this conception of the active belt, and may consider not only the mean number of amperes that traverse each square inch of it parallel to the shaft, but also the mean number of magnetic lines that traverse each square inch of it radially; and at the same time we may consider the speed with which it moves forward tangentially. There are here three items that enter severally into the expression for the power per cubic inch. They are in three different directions mutually at right angles to one another; the speed tangential, the magnetic flux radial, the current axial. To deal with these quantities we resort to symbols, as follows:—

E = E.M.F. (volts) generated by armature;
C = current (amperes) flowing through armature;
N = magnetic flux (lines) per pole;
Z = total number of armature conductors;
p = number of poles;
c = number of circuits in parallel through armature;
d = diameter of armature (in inches);
l = length of core-body (in inches);
s = length of tooth or depth of slot (in inches);
n = number of revolutions (per second);
v = peripheral velocity (in inches per second).

Now, the armature periphery is πdl; and the volume of the active belt is πdls. The output of the machine in watts is $E \times C$. Hence:

$$\text{Watts per cubic inch} = \frac{EC}{\pi dls} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now we may write for the E.M.F. of the machine:

$$E = \frac{npNZ}{c \times 10^8} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Further,
$$n = v \div \pi d. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Inserting the values of (2) and (3) into (1), we get

$$\text{Watts per cubic inch} = \frac{ZCNpv}{c\pi^2 d^2 ls \cdot 10^8} \quad . \quad . \quad . \quad . \quad (4)$$

This expression we may decompose into three factors, thus:

$$\text{Watts per cubic inch} = \frac{ZC}{\pi cds} \cdot \frac{Np}{\pi dl} \cdot \frac{v}{10^8} \quad . \quad . \quad . \quad (4A)$$

These three factors we may severally write:

$ZC \div \pi cds = \alpha$ = gross current density per square inch axially in active belt.

$Np \div \pi dl = \beta$ = gross magnetic density per square inch radially in active belt.

$v \div 10^8 = \gamma$ = a quantity proportional to the peripheral velocity.

If, then, we take out these three factors α, β and γ for any particular machine, we have at once a means of comparison between its design and that of other machines, in respect of the specific utilisation of materials. Some makers manage to crowd many amperes through the copper, or to have much copper in the belt: in their machines α will be large. Other makers contrive to have a high mean magnetic flux-density in the belt: in their machines β will be large. Others drive their machines with a high surface-speed, and thus manage to increase the specific output of a given quantity of active material. Now, owing to the conditions that are necessitated by sparkless commutation, α cannot be very high unless β is high also; though β may be high without α being so. But γ may be high or low quite independently of α or β.

The author has made a detailed analysis of some 50 modern generators to ascertain the values of these factors of specific utilisation. He did not include any smooth-core machines nor arc-lighting dynamos, nor any very small designs. In fact, the figures considered relate only to continuous current generators of modern type, and of sizes above 50kw., with slotted armature cores, as used for lighting or traction. In such machines the values of the constant α lie mostly between 300 and 460 amperes per square inch, a few being outside these limits.

The values of β lie mostly between 30,000 and 45,000, the extreme values being 22,000 and 58,000 lines per square inch.

The values of γ lie mostly between 0·000004 and 0·000009; or the peripheral speeds lie mostly between 400in. and 900in. per second, or between 2,000ft. and 4,500ft. per minute. In a few cases an even higher speed is used.

Multiplying together the three factors for any machine we get its specific output in watts per cubic inch of active belt. In the machines considered, the value of this varies between 45 and 120 watts per cubic inch. But in one case the value runs down to 15 watts per cubic inch, though the machine is by a first-class maker; and in one case the figure rises to the value of 192 watts per cubic inch. This machine is the 1,600kw. generator described by Mr. Hobart before the Engineering Congress last year at Glasgow. A high peripheral speed, and a high degree of saturation of the iron teeth conspire to give this machine a remarkably great output in proportion to its size and weight.

It is, of course, possible to obtain an apparently high specific utilisation value by a sacrifice of efficiency, or by admitting a higher temperature rise than is usually allowed to the manufacturers of machines. There is no doubt that British manufacturers have been hampered in the latter respect by ridiculous restrictions imposed by consulting engineers. A temperature rise not exceeding 20°C. has been been specified as the limit, in cases where a temperature rise of 40°C. or even 50°C. would have been perfectly safe. If the final efficiency is satisfactory, and the insulation adequate and honest, it is absurd to tie down a manufacturer to such a restriction as that in no part the temperature rise shall exceed 20°C. It handicaps him in attaining the highest specific utilisation of his materials, and forces him so to construct his machines that they are both heavier and more costly than otherwise they would be.

* Paper read before Section G of the British Association.

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The official report of the proceedings at the London Convention of the Incorporated Municipal Electrical Association has just been published. It contains the written replies of Messrs. A. S. Barnard, S. E. Fedden, A. A. Day, H. Faraday Proctor and J. F. C. Snell to the discussion on their Papers. The Papers and discussions on them have already been duly reported in *The Electrician*.

Mr. BARNARD (Hull) replying to the discussion on his Paper, "High Tension Continuous-current Systems," reiterated his opinion that from his experience there was absolutely no need for constant attention at the sub-stations. Where central control by pilot wires was adopted, an attendant in a sub-station was more likely to do harm than good in the event of a fault, as he was unable to tell what was going on in the other portions of the network. He (Mr. Barnard) was still convinced that continuous-current would prove to be more efficient than three-phase alternating current for transmission to the sub-stations, and equally reliable, even if, to satisfy the fears of those who had not tried it, the system of central control of the transformers was thrown to the wind. His experience of pilot wires, since the Board of Trade had insisted upon a minimum of 7/20s S.W.G. had not been as unfortunate as Mr. Snell's. He used jute-insulated, lead-covered, multiple-core cables, drawn into stoneware conduits, where they were laid beside high-tension feeders, and simply armoured with steel tape and laid under the flags, where there were no high-tension feeders on the same route. When the Hull tramway system was laid down, few manufacturers could say what would be the effect of putting such a varying load on to the high-tension continuous-current transformers. Since that time, however, experience had shown that the behaviour of these machines under most varying loads was all that could be desired, and at the present time he was supplying current to a shipyard where the load was as variable as an ordinary tramway load. Mr. Barnard then made the same criticism of Mr. Rider's comparison between the costs of supply stations with and without tramway load as was made in an editorial note in *The Electrician* at the time. He stated that at Hull the works costs per unit at the lighting station were 1·75d., and at the tramway station 0·90d., and the average costs at the two stations (taking into consideration the outputs of both) was 1·29d. per unit generated. Of 20 municipal works supplying a combined lighting and traction load, six only showed a smaller works cost than this, the remaining 14 showing a higher cost. The capital cost of the Hull electric lighting station was £72. 17s. 6d. per kilowatt, or £1. 11s. 6d. per 8 c.p. lamp connected. The average of eight large towns—viz., Bradford, Bristol, Hull, Nottingham, Glasgow, Leeds, Liverpool and Sheffield, showed capital cost per kilowatt of £81. 9s. 3d., and per 8 c.p. lamp connected £2. 7s. 5d. The cost of coal delivered to the bunkers at Hull last year averaged about 14s. 8d. per ton. The units unaccounted for during the same period amounted to 9·64 per cent. of the units generated. Since the high-tension continuous-current system had been in use they had varied from 4·21 to 11·63 per cent. In Glasgow, a typical low-tension station, during a corresponding number of years (when their output practically corresponded with the output of the Hull works), the units unaccounted for varied from 9·83 to 26·15 per cent. In Salford, during the year just ended, the units unaccounted for were returned as about 26 per cent. of those generated. He used concentric, jute-insulated, lead-covered cables, drawn into stoneware conduits, as high-tension feeders. So far these feeders had given absolutely no trouble, except when they had had pickaxes or similar instruments driven through them; and, even then, the effect had simply been that the automatic switches at the generating station had opened, and no further damage had been done. For some years two installations had been at work at 2,300 volts with one pole earthed. It was evident, therefore, that there was no difficulty in working a three-wire system with the centre pole earthed, at 4,600 volts; and the author understood that manufacturers were prepared to supply continuous-current dynamos and transformers up to 3,000 volts, running them with one pole earthed, and to supply plant for 6,000 volts, three-wire system, with the centre pole earthed. Then, as regarded mains, the continuous-current system would be on the same lines as a 6,000-volt, three-phase system. Probably Mr. Wordingham's experience with the Board of Trade was in connection with "extra high-pressure" systems, and not "high-pressure" systems. The electrical adviser to the Board of Trade and H.M. Electrical Inspector of Factories had both seen the Hull sub-stations, and neither of these gentlemen had suggested the desirability of having a constant attendant whilst the machinery was at work.

Mr. S. E. FEDDEN (Sheffield), in reply to the discussion on his Paper, "Steam Turbines," said that Mr. Wordingham was mistaken in thinking that he (Mr. Fedden) wanted to scrap all other machines except the steam turbine. The chief point he wished to show in his Paper was that, for engines over 2,000 H.P., it was not advisable to put in high-speed reciprocating engines. Comparing the price list of the turbine manufacturers with tenders from engine builders, the turbine in smaller sizes came out slightly cheaper than the price charged by the first-class high-speed vertical engine builders, while for medium-speed engines and larger sizes it came out about 25 to 30 per cent. cheaper. There was no reason why steam turbines, if they were treated with common sense and had ordinary repairs done to them when required, should not continue with the same steam consumption after five or 10 years' continual use. He thought that Mr. Ferranti's statement that "no good at all had been done with continuous-current generators driven by turbines" required some modification. At the Woolwich Arsenal they were running an 800kw. continuous-current turbo without the least trouble, and he also knew of two or three other continuous-current turbines of this power running perfectly satisfactorily. He thought the fact that the Metropolitan Company in London were now putting in Sulzer engines at their Willesden works did not in the least damn steam turbines, because large works on the Continent where Sulzer engines had been running for many years were now putting in steam turbines in the larger sizes. The trouble which Mr. Andrews had found from cross currents could be easily stopped as follows:—The author had found it almost impossible to run on light load or switch in or switch out his 500kw. turbo with other machines with only the shunt on the exciter. He found that it was necessary under the above conditions to have considerable resistance in the main alternator field. On one occasion, when the resistance in the alternator field was broken down, and he was running without it, he had very considerable surging both on switching in and switching out the turbine, and also cross-currents when running. With regard to Mr. Booth's remarks, Mr. Fedden did not think that he need have any fear that the air was apt to get back into the turbine and get churned up with the plates, because the glands at each end were steam packed, and as long as sufficient steam was turned on no air could get back.

Mr. A. A. DAY (Bolton), in reply to the discussion on his Paper "The Correct Type of Engine for Large Generating Stations," said that the remarks in the discussion might be divided into two heads. First, a few small points about which there appeared to be some misunderstanding; second, the statement made by one or two speakers that they disagreed with the author entirely, without producing any reason for their disagreement. He, therefore, summarised once more the opinions he had put forward in his Paper.

Mr. H. FARADAY PROCTOR (Bristol), replying to the discussion on his Paper "Notes *re* Earthing," explained that he desired it to be inferred from his Paper that he is in accord with the system advocated by Mr. Snell—namely, the use of two conductors only where continuous current was essential, the system being insulated from earth throughout, but he was not yet convinced as to its commercial economy. For alternating-current service, however, he believed that the neutral conductor could be earthed so as to allow of the advantage of a three-wire system without its disadvantages. If the neutral were earthed at every feeding point and junction box and at every consumer's premises, he believed that the desired result would be obtained under most conditions. If there was unintentional earth on the earthed conductors and a considerable quantity of current passed to earth at the fault, its locality could probably be ascertained by a telephone test, as the distributing cables would either be concentric or multiple core.

Fuses inserted in a neutral or an earthed conductor should have a carrying capacity in excess of that of the corresponding pole conductor fuse, so as to avoid the liability of the earth conductor fuse cutting out, prior to the pole conductor fuse, due to a normal or abnormal demand for current on the installation, the duty of a neutral conductor or earth conductor fuse being only that of preventing a large current passing through the earthed conductor should any earth fault develop upon it. With fuses so arranged, the risk of passing the return current of any section of an installation through an earth fault was minimised, and it was contended that trouble was far less likely to arise, or result, than from the return current of innumerable installations, which would be shunted through the earth fault, even when the single-pole switches on the non-earthed conductor were in an "off" position. The amount of such a shunt current might be comparatively unlimited if earth conductor fuses were not inserted.

Mr. J. F. C. SNELL (Sunderland), replying to the discussion on his Paper, "The Relative Advantages of Two and Three-wire Distribution," chiefly devoted his attention to Mr. Ruthven-Murray's criticism of his figures. Mr. Murray, he said, had evidently compared two conductors, say of 1 sq. in. section at 200 volts, with three conductors of $\frac{1}{2}$, $\frac{1}{2}$ and $\frac{1}{4}$ sq. in. respectively at 400 volts. It was proved that the latter showed a saving of 68$\frac{3}{4}$ per cent. At 1,000 amperes, however, the two wires would transmit 200kw., that is, 1,000 amperes at 200 volts. To transmit the same energy at 400 volts with three wires, the outers would have to carry 500 amperes, and would, therefore, work at 2,000 amperes per square inch. The correct way was to compare two two-wire mains with a three-wire system when the current-density was the same in both cases; then the saving would be 40 per cent., as stated in his Paper. He combated the statement that the increase of consumers lessened the advantages of balancing. His experience had been otherwise. He was strongly opposed to the use of concentric conductors in direct-current work. Authorities had no right to lay a system which they knew would disrupt the supply if a fault occurred. With conductors laid separately, a fault gave rise to an "earth," but that was easily localised and put right without consumers being aware of such a fault existing. On the other hand, a similar fault in a concentric cable invariably meant a "burning out" at that point, and his experience of these cables showed that the fault would not burn itself free, but necessarily meant a cutting off of the supply in the locality of the fault. That ought not to be. He had, he believed, been the first to adopt sectional pillar boxes for splitting up distributing mains at Sunderland, and made use of the same boxes as feeding points, so that the feeders might easily be cut off and tested. They worked at a current-density of 600 amperes, as a rule, but there were some home feeders working at over 1,000 amperes during the peak. He could not agree with Mr. Murray as to the relative costs of the systems. His own figures, showing 8 per cent., were taken from a schedule of prices recently entered into with an eminent firm, and he had since checked them again; and the advantages given in the Paper, which he contended, in spite of the criticism levelled against him, were nevertheless quite correct; 8 per cent. on those prices was the only saving shown on distributors, and not 19 per cent., as suggested by Mr. Murray. Mr. Murray's 62$\frac{1}{2}$ or 68$\frac{3}{4}$ per cent. saving could not be taken, for the reason that it was not practicable in the first place and also related to the saving in copper alone. Mr. Mountain was wrong in saying that the cost of feeders had been neglected.

Mr. Highfield had misunderstood him. He did not suggest a change of all the three-wire to two-wire systems, although he believed that the question of lamp density was becoming so pressing in large towns that sub-stations would have to be resorted to in such cases before long, and then, probably, all extensions would be on the two-wire system. He agreed that in a small town (but large enough to have boundaries beyond the economical limit of two wires) a three-wire system must be adopted, because in such a case the inconveniences he enumerated would be minimised, but even then it was a moot point whether battery sub-stations on a two-wire system might not offer a fair alternative. Referring to the recent explosions on mains in London, he believed that some of these were really due to overloading the third wire. They could calculate the current-density on the outers to a nicety, but he defied anyone to guarantee that the third wire would not be locally overloaded. Mr. Trotter's remarks had put his own position in a nutshell by saying that when the supply had outgrown the limits of a two-wire system, in many cases it would be found better to create new centres of distribution from sub-stations, keeping the whole of the network two-wire.

CORRESPONDENCE.

TWO-WIRE *v.* THREE-WIRE DISTRIBUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Snell's Paper on this subject, and the discussion which has resulted in the technical Press, are interesting but hardly conclusive. Probably those who maintain the orthodox three-wire practice are so well convinced of its advantage that an attack upon it finds them unprepared with argument, merely surprised that any question should be raised on what they regard as axiomatic. Yet it is always useful to re-examine accepted beliefs, and see whether the proof from first principles is as complete as we have assumed. Mr. Snell's letter to *The Electrician* of September 5th shows (as no one would seriously doubt) that he fully recognises the fact that under a given set of conditions there is a current-density which is most economical. Therefore, he correctly says that two pairs of two-wire conductors of 1 sq. in. each at 220 volts, should compare with a three-wire 440-volt distributor having a 1 sq. in. conductor for each outer. The section of the neutral is not susceptible of calculation on purely economic grounds, but experience justifies the usual practice of making half that of the outers. Hence, the three-wire will cost 62·5 per cent. of the two-wire distributor per yard run for an equal load in kilowatts.

The range or radius of distribution from each feeding point or sub-station will be limited by the allowable loss in pressure at the time of full load. As the permissible percentage of the working pressure is the same in both cases, it follows that this range or radius is twice as great with the three-wire as with the two-wire system. Therefore, the area that may be supplied from one feeding point or sub-station will be four times as great with the former as with the latter.

If the distributors are simply fed by trunk feeders, the saving in the conductors will be of the same order as in the case of the distributors; probably larger, as the neutrals may be of smaller relative section. If transformer sub-station feeding is employed, the smaller number, with larger units, will show a material saving in both capital and working expenses. So that, on a broader view of the distribution problem than Mr. Snell seems to have taken, the three wire system holds a position of great advantage.

No doubt there are some debits against it, and they are not so easy to value. The necessity for using balancing sets is one, but there is no evidence that these sets give any appreciable trouble. The greater range of regulation called for on a two-wire system is probably quite as expensive and troublesome in practice. Batteries can do a great deal of the balancing if suitably arranged and located; and there is experience to show that the actual balancing of the load on the mains between the two sides can, in many cases, be very closely arrived at. As to electrolysis, why should it be worse in the one case than the other?

If is true that negative cables are very generally damp throughout, the fact has been very successfully concealed; and that osmosis can act to carry water through lead sheathing is a surprising suggestion. Mr. Snell can hardly mean that, but no other interpretation of his words occurs to us yet. The collective effects of these disadvantages seems to be completely met by some incidental advantages beyond those already indicated. One that will appeal to those who have to lay and repair mains in the big towns, is that due to the lessened physical and mechanical difficulties experienced in such work in thoroughfares already crowded with subterranean structures, and especially in approaches and entrances to stations and sub-stations supplying large amounts of electrical energy. An additional 37½ per cent. of copper would mean very serious additions to those difficulties, already sufficiently great.—Yours, &c., H. M. SAYERS.

West Norwood, Sept. 18.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) and St. Marylebone Borough Arbitration Council.

ARBITRATION.

Following is a continuation of our report of the proceedings in this arbitration from p. 843 of our last issue, when Mr. John Conacher, general manager of the Metropolitan Company, was under examination:—

Mr. CRIPPS: We now come to the important question of the figures which have been prepared in connection with the purchase price of the company's undertaking, apart from the "severance" point. You will remember that Mr. Balfour Browne in opening these proceedings on behalf of the company pointed out what would have to be taken into consideration—namely, that we had plant ready for immediate supply. The engineers are dealing with this item, which will be somewhere between £50,000 and £60,000. This raises a legal point and is not brought forward in these proceedings at this stage. (To witness): Now, subject to this £50,000 or £60,000, after deducting the capital sum representing the deficiency of generating plant in Marylebone, your claim as regards the purchase value of the undertaking, and not the injuriously affecting or "severance" point, is £2,368,343?—Yes. First, the sale of current is priced from 1902 until the end of the concession in 1931. Then meter rentals, at 3 per cent., less ½ per cent., are added. These meter rentals, since we ceased to charge for the house transformers, have borne the proportion of 3·18, 3·10, 2·98 and 3·08, or an average of 3·08 to gross revenue from sale of current, and we estimate the future rentals on the basis of 3 per cent. in addition to the current rental.

Mr. MOULTON: Perhaps you will get the particulars of what these meter rents are? Judging of your estimate of future rental charges, it is important to know what your method of charging is.

WITNESS: The method of charging is to take 2s. 6d. per quarter per 50 lamps. If there is an installation of 50 lamps, 2s. 6d. is the charge, and for 100 lamps 5s. a quarter, and so on. That is the uniform basis.

The UMPIRE: Anything between 50 and 100 is 5s., and so on?—Yes.

Mr. CRIPPS: That works out, taking the percentage as shown in your tables, in this way. So that you allow ½ per cent. for bad debts and allowances?—Yes, that is the basis of our installation. We think 10s. or ½ per cent. a very ample figure to provide for bad debts and allowances in settlement. That gives a net addition to current revenue of 2½ per cent.

There is a gross revenue in 1902 of £117,000 odd and at the end of the concession £532,000 odd?—Yes.

We have to deal with the deductions to be made in order to get to our net figure?—Yes.

First, you deal with the percentages as regards working expenditure, maintenance and renewals, and this ultimately came down, on the gross revenue, to 40 per cent. on the advice of your engineers?—That is so; and in 1904 we get down to the reduced rate at which we believe we shall work when the continuous-current change has been given effect to and the other economies have been introduced, and with coal at average price, as we assume in 1904 it will be.

Now, in one set of figures submitted, you have put the amount of an allowance in respect of additional capital which would be required as your business grew?—Yes, that is a further deduction from the gross receipts. As the business increases an allowance has to be made for capital, and you have got to see what the charge against revenue will be in respect of that in order to arrive at the true net profit. The total deduction to be made from gross revenue, both under the head of capital required and working expenses, starts with £68,613 the first year and rises to £294,455 in the last year.

For the purpose of capitalisation you have gone up to 1904 on the 3½ per cent. basis?—Yes. We have distinguished between the profits as they are now and what they will have become when the works in hand have been completed, and we capitalise them on the 3½ per cent. basis, dealing differently with all profits above the amount of those to which we expect the business in 1904 will grow. To the surplus we apply the 5 per cent. instead of the 3½ per cent. basis. We apply that to the estimated net revenue in that year, after making allowance for the interest and depreciation upon additional capital.

Mr. MOULTON: Why down to 1904?

WITNESS: Because the existing profits of the company are practically assured. That revenue, we believe, can never be lost. The additional profits which will be obtained from the economies which we are introducing, the reduction of the price of coal, and the new business which in this year and the next two years will come, we think are perfectly certain figures upon which to go.

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The UMPIRE: The £72,473 which we find given as profit, after allowing for additional capital, is employed in other calculations in the statement put in?—Yes, for all future dates. The following year the figure is £79,282. £73,282 is taken at 3½ per cent., and the difference between £72,000 and £473,000 is taken on the 5 per cent. basis.

Mr. MOULTON: Do you estimate on the 3½ per cent. basis for the whole of the 31 years the sum equal to the profits in 1904?

Mr. CRIPPS: You take what I may call the ascertained, or "imminent" profit, and you capitalise it on a given basis. As regards anything beyond, which must be more or less a matter of estimate, you calculate it on a higher table.

Mr. MOULTON: Then the method you have applied is to take it at 3½ per cent. for the first and 5½ per cent. for the second.

Mr. CRIPPS: Yes, certainly.

Mr. MOULTON: Five for the margin.

Mr. CRIPPS: Certainly, you always do that.

WITNESS: £72,000 odd profits for 1904 is worked out at the present value of £25,815 in the last year and then the additional profit—that is, £156,000—works out at the present value of £38,372.

Mr. CRIPPS: As regards the "imminent" profit that you take at 3½ per cent., of course for the concession. You do not take it in perpetuity?—Only to the end of the concession. We discount that each year at 3½ per cent., and it constantly diminishes till it comes down to £25,815.

We have discounted this, Sir, and this may be a matter to call your attention to, as though the sale were to take place for the purpose of the relation between the parties and the adjustment of accounts at the end of 1901. If we took it at the end of 1902, of course we should not have discounted it to the same extent. I mean, that is, having regard to when the notice to treat was given, and it seemed to be a convenient time; but, of course, if we do not agree the time, we can leave it to you to settle figures of this sort. They always have to be adjusted in proportion to the actual date. We have taken all our calculations as though the transfer took place at Dec. 31, 1901, and from that date there will be interest on one side and profits to be handed over on the other.

The UMPIRE: Yes. The notice to treat was Nov. 1?

WITNESS: Yes.

The UMPIRE: It is very desirable a date should be agreed.

Mr. MOULTON: This is taken, as I understand.

Mr. CRIPPS: It is taken as though the adjustment were made on Dec. 31, 1901, and as though from that date the Borough Council were to have the profits handed over, and we were to have the interest on the amount handed over to us. That is simply the way under which we are entitled to do it under the Land Clauses Act. Generally you allow the interest and profits to halve off against one another. When you have got a terminable concession it may be important. All our figures are based upon that footing. Possibly the other way would be more favourable to us, but we have done it in this way because that depends practically upon how the award goes. (To witness): According to the view we are putting forward, the unascertained figure here, in reference to which, of course, there is always the element of risk, is the difference between the figure of imminent profit and what we hope to have in the future?—Yes, we think, having regard to the fact that that is more of an estimate, it is fair to put that upon the 5 per cent. basis. Of course, future profits must always be an estimate. After most careful inquiry and consideration of all the circumstances, I believe that the figures we have put forward are perfectly moderate in view of the market there is for this business in future in Marylebone.

That gives the value of the net profits, after allowing for additional capital, at £2,265,108?—Yes.

Now you have got to add to that the present value of the property in Marylebone which is not at present used in the business of the company, and this identifies the figure for the purpose of going into property value?—Yes.

Now there is a figure of £73. What is that?—There are a few hire-purchase agreements, which, of course, we hand over to the Borough Council. They are agreements under which the company have put the installations into houses under contract to be repaid by instalments. Those instalments will, of course, become payable to the Borough Council instead of to us, and we put them in as from the end of this year.

The UMPIRE: That might be left out and agreed.

Mr. CRIPPS: I now come to a set of figures which is important, because at the end of the concession the Borough Council have to take over our plant. The sum here dealt with does not include the item of £50,000 or £60,000 previously referred to. This is, to a great extent, an engineering table?—Yes, an engineering and valuers' table, but I should like to explain the first part of it. The left-hand portion shows the amounts expended by the company to Dec. 31 last upon the various buildings, showing each result separately, and upon the machinery and plant, and all the other items and expenses in the Marylebone area. It shows that the company had spent at that date £505,134. Then they are engaged in spending a further sum of £92,038, not in connecting new consumers—that is excluded—but in completing the work in hand and in providing for further requirements in Marylebone sub-station next winter. That is a matter that could not have been left over, as the company must provide for the public demands. Practically, that brings up the total expenditure on works and buildings and plant which the company will hand over to the Borough Council in Marylebone to £600,000. The rest of the table sets out the value which the valuers attach to the buildings as they will be in 1931, and the value which the engineers attach to the machinery and plant and mains as they will be in 1931, and the final result is that the property upon which the company have spent £600,000, as valued by the witnesses who will follow, is represented in 1931 by the sum of £392,534. The present value of that sum is represented by £139,821.

Of course it is clear that the £139,821 is based on the capital expended, and not on future requirements?—No, this is the expenditure by the company. Of course the company have no interest in the expenditure which the Borough Council will make so far as actual outlay at the present time is concerned.

That is so far as that is an expense upon the borough in the future, you have only allowed them interest on the amount?—Yes.

Ascertaining the allowance to be made in that way, you would not bring that capital into the capital which you would be entitled to have the benefit of when the concession terminates?—No.

You might have put it in another way, which would have given you that benefit?—We might have done so, but we only claim in respect of the capital actually expended by the company at the time of transfer, and not as regards any future capital which may be wanted hereafter, and that gives us the present value of the capital already expended £139,684. That is a discount figure, present value.

You have got to add to that whatever is the present allowance in the language of the act, because it has to be taken *in situ* and ready at once to proceed to its work?—Yes. That figure is subject to modification upon that point.

Then that brings out £2,417,180, subject to what the engineers say, from which you have to deduct for deficient generating plant on Dec. 31 £48,837, giving a total figure as regards the property purchased (we have to come to severance by-and-bye) of £2,368,343?—Yes, subject, of course, to the point which you have just referred to as to the engineers.

Mr. CRIPPS (addressing the Umpire): Perhaps, Sir, you would make a note that the figure which we think we are entitled to under these works is calculated at £56,858. That is a pure matter of argument. It is purely for you, but there is what you think fair to add, because of its being a compulsory purchase under the Lands Clauses Act. I do not think we shall suggest that the 10 per cent. applies as a hard-and-fast rule in a question of this kind, but we know on what that is based, and we will argue by-and-bye what should be the fair addition to a figure of this sort, having regard to an arbitration of this character. Of course, if we ask for the 10 per cent., it would be an addition of £230,000. This is to be a compulsory purchase under the Lands Clauses Act.

The UMPIRE: Mr. Ryde calls my attention to the fact that the Act of 1888 says expressly "but without any addition in respect of compulsory purchase."

Mr. CRIPPS: That would emphasise this, that as regards the smaller portion of this—because it is the smaller portion here—we should have it without the addition; but as regards by far the larger portion, we should have it with the addition. What Mr. Ryde points out is that as regards the plant taken over at the end of the term of the concession, the allowance for compulsory purchase is not to be added. That is in the Act of 1888.

The UMPIRE: That is a matter for argument as to how much of the section those words apply to.

Mr. CRIPPS: Yes, but this is being taken over under a special act.

The UMPIRE: But it is much better to do as you say, and not to enter upon it now. It is a matter entirely of argument.

Mr. CRIPPS: Yes, I will not ask the witness about it. Therefore, our figure will be those items I have given you. I dare say you have added the £56,858, or whatever that figure comes to, plus whatever you, in your judgment, think is the proper allowance, having regard to the conditions of compulsion under which the concern is taken over.

Now we come to the question of severance. We have to go to the injury which you estimate the company will suffer owing to the severance of the Marylebone district from the rest of their concern?—Yes.

Certain expenses will have to be incurred?—Before the severance can actually take place certain works will have to be carried out in order to enable Marylebone to be worked as a separate area, seeing that previously they were worked as one system. Another point is that the portion left in the company's possession will mean a smaller undertaking in business, and expenses will be rendered proportionately greater. First, there are the expenses before the severance takes place to permit of the severance.

The UMPIRE: The expense of disconnecting?—Yes.

Mr. CRIPPS: The table put in shows what you call the disconnecting costs as regards severing the various portions. This involves a great deal of electrical detail of figures which we can leave to be settled by the engineers?—Yes.

The UMPIRE: Take the first item, 1,580 yds. of 1in. cable. What is that?—That represents the cost of transferring the mid-London portion, served at present from Rathbone-place to another station at Tower-street, and setting free Rathbone-place entirely for the purposes of the Marylebone area.

Mr. CRIPPS: This involves a great mass of figures, and if we could get it adjusted *qua* figures it would be an advantage.

The UMPIRE: Yes, somebody on your side will meet somebody on the other, and give all necessary explanations.

Mr. CRIPPS: Yes, and if, after they have met, there is any difference, we must go into it. It is owing to disconnection and re-connection that these expenses are incurred. (To witness): The next point is the losses after severance?—Yes.

Now, we put what you call the increased working cost as regards the portion left in your hands after severance under two heads?—Yes, one being permanent loss arising from the separation of the remaining areas from Marylebone, and the other the temporary loss which will be sustained till the growth of the business in the future makes up for that about to be taken away.

The permanent loss being loss consequent on losing the connection over the whole area as a whole?—Yes, loss of certain advantages which have been of value to the company by reason of the connection of all the areas with each other.

Take the permanent loss first. I think the first and most important of those losses arises from the company not being able any longer to obtain assistance at Sardinia-street from Rathbone-place and Manchester-square, or even at Amberley-road?—That is so.

The UMPIRE: I do not follow that question.

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Mr. CRIPPS: We cannot any longer obtain at Sardinia-street, which will be left on our hands, assistance from Rathbone-place or Manchester-square (the two stations in Marylebone), or even from Amberley-road.

WITNESS: There are two trunk mains laid between all the generating stations of the company except Whitehall, by means of which for years past the company has been able to send current from one generating station to another, as circumstances required. The mains between Sardinia-street and Rathbone-place are capable of carrying 200kw. These trunk mains, I may explain, are distinguished from the trunk mains which are to remain the property of the company because those trunk mains are called, technically, extra high-tension mains—10,000-volt mains. I speak now of 1,000-volt mains. By means of the main I first described Sardinia-street could obtain at any time that amount of current from Rathbone-place, or if Rathbone-place could not give it direct, Rathbone-place could obtain it from stations further west. Then between Manchester-square and Amberley-road there are 1,000-volt trunk mains capable of carrying 600kw., and frequently, when it has been desired to shut down any one of the four stations for repairs, or to avoid Sunday running, or at other times of very light load, one or more stations has been shut down and the whole supply during those times has been obtained from one or two of the other generating stations. Sometimes, when any sudden demand, by reason of local fog or local darkness has sprung up, the station affected by that sudden demand has been able to obtain assistance to the extent I have indicated, Sardinia-street to the extent of 200kw, and any of the other three stations to the extent of 600kw., which the trunk main is capable of carrying.

You had a stand-by ready to use at any time?—Yes.

Now, take Sardinia-street, Manchester-square and Rathbone-place. You have had fires there?—Yes, two at Sardinia-street, one at Manchester-square and one at Rathbone-place. On each occasion the company was able to restore communication to consumers whose supply was affected by making use of these trunk main connections. We attach great value, therefore, to these trunk main connections. I think I said the trunk mains from Manchester-square were 600kw. They are 200kw.; the dividing line is at Manchester-square. Beyond Manchester-square the capacity is 600kw.; between Manchester-square and Rathbone-place it is 200kw. That enabled us to decrease to a minimum what I may call the ordinary stand-by at these stations, and in cases of sudden emergency gave us an opportunity of supplying our customers quickly. It also minimised the risk of having the supply diminished. If we had had the additional plant in, that plant would have been exposed to the same risk as the existing plant.

The UMPIRE: Have you power to continue your high-tension mains from Tower-street to Sardinia-street?—Yes, we have power in all our areas.

Lord ROBERT CECIL (for Marylebone): You will not take it that we assent to that.

Mr. CRIPPS: Now, as to these various fires. The connection with the other stations enabled you, with the least possible delay, to supply your customers with current?—Yes.

How can you guard against this same sort of difficulty and contingency in the future?—The only way in which we can guard against it is to erect at Sardinia-street and at Amberley-road a plant of equal capacity with the power of the trunk mains to carry current. That is, an additional 200kw. of plant should be provided at Sardinia-street, and an additional 600kw. at Amberley-road, and even that would not do what we want, because when the fire came our additional plant would be swallowed up the same as the other; it is the best way of doing it that I can see. In the case of Sardinia-street it is especially important because of the competitive elements.

It is not only inconveniencing your customers, but they can go elsewhere?—That is so, and if they go it is very difficult to get them back.

What is the cost of providing this additional plant?—At £65 per kilowatt, £52,000. The company expended upon the trunk mains £17,839, so that, deducting that sum from the £52,000, there is left £34,161, which represents the capital the company have been saved during past years.

You mean that, but for the possibility of having these trunk mains connecting the various stations, you would have had to make that additional outlay?—Yes, instead of spending only £17,000 upon the trunk mains, we should have spent £52,000 and have had no trunk mains.

Take 3½ per cent., which we have taken throughout on the £34,161, the annual saving to the company would work out at £1,195. 12s. 8d. a year?—Yes, that is the advantage we have been deriving from the trunk mains as against stand-by as far as capital outlay is concerned.

The next item is the annual saving in cost of working those stations—the annual saving on the trunk main connection. How do you get at that £1,500?—That is difficult to estimate. We are able to close these stations very often on Sundays and also during the summer, when we take the opportunity to do repairs, and also, we have got the advantage, during busy times, of the help one station can give to another, and after careful consideration we think that advantage cannot be expressed in less that £1,500 a year at the two stations taken together.

The UMPIRE: Before you leave that, will you necessarily lose a trunk line connection between Sardinia-street and Amberley-road?—The only right we have under the act with regard to Marylebone is to maintain and lay extra high-tension trunk mains, but these extra high-tension mains will not supply the place of the old trunk mains, because if a fire broke out at Sardinia-street, for instance, the transforming plant, without which the current sent through the extra high-tension mains could not be made use of, might also be destroyed, in which case the trunk mains would have been no use whatever to the company.

Mr. CRIPPS: This is a legal point. I am not sure we are right as to this. The section under which the purchase takes place says:—"Notwithstanding anything in this act, or the purchase by the Borough Council of the said undertaking as by this act provided, the company may lay, relay, maintain, alter or renew in and through the borough trunk mains between the stations of the company or any of them, and for that purpose all reasonable facilities shall be afforded by the Borough Council to the company." I will not argue the point for the moment, as it is clear the question you have asked will undoubtedly arise. (To witness): Your figure here, which comes out of the £2,695. 12s. 8d., is on the footing that you cannot get connection between Amberley-road and Sardinia-street?—That is so.

I do not know, assuming connection could be given between Amberley-road and Sardinia-street, the extent it would affect your figure?—If the existing connection can be maintained, the existing advantages would remain.

Then there are rental value of general stores and offices at Manchester-square and rentals of Post Office wires?—Yes; suitable offices would cost us £100 a year. We have also a number of private telephones and a telegraph laid in the pipes which contain the distributing and trunk mains in and through the Borough of Marylebone, and a communication of that kind, free from the interruption of any public telegraph or telephone system, is absolutely necessary for the conduct of the company's business. If we lose those means of communication by the severance of Marylebone we shall have to rent from the Post Office a corresponding number of wires in order that the means of communication may be maintained. This applies also between Sardinia-street and Amberley-road. Then there is extra cost of lighting offices when we have to take current from the Borough Council. These items come to £55,873. 0s. 3d.

What is the figure here of £490?—That represents a portion of a trunk main similar in character to the other trunk mains laid a few years ago between Manchester-square station and a station of the London Electric Supply Co. in Bond-street, at the Grosvenor Gallery. That cable has been made use of for the purpose of passing current between the one company and the other, and by the severance it becomes entirely useless to the Metropolitan Company. In fact, a portion of it would be entirely outside their area and inside the area of the London Company. The portion within the area goes to the Borough Council with the rest of the company's works. This portion we shall lose the use of, and we make the claim £490. 19s. 7d. for it.

The UMPIRE: You mean you had an arrangement with the London Company for an interchange of supply?—Yes, sometimes we helped them and sometimes they helped us.

Mr. CRIPPS: That gives your figure of severance under this head, subject to the legal points which have been raised, of £53,363. 19s. 10d?—Yes.

We now go to temporary loss, and we divide that into two heads. First you will have, in your view, insufficient employment for the capital expended in connection with Willesden, as a large proportion of the energy for Marylebone is now coming from Willesden?—Yes.

And you will have an increased proportionate cost of administration as regards the remaining portions of your undertaking?—Yes.

When you obtained your powers in connection with Willesden, was it in contemplation to have Marylebone as part of your area of supply?—Yes.

That step would not have been taken if you had known Marylebone was to be severed?—I cannot speak from personal knowledge, but I find from the records that if such an event as the purchase or sale of Marylebone had been contemplated the company would never have dreamt of establishing those great works at Willesden. They had difficulty in securing additional land in Marylebone, and had an injunction hanging over them for vibration at Manchester-square.

Then, by building at Willesden you got rid of the vibration difficulty as regards generating stations in Marylebone?—Yes; and we were able to get sidings and so obtain coal supplies more cheaply than any other generating station in London. We also receive payment for our ashes, whereas at our Tower station we have to pay a considerable sum for their removal.

When you say that Willesden was erected principally in connection with the supply in Marylebone, of course you had special provisions as regards your supply in other districts?—Certainly.

There is an obligation upon the company, as far as Paddington is concerned, to have the generating station within the area. There is no such obligation as regards Marylebone. Therefore, as far as Paddington is concerned, you are under a statutory obligation to have the generating station in the Paddington area?—Yes.

And are not entitled to use Willesden in connection with the Paddington supply?—No.

The UMPIRE: The propositions are not the same, but you do not argue that now.

Mr. CRIPPS: No.

You have, as general manager of the company, considered that Paddington is entitled to have its own generating station in its own area?—Yes.

As a matter of fact, apart from any legal question, have you in Paddington, or are you placing in Paddington, sufficient generating stations so that Paddington may be self-contained?—Amberley-road station, so far as the generators are concerned, is in excess of the present demands of Paddington, but the boiler supply has, within the last year, become insufficient. The company, two years ago, made an arrangement by which they obtained the right of entering into possession of land immediately adjoining the station on Ladyday, 1904, in order that they may erect additional boilers to keep pace with the demand.

Now, as regards your mid-London area and the supply which you can get from Willesden?—At the time the company decided to go to Willesden their position in the mid-London area was very uncertain. There were various schemes under discussion for forming a new thoroughfare between the Strand and Holborn, one or two of which would have passed through the site of the existing generating station in Sardinia-street, and ultimately the scheme adopted did require that site. The London County Council's London Improvements Act, 1899, provides for an equivalent site for that station, and that the Council shall give the company a sum of money sufficient to provide for the erection of a new generating station of a capacity of 4,000kw. in place of the existing station, which has a capacity of 2,365kw., and the Council have also to pay the cost of all alterations to the

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mains which will become necessary. So that in a few years the capacity of the company's generating plant in the mid-London area will be much enlarged.

At the present moment there is no arrangement whatever between you and the Marylebone Council under which they would take, or come under an obligation to take, your Willesden current?—No.

It is obvious that an arrangement of that kind, over the period of the concession, would undoubtedly affect our severance claim?—It certainly would, but there is none.

The UMPIRE: The particulars submitted on this point stop at 1925. I suppose that is because your estimate reaches a point at which you will require the whole supply from Willesden?—Yes.

In mid-London in 1925 you estimate you will require over and above what you can generate in mid-London 8,750kw. And that is practically the whole of the output of Willesden?—Yes, not as it stands to-day, but as it will stand when the machinery now ordered has been completed, and on the assumption it would suit the company to take current from Willesden to mid-London; but the company have been advised that it is very doubtful whether it would be advantageous to take current 8¼ miles into the heart of London into an area so suitable for the production and immediate distribution of continuous current.

Mr. CRIPPS: You say it is a question whether it would be practicable to take it 8¼ miles?—Yes, it has always been a doubtful point with the company.

Another table put in shows the extent to which Willesden will be unemployed between 1903 and 1925?—Yes.

Please explain that.—Taking the year 1903, the use which the company can make of Willesden apart from Marylebone, is 2,563kw. The total capacity of the station in 1903 is shown as 7,500kw., so that in 1903 the difference between 7,500kw. and the 2,563kw. the company can make use of is 4,937kw., which represents the proportion of Willesden which will then be unemployed. Dividing the cost of the station as it will be at that time, that is £525,000. By those two sets of figures the capital at that time which will be unproductive is £345,590. In 1904, the year Willesden will have reached its maximum capacity, as at present arranged, the deficiency which can be transferred from the town areas is 1,985kw. That is mid-London alone, and the balance of capacity unemployed is 7,015kw., which represents a capacity of £491,050. Interest and depreciation on that sum work out to £22,097. From that point it is all the same, the capital remains the same, but the proportions of productive capital and unproductive capital gradually change till by the end of 1925 Willesden (as it will be in 1904) will be fully employed by the demands of the mid-London area.

Though in 1904 you will have this 9,000kw. capacity, your station, as laid out at Willesden, was much larger?—Yes, Willesden was laid out for a capacity of 27,000kw.

The 9,000kw. is only what you have under order?—Yes, of course our further progress is arrested, but we intend to gradually enlarge Willesden up to its full capacity.

On this basis the table shows the loss to you under the head of depreciation and interest?—Yes.

Apart from this loss in interest and depreciation, you have calculated, over a period of time, additional expense in connection with the generation of a smaller output at Willesden?—Yes. In 1903 we estimate that, without any work to do for Marylebone, our output, or the number of units we should generate at Willesden, would be 8,400,000 instead of 10,934,000 as it was last year. Now, if this great station is to do so much less work, it will follow that the average cost of the diminished number of units will be higher, and we calculate that, instead of the cost working out at 0·78d., as it did last year, after giving effect to the economies anticipated, it would work out to 0·97d., or the 8,400,000 units would cost all over 0·19d. more to generate.

The UMPIRE: Your table shows you anticipate till 1912 you will continue to be working at an increased cost?—Yes, in proportion to the amount of reduction of output. In 1912 we assume we shall have grown up to the business done last year.

Mr. CRIPPS: In your table the kilowatt capacity of Willesden in 1904 is 9,000. I believe the actual capacity there is 13,500, but you allow so much for stand-by?—Yes. The extension upon which we are engaged just now provides for very much larger engines. The five engines now at work are 1,500kw. each, but with a view to still further cheapen production the company, in giving their last order for plant, adopted units of twice that size, and the new engines, one of which is now in course of erection, are of 3,000kw. capacity, or practically 5,000 H.P. Having these very large units, in order to guard against any sudden reduction in power of output by one of these great machines going out of work, we rate the station, as it will be with these two large machines and the five half-size machines, at only 9,000, although, if they were all going the capacity would be 13,500kw. The difference is 4,500kw.—that is, one of each of those engines. When we have got the two large engines in the proportion of spare, as we call it, it is considerably more.

The UMPIRE: With the figure at 4,500, what is the stand-by?—We have 6,000 at the present time, and we rate the output at 4,500. That is one-third for stand-by; when the whole plant is available we shall have 4,500 spare out of 13,500, or one-third.

Mr. CRIPPS: When you started, 1,500kw. engines were the largest unit done up to that date?—Yes, that was the largest plant of the kind contemplated at that time, and when we decided on a still further advance last year we were taking a step a long away ahead of general practice with a view to greater economy.

Mr. RYDE: In 1903 you put a figure of 8,400,000, then fall for two years and then rise again. I understood this 8,400,000 was the total amount generated at Willesden?—No; last year we generated at Willesden practically 11,000,000 units. In 1903, if we do not generate at all for Marylebone we expect that, in order to provide for the deficiency in mid-London and in Paddington, we can make use of Willesden to the extent of 8,400,000 units.

Mr. CRIPPS: The next point is your temporary loss from increased cost of administration. You have got the cost of administration in Marylebone in 1901, the proportion of management expenses and so on, working out at £8,119. 7s. 5d.?—Yes; those expenses would practically remain to be borne by the company.

How do you deal with that figure?—We deal with it in the same way as we have dealt with the increased cost of working at Willesden. We find out, by comparison of the number of units sold in Marylebone and in the other areas respectively, that in about six years' time the business of the company will have grown up in the other areas to what it is in the whole of the areas at the present time, and we assume the £8,119 loss as for last year will be gradually worked off on the increasing business during the next five years. In the sixth year there will be no loss, and starting with £6,766 as the additional cost of administration of the remainder of the undertaking this year, it falls to £1,354 in the year 1906, and after that disappears. This gives a total of £18,751 as the present value of that additional burden which the company will have to bear for five years on the 3½ per cent. basis, and is working out the loss on the cost of administration owing to the severance down to a minimum figure.

We sometimes have 15 and sometimes 20 years' purchase, but you work it out for six years?—Yes.

Sir EDWARD CLARKE: May I ask how the £7,592 is arrived at—the proportion of management expenses?—That is the proportion of expenses which are shown in the Board of Trade accounts as having been allocated to Marylebone—that is to say, the expenses of administration are divided rateably over all the areas in proportion to the gross revenue of other areas, and the proportion which has been allocated to Marylebone is the sum shown on the first portion of this table.

Is that in proportion to the rateable value of Marylebone?—No, in proportion to the gross revenue of the Marylebone area of the company. The £7,592 is made up of £1,604. 5s. directors' remuneration, salaries and management, secretary's, engineer's salaries, &c. That is exclusive of the engineers at work with the areas.

Mr. CRIPPS: We have now got into the position of summarising our figures under the severance part of our claim, which is £346,507?—Yes, and so far as the value or purchase price is concerned of the property, apart from severance, it comes to £2,425,200.

Mr. CRIPPS: Some allowance will have to be added for compulsory sale, but I will leave that for argument.

To that we have to add £346,507, which makes a total, leaving out odd figures, of £2,771,700?—Yes, subject to a proper addition for compulsory sale, as far as the purchase price is concerned.

In these calculations you have tried throughout to put together what you consider reasonable figures, making allowance for any reductions which ought to be made?—Yes, I have gone into this matter with great care, and with a desire to put before the arbitrators figures which I and the directors believe to be fairly representative of the value of the company's undertaking, including its future prospects. We have a very high opinion of the undertaking, based on the facts disclosed and a most careful study of the conditions and circumstances under which the company are working.

We all of us know of your connection with railways, particularly as manager of the North British, and that you have had great experience in compensation cases?—I have.

Have you known any case where a company has been taken over in what I may call such an incohate condition and such a large prospect?—No, I cannot recall to my mind any case of the kind where a company has been purchased under compulsory powers at so early a stage in the development of what is practically a new industry. The conditions may be altogether different after electric supply companies have had some more years in which to work, but they have really had to break virgin ground and build up this business from the beginning without any assistance to establish that income which is now produced.

It has been shown that in the early days, when they were a pioneer company, they got substantially no return?—That is so, and peculiarly so in Marylebone, on account of the very widespread character of the area. We are in the position of a pioneer company having gone through the stage of risk and got firmly into the saddle, without having nearly reached our normal development.

Mr. Conacher's examination-in-chief was followed by the examination by Mr. Cripps, K.C., of Mr. J. G. Head, surveyor, house and land agent (Messrs. George Head & Co., 7, Upper Baker-street, Marylebone). Mr. Head's evidence was devoted to the question of the development of the Marylebone district in building matters, especially in the relation of these building operations to the improvement of the class of buildings erected in the borough, and their consequently increased value to the Metropolitan Company as probable consumers of electric current. After cross-examination by Sir Edward Clarke, K.C., for the Marylebone Council, Mr. Head was followed by Mr. E. W. Rushworth, surveyor, house and land agent (Messrs. Rushworth and Stephens, 22, Savile-row, W.), Mr. S. Clarke, surveyor, 8, New Coventry-street, W.; and Mr. C. W. Miller, surveyor, 46, Pall Mall, W.

British Power, Traction and Lighting Co. (Ltd.) (Petition of L. Hannen.)

This matter came before Mr. Justice Swinfen Eady on Wednesday on a creditors' petition for the compulsory winding-up. The company asked that the petition should stand over for two months. Unless the company could get fresh capital it must stop, and then there would probably be nothing for the unsecured creditors.

Subsequently counsel said it had been agreed that the petition should stand till the first petition day after Nov. 17.

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Rechard v. Mazarron Electric Light Co. (Ltd.)

On Wednesday Mr. Justice Swinfen Eady heard this case, which was a motion for the appointment of a receiver and manager. Plaintiff was holder of five debentures of £20 each in defendant company, which was formed in 1893 to establish a system of electric lighting in Mazarron (Spain) under a 50 years' concession. It appeared that the company was now working that concession. The ground of the application was that the company had committed a breach of its debenture conditions. The company submitted there was no ground for the appointment. The company offered to pay plaintiff off, but was not willing to pay the costs of the action.

His lordship granted the application, and appointed Mr. Hussey receiver and manager.

Re the Universal Microphone Co. (Ltd) v. Nye and Another.

This matter came before Mr. Justice Swinfen Eady on Wednesday on two motions by plaintiff company asking for injunctions against defendants to restrain them from assigning patents.

Mr. HOUSTON, for plaintiffs, said defendants had filed affidavits, though they did not appear, and they had undertaken meanwhile not to deal with the patents which were the subject of the action, and his Lordship allowed the motions to stand over for a week.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An assistant lecturer in electrical engineering is required for Hartley College, Southampton. Further particulars from the principal, Dr. S. W. Richardson, to whom applications by Sept. 24. See also advertisement.

The National Boiler and General Insurance Co. (Ltd.), 22, St. Ann's-square, Manchester, require additional surveyors of electrical plant. Further particulars are given in an advertisement. Applications to the chief engineer (Mr. Edward G. Hiller).

A draughtsman is required for the rolling-stock department of the British Electric Traction Co. Applications to the secretary, Donington House, Norfolk-street, London, W.C. See advertisement.

An electrician is wanted immediately on board cable-repairing ship in West Indies. Applications to manager, West India and Panama Telegraph Co., 187, Dashwood-house, London, E.C. See advertisement.

St. Pancras (London) Borough Council require a junior clerk for their electricity and public lighting department. Forms of application from the chief clerk (Mr. A. E Pyecraft), 57, Pratt-street, Camden Town, London, N.W., to whom applications by noon 27th inst. See advertisement.

Poplar (London) Borough Council require a general clerk for electricity undertaking. Applications to town clerk by Sept. 29.

An assistant lecturer in physics is also required at Hartley College, Southampton. Applications by 24th inst.

An assistant lecturer is required at Huddersfield Technical College. Applications by September 24th.

Mr. H. W. Malcolm, M.A., B.Sc., has been appointed lecturer and demonstrator in physics at University College, Bristol, in succession to Mr. L. N. Tyack. Mr. Malcolm was educated at Robert Gordon's College, Aberdeen, and at Aberdeen University. He gained the first medal in each of the classes in inorganic, organic and practical chemistry at the University, and in April last graduated Master of Arts and Bachelor of Science with first-class honours in mathematics and natural philosophy, taking also the Simpson prize of £65 in mathematics, the Greig prize of £30 in natural philosophy, and the Rennet gold medal for problem papers.

Mr. P. R. Sanderson, of Stockton, has been appointed by the Hyde, Stalybridge, Mossley and Dunkinfield Tramways and Electricity Board to inspect the rails being manufactured for the electrical tramway at a fee of 3d. per ton on accepted rails.

Mr. W. R. Kelsey, B.Sc., A.I.E.E., of Bradford Technical College, and formerly chief draughtsman to Messrs. J. G. Statter & Co., has been appointed principal of Taunton Municipal Technical Institute.

Mr. W. B. Morgan, assistant mains engineer at Bristol, has been promoted mains engineer in succession to Mr. Jenkins resigned.

Mr. A. P. Dryburgh, of Swansea, has been appointed assistant electrical engineer at Dewsbury at £120 per annum.

EDUCATIONAL NOTICES.

Owens College, Manchester.—Special equipment, including experimental electric furnaces, is provided in the new physical laboratories for instruction and research in electro-chemistry and electro-metallurgy. Particulars of day and evening classes may be obtained from the registrar (Mr. S. Chaffers). See also advertisement.

To encourage employés at their works to engage in technical studies, and more especially in the advanced courses of electrical engineering at the municipal technical schools, Wolverhampton, the directors of the Electric Construction Co. have offered free scholarships, covering class fees, for the 1903-4 session.

Abersychan.—The Council have decided to apply for a provisional electric lighting order.

American Electricity Statistics.—From statistics published at Washington it would appear that the capital employed in the United States in telephone operations amounts to $300,000,000, that there are over 2,000,000,000 conversations per annum over the telephone lines, and that in 1900 the per capita use of the telephone throughout the United States was one in 40 and in San Francisco one in 12, this latter being claimed to be the highest rate in the world. Mr. T. C. Martin, who is, we believe, responsible for the figures under review, refers to the great advance made recently in wireless telegraphy, automatic telephony, X-ray work, teleautographic devices, wireless illumination, &c. During 1899, Mr. Martin gives the production of copper electrolytically at 200,000 tons. The value of electrical products manufactured in the United States in 1900 is given at $91,348,889, and the total capital invested in the manufacture of electrical apparatus and appliances at $83,130,943. During the past 25 years 17,539 patents have been issued in relation to telegraphy, telephony, signalling and electric lighting, power and traction. Of this number 6,800 patents were taken out from January, 1896, to June, 1900, Mr. T. A. Edison being responsible for 711 of these and Prof Elihu Thomson for 394 The average annual expenditure per capita on electrical applications is put at $7—$1·25 for electrical apparatus and supplies, $3 for traction, $1·50 for electric lighting, 75c. for telephone service, 50c. for telegraphs, fire alarms, signalling, &c, the people, in fact, paying as much per head of the population for electricity as for the staff of life. The total horse-power used in manufacturing establishments of all kinds in the United States is given at 11,300,000, of which 4·4 per cent. is electrical. In 1890 the street railway companies of the States numbered 789, of which 144 were electric lines. There were then 2,895 electric cars out of a total of 32,505, and 1,262 miles of track out of 8,123 were electric. In 1900 there were 871 street railways, nearly all electric, with 50 658 electric cars and carriages running on electric railways and tramways, and the total number of miles of track was 17,969. The total horse-power of electric fans used in the United States in 1900 was 12,766. For the 12 months to June, 1902, the exports of electrical machinery from the United States were valued at $5,379,746, compared with $5,812,715 for the corresponding period in 1901.

Ashton-under-Lyne.—In presenting the report of the Electricity committee, the chairman (Mr. Barlow) stated that during the last month, owing to the utilisation of the refuse destructor and new condenser, they had been able to reduce the consumption of coal from 120 to 80 tons. The committee had fixed the charge for current to the Corporation tramways at 1½d. per unit. This price, said Mr. Barlow, was only equalled by Liverpool and Bradford.

Bangkok (Siam).—Five and a-half miles of new electric tramways were laid in this city during 1901 by the Siam Electricity Co., which now owns both the electric tramways and the electric lighting. This latter branch of electrical industry is now in general favour, public and private buildings, factory premises, &c., being almost uniformly lighted electrically, and the demand for electric fans and ventilating appliances is extensive and increasing. Between 40 and 50 electric fans are being installed at the King's palace. The imports of electrical apparatus and materials for 1901 into Bangkok were valued at £15,654. £9,037 came from the United States, £6,086 from the United Kingdom, and £531 from Germany and elsewhere.

Battersea (London).—A dispute has arisen between the Borough Council and the Postmaster-General in regard to the erection of telephone wires. The Council were asked to consent to the erection of wire to connect the Post Office telephone system with that of the National Telephone Co., but the Council, deeming the extension of the National Company's powers contrary to the interests of the public, refused. The Postmaster-General has applied, under the provisions of the Telegraph Acts, to the local police magistrate to settle the dispute, but the Council threaten that, if the decision be adverse to them, they will appeal to the Railway and Canal Commissioners. In the meantime the Council have invited the other Metropolitan Borough Councils to send delegates to a conference on the subject at Battersea on Tuesday next.

Bournemouth.—The Council are considering the question of constructing a short electric tramway to connect up the pier with the town system of tramways.

Brighton.—The Corporation have decided to ask the Councils of Portslade, Southwick and Shoreham to approve of Brighton supplying electricity in their districts.

Bromley.—The British Electric Traction Co. propose to construct a system of electric tramways connecting Bromley with Penge and the lines of the London County Council. A committee is considering the matter.

Broughty Ferry.—The inauguration of the electricity works has been fixed for 24th inst.

Buenos Aires.—The *Review of the River Plate* says that the Intendente of Buenos Aires has declared as lapsed the concession granted to Messrs. Miranda, Beyer & Co. for the construction of an electric tramway, but the Public Works committee of Congress has

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reported favourably on the petition of Messrs. Quesada Bros. for an extension of one year in which to commence work on their electric tramway from Buenos Aires to Almirante Brown (Adrogué).

Cardiff.—The electric lighting of several additional thoroughfares has been authorised. The Local Government Board has refused its sanction to a loan of £107,611 for extensions at the Roath power station. It is urged that £48,750 out of the £107,611 has already been expended, and the demand for electric current for lighting and power is increasing at such a rate that the committee will be in a deplorable state unless extensions are made. The borough electrical engineer and tramways manager (Mr. A. Ellis) stated at a meeting of the Lighting committee that if the Local Government Board get their own way it would be necessary to erect a third station, which would be a waste of money. The Board objected to the expenditure upon continuous-current supply, on account of the plant having been put down at the power station. Mr. Ellis suggested that the Tramways committee should obtain the sanction of the Board of Trade and sell the energy to the Lighting committee. The matter was left in the hands of the chairman (Ald. Carey), the chairman of the Tramways committee (Mr. T. Andrews), the borough engineer (Mr. Harpur) and Mr. Ellis.

The chairman (Ald. Carey) stated that if the Cardiff Railway Co. persisted in their refusal to give the Corporation access to the Bute Docks for the purpose of supplying the numerous applicants among the tenants with electric current for lighting and power, the South Wales Electrical Power Distribution Co. would probably step in and give a supply.

On Tuesday continuous current was supplied for the first time in the central and docks districts.

Camborne.—The Council have opened negotiations with the Urban Electric Supply Co. for the electric lighting of certain new thoroughfares.

Dingwall (N.B.)—The Council have approved a scheme for the electric lighting of the town, drawn up by Mr. Deacon, electrical engineer for the Strathpeffer electricity works.

East Stonehouse.—Devonport Council will oppose the application of the Provincial Electric Supply and Traction Co. for a provisional order for East Stonehouse.

Edinburgh—The Electric Lighting committee have practically come to terms with the Caledonian Railway Co. for the supply of electric energy for lighting and power for the Princes-street station, the hotel and the adjoining goods yard. The company will require about 500,000 units per annum. Hitherto a private installation has been used.

Electricity Statistics.—The census returns for Kent show that there are in the county 1,457 persons engaged in electrical pursuits, compared with 203 in 1891.

Exhibitions.—An international motor-car exhibition will be held at Hamburg from Oct. 3 to 11.

There was to have been an industrial and general exhibition in Athens next month, but notification is now made that the exhibition is postponed to 15th March next.

The movement for holding an exhibition in Cape Town in 1904 is progressing, and the manager (Mr. A. P. Baker) has opened London offices at 20, Victoria-street, S.W. There will be 28 sections, including mining, engineering and machinery, light railways, tramways, &c., railway and motor cars, &c., marine engineering, electricity, &c., construction, sanitation and ventilation, decorations, paints, dyes and colours, fuel, smoke abatement, inventions, arts and sciences, hardware, tools, &c.

Fire.—The electric generating plant of the Nordrach Sanatorium for Consumption on the Mendip hills was badly damaged by fire on Friday last, the whole of the plant, it is stated, being rendered useless.

Glasgow.—The Board of Trade inquiry into the circumstances attending the recent tramway accident was opened by Major Druitt, R.E., on Thursday last. There were 20 witnesses, the proceedings being, of course, conducted in private.

Halifax—The new electric tramway route between King's Cross and Sowerby Bridge was officially inspected on Friday. Extensions of the electric tramway system to Hipperholme and Greetland have been authorised.

Hampton—The Highways committee are reporting on the advisability of carrying out the terms of their provisional order.

Hythe—The Council have sealed the agreement with the Folkestone Electricity Supply Co. for the supply of electrical energy in the borough.

Leatherhead.—Leatherhead and District Electricity Co. have commenced the supply of current, and the Council are considering the question of wiring the public buildings.

Leek.—An inquiry was held on Friday into the application of the Council to borrow £10,061 for electricity works. There was no opposition.

Littlehampton.—The British Electric Traction Co. seek the Council's consent to the extension of the Worthing tramway system to Littlehampton.

Municipal Telephony.—Hull Corporation have been granted a licence to establish a municipal telephone service.

Scarborough Telephone sub-committee have accepted the draft telephone licence issued by the Postmaster-General, and Mr. A. R. Bennett has been instructed to prepare plans and specifications.

Huddersfield Town Council on Wednesday again discussed the question of establishing a municipal telephone service. Ald. Sugden moved that an underground and modernised system of telephonic communication should be established in Huddersfield, and that an agreement be entered into with the National Telephone Co. for laying wires underground within the borough for a period not exceeding 25 years, subject to satisfactory terms being arranged. He submitted that if the National Telephone Co., with their large experience and wide operations, failed to secure what could be considered adequate return for their investments, the Corporation, working on its own modest scale, were not likely to succeed. Mr. Sykes seconded the motion, and said the most powerful argument against the proposed municipal undertaking was that their hands were already fully engaged. Ald. Sugden's resolution was carried by 23 votes to 22.

Brighton Telephone committee have received the revised plans and estimates of the consulting engineer (Mr. A. R. Bennett) for the proposed municipal telephone system. The borough of Hove is excluded from the new scheme, and application has now been made for sanction to borrow £42,000 in lieu of the £45,000 previously applied for.

Bournemouth Corporation have invited the Corporations of Poole and Christchurch to co-operate in a united scheme of municipal telephony.

Newcastle-upon-Tyne.—The Tramways committee have reduced the charge for arc lighting from £18 per lamp per annum to £15. 10s.

Northampton.—Negotiations for the acquisition of the undertaking of the Northampton Electric Light and Power Co. by the Town Council have been broken off.

Overhead Coverings for Electric Tramways.—The introduction of an "upper deck" cover for the electric tramways at Liverpool is attracting attention in tramway circles, and this week deputations from Walsall and Huddersfield have inspected Mr. C. R. Bellamy's contrivance for providing outside passengers on tramcars with protection against weather and other discomforts. It is claimed for Mr. Bellamy's device that it does not in any way detract from the good external appearance of the car, and is not costly in application. A light wooden frame is provided, the top and sides of which are fitted with a series of spring waterproof roller blinds which can be easily opened or closed by the passengers, and which enable the outside of the tramcar to be perfectly closed in in a short space of time. The ordinary trolley standard is abolished on the cars on which Mr. Bellamy's covering is adopted, giving a clear gangway and increasing the seating accommodation to a considerable extent. Additional facilities for lighting the car on the outside are also possible with the use of the covering. Mr. Bellamy has introduced in his new design of car an improved form of staircase, the Bellamy lifeguard and other improvements.

Paris.—The construction of the second section of the Metropolitan Underground Electric Railway, which is intended to serve the outer boulevards north of the city, is approaching completion, and is likely to be opened for traffic early next month. The net profit on the first section during August amounted to £4,432, compared with a loss in the corresponding month last year, the improvement being due both to increase in traffic and reduction in working expenses. The profits during the first eight months of 1902 amounted to £66,250, against £45,778 in the same period of 1901, and the proportion of working expenses to gross receipts having declined from 46·41 to 42·44 per cent.

Perth.—The question of the purchase of the local tramways will be discussed at a special meeting of the Council, the former resolution to purchase having been informal.

Prison Lighting.—In the report of the Commissioners of Prisons it is stated that much attention has been given to the question of providing better light in the prisoners' cells, and it is proposed to gradually discontinue the use of opaque glass, and, if the cost is not prohibitive, to take advantage of any public supply of electricity in the prison districts.

Ramsbottom.—The Council have appointed Mr. A. B. Chatwood consulting engineer, at a fee of £250, to prepare an electricity supply and tramway scheme.

Rating of Telephone Wires.—At Dundee District Valuation Appeal Court last week,

Mr. GEORGE BEAN, rating clerk of the National Telephone Co. (Ltd.), craved that a valuation of £2,562 placed on the company's 1,538 miles of wire in Dundee should be reduced to £1,538, or £1 per mile. Two years ago it was argued by the assessor before the Court that the underground wires involved less outlay than the overhead wires, and that therefore they must be regarded as increasing the value of the company's property. He (Mr. Bean) was now able to say that that was not so, and he had the figures before him, which he would submit privately to the Court, but would not read, as he did not wish them to be reported. His reason for this was that there was a possibility of the Dundee Corporation competing with his company in the future. They had serious opposition in Glasgow.

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The CLERK said the figures should be submitted in public.

Mr. BEAN replied that the maintenance of underground wires cost more, the cost per mile in 1899 being 1s. 3d. for a certain period, and 1s. 4½d. for the same period in 1902.

Mr. W. B. DICKIE, solicitor, representing the Parish Council, said that what the Court had to consider was not whether the valuation should be £2 on underground wires, but whether £2,562 was a fair valuation on which to rate the company. The company should be assessed on the profits, and he asked that the books should be called for in order that these might be ascertained.

The Court dismissed the appeal.

Rating Appeal.—An important point was raised before the Valuation committee of the Fife County Council on Tuesday in the form of a test case as to the valuation of certain electric lighting plants at the pits of the Wemyss Coal Co. The appeal was conducted under the auspices of the Coalmasters' Association, who were represented by Advocate Andrew Burt, of Edinburgh.

Mr. BURT said that in recent years electric lighting had been introduced into many of the pits of Fifeshire, and the question to be decided was whether or not electric lighting plants were to be entered in the valuation roll as a separate subject for assessment, or whether electric lighting in the pits was covered by the rents and the lordship paid to the owner of the coal. On behalf of the coalmasters he urged that the royalty or lordship paid to the owner of the coalfield was included in the fair annual value of the lands and so should not appear separately in the valuation roll. He contended that the assessor would not have entered these electric lighting installations in the valuation roll had it not been for the Act of 1902. That act was passed to correct the decision given in the Court of Session with reference to what was known as the Dundee machinery case. It was found that this decision was disturbing existing law and practice in Scotland, and he believed that rating assessors in Scotland had been instructed to pay no attention to the Dundee case in making up their rolls. In this particular case electric lighting was not supplied for any purpose except ordinary operations, and clearly fell under the exception of an improvement for the purpose of working and cleaning the minerals, and on that account alone he considered he was entitled to succeed in the appeal. Formerly, the lighting of these pits was effected by oil lamps, and it was for the greater safety, greater expedition, greater cleanliness and comfort, and to preserve the amenity of the pit, that electric lighting had been introduced. If any increased rent was obtained from the pit owing to its introduction, or if more coal was produced, then the assessor got the benefit in the increased lordship paid to the owner of the coalfields in the one case or the benefit of increased taxation in the other.

The ASSESSOR (Mr. Sulley) agreed that unless he could prove this was an independent subject, capable of being separately let and not covered by mineral royalty, his valuation must fail. The landlord (he continued) was not concerned in any way whatever with the electric lighting. He was just as well paid and his royalties were just as good; his rate per ton was not in the slightest degree affected whether the colliers worked by oil lamps or with electric lamps.

The CHAIRMAN OF THE COMMITTEE (Provost J. Ritchie Welch) said the question was a very important one. He asked the assessor whether, if the Wemyss Colliery Co. had erected a small gas plant at the head of each of the pits, and had lighted their collieries by gas, would these works have been put in the valuation roll?

Mr. SULLEY: Certainly, these works have been placed on the valuation roll since 1854 as a separate subject, quite apart from the royalty which covered the machinery. The Fife Coal Co. were opening up the largest coal pit in Scotland, and it was perfectly conceivable that in opening up a new coalfield the company would lay down a large electric generating plant from which they would supply their own colliery, and might supply adjacent collieries and charge a rental. He held, therefore, that electric lighting had a letting value, was capable of being let, did not affect the coalowner, and was not necessary to the owner in the same way as the pithead buildings and machinery, and so was not covered by the sum which appeared in the valuation roll as mining royalties.

The CHAIRMAN: Has any similar case been dealt with in Scotland?

The ASSESSOR: No.

Mr. BURT, replying to the points raised by the assessor, said that in this case there was no selling of electric current for lighting to anyone, and no intention of using it for any other purpose.

The CHAIRMAN said that the Court, after giving careful consideration to this important matter, had unanimously come to the conclusion that the appeal must be sustained. They did not see their way to enter electric lighting in the valuation roll separately.

Mr. SULLEY expressed dissatisfaction at the decision, contending that it was erroneous in law, and asked that a case might be stated with a view to appea

Rowley.—The Midland Electric Corporation for Power Distribution have notified that they propose to lay electric lighting mains in various parts of the district.

Mr. R. P. Wilson has been appointed consulting engineer for the Brierley Hill-Rowley light railway scheme.

Prestwich.—The Board of Trade has deferred the question of the revocation of the provisional electric lighting order for 12 months.

South Shields.—The Council propose to apply for Parliamentary powers to construct and work electric tramways on the overhead system, estimated to cost £213,360.

Southampton.—The construction of the electric tramway from Bitterne Park has been carried out by the Corporation under the supervision of the borough electrical engineer (Mr. H. F. Street) instead of being put out to contract.

Stonehaven.—The Lighting committee are considering the proposals of Messrs. Barlow and Young regarding the erection of electricity works. The firm offer to supply current for public lighting at 4d. per unit for street lighting, and at 6d. for private lighting, the Council to have the option of purchasing the undertaking at the end of 12 years.

Straits Settlements.—Singapore is possessed of an excellently organised telephone service, operated by the Oriental Electrical and Telephone Co. This company also works and maintains the Government telephone lines connecting up the Government buildings throughout Singapore.

In Penang, Wellesley and Malacca the Government maintains its own telephone lines. There are in Penang 136½ miles of service lines, of which 49½ are connected with the public exchange and 87 miles are not so connected. There is 105½ miles of subscribers' lines. The Government telephone exchange in Penang was opened on March 1, 1901, with 50 subscribers, and on Dec. 31 there were 105 subscribers' lines and 22 service lines connected.

There will be opened, towards the end of 1902, the Singapore–Kranji railway, which will ultimately be considerably extended. Negotiations are on foot for leasing the railway to the Singapore Tramways Co., who are likely to adopt electric traction on their tramways and to connect the new railway with their tramway system. The Singapore Tramways Co. was formed in 1901 for the operation of electric traction and the supply of electric current in the town generally. The company owns a 35 years' concession, and is likely to be in full operation by the end of 1902. The tramways of Penang were taken over by the Government early in 1901, and the Singapore Company will most likely obtain a lease of these lines in the near future and operate them electrically.

Taunton.—The Council have entered into a revised agreement with the National Electric Wiring Co. for wiring of premises. In future the company will receive from the Council 11 per cent. per annum on the cost of unpurchased installations, which at present stand at £2,119. 1s. 10d., in lieu of the present charge of 1d. per unit with a minimum of 1s. per annum per 8-c.p. lamp installed. This will mean an annual payment to the company of £232. 2s., and, taking last year's supply of current to "free"-wired consumers, represents a payment of 1·37d. per unit.

The Pacific Cable.—The c.s. "Colonia" has arrived at Victoria, B.C., with the last section of the Pacific cable on board.

West London Tramways.—Two new routes of the London United Tramways system were opened for traffic last Saturday. One is a continuation of that branching off from the Shepherd's Bush, Hammersmith and Hounslow line through Isleworth. The line now goes over Cole's Bridge to King-street, Twickenham. The other line extends from Twickenham to Richmond Bridge. The lines are extremely popular, and bid fair to be as well patronised as the other lines of the London United Tramways running from the Shepherd's Bush terminus of the Central London Railway.

Whitburn-South Shields Tramway.—The British Electric Traction Co. will apply for powers to construct tramways from Whitburn to Cleadon, Harton and South Shields. Harton Council have already decided to support the scheme.

Whitby.—The Council are seeking sanction to re-borrow all the expended capital on electric lighting account and to borrow any further capital required, repayments to extend over a period of 30 years, interest only to be payable during the first five years.

Whitehaven.—The Council has instructed the electrical engineer (Mr. P. J. Watt) to prepare a report upon the charges at present made for electricity supply with a view to reductions in the early future.

Mr. Watt has been complimented upon the completion without mishap of the changing over to the higher voltage.

The large works at William Pit are to be supplied with current at 2d. per unit as an experiment.

Some of the electric lighting mains which were originally laid in earthenware pipes have, it is said, been found to be saturated with coal-gas, necessitating their relaying. The Corporation is considering the liability of the local gas company in the matter.

Wilmslow.—The Council have decided to establish municipal electricity works.

Wishaw.—The Council have decided to take electric current from the Clyde Valley Electrical Power Co.

Withington.—The Board of Trade has approved the system of electric traction proposed to be adopted on the local tramways. Parliamentary powers are being sought by a syndicate to construct and electrically equip a tramway connecting the present tramway terminus at Stretford with Altrincham, Sale and Withington if the consent of the local authorities interested can be secured.

Marriage.—On 11th inst., at St. Luke's Church, Southport, Mr. W. Mackintosh, chief assistant electrical engineer in the Corporation electricity department, Keighley, was married to Miss M. G. Davies, of Southport.

Football.—The General Electric Co.'s Football Club is anxious to try conclusions with clubs of other electrical houses, and fixtures can be arranged on application to Mr. H. Bowthorpe, hon. sec., 71, Queen Victoria-street, London, E.C.

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TRADE NOTES AND NOTICES.

[Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.]

TENDERS INVITED.

Ilford District Council invite tenders for supply and erection of dry-back, semi-marine-type boiler, superheater and accessories and motor feed pump; steam feed and low half pipes and feed filter; and surface condenser, cooling tower, motor pumps, hot well, grease extractor, exhaust steam and water pipes Specifications, &c, of the clerk to the Council (Mr. J. W. Benton). The works have to be carried out to plans and specifications prepared by the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., from whom further information can be obtained. Tenders, addressed chairman of Council, Council offices, Ilford, by noon, Oct. 6. Further particulars are given in an advertisement.

West Ham Borough Council invite tenders for 46 combined arc lighting and traction poles, with side brackets. Specifications, &c., from the borough electrical engineer (Mr. James K. Bock), Abbey Mills, West Ham, after 22nd inst., and tenders to town clerk (Mr. Fred. E. Hilleary), Town Hall, by 4 p.m. Oct. 7. An advertisement contains further particulars.

Swindon Corporation invite tenders for station lighting and motor wiring, and testing instruments and accessories. Specifications, &c, may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester, and be obtained from the former office. An advertisement contains further particulars. Tenders to town clerk (Mr. Robert Hilton) by Oct. 4.

Huddersfield Corporation require tenders for high and low-tension cable. Specifications of the borough electrical engineer (Mr. A. B. Mountain), and tenders to the town clerk (Mr. F. C. Lloyd), Town Hall, Huddersfield, by 30th inst. See advertisement.

Rochford District Council invite tenders for the supply, delivery, erection and maintenance for one month of electrical transmitting and recording instruments, and about 1¼ miles of overhead wire, poles, &c., for communication between the water tower and South Benfleet, Essex Specifications from the consulting engineers (Messrs. James Mansergh & Sons), 5, Victoria-street, Westminster, and tenders to the clerk, Mr. Frederic Gregson, solicitor, Southend-on-Sea, by 10 a.m. 30th inst. See advertisement.

Maidenhead Corporation invite tenders for complete electric lighting installation for the Guildhall. Specifications from the resident electrical engineer (Mr. C. O. Milton), and tenders to town clerk, Guildhall, Maidenhead, by 4 p.m. Oct. 6. See advertisement.

Belfast Gas and Electric Light committee invite tenders for supply of electric motors for 12 months. Specifications from the city electrical engineer (Mr. Victor A. H. M'Cowen), East Bridge-street, and tenders to the town clerk (Sir Samuel Black) by noon, Oct. 10. See advertisement.

Dundee Gas Commissioners invite tenders for water-tube boilers, with mechanical stokers and superheaters and induced draught apparatus. Tenders to the clerk (Sir Thomas Thornton, LL.D.), by Sept 24.

Dundee Gas Commissioners also invite tenders for carbons for public lamps. Tenders to Sir Thomas Thornton by Sept. 24.

By command of the *Postmaster General* tenders will be received until 10 a.m. of Sept. 29 for the supply of Swedish, Norwegian or Finland red fir telegraph poles, and for creosoting same. All particulars of Mr. S. C. Hooley, controller of stores, G.P.O., London, E.C.

The directors of the *North-Eastern Railway Co.* invite tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders to secretary, York, by noon Oct. 7.

Oldham Corporation Electricity committee invite tenders for erecting a bridge over the railway to connect their Rhodes Bank and Greenhill electricity works. Tenders by Sept. 26.

Burton-on-Trent Corporation invite tenders for supply and laying of electric mains, conduits, junction boxes, &c. Tenders to town clerk before noon Sept. 30.

The managers of the *West London School District* invite tenders for the electric lighting, &c., of their schools at Ashford, Middlesex. Tenders to managers at the schools, Ashford, by 6 p.m. 25th inst.

Stafford Gas and Electricity committee invite offers for six battery regulating switches and 19 contacts. Offers to engineer and manager, Mr. Hubert Pooley.

Grimsby Corporation invite tenders for continuous-current motors for letting on hire. Tenders to borough electrical engineer, Mr. W. A. Vignoles, by Sept. 20.

Middlesex County Council require tenders for permanent way construction of about 10½ miles of light railway. Tenders to Guildhall, Westminster, S.W., by Oct. 7.

Peterborough Town Council require a Lancashire boiler. Tenders by Sept. 30.

Blackpool Tramways committee require steel rails, fishplates, bolts and nuts, tie bars, points and crossings. Tenders by 23rd inst.

Southampton Corporation invite tenders for electrical plant for street alarms, steam fire engine, &c. Tenders by 24th inst.

Dungannon (Ireland) District Council require tenders for electricity generating plant, mains, &c. Tenders by Sept. 24.

Aylesbury District Council invite tenders for erection and maintenance of electricity works for a term of years. Tenders by Oct. 8.

Blackburn Town Council invite tenders for an electrically-driven travelling crane. Tenders to town clerk by noon Sept. 22.

Sheffield Tramways committee require 500 poles and 400 bracket arms for overhead line construction. Tenders by Sept. 30.

Messrs. Preece and Cardew are authorised by the *Shanghai* Municipal Commissioners to receive tenders for the supply and delivery (c.i.f.) of two 500kw. steam alternators, switchboards, two condensers and circulating water pumps. Tenders to Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, by noon Oct. 30.

The *Madrid Gazette* of Sept. 14 invites tenders for the taking over of certain electric lighting plant, &c., belonging to the municipality of Irun, tenderers at the same time undertaking the electric lighting of the town on a 25 years' concession. Tenders are due by 11 a.m. Oct. 19.

Particulars are given in the *Madrid Gazette* for Sept. 11 of the conditions under which the town of Huéscar is prepared to grant a concession for the electric lighting of the city for a period of 25 years. The municipal authorities will receive tenders until Oct. 13.

[Copies of the *Madrid Gazette*, containing the conditions and other particulars of the above matters, may be seen, by appointment, at (but are not obtainable from) the offices of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London.]

TENDERS RECEIVED AND ACCEPTED.

Ipswich Town Council on Wednesday accepted the following tenders:—

Allgemeine Electricitäts Gesellshaft (Berlin), dynamos (with Reavell engines) at £6,564. 5s. Work to be completed in 28 weeks.

Tudor Accumulator Co., storage battery at £1,256, with five years' maintenance at £83 per annum. Contract to be completed in 12 weeks.

Ransomes and Rapier, overhead travelling crane at £350. To be completed in 18 weeks.

Johnson and Phillips' Electric Cable Works, cables at £12,901. The work to be completed in 40 weeks.

Dick, Kerr & Co., construction of tramway permanent way and track at £41,220, on condition that English rails are supplied, and that the work be started within eight or 10 weeks and completed within six months.

S. A. Kenney, erection of generating station and offices, £26,948. Contract to be completed in 42 weeks.

The acceptance of the tenders for arc lamps has been deferred pending further consideration.

Watford School Board have received the following tenders for the electric lighting of the new Victoria Boy's school:—

	A.	B.
Rogers and Gowlett (*accepted*)	£113 10	£96 5
Harold Downer	125 12	119 10
Watford Engineering Works	139 0	132 1
Firth & Son	138 0	134 0
Ridout & Co.	166 0	166 0

A Conductors in steel tubes, B in white wood.

West Ham Corporation have accepted the tender of Babcock and Wilcox for supply and erection of steam, exhaust, feed-water and drain piping, water softener, steam traps and superheaters at £11,133. 16s.; and that of the Sir Hiram Maxim Electrical and Engineering Co. for circulating and air-pump discharge piping, water purifier and vapour pipes at £4,784.

Doncaster Corporation have received the following tenders for ejector-condenser, pumps, piping, &c.:—

Geipel and Lange (*accepted*)	£1,069 10 9
T. Ledward & Co.	1,213 0 0
Korting Bros.	1,095 5 0
Klein Engineering Co.	1,075 0 0
R. Morton & Sons	1,051 0 0

Bexley District Council have accepted the following tenders:—

Anchor Cable Co., cables.
Hart Accumulator Co., accumulators.
Electric Construction Co., motor booster.
Rosling and Fynn, rotary converter and motors.
J. G. White & Co., tramway permanent way construction and rail bonding.
Dick, Kerr & Co., overhead equipment, car bodies, trucks and electrical equipment complete.

The following contracts have recently been placed with Messrs. Belliss and Morcom (Ltd.), Ledsam-street Works, Birmingham:—

Two 40 H.P. engines for coupling to Laurence-Scott dynamos for Langho Inebriates' Home.

Two 540 H.P. engines for coupling to Dick-Kerr dynamos for Pemberton.

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Two 88 H.P. engines for coupling to E.C.C. dynamos for Wolverhampton workhouse.

One 730 H.P. engine for coupling to Siemens and Halske dynamo for Gateshead.

Aberdeen Electrical Engineering Co. have secured the contract for the complete electric lighting plant at the Kingseat Asylum, Aberdeen, including engines, dynamos, switchboard, main cables and wiring of 24 buildings, telephones and tell-tales.

Stretford Council have accepted the tender of W. Thorpe for the erection of electricity generating station buildings at £8,587; that of Clayton, Son & Co. for steel work for roof, &c., at £1,783; and that of the Chatteris Engineering Co. for a travelling crane at £145.

Coventry Corporation have accepted the tender of the British Schuckert Electric Co. for the supply and erection of a 600kw. alternator.

Swindon Guardians have accepted the tenders of the Northern Electrical Co. and the Tudor House Company for laying down electric lighting plant and wiring the workhouse.

Oban Town Council have accepted the tender of Messrs. Ashmore, Benson, Pease & Co. for a storage battery.

The Johannesburg Municipality have placed an order with Messrs. Willans and Robinson for a 240 H.P. compound engine.

Southend-on-Sea Corporation are installing a 250 H.P. Willans engine direct-coupled to a B.P. dynamo for the Southend electric tramway power station.

The tender of Messrs. Geipel and Lange has been accepted by the War Office for 67 Geipel steam traps No. 2 for the Royal Gunpowder Factory at Waltham Abbey.

We published last week a set of figures purporting to be the amounts submitted by various firms to the Amsterdam (Holland) municipal authorities for the supply, delivery and laying of cables for the municipal electric lighting scheme. These figures came to us from an official source, but it is necessary to explain that they must only be taken tentatively. It would appear that the tenders sent in have not all been prepared according to the conditions of the specification supplied by the Amsterdam authorities. For instance, the specification stipulated for the prices to be sent in on the basis of copper at £60 per ton, but some of the tenders submitted, instead of taking copper at £60, were based upon the lower prices now prevailing. In some cases, again, the laying of the cables is not included in the price submitted, although this was a condition of the tender. It is gratifying, however, to learn that the tenders sent in by British manufacturing firms were all to specification, and they may, consequently, be taken as the lowest of the group of tenders submitted. It is considered that about a month must elapse before the true comparative figures can be published. It will be further seen that our conversion of the Dutch florin is erroneous. This arose from the calculation being made on the franc effective basis instead of the florin, and consequently the sterling figures given by us last week have to be increased by about 110 per cent.

BUSINESS NOTICES.

Messrs. W. T. Glover & Co., Manchester and London, have, for the convenience of customers in Ireland, made arrangements with Mr. F. A. Porter, 13, Queen's-square, Belfast, to keep stocks of their vulcanised wires, cables and flexibles.

Messrs. A. Edler & Co, electrical engineers, &c., have removed from 54, City-road, to 19 and 20, Appold-street, Finsbury, London, E.C.

The Electrical Co. (Ltd.), of 122 and 124, Charing Cross-road, W.C., and the Allgemeine Electric Co, of 25, Victoria-street, S.W., have amalgamated, and the joint businesses will be conducted under the name of the Electrical Co. (Ltd.). Mr. Hadley, the former manager of the Allgemeine Company, has been appointed joint general manager of the Electrical Co., and will conduct the central station and tramway business both at home and abroad.

Messrs. Geo. Piggott & Co., 110, Cannon-street, London, E.C., have been appointed sole agents by Messrs. Isaac Griffiths & Sons for enamelled steel conduit tubes and fittings.

Messrs. E. A. Edwards and Jas. Marsden, trading as Edwards and Marsden and as the Forward Electrical Installation Co, at 46, Lincoln's-inn, Birmingham, have dissolved partnership. Debts by Mr. Edwards, who continues.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Pile Bloc Battery Co. (Ltd.) is being wound up voluntarily. Mr. T. F. Harvey, Riverdale House, Richmond, Surrey, is liquidator.

The public examination of David Roberts, electrical engineer, &c., Whiston-street, Derby, took place at the local County Court on Tuesday. Debtor commenced business with borrowed capital, and lost £60 in a legal action. He now resided in Nottingham, and his wife was tenant of a house in West Bridgford. Adjoining were business premises belong to the West Bridgford Motor Co., which consisted of his wife and mother, and upon the filing of his petition his wife removed her portion of the machinery from Derby to Nottingham. There were certain transactions with his wife and mother, and after debtor had explained these, the examination was adjourned for a month.

Plant for Sale.—Two complete Parsons steam turbine generating sets are for sale. Particulars from Mr. F. Stobart, Lambton Office, Fence Houses, Co. Durham. See also advertisement.

Messrs. Whittaker Bros. (Ltd.), Dudley, have for sale a 16kw. compound-wound dynamo (230 volts) and a watt-hour meter. See advertisement.

Messrs. Carr Bros., Darlington, have for sale a 150kw. three-phase B.T.-H. dynamo; a 60kw. three-phase motor and two spare armatures; also three nearly new Babcock and Wilcox water-tube boilers. Further particulars in advertisements.

Messrs. Findlay, Durham and Brodie, 110, Cannon-street, London, E.C., have a new planing machine and two tool boxes for sale. See advertisement.

"Diamant."—Particulars of some recent tests made with this new insulating line material have been forwarded to us by the manufacturers, the St. Helens Cable Co., Warrington. The comparisons made in these tests were with three other makes of material—"Ætna," "Dirigo," and the N.Y. Electrical Co. The results are given as under:—

Test No. 1.—Small Brooklyn strain insulator, "Diamant" insulation, to take up 4in. slack, immersed in tank of water for 24 hours, taken out, wiped and immediately tested for insulation resistance. Reading, 20,000 megohms. Then subjected to pressure test of 9,000 volts alt. before breaking down. Absorption test, ½ per cent. Dry heat test, 270°F. for two hours; no deformation, and did not become plastic.

Test No. 2.—"Ætna" globe strain insulator, after 24 hours' immersion, showed insulation resistance 2,200 megohms, and broke down through inner lugs at 4,000 volts alt. Absorption, 2 per cent. Became plastic after being in oven for 30 minutes at 220°F.

Test No. 3.—St. Helens strain insulator, "Diamant" insulation, after 24 hours' immersion, wiped thoroughly, and then had insulation resistance 22,000 megohms. Pressure test, 5,000 volts alt. before breaking down. Dry heat test, 270°F. for two hours; no deformation, and not plastic. Absorption test, ½ per cent.

Test No. 4.—N.Y. strain insulator, N.Y. Electrical Co.'s insulation, before immersion gave an insulation resistance of 4,500 megohms. Pressure test, 4,000 volts alt. before breaking down through inner lugs. Absorption moisture, 2½ per cent. Dry heat, 215°F. for 1½ hours, when it became plastic.

Test No. 5.—"Diamant" strain insulator, large pattern 5in. slack, after 24 hours' immersion, taken out and dried, insulation resistance, 22,000 megohms. Pressure test, 9,000 volts alt. for two hours; no deformation, and not plastic. Absorption test, ½ per cent.

Test No. 6.—⅝in. insulation stud bolt, "Dirigo" insulation, before immersion showed insulation resistance 2,100 megohms. Pressure test, 8,500 volts alt. before breaking down. Absorption test, 2 per cent. Dry heat, 210°F. for one hour, when insulating bolt became plastic.

Test No. 7.—⅝in. insulating stud bolt, "Diamant" insulation, after 24 hours' immersion showed insulation resistance = infinity. Pressure test, 10,000 volts alt. before breaking down. Absorption test, ½ per cent. Dry heat test, 270°F. for two hours; no deformation, and not plastic.

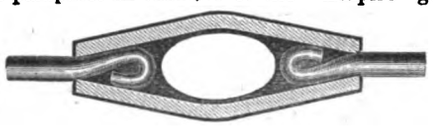
Crushing Strain.—(1) Small Brooklyn strain insulator, "Diamant" insulation, crushing strain, 2,128lb. (2) "Diamant" strain insulator, large pattern, crushing strain, 2,128lb. (3) St. Helens strain insulator, small pattern, 3½in. slack, crushing strain, 2,128lb. In all three cases no sign was given of insulation splitting or cracking or deformation. (4) ⅝in. insulating bolt, "Diamant" insulation, crushing strain, 2,000lb., without signs of insulation cracking or splitting, or threads of bolt stripping. Bolt after test was of true diameter and showed no signs of strain.

"Diamant" insulation is claimed to be tough, resonant when struck, can be dropped on to stone or iron from a height of 25ft. without break or fracture. It is non-hygroscopic, practically non-absorbent, and unaffected by temperature changes. Further, that the insulation resistance previous to immersion is so high that it cannot be measured by the ordinary deflection method.

British Westinghouse Works.—The British Westinghouse Co. intend to show in the power equipment of their manufacturing works at Manchester typical examples of modern machinery as manufactured by them. The generating plant is to consist of reciprocating steam engines, steam turbines and gas engines. At present, two 1,200 H.P. Westinghouse-Corliss engines, and two 350 H.P. Westinghouse single-acting type engines are installed. We are informed that the capacity of these generators is not nearly sufficient for the demands of the company's works, representing only the first instalment of an electric power generating centre which will eventually be in keeping with the immense size and nature of the works driven.

Catalogues.—Messrs. Estler Bros., 25, Laurence Pountney-lane, London, E.C., have ready a pamphlet dealing with telegraph and telephone supplies. Special attention is called to a compressed solid-drawn steel signal wire for electric railways, collieries, mines, &c. A series of experiments on various alloys of steel, and different methods of tempering, drawing, &c., has led to the introduction of a galvanised single steel wire for signalling work. A special joint is

supplied for use on this wire, which is shown in the illustration. The weight of this joint is 2½oz., or about 4oz. per mile of single wire, this adding practically no weight to the signal. There is also shown in the pamphlet an example of the "Empire" guy anchor, a



new method of guying telegraph, telephone, electric light and other poles, &c. By the use of these anchors it is claimed that digging, filling, tramping and general disturbance of the ground is avoided.

The Electrical Co., 122–124, Charing Cross-road, London, W.C., have now ready price list No. 14, dealing with switchboards. The list is illustrated with a number of views of boards actually erected, and particulars and prices are given of switchboards, switchboard accessories, &c.

A useful catalogue of enamelled steel conduit tubes and fittings is being sent out by Messrs. Geo. Piggott & Co., 110, Cannon-street, London, E.C., on behalf of Messrs. Isaac Griffiths & Sons, of Wednesbury. A feature of these manufactures is that the tubes and fittings are subjected to a high-temperature enamelling inside and out, which is claimed to add to the preservative qualities of the goods, which are further claimed to be watertight and damp-proof, and being made of steel have the lightness combined with strength and rigidity which that material gives.

Mr. W. Gyllich, of Lloyd's-avenue, London, E.C., sends illustrated particulars of "Titan" electric lifts, workable on the push button system. These lifts are manufactured by the Titan Co. (Ltd.), of Copenhagen, for which Mr. Gyllich is agent.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Sept. 10 to 16, with the ports of destination :—

Africa—Alexandria, £150 ; Cape Town, £620 (including £356 telegraph material) ; Durban, £3,758 (including £3,156 telegraph material) ; East London, £1,141 ; Port Elizabeth, £85. *Australasia*—Christchurch, £55 (including £3,156 telegraph material) ; Melbourne, £166 ; Otago, £24 ; Sydney, £377. *Belgium*—Antwerp, £83. *Ceylon*—Colombo, £155. *Channel Islands*, £20. *China*—Shanghai, £400. *Denmark*—Copenhagen, £113 (telegraph wire). *Germany*—Hamburg, £800 (telegraph material). *Holland*—Amsterdam, £55 ; Flushing, £22. *India*—Calcutta, £573. *Japan*—Nagaska, £21 ; Yokohama, £3,815. *Malta*, £16. *North Atlantic*, £2,500 (telegraph cable). *Norway*—Christiania, £23 (telegraph wire). *Portugal*—Lisbon, £55 ; Oporto, £70. *Siam*—Bangkok, £29. *Sweden*—Gothenburg, £219 ; Stockholm, £255 (including £94 (telegraph wire). *U.S.A.*—New York, £105. Total £15,705, against £15,205 in the corresponding week last year (Sept. 11 to 17).

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 23⅞d. per oz. (Sept. 18). Consols (2¾ per cent.) 93 1/16—93 3/16 for money, 93⅛—93¼ for account ; 2½ per cent. 93¼—93⅜ (Sept. 18). Consols Pay day, Oct. 2 ; Stocks and Shares Continuation Days, Sept. 24 and Oct. 13 ; Ticket Days, Sept. 25 and Oct. 14 ; Pay Days, Sept. 26 and Oct. 15 ; Mining Share Carry-over Days, Sept. 23 and Oct. 10.

AMERICAN WIRELESS TELEPHONE AND TELEGRAPH CO. (LTD.)—In connection with the issue of shares in this company, to which we made reference in our issue of April 18 last, the *Morning Leader* of Sept. 15 contains an exposé which should put intending applicants for shares in this concern on their guard.

BRITISH INSULATED WIRE CO. (LTD.)—An interim dividend at the rate of 8 per cent. per annum has been declared on the ordinary shares to June 30.

DIRECT WEST INDIA CABLE CO. (LTD.)—The report of the directors to June 30 last was approved at the meeting on Tuesday. The net result of the year's working showed a profit of £4,789. 10s. 2d., compared with £5,236. 10s. 3d. for the previous year. An interim dividend of 3 per cent. has been paid, and a further equal payment, tax free, leaves £2,989. 10s. 2d. to be carried forward, increasing the amount to credit of revenue to £30,981. 13s. 6d. The company's cables continue to work with complete efficiency,

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS (LTD.)—The directors' report states that after allowing £4,041. 2s. 4d. for depreciation, the profit for the year to June 30 last is £17,432. 3s. 8d. (with £2,578. 2s. 7d. from last year). The directors recommend that £2,000 be carried to reserve, £12,000 to pay a dividend of 8 per cent. (less tax), and the balance (£3,432. 3s. 8d.) carried forward.

GENERAL ELECTRIC CO. (1900) LTD.—The transfer books for the debenture stock are closed from 17th to 30th inst. inclusive.

GLASGOW AND SOUTH-WESTERN RAILWAY CO.—At the meeting on Tuesday the chairman (Mr. P. T. Caird) said that the large decrease in the number of passengers carried, compared with the comparatively small decrease in receipts, was accounted for by the fact that three-fourths of the total decrease was suburban traffic, where the fares were low, and was entirely due to the competition of the electric tramways. The matter was receiving the careful attention of the directors. Reference is made to this matter in another column.

HALIFAX AND BERMUDAS CABLE CO. (LTD.)—The directors' report for the year to June 30 last was presented to the shareholders on Tuesday, and approved. The net result of the year's working is a profit of £3,362. 0s. 1d., compared with £4,904. 14s. 7d. for 1901. An interim dividend of 2½ per cent. has already been paid, and a further equal payment, tax free, was now proposed, leaving £862. 0s 1d. to be carried forward, increasing the amount to credit of revenue to £16,100. 14s. 5d. The company's cable continues to work with complete efficiency.

STOCK EXCHANGE NOTICES.—Oct. 1 has been appointed a special settling day in the further issue of 32,268 £5 shares (£2. 10s. paid) of the *Calcutta Tramways Co. (Ltd.)* and 10,000 £10 6 per cent. cumulative preference shares of *County of London and Brush Provincial Electric Lighting Co. (Ltd.)*, and these securities, together with the further issue of 30,000 £5 fully-paid ordinary shares and 20,000 £5 fully-paid 6 per cent. cumulative preference shares of the *British Insulated Wire Co. (Ltd.)*, have been ordered to be quoted. The committee has also been asked to appoint a special settling day in £120,000 5 per cent. first mortgage debenture stock of the *Colombo Electric Tramways and Lighting Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Sept. 6	1,143	+ 328	14	16,373	+ 4,023
Ayr Corporation	„ 13	302	...	17	6,684	...
*Birmingham Tramways.	„ 13	5 089	+ 277	10	49,850	+ 1,689
*Blackburn Corporation..	„ 12	903	+ 95	25	21,079	+ 3,742
Blackpool Corporation...	„ 11	2,183	+ 233	24	29,177	− 305
Blackpool and Fleetwood	„ 13	1,495	+ 261	11	15,275	− 672
Bolton Corporation	...	...	...	..	...	...
Bradford Corporation ...	...	...	...	...	...	...
Brighton Corporation ...	„ 7	1,113	...	42	31,295	...
	„ 14	1,039				
Brisbane Tramways.....	July 30	2,153	+ 419	5	11,448	+ 2,316
*Bristol Trams & Carriage	Sept.12	5,180	+1,169	16	51,902	+10,443
*Buenos Ayres & Belgrano	Aug. 17	2,958	+ 363	7	19,977	+ 1,630
Burnley Corporation ...	Sept.13	764	+ 464	‡24	16,254	+ 6,817
Calcutta Tramways Co...	„ 13	R27.653	+R6,258	11	R277,816	+R52,916
Cardiff Corporation	„ 13	1,706	...	24	33,614	...
Carlisle Tramways Co....	„ 13	201	+ 10	†37	6,580	+ 435
Central London Railway	„ 13	6,137	+ 479	11	69,013	+ 5,795
Chatham & Dist. Lt. Rys.	„ 11	571	...	¶12	6,698	...
City & South London Ry.	„ 14	3,029	+1,193	11	30,365	+10,134
Cork Elec. Tramways Co.	„ 11	908	+ 383	§36	21,028	+ 3,744
Devonport & Dist. Trams	„ 5	514	+ 29	35½	15,427	538
Doncaster Corporation...	...	...	...	...	...	...
Dover Corporation	...	...	...	...	...	...
Dublin & Lucan Railway	„ 14	124	+ 7	11	1,544	− 45
Dublin Southern Dist....	„ 12	1,016	+ 48	†11	13,497	− 51
Dublin United	„ 12	3,966	+ 172	†11	43,785	
Dudley—Stourbridge ...	„ 5	866	+ 58	35½	26,615	+ 3,453
*Dundee Corporation ...	„ 10	823	+ 130	§16	13,023	+ 1,268
East Ham Council	„ 13	579	+ 168	12	6,459	+ 988
Gateshead & Dist. Trams	„ 5	873	+ 248	35½	26,019	+ 4,345
Glasgow Corporation ...	„ 13	12,701	−1,005	15	179,517	− 5,463
Gravesend	„ 5	203	...	5	1,118	...
Greenock & Port Glasgow	„ 5	636	+ 407	35½	17,865	+10,873
Hartlepool Tramways ..	„ 5	330	+ 51	35½	9,210	+ 1,159
Hull Corporation	„ 13	1,780	+ 142	24	42,426	+ 1,852
Isle of Thanet Co.	„ 13	1,599	+ 281	11	17,001	+ 890
Kidderminster & Dist....	„ 5	144	− 12	35½	4,480	− 7
Leeds Corporation	„ 13	5,286	+ 943	24	129,968	+21,702
*Liverpool Corporation...	„ 6	10,673	+ 842	36	348,885	+28,210
Liverpool Overhead Rly.	„ 14	1,522	− 85	‡11	17,818	− 1,148
Manchester Corporation	„ 13	5,642	+3,476	65	190,971	...
Merthyr.....	„ 5	213	− 22	35½	7,248	− 1,347
Middleton	„ 5	364	...	23½	7,488	...
Newcastle-on-Tyne Corp	„ 13	290	...	...	...	...
Oldham, Ashton & Hyde.	„ 5	651	− 10	35½	18,810	+ 760
Perth (W.A.) Elec. Trams	„ 12	1,000	+ 225	¶36	38,473	+ 6,518
Poole & Dist.....	„ 5	351	− 17	35½	9,216	− 160
*Portsmouth Corporation	„ 13	2,062	+ 990	...	...	...
Potteries	„ 5	1,591	+ 109	35½	51,844	+ 1,959
Rothesay	„ 5	246	+ 76	2½	806	+ 214
Salford Corporation ...	...	...	...	...	...	...
*Sheffield Corporation ..	„ 14	4,124	+ 309	11	47,430	+10,710
Southampton Corp.	„ 11	1,199	...	...	...	...
Southend Corporation...	„ 10	453	+ 90	23	7,519	...
Southport Tramways ...	„ 5	395	+ 178	35½	9,245	+ 3,276
*S. Staffordshire Trams..	„ 5	705	− 128	35½	27,349	− 95
Sunderland Corporation.	...	...	...	...	...	...
Swansea Trams.....	„ 5	533	− 25	35½	16,903	+ 1,123
Taunton Trams.....	„ 5	79	− 43	35½	2,394	− 125
Tynemouth & Dist.	„ 5	446	+ 91	35½	10,629	+ 1,130
Weston-super-Mare	„ 3	309	...	17½	4,329	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 5	310	+ 185	35½	6,633	+ 4,388

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

PRESENT AMOUNT.	AMOUNT OF SHARE.	LAST DIVIDEND.	NAME.	PREVIOUS WEEK'S PRICE, SEPT. 10.		PRICE WEDNESDAY, SEPT. 17.		RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS DONE DURING WEEK ENDING SEPT. 17.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Bl'ckb'rn & Gr'nw'ch Dist'ct Elec. Lt. Ord. (fully pd.)	½	¾	¾	¼	...	...	...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103	106	103	106	4 6 0	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	12	13	5 7 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	101	104	102	105	4 5 10	...	...	...
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord	10½	10⅝	10¼	10⅝	3 14 5	...	10⅝	10⅜
20,000	5	3/6	Do. 7 per Cent. Preference	10½	10⅝	10¼	10⅝	3 5 1	March and September	10½	...
3[illegible],000	5	3 6	Calcutta Elec. Supply Ord. (1 to 30,000)	7	8	7	8	3 15 0	...	...	...
1[illegible],000	5	...	Do. (30,001 to 40,000)	7	8	7	8	...	...	7⅛	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	108	105	108	3 14 8	...	...	...
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	9¼	9	9½	5 5 3	February and August	9⅝	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	5¾	5⅞	6	3 15 0	...	...	...
40,000	5	...	Do. City Undertaking 4½% Cum. Pref.	4½	5½	4½	5½	...	...	5¾	...
£2[illegible],000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	...	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½	5¾	5⅞	6⅛	2 12 2	...	...	...
£[illegible],000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	March	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	9	10	9	10	5 0 0	June and December	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12½	13½	12½	13½	4 8 11	February and August	9⅛	9⅛
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	123	128	3 18 4	January and July	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 5 0	June and December	125½	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½	9⅜	8½	9⅜	4 4 3	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12⅜	11½	12⅜	4 16 0	March and September	12⅛	12¼
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	110	113	111	114	3 19 8	...	...	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	5¾	6¼	5¾	6¼	3 12 0	...	6⅞	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10½	11½	10½	11½	4 6 11	...	10⅞	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6¾	6¾	6¾	6¾	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105	108	105	108	3 15 0	...	107	...
£111,000	3	...	London Electric Supply Ordinary	1⅞	2⅛	1⅞	2⅛	...	...	...	...
49,340	5	2/6	Do. 6 per Cent. Preference	4⅞	5⅛	4⅞	5⅛	5 4 9	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	96	99	96	99	4 1 2	Mar., June, Sept., Dec.	97½	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15	16	15½	16½	4 4 10	April and October	16	15⅝
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	109	113	110	115	3 18 11	June and December	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99	102	99	102	3 9 2	...	101½	...
10,852	10	6/0	Notting Hill Electric Ordinary	13½	14⅜	13½	14⅜	4 2 9	March	...	...
12,194	5	2/6	Oxford Electric Ordinary	5	6	5	6	4 3 4	"	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	97	100	98	101	3 19 7	...	...	...
300,000	1	...	Rand Electric	⅞	1	⅞	1	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 7 0	April and October	...	...
40,000	5	5.0	St. James's and Pall Mall Electric Ordinary	14½	15½	5	16	4 10 8	February and August	15¼	15⅛
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9⅜	8½	9⅜	3 13 8	" "	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	97	100	98	101	3 9 7	...	...	...
13,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2	3	2⅛	3	...	...	...	...
30,000	5	...	Urban Electric Supply Ord. (£3 paid)	2⅞	3⅜	2⅞	3⅜	...	...	...	...
30,000	5	...	Do. 5% Cum. Pref.	2⅞	3⅜	2⅞	3⅜	...	...	3	...
110,000	5	5 6	Westminster Electric Supply Ordinary	1	2	11	12	4 11 8	March and September	1⅝	1½
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	5¾	6¼	6	6¼	3 16 11	...	6¼	6
			TELEGRAPHS.								
£67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98	102	98	102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3½	4½	3½	4½	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£[illegible],840	Stock	15/0	Anglo-American	47	50	47	50	5 17 0	Feb., May, Aug., Nov.	49	...
£3,105,580	Stock	30/0	Do. Preferred	93	95	92	94	6 2 4	" "	94	92½
£3,105,580	Stock	2/0	Do. Deferred	7½	8	7½	8	1 5 0	" "	...	...
$13,333,300	$100	$11	Commercial Cable Capital Stock	160	170	160	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	95	97	95	97	4 2 6	" "	96¾	93
16,000	10	4/0	Cuba Submarine Ordinary	5½	6½	5½	6½	6 13 4	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 6	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2½	3½	2⅜	3½	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7	8	7	8	6 5 10	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞	103⅞	99⅞	103⅞	4 7 8	January and July	...	...
60,710	20	4/0	Direct United States Cable	10⅛	11	10⅛	11	5 18 2	Jan., Apr., July, Oct.	10⅛	10⅛
496,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	100	103	100	103	4 7 10	June and December	...	...
£4,000,000	Stock	65/0	Eastern Ordinary [to 1,200) (red.)	124	129	124	129	5 8 6	Jan., Apr., July, Oct.	128	125½
£1,955,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	90	93	90	93	3 15 8	" "	92½	91
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108	111	108	111	3 13 0	May and November	109½	109½
300,000	10	2/6	Eastern Extension	12½	12⅝	12½	12⅝	5 9 10	Jan., Apr., July, Oct.	12⅝	12⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 0	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 18 7	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101½	104½	101¾	104½	3 17 6	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen	25	27	25	27	5 11 1	January and July	...	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos	99	102	99	102	4 8 1	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	38	42	38	42	5 19 1	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	101	105	101	105	5 14 3	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3½	4½	3½	4½	...	...	4	...
30,008	2½	...	West Coast of America	⅛	⅜	⅛	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97	100	97	100	4 0 0	January and July	...	...
88,321	10	...	West India and Panama	¼	½	¼	½	...	May and November	...	...
34,563	10	€/0	Do. 6 per Cent. 1st Pref.	4½	5½	4½	5½	11 8 6	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3	4	3	4	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	January and July	...	...
207,980	10	3/0	Western Telegraph (late Br zil'n Submarine)	11⅜	12⅛	11⅜	12⅛	5 14 3	Mar., June, Oct., Dec.	12	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 10	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	98	101	98	101	3 19 9	...	100	...
			TELEPHONES.								
44,000	£5	5 0	Chili Telephone (fully paid)	3¼	4	3¼	4	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1 0	2/0	1/0	2/0	15 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	½	½	½	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£1,963,333	Stock	6%	National Co. Preferred Stock	93	95	93	95	6 5 10	...	94½	93
£1,966,667	Stock	4½%	Do. Deferred Stock	55	57	55	57	7 17 10	...	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	13	12	13	4 12 4	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11	12	11	12	4 12 4	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅜	5⅜	4⅜	5⅜	5 0 1	" "	5	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	96	99	96	99	3 10 10	June and December	96½	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6	...	104½	...
171,504	1	0/8½	Oriental	1⅛	1¼	⅞	1⅛	5 6 8	April and October	...	...
58,000	5	4/6	United River Plate	4¼	5¼	4¾	5¼	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4½	5	4½	5	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 16 2	June and December	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅜	6	5⅜	6	5 0 0	...	...	...
180,337	10	4/9	Globe Telegraph and Trust	9½	10	9½	10	5 5 0	Jan., Apr., July, Oct.	9⅞	9¼
180,042	10	3/0	Do. 6 per Cent. Preference	13½	14	13¾	13⅞	4 7 3	" "	13¾	13⅜
11,389	8	4/0	Reuter's	6½	7	6⅞	7	5 14 3	April and October	...	...
3,808	£100 Cert	...	Submarine Cables Trust	111	120	111	120	5 0 0	...	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 10.		Price Wednesday, Sept. 17.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 17.	
								£ s. d.		Highest	Lowest
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4¼	4½	4⅜	4⅝	4 11 5	April and October	4⅝	4½
£280,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9	11	9	11	2 14 7	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	9	10	9	10	5 0 0	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 2	...	...	...
15,000	10	4/0	Blackpool and Fleetwood Tramways	13	14	13	14	4 12 10	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3⅜	4½	3⅜	4	...	...	4⅛	3⅝
75,000	5	2/6	Do. 5% Cum. Pref.	4½	5	4½	5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	103	106	103	106	4 5 0	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	20½	21½	20½	21½	3 14 2	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106	108	106	108	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7½	7	7½	2 13 4	...	7	...
20,000	10	5/0	Do. 5% Preference	9	9½	9	9½	5 5 3	May and November	9⅝	9⅜
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	103⅞	105⅞	103⅝	105⅞	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12⅛	13⅛	12⅛	13⅛	6 13 4	...	13⅛	12⅛
100,000	10	6/0	Do. 6% Cum. Pref.	12¼	12⅝	12⅛	13	4 12 4	February and August	12⅝	12⅜
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	125	128	3 18 1	...	126½	125
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅜	1⅞	1⅜	1⅞	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	5	5⅛	5	5⅛	5 9 1	...	...	...
27,500	5	10/0	Do. "B"	5	5⅛	5	5⅛	5 9 1	...	5⅛	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	103	106	104	107	4 14 3	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.)	97	100	97	100	5 0 11	...	100	...
70,000	10	6/0	Calcutta Tramways	7	7⅛	7⅛	7⅜	3 17 5	...	7 9/16	7 7/16
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	109	107	109	4 3 1	...	107⅞	...
480,000	1	1/2⅜	Cape Electric Tramways Shares	2⅛	2⅜	2⅛	2⅜	6 14 9	...	2 3/16	...
£1,810,014	Stock	4%	Central London Ordinary Stock	103	106	103	106	3 15 6	June and December	104½	104
£494,093	Stock	4%	Do. 4% Preferred Stock	105	108	105	108	3 14 4	...	106½	106½
£494,993	Stock	4%	Do. Deferred Stock	103	106	103	106	3 15 6	...	...	...
£898,201	100	4%	Do. 4% Deb.	115	118	115	118	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams, Co. 5% Cum. Pref.	5	5½	4⅝	5½	4 15 3	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	3%	City and South London Railway Con. Ordinary	72	74	72	74	3 11 7	February and August	72	...
37,500	10	1/0⅜	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	" "	...	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	...		...		...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	131	128	131	3 16 6	" "	...	...
£200,000	Stock	5%	Do. (1896)	126	129	126	129	3 17 6	...	...	...
[£150,000	Stock	5%	Do. (1901)	121	125	121	125	4 0 0	...	124½	...
£446,463	Stock	5%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	...	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛	12⅛	11⅛	12⅛	4 8 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14⅛	15⅛	14⅛	15⅛	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4¼	4⅜	4¼	4⅜	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	102	99	101	4 18 0	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref, Ord. (4%)	8	9	8	9	3 6 8	...	...	...
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	13⅝	13½	13⅝	4 7 3½	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	108	110	109	111	4 1 3	January and July	...	...
30,000	5	2/6	Isle of Thanet Elec. Trams and Light'g 5% Pref. xd	4½	5	4⅜	4⅝	5 5 3	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4⅜	4½	4⅜	4⅝	2 4 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	9½	10½	9⅜	10½	4 17 7	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	99	1 1	99	101	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	11½	11⅝	11⅛	12	4 3 4	...	11⅝	11⅛
30,999	10	2/3	Do. (£7. 10s. paid)	8½	9	8⅜	9⅛	4 1 0	...	...	...
£655,341	Stock	3%	Do. 4% 1st Mortgage Debenture Stock	105	110	108	110	3 12 9	...	109⅛	108⅛
£169,659	Stock	18 0	Do. Prov. Certs. (£75 paid)	81	83	82	84	...	...	...	...
$3,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112	117	112	117	4 5 7	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	104	106	104	106	4 14 3	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	108	110	108	110	4 2 2	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3	4	7 10 0	May	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93	98	93	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	100	103	101	105	4 6 5	...	...	...
13,334	10	8/0	Potteries Electric Traction Ordinary	8½	9½	8⅛	9⅛	4 4 3	...	...	...
20,000	10	5.0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108	111	108	111	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...		...		...		...	...
51,182	1	...	Do. 6% Preference (14/0 paid)	...		...		...	April and October	...	...
50,000	1	...	Do. 5% Preference (fully paid)	...		...		...	" "	...	...
500,000	Stock	...	Do. 4½% Debenture Stock (70% paid)	...		...		...	January and July	...	...
£540,800	Stock	3%	Waterloo and City Ordinary	90	93	90	93	3 4 6	June and December	91½	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛	¼	⅛	¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	1/16	1/8	1/16	1/8	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	¼	⅜	¼	⅜	12 0 0	March and September	...	...
100 000	5	4/0	British Insulated Wire Ordinary	7¼	7½	7¼	7½	5 16 2	July and February	...	...
100 000	5	3/0	Do. 6 per Cent. Preference	5⅝	6	5⅝	6	5 0 0	January and July	...	...
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	101	104	101	104	4 6 1	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	5⅝	6⅛	5⅝	6⅛	4 18 0	...	6⅛	6
£500,000	Stock	14,0	Do. 4 per cent. Mortgage Deb. Stock	103	105	103	105	...	...	...	...
106,731	2	...	Brush Electrical Engineering	1	1¼	¾	1¼	...	March	...	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1¼	1½	1¼	1½	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	100	103	100	103	4 7 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	93	98	93	98	4 11 6	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15⅛	16½	15⅛	16⅛	4 10 11	" "	16½	16
40,000	5	3/6	Do. 5 per Cent. Cumulative Preference	5⅜	6⅛	5⅜	6⅛	4 0 0	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109	113	109	113	3 19 8	November and May	...	...
450,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	94	99	94	99	4 11 0	...	...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	9 2 0	March	...	...
85,000	3	1/9¾	Crompton and Co. (Nos. 1 to 54,000)	2½	3	2⅜	3	6 0 0	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	104⅞	106⅞	104⅝	106⅝	4 14 4	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜	⅝	⅜	⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1½	2⅛	1½	2⅛	...	" "	...	...
344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	74	78	74	78	5 3 0	June and December	...	...
£ 00,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	78	83	78	83	6 2 10	...	...	...
50,000	5	4/0	Edmundson's Electricity Corporation Ord.	6½	6⅝	6½	6⅝	5 3 8	Half-yearly	6⅝	6½
30,000	5	3/0	Do. 6% Cumulative Preference	6	6⅛	6	6⅛	4 12 4	...	6⅛	6 3/16
£ 40,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	107	110	4 2 1	...	...	...
112,100	2	1/2½	Electric Construction Co.	1⅜	2⅛	1½	2	6 0 0	January and July	1⅜	1 13/16
31,390	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅜	3	2½	3	4 13 4	July	...	...
£ 32,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 19 1	January and July	99	...
122,985	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent Cumulative Preference	¾	1⅛	¾	1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	10	10⅛	10	10⅛	4 15 3	...	10 1/16	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	100	103	100	103	3 18 11	...	...	...
35,000	5	6/0	Henley's Telegraph Works Ordinary	16	17	16	17	4 14 2	February and August	16⅝	16⅜
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	5⅜	5⅛	5⅜	3 18 3	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	109	113	109	113	3 19 8	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20⅛	21⅛	20⅛	21⅛	4 13 0	" "	21	20⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	103	100	103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½	15½	14½	15½	6 9 0	July	...	...
37,350	12	12/0	Telegraph Construction and Maintnce,	38	41	38	41	5 17 0	March and July	39	...
[£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	January and July	...	...
66 666	5	5/0	Willans and Robinson Ordinary	...		...		...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	...		...		...	" "	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee have refused to quote these.

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NOTES.

As will be seen in one of our Notes this week, which we reprint from *The Times*, there has been a revival of the proposal of the German Government for an international conference on wireless telegraphy. With the purpose of this proposal we are in full sympathy. If the various systems of wireless telegraphy —now rival systems—are to be of service to the mercantile marine and navies of all civilised countries, and to supply that auxiliary aid to cable telegraphy which future developments may enable them to do, it is imperative that rivalry shall cease, and that these various systems shall be legislatively brought into co-operation. We have previously observed, however, that the proper *locus* for such an international conference of delegates would be the International Telegraphic Conference already arranged to be held in London next year. We press upon HIS MAJESTY'S Government the desirability of immediately proposing this to the German Government.

FOR the benefit of those persons to whom information more than a year late is as valuable as information up-to-date, the Board of Trade has rendered a return "relating to authorised electricity supply undertakings in the United Kingdom belonging to local authorities for the year 1900," and a similar return for undertakings belonging to companies. According to these documents there were, at that somewhat remote period, 165 municipal undertakings and 71 company undertakings, which had made returns for the year's work. The financial and other data of the year's working are set forth separately for each of these 236 concerns, though we cannot congratulate the compilers of the returns upon the completeness or the minuteness of detail of the items given. Our readers, however, are provided not only with more detailed and complete, but also with more prompt, returns, in our weekly analyses of accounts and in the annual summary of these analyses published in our New Year's issue. The Board of Trade returns are unprovided with any summary. Could these returns be published more promptly and have a summary or digest appended to them, they would be of value to the electrical profession. As it is at present, we can see no use in them except, perhaps, for historians.

IT was mentioned during the discussion on Mr. KINGSBURY'S telephone Paper, at the British Association, at Belfast, that the introduction of the telephone into that city had seriously injured the business of jaunting car and cab proprietors. A Nottingham newspaper now states that the electric tramways there have had a similar effect on the local cab business. One man is reported to have brought in 3s. as the result of two days' work, and it is added—in Hibernian terms—that "out of that there was 7s. to pay him for wages." Seven from three you cannot. Another man came in at night with "absolutely only a single shilling." While regretting the distress accompanying the decay of this, as of every other decadent, industry, we cannot but point out that the social forces which set up this decay are acting in general for the public good. Everything, as PLATO long ago taught, is in a state of flux; and in the progress of civilisation from a cruder to a more perfect state it is inevitable that things seemingly solid shall dissolve and disappear in the seething pot of social evolution. A time may come when many of the electrical industries, which nowadays we regard as being solidly founded, shall in like manner disappear before the march of civilisation. Yet, though industries may thus pass away, it is not essential that the workers in them shall seriously suffer. For instance, we know of not a few electric tramway companies who have found their best conductors and motor-men in the men whose cabs and 'buses their tramcars had driven off the road.

DURING the recent apology for a summer, the sport of motor-careering has been much more *en évidence* in the land, whether in rural or in urban districts, than during previous years. Evidently the motor car is fast increasing in popularity, not merely as an economic means to a business end, but also as a

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sometimes by no means economic means of recreation and sport. The exhilaration of motor-careering grows upon the rider, one of the most common results being that he becomes more and more impatient at the speed limit of 14 miles an hour which a cautious Government imposed upon a decidedly dangerous innovation. This impatience finds frequent and varied ventilation. It manifested itself recently at Section G of the British Association, actually under the auspices of the Roads Committee; and it has cropped up in the press, latest of all in a leading article in *The Times* last Tuesday.

Our contemporary is in sympathy with the malcontents. "It was never dreamt," it observes, "that motors would soon be able to show even railways that the speed of their express trains was not unsurpassable on the road." There would be more of the nightmare in the dream than is altogether pleasant; and if the removal of the speed limit, which our contemporary advocates, implies the realisation of such a dream, we heartily hope that nothing so perilous to the general public will be sanctioned. *The Times* writer glibly talks of speeds of 25, 30 and even 50 miles an hour. Others point out that motor cars are required to slow down on passing through towns; but there is no reasonable justice in that. Why should town pedestrians be protected, while children running out of a rural school-house are liable to swift death from a motor car rushing along at express speed? Indeed, this very mania for motor-careering at express speeds on public highways is the strongest justification for strict insistence on a legal speed limit. We venture to suggest that if no motor car had ever been run at more than 20 miles an hour, the speed limit would long ere this have been officially raised to that figure.

But we are in agreement with *The Times* leader writer in doubting whether a speed limit is all that is necessary to protect the public, though we do not, with him, wish to see the limit abolished altogether. If a speed limit is all that is insisted on, those who keep within the limit may plead this virtue in exculpation for any harm they may do. There is much to be said in favour of the principle that each case should be tried on its individual demerits; but we fail to see that the adoption of such a principle by the magistrates affords any argument for the abolition of a speed limit by the legislature. Prevention is better than cure, even in road accidents; and it is not wise to leave the decision as to what is, at any particular moment, a safe speed wholly to the judgment of a motor enthusiast thrilled by the excitement of motor-careering.

Amidst the electrical activity of Sections A and G at the British Association meeting at Belfast, it is perhaps excusable that we should have overlooked temporarily an obscure yet nevertheless remarkable reference to electrical phenomena in the presidential address of Dr. W. D. Halliburton to the Physiology Section. It is not often that electrical research takes us into the domain of biology, but whenever it does so we do not need to apologise for taking our readers with us. Dr. J. C. Bose's researches, for instance, have revealed the closeness of the relationship between electrical stimulus and the physiological reactions of living tissue. Startling as are the inferences which have been suggested by Dr. Bose's experiments, they are far surpassed by the amazing deductions referred to by Dr. Halliburton. Our only comment, at present, shall be that the experimental foundation for these deductions appears to be inadequate. We shall be interested to note how physiologists will treat the subject in future:—

The new branch of inorganic chemistry called physical chemistry has given us entirely new ideas of the nature of solutions, and the fact that electrolytes in solution are broken up into their constituent ions is one of fundamental importance. One of the many physiological aspects of this subject is seen in a study of the action of mineral salts in solution on living organisms and parts of organisms. Many years ago Dr. Ringer showed that contractile tissues (heart, cilia, &c.) continue to manifest their activity in certain saline solutions. Howell goes so far as to say, and probably correctly say, that the cause of the rhythmical action of the heart is the presence of these inorganic substances in the blood or lymph which usually bathes it. The subject has more recently been taken up by Loeb and his colleagues at Chicago; they confirm Ringer's original statements, but interpret them now as ionic action. Contractile tissues will not contract in pure solutions of non-electrolytes like sugar or albumin. But different contractile tissues differ in the nature of the ions which are their most favourable stimuli. An optimum salt solution is one in which stimulating ions, like those of sodium, are mixed with a certain small amount of those which, like calcium, restrain activity. Loeb considers that the ions act because they affect either the physical condition of the colloidal substances (proteid, &c.) in protoplasm or the rapidity of chemical processes. Amœboid movement, ciliary movement, the contraction of muscle, cell division and karyokinesis all fall into the same category as being mainly dependent on the stimulating action of ions. Loeb has even gone so far as to consider that the process of fertilisation is mainly ionic action; he denies that the nuclein of the male cell is essential, but asserts that all it does is to act as the stimulus in the due adjustment of the proportions of the surrounding ions, and supports this view by numerous experiments on ova in which, without the presence of spermatozoa, he has produced larvæ by merely altering the saline constituents, and so the osmotic pressure of the fluid that surrounds them. Whether such a sweeping and almost revolutionary notion will stand the test of further verification must be left to the future; so also must the equally important idea that nervous impulses are to be mainly explained on an electrolytic basis.

Tyneside Tramways.—On Monday next the lines and power station of the Tyneside Tramways and Tramroads Co. will be formally opened.

Electric Traction in Berlin.—The last horse-drawn tramcar has now disappeared from the streets of Berlin, replaced by electrically propelled vehicles.

Brussels–London Telephone.—The Brussels correspondent of the *Daily Telegraph* states that the inauguration of the Brussels–London telephone will not take place before February or March, 1903.

Wireless Telegraphy in U.S.A.—The United States Government is equipping the gunboat "Topeka" with wireless telegraph apparatus for the purpose of carrying out tests and investigations. Later, another vessel will be commissioned to work with her.

Wireless Telegraphy in the West Indies.—Owing, it is said, to cable communications being no longer reliable, and the breakdowns due to volcanic action, the French Minister for the Colonies is endeavouring to establish communication by wireless telegraphy between Martinique and Guadeloupe.

Consulting Engineers in Canada.—The *Canadian Electrical News* states in an editorial article that the field for consulting engineers in Canada is gradually widening. Up to the present time technical advice has usually been sought in the United States, and as a result much of the machinery is of American manufacture.

Electric Railway on Russian Frontier.—The *Engineer* states that plans are under consideration for the construction of an electric railway to connect neighbouring towns on the western frontier of Russia, and the establishment of a road to cross the Caucasus mountains, between the town of Sahkun and one of the stations of the Vladikavkaz Railway. For this

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latter road it is proposed to utilise the hydraulic force of the mountain streams.

A Profit on the Quantity.—The London correspondent of an eastern counties daily states that when the London County Council electric tramways are running, "the passenger will be carried straight away from central London—from Waterloo or Westminster or Blackfriars—right away to the distant suburbs, say, 12 miles, for a penny. The Council expect to effect this great reduction of fares and at the same time to realise a profit of £100,000 a year." *Nous verrons.*

Cable Interruptions.

	Date of Interruption.
Latakia—Cyprus	June 21, 1899
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Santa Cruz—Teneriffe	July 7, 1902
Puerto Plata—Martinique	July 10, 1902
Anjer—Kalianda	Aug. 2, 1902
Guantanamo—Mole St. Nicholas	Aug. 5, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Gibraltar—Tangiers	Sept. 19, 1902
Maranham—Para	Sept. 19, 1902
Maranham—Ceara	Sept. 19, 1902

Locomotive Headlights.—A new type of headlight, with a vertical as well as a horizontal beam, is described by the *Scientific American*. The apparatus consists of a turbine, direct-coupled to a small generator, capable of supplying from 80 to 83 amperes, at 30 to 33 volts, to an arc lamp, at a speed of 2,000 revs. per min. On the outside of the lantern is an auxiliary plane reflector placed at an angle of 45deg., and in such a position as to intercept 40 per cent. of the total volume of light and direct it vertically. This vertical beam has been seen for a distance of 21 miles on a cloudy night, and the horizontal beam lights up a straight clear track for ½ to 1 mile ahead of the locomotive carrying it. All the machinery is on one bed-plate, which is bolted to the smoke stack.

Troop Telegrams Exchanged with South Africa and China.—Official notification is given by the Post Office of the cessation of the messages exchanged with soldiers and sailors in South Africa and China, and on this subject Mr. J. C. Lamb, of the General Post Office, writes to the directors of the Eastern and Eastern Extension Telegraph Companies, under date August 8, 1902, as follows:—"Will you be so good as to convey to your directors a renewed expression of the Postmaster-General's sincere thanks for the facilities which the companies have for so long generously placed at the disposal of the troops in South Africa and China and their friends in this country and the various parts of the Empire from which contingents have been sent to the seat of war."

Opening of the Broughty Ferry Electricity Works.—This electrical undertaking, owned by the local authority, was formally opened on Wednesday. The boilers are by Messrs. Babcock and Wilcox, and work at a pressure of 160lbs. per square inch. Steam is supplied to two Belliss compound enclosed high-speed engines, direct-coupled to Parker dynamos. The machines are 60kw. and 80kw., at a speed of 450 and 550 revs. per min. respectively. The battery consists of 136 E.P.S. cells, each having a capacity of 220 amperes for one hour, and is charged by a Parker booster. Distribution is carried out by means of the two-wire system, the cables being laid solid in wood troughs, and the voltage at the station is 230. The street lighting is accomplished by combining arc and incandescent lamps on the same post, the former being extinguished at midnight.

An Electric Postal System.—With reference to the note on "An Electric Postal System," which appeared in our issue of September 12th, we are now able to give more detailed information regarding the above scheme. It is intended to construct a track of steel wires, supported every 300ft. by poles 45ft. in height, from which are suspended small motors propelled by current from the line. Each steel wire is designed for carrying a weight of 2 tons, and the motors with their aluminium luggage carriers weigh only 70lb. each. It would be possible to carry 2,000 newspapers at a time, and to read the news at 10 o'clock in Milan contained in the paper printed at 8 o'clock at Rome. The complete installation of this system would, it is stated, cost about 3,000 lires (£120) per kilometre.

A New York State Electrical Laboratory Projected.—The *American Electrician* says that, at the recent session of the New York State Legislature, a commission, composed of Edward A. Bond, of Albany, Charles P. Steinmetz, of Schenectady, and Harold W. Buck, of Niagara Falls, was appointed for the purpose of determining the advisability of establishing a State electrical laboratory to provide independent authoritative information on questions of electrical science and official standardisation of electrical measuring instruments, apparatus and standards. The commission is to report to the Legislature at the opening of its session in 1903, and if in its judgment the establishment of a laboratory is necessary, detailed plans and specifications for the construction and equipment of such a laboratory are to be prepared and submitted in connection with the commission's report.

Obituary.—Mr. Hamilton Rendel, late head of the engineering department of the Elswick works, died on the 18th inst. The deceased gentleman retired from his position only two months ago, and was 60 years of age at the time of his death. After graduating at Cambridge he became assistant to Mr. Westmacott, chief of the Elswick works, and succeeded him later. Mr. Rendel was the younger son of Mr. J. M. Rendel, F.R.S., and brother of Lord Rendel.

Dr. Arthur Barry Blacker, M.D., died on Wednesday at 16, West Halkin-street, Belgrave-square, at the age of 40. He was superintendent of the X-ray departments of St. Thomas's and the Brompton Hospitals, and a member of the Council of the Röntgen Society. Dr. Blacker advocated the establishment of the X-ray department at St. Thomas's, and was recognised as a great authority on the subject. He wrote many valuable works on light as a therapeutic agent.

Marconi in Italy.—A Reuter's telegram, dated September 19th, from Turin, states that Signor Marconi has submitted to the Italian Minister of Posts and Telegraphs a scheme for the creation of a radio-telegraphic station communicating with the stations established or to be established by the Marconi companies in London and in South and North America. This scheme will be studied by the Government and afterwards submitted to Parliament. The cost would be about 700,000 lire. During the course of a dinner given in Marconi's honour, the Minister read out a telegram from the King announcing that the Cross of a Grand Officer of the Italian Order of the Crown was bestowed on Signor Marconi. The Italian cruiser "Carlo Alberto" will leave Spezzia to-day for Gibraltar, where she will await Mr. Marconi, who will carry out further experiments in wireless telegraphy in the Atlantic on board the warship.

Tramways and Railways.—According to *The Times* of Saturday last, a new departure was made known at the fortnightly meeting of the Tramways committee of the Liverpool Corporation on Thursday, 18th inst., Mr. S. W. Higginbottom, M.P. presiding. Mr. E. L. Lloyd said that an arrangement had been made with the Cheshire Lines committee to enable through traffic to be run from St. Helens to Southport. Under this arrangement passengers would be able to travel over the South Lancashire Electric Traction Co.'s and the Liverpool Corporation tramway systems at Knotty Ash, and then join the Cheshire Lines railway to Southport. It marked a new departure, the effect of which they could hardly realise at the moment. It was the beginning of a system likely to be very complicated, but very beneficial to the people at large. The general manager reported that 4,538,135 passengers had been carried on the Liverpool tramways in the fortnight, against 4,153,352 in the corresponding period last year.

The St. Vincent Cable.—News is to hand that the cs. "Newington," belonging to the West India and Panama Telegraph Co., on September 16th repaired the broken St. Vincent section of the St. Lucia–St. Vincent cable (which had been broken since May 9th, the date of the disastrous eruption of Mont Pelée, Martinique, which involved the loss of the cs. "Grappler"). The cable again became interrupted on the 18th, supposed to be due to a slight eruption of La Souffrière, St. Vincent, on

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the night of the 17th. The "Newington" then proceeded to repair the cable again, and had just finished buoying the northern end, about 16 miles from the St. Vincent hut and 4½ miles from La Souffrière, when a violent eruption of the volcano took place without the slightest warning, necessitating the vessel's prompt clearance from the neighbourhood. When the repair was made on the 16th it was found that the cable had been greatly damaged by volcanic action. Repairing operations in the immediate vicinity of the volcano have been abandoned for the present.

Hunting of Rotary Converters.—The *Electrical World* of New York describes two patents, issued August 19th, in America, to Alexander Churchward, describing a means for overcoming the difficulties encountered in operating synchronous alternating-current motors when the generator fluctuates in speed in different parts of a revolution, the effect of which is to produce hunting at the motor. The method consists in applying to the shaft of the motor, or on a shaft driven by it, a flywheel connected to the shaft through a yielding connection in the nature of a friction brake. The effect of this flywheel is as follows:—If the generator speed suddenly increases, the armature tends to accelerate its speed correspondingly, but the flywheel lags behind, thereby putting a slight load on the motor. When the generator slows down the motor armature tends to run slower, while the flywheel, tending to run at a uniform speed, catches up with the motor-shaft and forces it ahead or resists its tendency to slow down, thereby again putting a slight load on the motor. The load in either case serves to steady the armature and prevent pumping. One of the patents describes details of the flywheel flexible connection.

Power Development at Niagara.—The *Electrical World* of New York states that there is every prospect of the Niagara Falls Power Co. being able to deliver power from their second station by October 1st. The total capacity of the plant in this station will be 55,000 H.P., developed by 11 generators, coupled to turbines each of 5,000 H.P. The turbines are placed in a new wheel-pit 178½ft. deep, 18½ft. wide, and with a length of 468ft. 8in. This wheel-pit is excavated out of the solid rock, and to meet its requirements the tunnel was extended. The new power house covers the pit, having a total length of 560ft., a width of 70ft., and on the west side there is a covered forebay structure 40ft. in width. The turbines are of the internal discharge type, the water being carried off through draft tubes, giving an increase of about 10 per cent. to the effective head. The generators are being manufactured by the General Electric Co. of America, and the first one is now being erected. There will be two styles of generators in the new station, the first six to be of similar design to those in the old station—viz., with an external revolving field. The remaining five will be of the internal revolving field type.

Seattle-Tacoma Inter-urban Electric Railway.—A recent issue of the *Western Electrician* of Chicago contains an interesting description of the construction of an electric railway between Seattle and Tacoma. The third-rail system will be used except in city districts, where the overhead trolley will be adopted. All cars will be controlled by the multiple unit system, each motor car having four motors with an aggregate capacity of 500 H.P.: this arrangement will give a speed of 60 miles per hour. Power will be supplied by a supply company at 2,200 volts, two-phase, for 1 mile to the step-up transformer station, which will contain four 500kw. water-cooled transformers. These will raise the potential to 27,500 volts, and thus feed the high-tension line with 60-period three-phase current. The sub-stations will be situated 3·5, 16·9 and 29·4 miles respectively from the generating station, and at each station there will be one complete 300kw. motor-generator set, which will be fed by two 180kw. oil-cooled, step-down, three-phase to two-phase transformers. The machines consist of one eight-pole, 300kw., 600-volt, direct-current railway generator, direct-coupled to a 16-pole, 450 H.P., 2,200-volt, two-phase induction motor. There will also be three storage batteries of 288 cells each. Power will be supplied at the generating station by two 1,600kw. Westinghouse 2,200-volt, 60-period alternators.

Compensated Alternators.—*The Electrical World* of New York describes a patent issued to Mr. Henry G. Reist, on improvements in "compensated alternators," or alternating-current generators the fields of which are supplied with direct current from a synchronously-driven exciter. The voltage of the exciter is automatically controlled by passing current derived from the main alternator through the armature of the exciter, thereby varying the armature reaction of the exciter, which in turn varies the field strength and regulates the voltage. The alternating current is fed to the exciter in such a manner as to produce in the armature-winding a rotating magnetic field, moving with respect to the armature in a direction opposite from the direction of rotation of the armature. As the exciter armature moves forward with the same speed with which the rotary field therein moves backward, the field as a consequence remains stationary in space as long as the power factor of the load remains constant. To secure the necessary initial adjustments of this field with respect to the field-magnets upon which in practical operation it reacts, Mr. Reist devised a structure in which the field-magnets of the exciter are mounted so that they may be angularly displaced, thereby adjusting the angle at which the armature-flux is permitted to act upon the field. Another feature of his arrangement consists in bridging over the field-poles of the exciter by a band of magnetic material, which by reason of saturation does not allow an undue short-circuiting of the field-flux. He finds that the presence of this bridge makes the compounding more regular.

Wireless Telegraphy for Ocean Liners.—The log of the Marconi wireless telegraph system for the just completed round voyage of the Cunard steamship "Campania" is as follows:—The "Campania," which left Liverpool at 4:30 p.m. on Saturday, August 30th, was in communication until 6:10 p.m. with the same company's steamer "Ivernia," also fitted with the Marconi system, in the Huskisson Dock, Liverpool. From 7:5 to 8 p.m. she was in communication with the homeward-bound "Umbria" in the Channel. At 8:30 Holyhead was signalled, followed by Rosslare station, at the south-east-corner of Ireland, with which she was in touch until 8 a.m. on Sunday, August 31st. Passengers and mails were embarked at Queenstown, and the ship sailed at 10:15 a.m. on that day. The "Campania" was next in touch with Crookhaven from 11:40 a.m. until 8:15 p.m. At 1:35 a.m. on the 3rd inst. she got in communication with the homeward-bound "Lucania" and exchanged messages with her for some time. At 4:45 p.m. on the 5th inst. she signalled Nantucket lightship, and continued in communication until 8:30 p.m. At 11:30 p.m. Sagaponack station replied to her call, and continued "talking" until 1:40 a.m. on the 6th inst., when she was abreast of Fire island, distant about 60 miles, and the new station, Babylon, north of Fire island, came into communication about the same time as Sagaponack ceased. She kept in touch with Babylon until Sandy Hook lightship was passed at 3:18 a.m. Homeward-bound the "Campania" left New York on the 18th inst., and was in communication with the "Umbria," which was just arriving at that port. She then got in touch with the Babylon station at 7:40 p.m., and continued until 10:40 p.m. Sagaponack station followed. She next communicated with the outward-bound "Lucania" on the 16th inst. at 11 p.m., and continued until 1:40 a.m. on the following day. On the 17th inst. she conversed with the Atlantic transport vessel "Minnehaha" for some hours. The Cunard homeward-bound "Saxonia" was signalled at 2:50 p.m. on the 18th inst., when she was 36 miles ahead of the "Campania," and the two steamers were in communication until the evening, when the "Saxonia" was 100 miles astern. Crookhaven was signalled on the 19th inst. at 8:45 a.m., and continued until 11:40 a.m. The "Campania" arrived at Queenstown at 12:50 a.m. on the same day.

Large Storage Batteries at Milan.—In an article in a recent number of *L'Industrie Electrique* there are described two large storage batteries installed in connection with the water power scheme at Paderno (see *The Electrician*, Vol. XLII., pp. 255,

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861 and 413). At Paderno current is generated by means of water power, at 13,500 volts, three-phase, and transmitted to a sub-station at Porta Volta, where it is transformed down to 8,600. The current received at this sub-station is not sufficient, and therefore steam alternators are installed to make up the deficiency. A portion of it is then distributed by underground network in Milan for power distribution and stepped down, where required, to 150 volts. The remainder is transformed by rotaries to continuous current at 550 volts for the tram way, and to 110 for lighting. One of the two batteries is for the tramways, and has a capacity of 3,464 ampere-hours, and the second is for the lighting, and its capacity is 20,000 ampere-hours. Each cell of the traction battery weighs 2·2 tons, and has 25 plates (12 Planté positive and 13 pasted negative). The lighting battery is composed of four separate batteries, each containing 78 cells, connected up in parallel, each cell having a capacity of 4,624 ampere-hours and weighing 2·6 tons. There are 33 plates in each cell, and it is calculated that in the event of a breakdown of the three-phase current the batteries will not only be sufficient to take the top load, but will constitute an efficient reserve. The batteries were supplied by the Tudor Company, and cost a million lires (about £40,000).

Germany and the Marconi System.—The Berlin correspondent of *The Times* state that the German Government is of opinion that the establishment of stations throughout the whole world for the Marconi system of wireless telegraphy and the arrangements concluded between the Marconi Co. and Lloyd's threaten an absolute monopoly which would be open to objections both of a commercial and of a political nature. As the Imperial Government considers that the matter also affects other States, and as opposition to the idea of a monopoly has been expressed in various quarters, Germany has resolved to take the initiative and has invited England, France, Russia, Italy, Austria-Hungary, and the United States to make arrangements for a meeting of delegates to prepare a programme for an international conference on the subject. The object of the proposed conference would be to draw up an international convention, settling the "conditions under which the establishment of stations for wireless telegraphy shall be allowed." It is semi-officially announced that the suggestion of the German Government has been met in a friendly spirit by the States to which it has been addressed, and that the appointment of delegates by these Powers may be anticipated in the near future. The ultimate co-operation of all maritime States concerned is contemplated, and their participation in the proposed international agreement will be invited, as soon as a programme for the deliberations of an international conference has been arranged by the delegates of the Powers named.

Letter-stamping Machine.—An interesting machine for stamping letters has just been permanently installed at the General Post Office after many trials and experiments. The motive power is supplied by a small bipolar motor of about ½ H.P., connected by a belt. The electric motor is not essential to the proper working of the machine, as it could be run equally well from countershafting; but it is more convenient, and hence its adoption. The letters to be stamped are fed by hand on to the machine, and passed along, by means of pieces of rubber revolving eccentrically in a horizontal plane; they then pass between two rollers, one of which possesses the necessary surface for obliterating the stamps, and are pushed out at right angles to the direction of motion by another eccentric. The machine can easily stamp 400 letters per minute, and, under favourable conditions, even 600. The proportion of "misses" is exceedingly small, being not more than 1 per cent, and it will take any size of letter provided it is not too bulky. An expert human stamper can seldom do more than 100 letters per minute, and this speed cannot be maintained for more than 30 minutes, so that a machine whose up-keep is small, and which is able to work at four times the rate, and in addition, is able to keep up the rate without cessation, cannot fail to be economical. The authorities have found these machines so satisfactory that they have decided to instal 12 of them altogether, and by so doing, they anticipate saving 10 to 11 minutes in the despatch of each mail.

CONTEMPORARY ELECTRICAL SCIENCE.

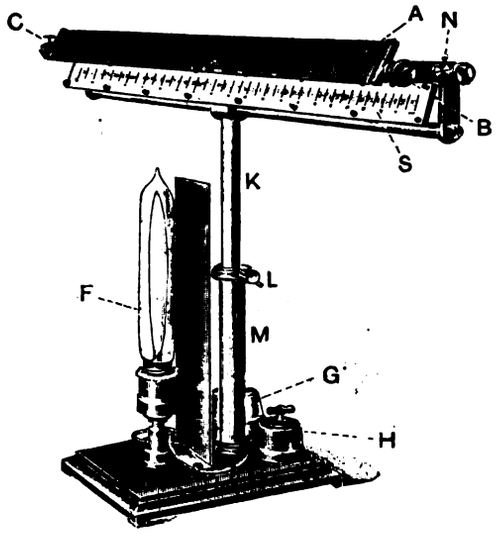
[Compiled by E. E. Fournier D'Albe.]

The Weights of Atoms.—Lord Kelvin summarises the various attempts that have been made to determine the sizes and weights of atoms, and deals more fully with Lord Rayleigh's theory of the colour of the atmosphere in this connection. Assuming somewhat arbitrarily that the number of molecules in a cubic centimetre of a perfect gas at standard temperature and pressure is 10^{20}, he gives the following table of masses and densities:—

Substance.	Mass of atom or H_2O in grammes $\times 20^{-24}$.	Density.	Number of atoms per cubic centimetre.	Average distance apart, centimetre.
Liquid H at 17° abs.	0·45	0·090	200×10^{21}	$1·71 \times 10^{-8}$
Liquid O at freezing point	7·15	1·27	178×10^{21}	$1·78 \times 10^{-8}$
Water	8·05	1·00	124×10^{21}	$2·00 \times 10^{-8}$
Ice	8·05	0·917	114×10^{21}	$2·06 \times 10^{-8}$
Water vapour at 0°	8·05	$0·487 \times 10^{-3}$	605×10^{15}	$118·2 \times 10^{-8}$
Liquid nitrogen ...	6·29	1·047	166×10^{21}	$1·82 \times 10^{-8}$
Liquid argon	17·81	1·212	$68·1 \times 10^{21}$	$2·45 \times 10^{-8}$
Gold	88·52	19·32	218×10^{21}	$1·66 \times 10^{-8}$
Silver	48·47	10·53	217×10^{21}	$1·66 \times 10^{-8}$
Copper	28·43	8·95	311×10^{21}	$1·475 \times 10^{-8}$
Iron	25·15	7·86	313×10^{21}	$1·47 \times 10^{-8}$
Zinc	29·30	7·15	244×10^{21}	$1·60 \times 10^{-8}$

[Lord Kelvin, *Phil. Mag.*, September, 1902.]

Objective Readings.—The chief advantage of the spot of light over the reading telescope for reading deflections is that it can be read by several observers at the same time, besides being less straining to the eye. It is, however, still subject to the



disadvantages that it requires a dark room and that the observer's head is often in the path of the beam. With translucent scales, also, the reading is indefinite and depends upon the point of view. M. T. Edelmann describes a new arrangement in which those drawbacks are eliminated, and all the advantages of the objective reading retained. On a cast-iron base stands a column, M, in which the rod K can be moved up and down and fixed at L. It carries the celluloid scale S loosely hung in and finely adjusted by the screw N. The mirror A is turned at B and fixed at C. The lamp is an incandescent lamp, F, with a thin central filament and a thicker lateral filament. The latter does not glow, and the glowing filament thus provides a single straight line. H is a switch and G an insertion key. The scale is read from the other side, through the mirror, and no darkening of the room is necessary. It is, of course, possible to employ any other kind of lamp, but that may possibly require a dark room.

[M. T. Edelmann, *Physikal. Zeitschr.*, August 15, 1902.]

Inertia of a Current in a Wire.—Maxwell made an experiment to determine whether any part of the kinetic energy of

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an electric current could be expressed by a term depending on the product of an ordinary velocity and an electric current. The velocity he considered was a velocity of the wire carrying the current in the direction of its length, and Lagrange's equations of motion show that if the term referred to exists, whenever a current is started or stopped in a wire, there would be an impulse acting on the wire in this direction. As Maxwell states, no evidence of any such effect has ever been discovered. W. S. Day has made a similar experiment, in which the mechanical co-ordinate considered is one such that its velocity means a rotation of the wire around its axis, the corresponding impulse when the current is suddenly started or stopped being an impulsive torque, if the term in question exists. No evidence of the existence of such an effect was discovered, but a maximum limit to its value was obtained. A wire was suspended by a quartz fibre. It was provided with two mercury cups to lead in the current, and the earth's magnetic field and certain electrodynamic and induction effects acting as sources of error were carefully eliminated. In Lagrange's equation of motion,

$$T = \tfrac{1}{2}L\dot{x}^2 + K\dot{x}\dot{y} + \tfrac{1}{2}L\dot{y}^2,$$

where T is the kinetic energy, x the mechanical co-ordinate and y the electrical co-ordinate, the value of K per centimetre of wire cannot exceed 0·000016, according to the experimental result. For a current of 1 ampere decreasing to zero in 1 second, this would give a torque of 0·000016 dynes per centimetre of wire, and this was within the limits of experimental error.

[W. S. Day, *Phys. Review*, September, 1902.]

The Law of Inverse Squares.—S. J. Barnett points out a fallacy in the attempt to investigate the law of force in electrostatics by experiments on hollow closed conductors. The experiments of Faraday with hollow conductors, of one of which the experiment of Cavendish is only a particular case, have shown conclusively that the substance of a conductor cannot support a static field, and that a hollow closed conductor screens perfectly the region within it from all external electrostatic effects. There is no reason to suppose that this property of a conductor has anything whatever to do with the law of force. Indeed, it seems perfectly certain that the law of force depends only on the nature of the electric displacement in a dielectric and the three-dimensional nature of space. If the displacement is continuous, or the electric flux along a tube of displacement constant, and the dielectric homogeneous and isotropic, the law of inverse squares is an immediate deduction. Thus, no matter what the law of force, there is no reason to expect to find an electric charge or an electric field within the substance of a conductor or on the inner surface of a hollow closed conductor in a static field. It therefore follows that the experiment of Cavendish is not conclusive, so far as the law of force is concerned. Electrostatics can be built up without Coulomb's law, as has already been shown by Pellat.

[S. J. Barnett, *Phys. Review*, September, 1902.]

Spectra of Discharges through Liquids.—In an endeavour to obtain an easy means of producing intense band spectra, and also to shed some light on their origin, P. Konen has investigated the spectra shown by the electric arc, the brush discharge, and the spark discharge as produced in liquids such as distilled water, salt solutions, ammonia, acids, turpentine, aniline, glycerine, carbon bisulphide and benzol. It was found that the nature of the liquid has little influence upon the arc spectrum unless carbon terminals are used. Metallic electrodes may be plunged into a solution containing several per cent. of lithium without giving the lithium lines in the arc spectrum. With carbon electrodes, the cyanogen bands are absent in water, salt solutions, alcohol, turpentine, glycerine and CCl_4. But small traces of air suffice to bring out the band 8,883. This confirms the supposition that the cyanogen spectrum is due to a nitrogen compound of carbon. The "Swan" spectrum—*i.e.*, the carbon band spectrum possessing edges at 4,382, 4,738, 5,164, 5,683 and 6,187—could not be made to disappear even by the most careful elimination of oxygen. But the author does not consider this conclusive as against the carbon monoxide theory of the Swan spectrum. The brush discharge shows a somewhat similar behaviour to the arc. The spark spectrum is continuous and overlaid with lines due to the electrodes and the liquid.

[P. Konen, *Physikal. Zeitschr.*, September 1, 1902.]

Hollow Conductors in Wave Telegraphy.—A. Turpain has studied the effect of employing hollow conductors, both as regards protection from penetrating waves and concentration of waves inside them. An exciter could be enclosed in a box lined with tin, about 25cm. square. A receiver, comprising a coherer, a relay, and a bell and battery, could be enclosed in a similar box. Each box had a circular hole 14mm. in diameter, through which a conductor could be introduced consisting of a bare wire, a tube, or a leaded cable 10 metres long. When the transmitter and receiver are both completely enclosed, no action between them is possible. Also, when the holes are open, and are joined across by a metallic tube, no action is noticed. But when the tube enters the boxes without touching the tin, or when the boxes are removed, a decided response is seen. In these cases the tube appears to concentrate the waves upon the receiver. The action is still better when a cable with metallic covering is substituted for the tube. In this case the core of the cable joins the two apparatus, and the leaden wrapping serves to concentrate the waves. This concentrating action is not impaired by pealing off a short length of the leaden wrapping, so long as there is no metallic connection between the core and the portion of the wrapping attached to the receiving box. If the other portion of the wrapping is connected with the core, it makes no difference. These observations give valuable hints with regard to Hertzian wire-telegraphy. The metallic wrapping of every submarine or subterranean cable should be continued right up to the transmitter and receiver. Each of the latter should be contained in a hollow conductor connected with the metallic wrapping. Under these conditions a powerful concentration of the electric waves is obtained, which would be impossible if the waves passed from the core to the metallic wrapping of the cable at the point where the cable commences. Beyond that point the waves would be dissipated in the ground or in water. The experiments may be utilised also for wave telegraphy. The author proposes that both transmitter and receiver should be enclosed, and joined to the air wire by means of a cable with metallic wrapping. The experiments show that no inconvenience is caused by connecting the wrapping of the transmitter cable to the air wire itself. As regards the receiver, a connection between the cable wrapping and the air wire would constitute a very effective and convenient protection of the receiver against waves emitted from the station. This connection could be interrupted when receiving.

[A. Turpain, *Comptes Rendus*, September 8, 1902.]

Conduction in a Nernst Lamp.—The accepted theory of the burning of a Nernst lamp is that it is a process of electrolytic conduction. The difficulty then confronting us is that such a lamp will burn hundreds of hours and consume a direct current which should theoretically electrolyse it in about five minutes. E. Bose imagines the process to be as follows:—In the oxides which make up the conductor, the velocity of migration of the cation is probably very much smaller than that of the anion. Hence the chief part in the current conduction is probably played by oxygen ions, whereas the metallic ions in a stationary state undergo no displacement. The oxygen evolved at the anode diffuses back to the cathode in the interior of the rods, and there oxidises the metal again. The oxygen of the air, which surrounds the rod and also penetrates into it encourages the process, and leads to the well-known increase of durability of the lamp as against its behaviour in a vacuum. This is substantially Nernst's "Reststrom" theory, and the author confirms it by some interesting observations. One of them is that in a vacuum the rod gradually assumes a darker hue and a metallic aspect, which disappears on exposure to air. The vacuum round the glowing rod could never be driven so far as it could when the rod was cold.

[E. Bose, *Ann. der Physik*, No. 9, 1902.]

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THE WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.*

(*Concluded from page 822.*)

High-tension Feeders and Subway System.—The three-phase 25-cycle current at 6,600 volts generated at the Waterside station is distributed to the various rotary converter sub-stations by underground cable feeders, leaving the high-tension cable vaults at the Waterside station and following four distinct trunk lines of subway ducts, west on Thirty-eighth-street and on Thirty-ninth-street, and north and south on First Avenue. The ducts in which the cables are drawn are either made of iron pipe laid in concrete or glazed tile laid on a bed of concrete. The number of feeders to each sub station was based on the most economical copper section for the observed station load factors, the maximum drop not to exceed in any case 5 per cent.; and the maximum carrying capacity for continuous load has been fixed at 250 amperes per phase. To fulfil these conditions, the standard copper section of 250,000 circular mils was adopted for each of the three conductors.

The first three-phase high-tension 6,600-volt cables installed by the company in 1898 were rubber insulated, and this type was used in the early extensions; but in the more recent additions to the high-tension cable system paper insulation has been used exclusively. The company is now operating about 41 miles of rubber-insulated cables and 28 miles of paper-insulated 6,600-volt cables. The specifications for the high-tension feeder cables called for three-conductor paper-insulated, lead-covered cable, each conductor made of 37 strands, with a combined sectional area of 250,000 circular mils when each wire is laid out straight. The paper insulation is $\frac{5}{32}$in. around each conductor and $\frac{5}{32}$in. for the outside insulating jacket. The lead covering is $\frac{4}{32}$in. in thickness, and contains from 2 to 3 per cent. tin. The open spaces between conductors are filled with a dry jute filler, saturated with an insulating compound to exclude air or moisture. The test pressure between the conductors, and also between the conductors and lead was 15,000 volts alternating current for one hour. The insulation resistance in subways, including joints, was specified to be 800 megohms per mile at 60°F.

Fig. 12 is a map of the present distributing system of this company, and from this the nature and size of the area supplied will be understood.

The general principle followed in planning high-tension feeders has been to run direct lines from the Waterside station to each sub-station, but in some cases feeders are looped into an intermediate sub-station along the route. In such cases the looped feeder is connected to a high-tension tie feeder panel provided with suitable connection, so that the tie feeder may also, if desired, be connected to the local station feeder panels which feed the rotary converters at the station, thus providing an additional feeder in case of an emergency.

A feature of the high-tension feeder scheme is the general tie feeder connecting all stations and sub-stations from Duane to 124th-street. Along its route the general tie feeder is either looped in or "teed" in to the sub-stations, and furnishes to them a valuable auxiliary feeder, which can be used to transmit high-tension current between sub-stations, independently of the Waterside station, as it has been extensively used in the past when inverted rotaries have been operated to supply current at night from the downtown steam generating stations to the rotary converter sub-stations uptown.

Sub-stations.—The company has now in operation 16 rotary converter sub-stations on Manhattan island, as shown on the map above. In several of these sub-stations the rotary converters are operated in connection with existing steam plants; in others rotary converters only are operated. In all of the latter, as well as in several of the former, there are one or more storage batteries, of which mention will be made later.

The typical equipment of a rotary converter sub-station is:

1. High-tension switchboard for high-tension feeders and rotary converter machine panels.
2. Air-blast static transformers.
3. Low-tension, alternating-current switchboard for the operating of rotary converters.

* Abstract from the *Electrical World* of New York.

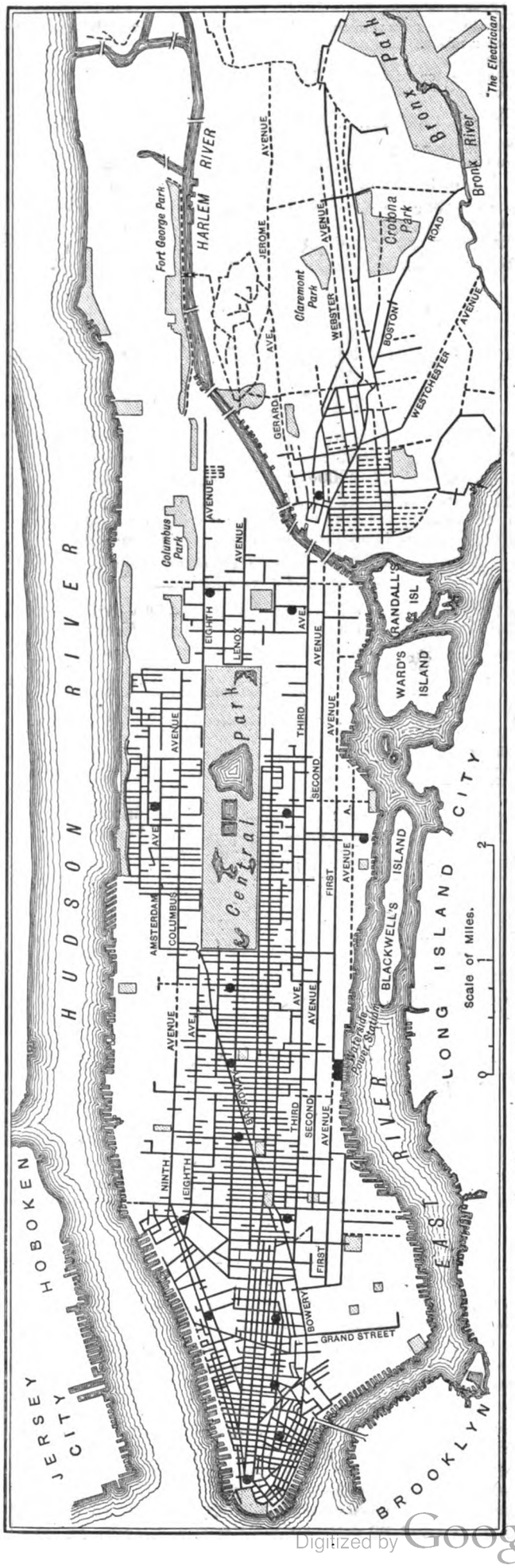

FIG. 12.—MAP OF MANHATTAN AND THE BRONX SHOWING THE AREA SUPPLIED BY THE NEW YORK EDISON CO.

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4. Rotary converter I.R.T. regulators.
5. Rotary converters.
6. Low-tension direct-current switchboard and 'buses, with instruments and synchronisers.
7. Storage battery and booster set.
8. Compensator for balancing loads on three-wire system.
9. Low-tension feeder panels.

In Figs. 13 and 13A is given a diagram of the connection of this apparatus.

The course of the current through one of the sub-stations is as follows:—Coming into the station on the high-tension, three-conductor cable feeder as three-phase 6,600-volt 25-cycle alternating current, it passes through the high-tension feeder panels equipped with suitable switches, circuit breakers and transfer cable arrangements, with connections to the 'buses of the high-tension machine panels. From the high-tension machine panels connections are made by duplex cables to the high-tension primaries of the static transformers, the secondaries being connected through alternating-current switches to an I.R.T. regulator and then to the alternating-current collector rings of the rotary converter. The direct-current terminals of the rotary converter are wired to the positive and negative switches of the machine, which can be connected to three sets of 'bus bars supplying current to the low-tension direct-current feeders. The rotary converters are all built for a normal potential of 270 volts, which can be raised or lowered 30 volts by the I.R.T. regulators, and the unbalancing of the station load between the two sides of the system is supplied by the storage battery and a compensator.

Static Transformers.—The static transformers are all of the air blast type and are in sets of three 200kw. and three 400kw. respectively for 500kw. and 1,000kw. rotary converters. They are mounted on a platform constituting the air duct for ventilation under an air pressure of $\frac{1}{2}$oz. to $\frac{3}{4}$oz., supplied by electric blowers installed at one or both ends of the platform. The primary and secondary transformers are wound for a ratio of transformation of 6,300 to 170 volts, but other ratios may be obtained by connecting to intermediate taps to compensate for drop on feeders of different lengths and to facilitate adjustment of alternating-current voltage to direct-current voltage required. In the later transformers a thermometer is mounted in a casing between transformer coils to give temperature indications. The transformers are designed to operate at 25 per cent. overload for three hours after a 24 hours' full load run, or 50 per cent. overload for one hour without undue heating. The efficiency of the transformers is 97½ per cent. for the 200kw. transformer and 98 per cent. for the 400kw., with a regulation of 1¼ and 1 per cent. They are wound with double secondary winding, connected in a double independent delta, the middle points of which are connected to the alternating-current electrically operated switches.

Rotaries.—These are six-phase and of two sizes, 1,000kw. and 500kw. rated capacity. The 1,000kw. rotaries are 270-volt

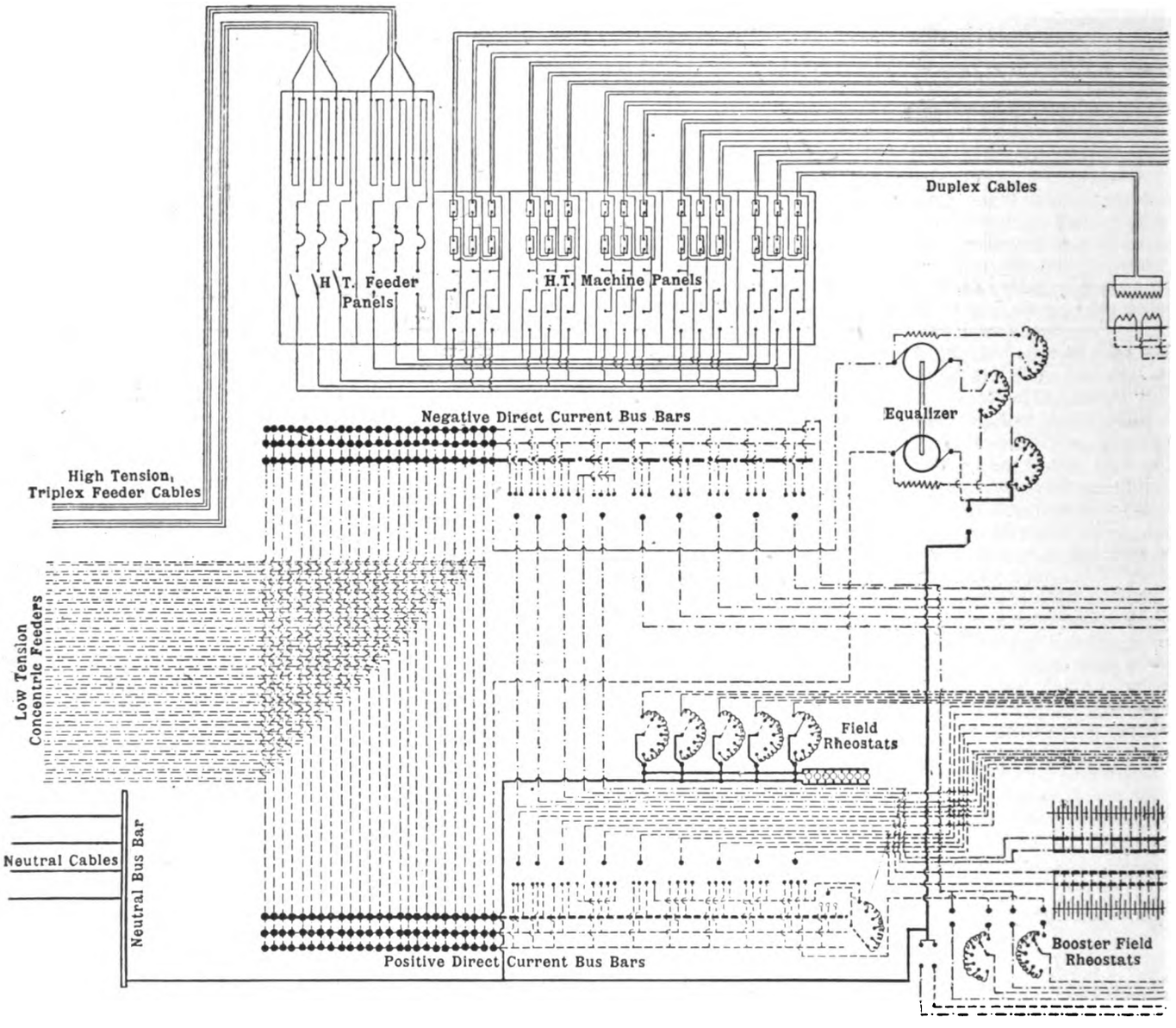

FIG. 13.—GENERAL DIAGRAM OF SUB-STATION CONNECTIONS.

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direct-current, 187½ revs. per min.; the 500kw. rotaries are either six-phase, 270-volt direct-current, 375 revs. per min., or six-phase, 300-volt direct-current, 375 revs. per min. The latter type are equipped with 130kw. I.R.T. regulators, by means of which the rotary can be operated between the range of 240 to 350-volts direct-current, the higher voltage being required in the uptown sub-stations owing to the length of low-tension feeders. The overload capacity of the rotaries is liberal: they are designed to carry 25 per cent. overload for three hours after carrying continuously full rated load or 50 per cent. overload for one hour.

The efficiency of the rotary converters is high. In the case of 1,000kw. converters an efficiency of 96¾ per cent., and in the 500kw. 95¾ per cent. has been obtained.

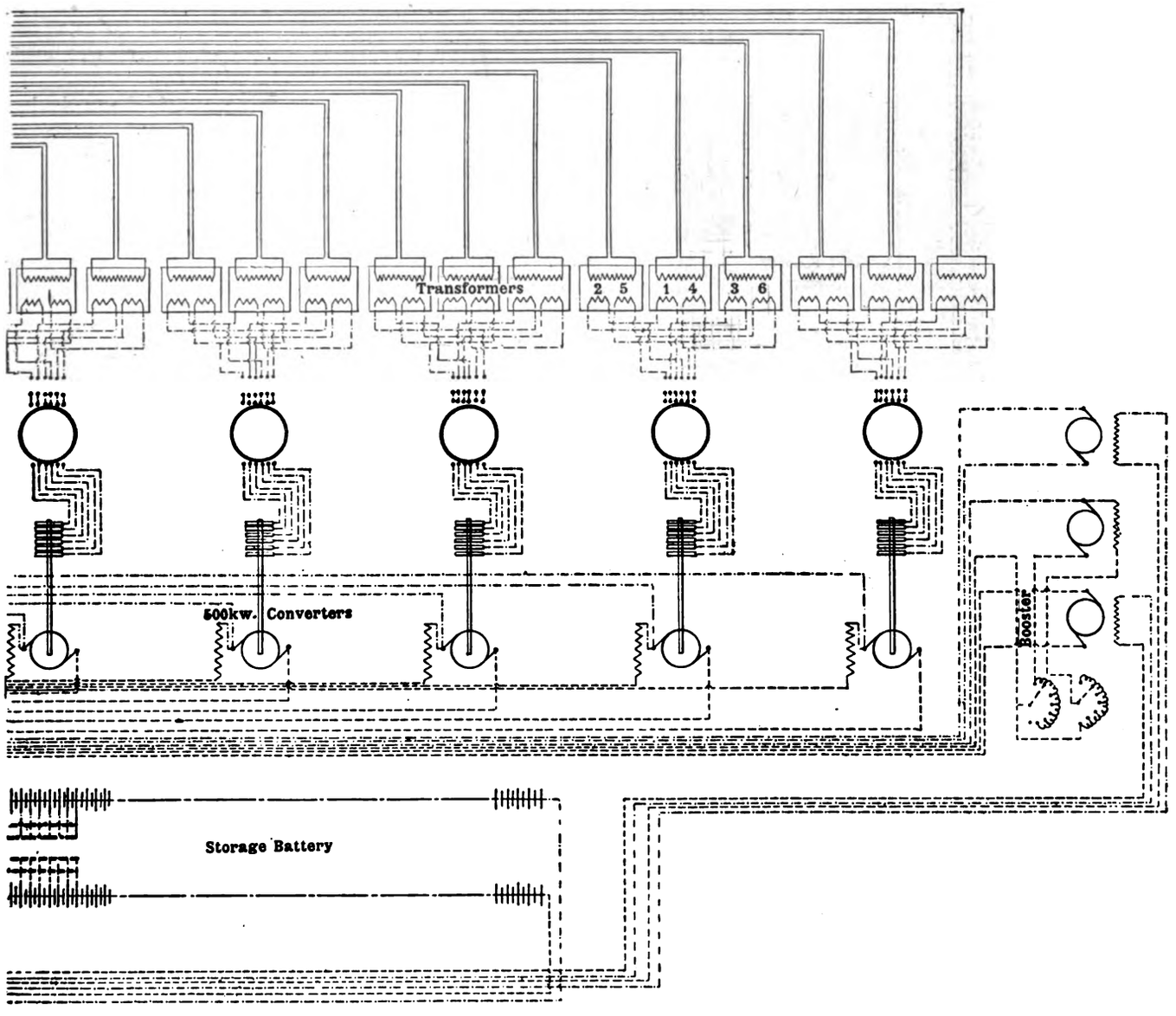

FIG. 13A.

The Low-tension Direct-current Switchboard.—The direct-current switchboards of all New York Edison stations are divided into two independent sections for the positive and negative poles, the negative side being used for connecting the machines to the 'buses. The regulation and switching is usually done from the positive switchboard, which is provided with a complete equipment of instruments. The negative switches used as selectors have three poles, one for each set of 'bus bars. To economise space and avoid long runs of cables in some sub-stations, three-pole selector switches of the laminated toggle Brush type are used, having an arm pivoted at the centre, and having a parallel motion to the base of the switch. In other sub-stations the negative cable connections of the rotary converters are brought to the negative switchboard proper, where they make connection to a three-pole switch of the type shown in Fig. 14, where three switches, mounted on a heavy cast copper frame, alive from the machine, enable one to make connection to either of the three 'bus bars on the back of the switchboard. These switches are only 12in. or 18in. wide respectively, for the 500kw. and 1,000kw. rotaries, and reduce the width of the negative machine panel to a minimum. An outside pole field switch, mounted on the same panel with the negative 'bus-selector switch, connects to the main 'bus, from which all rotaries are excited. The switchboard connections of the positive side of the rotary converter are made to a three-pole selector switch similar to the one last described and shown in Fig. 14. In this case, however, there are four switches mounted, the top one being a smaller starting switch for starting the rotary from the direct-current side. This switch makes connection with a starting 'bus provided with a starting rheostat and fuse, and a three-'bus starting selector switch mounted at one end of the switchboard. Above the machine 'bus-selector switch is mounted a double dial rheostat frame holding edgewise rheostat dials for two rotary converters. On the same frame are mounted two small S.P.S.T. switches operating the E.O. switches on the alternating-current panels previously described, and a small double-

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pole double-throw switch operating the motor controlling the position of the I.R.T. regulator. Above the rheostat dials are the indicating instruments, consisting of one alternating-current hot-wire round type Stanley ammeter, one synchronising lamp, one direct-current Van Vleck edgewise Weston ammeter and one hot-wire alternating-current Stanley voltmeter for each station, this latter instrument being supplied with a sliding contact switch, by means of which it can be connected to any machine.

Storage Batteries, Boosters and Compensators.—Storage batteries are installed at nearly all the stations from which current is distributed, and they perform at least three important functions. First, they ensure continuity of the service; second, they smooth out the irregularities of the local demand; third, they assist in the regulation of the system. The standard battery used contains 150 cells, 75 between the neutral and each outside wire. Each cell has a capacity of 2,000 ampere-hours at a one-hour rate, 3,000 ampere-hours at a three-hour rate, 4,000 ampere-hours at a 10-hour rate.

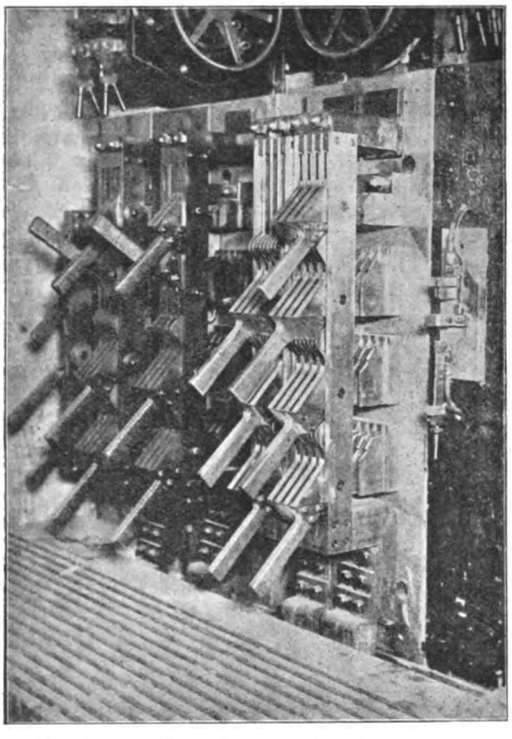

FIG. 14.—OUTSIDE POLE POSITIVE 'BUS SELECTOR SWITCH.

Connections from 20 cells at each end of the battery are brought out to the positive and negative end-cell switches, which are operated by a small motor controlled from the main switchboard. Each battery has two end cell switches on each side of the system, permitting simultaneous connection to two 'buses. The batteries are charged by means of a booster set, consisting of a 110 H.P., 240-volt motor operating at 750 revs. per min., and two 40kw. 50-volt generators mounted on the same shaft. The company's policy of requiring lighting installations of a capacity of more than 5 amperes to be connected on the three-wire system has created an almost perfectly balanced load on both sides of the system. In addition to the battery, which assists in maintaining the balance, each rotary sub-station is provided with a small compensator set consisting of two 125-volt dynamos, rigidly coupled together and connected in series across the system, with the middle point connected to the neutral. When there is a perfect balance, both dynamos run as motors, but in case the system is unbalanced, one dynamo becomes a generator supplying current to the weaker side.

Low-Tension Feeders and Mains.—The feeders and mains are all underground, and are connected in a continuous network in the Edison three-wire system with 2 × 120 volts at the customer's service. In the early underground construction the company used three conductor Edison tubes exclusively for its feeders and mains; but for some years paper-insulated cables have been used for feeders, and more recently for mains also. For feeders the company has adopted a lead-covered, paper-insulated two-conductor concentric cable, with a copper section of 1,000,000 circular mils for each conductor, and provided with six pressure wires (Fig. 15). These cables are designed for a maximum working pressure of 750 volts direct current, and have $\frac{5}{32}$in. paper insulation and a $\frac{9}{64}$in. lead jacket. The common neutral system is used as a general neutral serving for all feeders and connecting with the neutral main at every block.

The cable mains shown in Fig. 15 are either 350,000 circular mils or 200,000 circular mils single-conductor, paper-insulated, lead-covered cables. They are designed for a maximum working pressure of 750 volts direct current, with $\frac{4}{32}$in. insulation and $\frac{4}{32}$in. lead jacket.

The map shows the extension of the Edison system on Manhattan island, many of the streets having mains on both sides, and the distributing system of feeders and mains represents a total length of nearly 350 miles.

Present Station Equipment.—In Fig. 16 is shown the load diagram of the output from the low-tension direct-current service for all stations of the New York Edison Co. on Manhattan island on the day of maximum load, December 23, 1901. The maximum load reached was more than 35,000kw., exclusive of the alternating-current 60-cycle service and the direct-current series arc lamp service of the New York Edison Co. This load was carried by the existing low-tension steam plants, by rotary converters and by the storage batteries

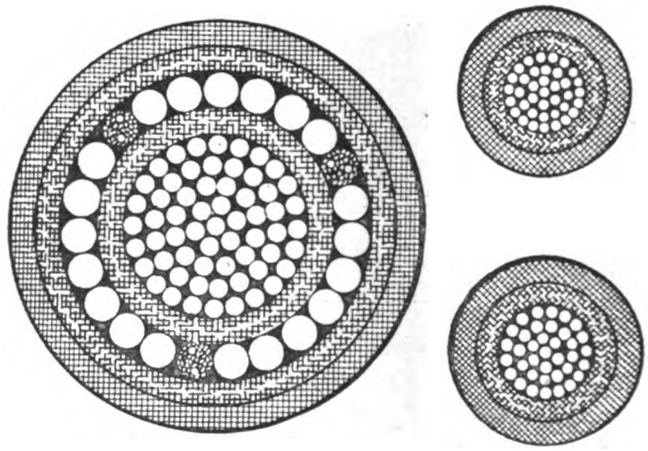

FIG. 15.—TWO-CONDUCTOR PAPER-INSULATED CABLE FOR FEEDING LOW-TENSION MAINS, AND SINGLE-CONDUCTOR PAPER-INSULATED CABLES.

distributed among the different stations. Beginning at the lower end of Manhattan island in the Bowling Green Building is an annexe with two 400kw. rotary converters and a storage battery used for the peak load and local distributing purposes. At Gold-street, near Fulton, is a 1,650-H.P. steam station, equipped also at present with a 500kw. rotary and a storage battery. At Duane-street is the largest station of the company, erected in 1890, and equipped with three 2,500 H.P., two 1,250 H.P. and three 600 H.P. engines, all of the multiple expansion type, driving direct-connected dynamos for a 240-volt three-wire system. The engines are of the Southwark and of the Dickson make, and the boilers Babcock and Wilcox. This station has also a rotary converter equipment consisting of three 1,000kw. units. On Elm-street, near Spring, is a rotary sub-station, with a capacity at present of 2,000kw. and a storage battery, and at Vandam-street is a 1,500 H.P. steam station, with one 1,000kw. rotary converter. At Horatio-street is a sub-station with one 500kw. rotary converter and a storage battery, and at 12th Street is a steam station containing two 1,250 H.P. compound condensing engines and one 500 H.P. single-cylinder McIntosh and Seymour engine, two storage batteries and 2,500kw. capacity in rotary converters. The Twenty-sixth-street station contains three 1,250 H.P. Southwark, three 600 H.P. Dickson and two 250 H.P. Armington and Sims engines, and in the adjoining

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annexe four 1,000kw. rotary converters. At Thirty-ninth-street are six 250 H.P. engines, 3,000kw. in rotaries and a storage battery. At Fifty-third-street 1,000 H.P. in engine capacity, 2,500kw. of rotaries and two storage batteries. The annexe stations in the upper part of the city are as follows:—East Eighty-third-street, three 500kw. rotary converters and storage battery; West Eighty-fourth-street, two 500kw. rotary converters and storage battery; East 121st-street, three 500kw. rotary converters and storage battery; West 124th-street, one 500kw. rotary converter and storage battery. A steam station in East Eightieth-street of 3,500 H.P. with two-phase alternating-current and arc light machinery, completes the equipment. The storage batteries in all of the plants mentioned, except at Fifty-third-street and Twelfth-street, where the capacity is double the others, are equal to an output of 6,000 ampere-hours at 185 volts at a three-hour rate of discharge. They were furnished by the Electric Storage Battery Co.

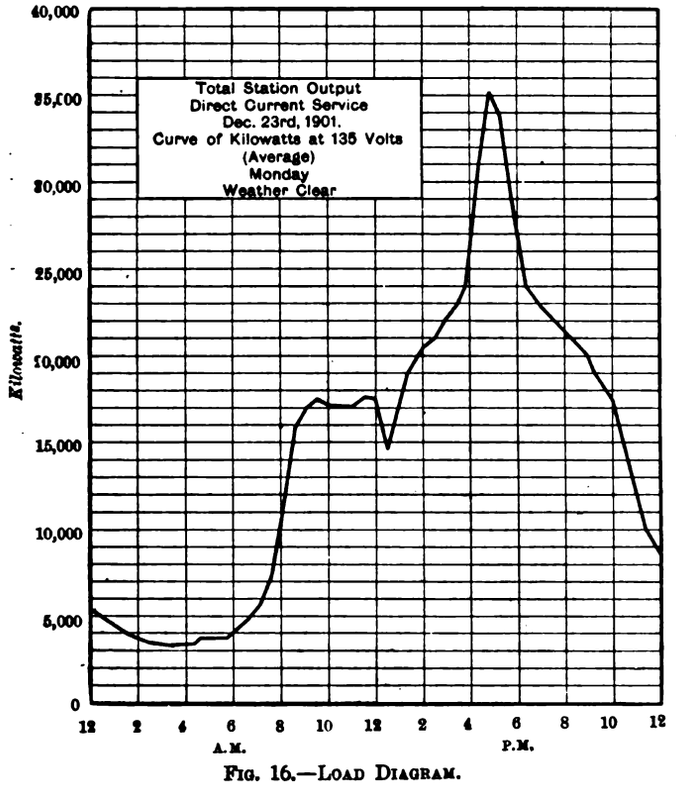

FIG. 16.—LOAD DIAGRAM.

Company's Installation.—The electrical installation supplied from the New York Edison Co.'s system on Manhattan island, December 31, 1901, is as follows:—

Incandescent lamps	970,899
Arc lamps	13,140
Horse-power motors	50,634
Total 16 c.p. equivalent	1,867,442

Each arc lamp is figured as equivalent to 10 16 c.p. incandescent lamps, and each horse-power in motors equivalent to 15 16 c.p. The total installation equivalent supplied by central station service on Manhattan island and the Bronx is 2,282,980 lamps.

Trans-Saharan Telegraphy.—According to *Engineering*, Lieut.-Col. Monteil is about to proceed to Gabes for the purpose of studying the question of the desirability of making that place the terminus of the Trans-Saharan telegraph line. This line would put Tunis and Algeria in connection with the French-African possessions to the north, the south and the east of Lake Tchad. Arrangements are also being made for uniting the Soudan with the Lake Tchad district. The time is accordingly approaching when all the French colonies in Northern, Western and Central Africa will have telegraphic communication with each other. It is proposed to establish wireless telegraph communication between French Africa and Paris.

SOME NOTES ON ALTERNATOR DESIGN.*

BY JOHN DENHAM.

The types of alternators in the market at the present time are so varied in electrical design that it is interesting to analyse their good and bad features. The makers of all of them claim exceptional efficiency, good regulation and perfect parallel working. Probably all modern alternators have good electrical efficiency, but they vary very much as regards output per unit weight at same speed and also in price. The rated speed of most alternators is considerably higher than one would wish to run them in everyday work; but, no doubt, competition is largely responsible for this state of affairs.

The types I propose to discuss first are: (1) Those in which the magnetic flux through the armature varies in direction; (2) those in which the magnetic flux is constant in direction, but varies in intensity.

Of the first kind there are a great variety, both with disc, drum and ring armatures, some with revolving field and others fixed. Among the latter kind is a well-known disc armature machine and some inductor alternators, the general principle in this class of machine being to have one common exciting coil for all polar projections.

Fig. 1 is a diagram of a six-coil disc armature machine, with six revolving poles alternately north and south. An equal number of poles of opposite sign would, of course, be immediately behind. Fig. 2 shows a disc armature machine with the same number of coils as that in Fig. 1, but with the magnetic flux constant in direction,

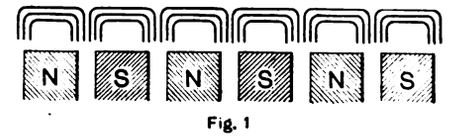

Fig. 1

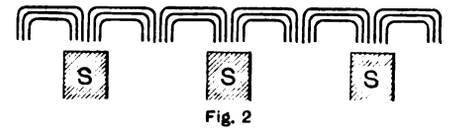

Fig. 2

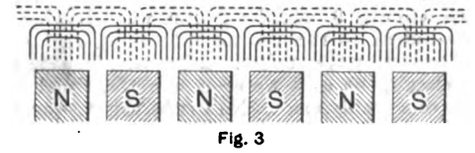

Fig. 3

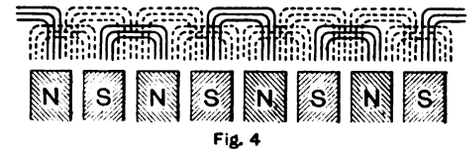

Fig. 4

in which case there must be twice as many coils as polar projections, as the amount generated is due to the difference in the number of lines passing through the coils and not in their direction, therefore three poles only are shown, those of opposite sign being behind. Machines of the disc type, with iron-cored armatures, have been constructed; for instance, about 1882 the late Dr. Hopkinson designed an iron-cored disc armature magneto-alternator, which was made by winding iron ribbon tightly round a suitable ring mounted on a shaft, and milling out radial slots on both sides for the reception of the flat V-shaped coils. The magnet system consisted of some hundreds of steel horse-shoe permanent magnets, varying in size with the width of the coils. The output of the machine was very low for its weight, owing to the weak magnetic field, and some difficulty was experienced in keeping the windings in place. Only a few such machines were actually manufactured.

Iron-cored disc machines are now obsolete, though whether they deserve to be, from an electrical point of view, remains to be seen. Of coreless disc dynamos and alternators there were several varieties in the early days, such as the "Arago" disc dynamo with revolving armature and wooden cores, as exhibited at the Crystal Palace in 1882, the Ferranti air-core machine with copper strip wave-wound revolving armature, and the Siemens alternator with open coils and revolving field. Of later patterns may be cited the "Mordey" with slate or porcelain cores, and the modern Siemens, Ferranti and American Brush machines.

Returning to the figures, assuming in both cases the coils are of the same size and winding, and the poles are equally excited, it is

* Paper read before the Cape Town Local Section of the Institution of Electrical Engineers, April 28th.

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obvious that the coils in Fig. 1 cut twice the number of magnetic lines *at the same speed of revolution* as do those in Fig. 2. Assuming the magnetic leakage to be the same in both cases, the first machine would give double the output of the second, with the same sized armature, and at the same speed, but would need twice the exciting power and be somewhat heavier as regards the field. The leakage between poles on the same crown, and the cross magnetic effect of the stray field would tend to reduce the actual output to some value less than twice that of the second machine. On the other hand, in certain positions the coils in Fig. 2 are not merely not being usefully acted upon, but are in reality so much idle resistance in series with the working coils. Practically only half of the coils are doing actual work at any period of the revolution, and part of the generated pressure is consequently absorbed in the passage of the current through the remaining half of the armature.

Where a single exciting coil is employed the magnetic circuit is usually a long one, especially in machines of large diameter, and there is a large waste field from the shaft itself.

The insertion of an iron core to these machines would in both cases reduce the air-gap from, say, 1in. to ¼in., while leaving the actual mechanical clearance the same as before. The iron core would be of considerable benefit to first machine, as it would reduce the pole-to-pole leakage and the stray field very considerably; whereas in the second machine the iron core would merely have the effect of shortening the air-gap between poles of opposite sign. It might even be deleterious in causing a greater fringe to the magnetic lines, thereby generating opposing E.M.F. in adjoining windings. Further, those coils not being usefully acted upon would be as so many choking coils in the circuit which would reduce the effective voltage of the machine considerably.

As the mechanical difficulties in the way of building iron-cored disc machines are so great, there must always exist the unusually large air-gap of 1in. or more, however small the actual clearance may be. This gap may be even 2in. in large machines, where the coil windings are broader, to insure rigidity.

Another disadvantage to the disc machines is that the clamps supporting the coils are subjected to a varying magnetic flux, and although they are usually made of a high resistance metal, the eddy currents must be of considerable magnitude. It is usually assumed that in coreless machines, wound with copper strip on edge, there can be no eddy currents generated, as the laminations are parallel with the lines of force. This, however, is not so. I have experimented with a 75kw. machine, and found that when fully excited, but on open circuit, 9 additional H.P. was absorbed over and above that required to run the machine light, and allowing for the power absorbed by the exciter. After running for an hour or two on open circuit, the coils were quite warm, which proved that eddy currents do actually exist. No doubt this is due to the magnetic fringe from the poles striking, to a certain extent, upon the *side* of the strip and causing eddy currents in its breadth.

Coming now to those machines in which the coils are placed on or in a laminated drum, or are on or in the inner surface of a ring, we have again the choice of alternate poles, as in most alternators, or of a unidirectional flux, as in some inductor machines. The relative gain in using alternate poles, as in Fig. 1, is about the same as between the two types of disc armature machines, but in the drum or ring pattern, the actual clearance and the air-gap are synonymous, and may be reduced to ⅛in. with safety, and a consequent saving of magnetising power results. A single disadvantage, however, exists in that both the armature ring and the field magnet pole should be laminated.

So far the advantage of output lies distinctly with machines that have alternate poles and drum or ring iron-cored armature. About 12 years ago there was a great controversy respecting the relative merits of different patterns of alternators for running in parallel. The historic Paper by Mr. Mordey, detailing certain experiments made with coreless disc armature machines (which I had the privilege of witnessing), startled the scientific world. Mr. Mordey maintained that the less self-induction, and the less the resistance in or between the two machines, the better they would be for parallel working, because anything that tended to retard the instantaneous interchange of current between the two (as one or the other tended to lead or lag) would reduce the force of maintaining them in synchronism. Mr. Mordey, therefore, claimed that the machines of his invention, being without iron in the armature, and having a minimum resistance, possesses all the necessary attributes, and should, and actually did, work perfectly in parallel. Other eminent electrical engineers maintained that a certain amount of self-induction was necessary for parallel running, and pointed to machines with iron-cored armatures which ran well together. Then the engines driving the alternators were criticised and blamed if paralleling was unsuccessful, and no doubt there was good reason for this in many cases.

High-speed engines receiving a large number of impulses per unit of time naturally give a more uniform torque than slow-speed ones; also, some engines when running light (as when driving an excited but unloaded alternator) take a large gulp of steam one stroke, and none at all for perhaps two or three revolutions, then another gulp, and so on; and in such cases synchronising is very difficult, but can be rendered easier by applying an artificial load to engine or alternator until the governor allows a certain quantity of steam to be admitted every stroke, when the torque becomes fairly uniform. Probably all modern alternators, whether iron cored or not, will run in parallel when driven uniformly; but if not some will run better than others.

Coreless machines having but small self-induction in the armature, permit the passage of a large current even with but a slight difference in phase, and this large current is needed to keep the machines in step, because it has such a relatively small magnetic effect; whereas a much smaller current passing between iron-cored machines has the same steadying effect, for it must be remembered that it is the *magnetic effect produced* that pulls and holds the machines into step, and not merely the number of amperes passing. Those who have had to run coreless machines in parallel when driven by slow-speed engines, are aware that heavy surgings of current pass between the machines, tending to blow the fuses, and rendering the dynamo ammeters unreadable. This is much less marked with the other type of machine, where the self induction prevents such sudden rushes, but permits sufficient current to pass to achieve the desired result.

Given uniform angular velocity, there is probably little to choose between the two types as concerns parallel running; but as some of us still prefer slow-speed engines, it would appear to be better to employ alternators that will work in parallel whether driven by slow or high-speed engines—viz., those with iron-cored armatures In Figs. 1 and 2 it will be noticed that there exists a considerable empty space as core to each coil; such space is frequently two or three times the width of the windings of one side of the coil, sometimes more. If this space is filled in by overlapping coils, as shown in Fig. 3, it is important to notice that without alteration the output of the machine is immediately doubled, at the same speed and with the same excitation, and a two-phase current produced, or two separate single-phases. With disc armatures such additional coils cannot be added without doubling the air-gap; increasing the magnetic leakage, &c., it would be actually impracticable. Whether one desires a two-phase current or not, it certainly appears advisable to fully utilise the available armature space, seeing that the dimensions of the machine are not thereby increased. If a three-phase current is preferred, the same armature and number of coils hold good, but the field magnetic poles have to be increased in number (see Fig. 4), involving an increase of some 30 per cent. in exciting power beyond that required for two-phase, and greater tendency to leakage between adjacent poles as the pitch is reduced. The output of the machine for the three-phase is the same as for the two-phase. If the load of the station consists principally or entirely of lamps, the substitution of two-phase machinery for single-phase might still be advantageous, as the two-phase could be used entirely separate if desired, and existing mains (even with the outer earthed), transformers, &c., utilised, provided the periodicity was kept about the same. A disadvantage of the bi-phase type is that if the loads on, and the capacity of, the two legs are not approximately equal, some method of adjusting the voltages must be provided. The insertion into the mains of a variable choking coil on the lighter loaded side would answer the purpose, but would have to be of large size to have any effect with small currents, and would cause a lag in the current and a slight reduction in the power factor.

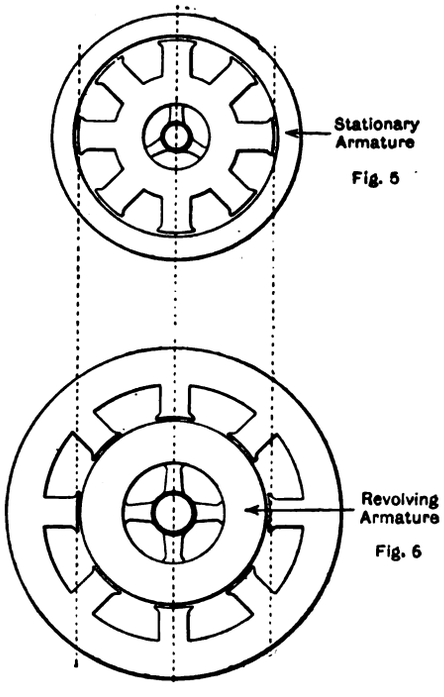
A better method, and one which is frequently adopted, and, I believe, with perfect success, is to employ a small boosting transformer, one coil being connected across the mains and the other in series with one leg. The series winding has tappings at intervals for connection to a multiple switch, by which the pressure can be boosted up as much as desired. By the use of a reversing switch an opposing voltage can be inserted if the leg in which the booster is placed happens to be the more lightly loaded. Such boosters are very valuable adjuncts, as they can be placed anywhere along the line, giving assisting or retarding volts at the expense of a few amperes.

Existing stations, possessing single-phase alternators, might possibly utilise some of the existing machinery by paralleling one or more single-phase machines, provided, of course, that the periodicity coincided, and that the wave forms of current were about the same. If, at a future time, a demand for motors arose, the two single-phases could be easily combined, and either used as two-phase or converted into three by Scott's method of coupling transformers. As a rule, however, the periodicity of single-phase machines is in neighbourhood of 100, which is too high for motors giving very high speed. This point will be referred to again later on.

A two-phase machine on this principle will cost more than a single-phase machine, owing to having twice the number of armature coils, but the cost will not be anything like double, as the full magnetic system remains the same, and the armature reactions are not altered. With disc armature machines, it has been proposed that two or three-phase currents can be produced by removing two or more coils to make room for the angular displacement of those remaining. This, of course, *can* be done, but it still further wastes valuable armature space, and reduces still more the output per unit of weight of this class of generator, which is very low already compared with the other

types. Inductors or alternators, whether single or polyphase, can never reach the output attainable from these with alternate poles, as one-half the coils must always be either inactive, or worse still, generating some opposing voltage. The slight advantage of having all windings stationary, both field and armature, would thus appear to be completely outweighed. Many experiments have been tried, and it appears that the best results are attained with hole or slot-wound armatures, either revolving or stationary, and with two or three-phase connections. The advantages of hole-wound armatures are numerous; they admit of very small clearance, prevent any mechanical stress on the windings, and the conductors need not be laminated, as no eddy currents are generated in them. They are, however, more difficult to wind or repair than those in which the coils are simply wound to form and dropped into slots. In certain cases (instead of windings) single bars slid through an insulating tube and connected by bent strips are used. In large machines of 3,000kw. or 4,000kw. capacity, as high an E.M.F. as 6,000 volts can be generated with single bars, and in the case of 8,000kw. 11,000 volts.

This would appear to be an ideal form of construction, as no internal short-circuiting of coils would be possible, and the chance of a contact to frame is minimised by the conductor being actually surrounded by a highly insulating tube. Even if it became necessary to withdraw a bar owing to, say, the insulation being pierced, this is a very simple process, and only calls for the unsoldering of the end connections. This plan, however, takes longer than the replacement of a coil in a disc armature machine.



Field Poles equal Length, Width and Pitch.

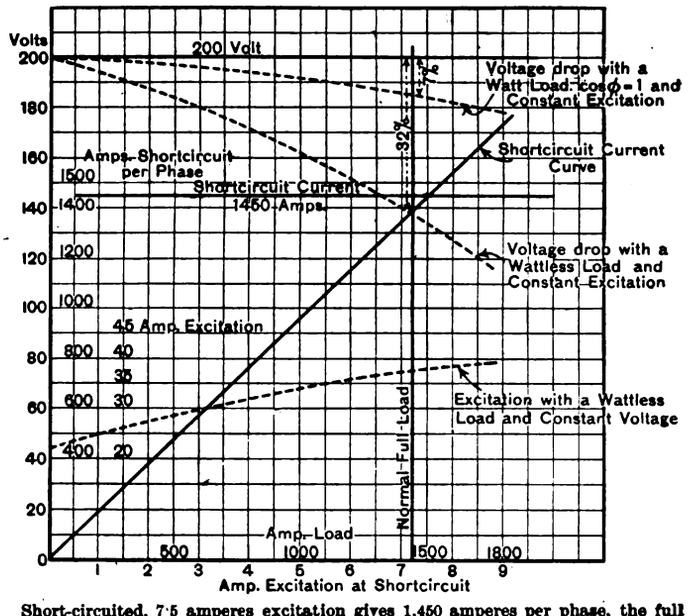
The next point worthy of consideration is whether the armature or field magnets should revolve. In the first place, it is easier to insulate a fixed than a moving armature, and collecting rings carrying high pressures are objectionable. Secondly, the air churning due to the pole-pieces, while absorbing some power, has the good result of assisting the cooling of the armature.

If the field-magnet system is to revolve, one would probably decide to have an external armature in the form of an outer stationary ring, and from Fig. 5 it will be seen that with a certain number, size and pitch of the poles, the armature has somewhat greater available area for the coils, more cooling surface and shorter magnetic circuit than if the same size, number and pitch of poles were used with an inwardly projecting magnet system and a drum armature as shown in Fig. 6. It will be noticed that in both figures the pitch and number of poles is the same, but the size of the latter machine is very much greater for a slightly less output. It is interesting to observe that the arrangement of armature and field magnets shown in Fig. 6, which would appear to be far less advantageous than that shown in Fig. 5, is, nevertheless, universally adopted as standard for direct-current machines (except in very small sizes). No doubt the reason for this is that were an external stationary armature adopted for direct-current productions it would be necessary to have the complicated brush system fixed to the field magnets, and revolve with them. This would, of course, render any adjustment of brushes impossible while the machine was running, and no doubt this advantage has been the reason for the adoption of the design shown in Fig. 6 in preference.

Mechanical difficulties stand in the way of revolving the armature in Fig. 5, but I believe such machines have been constructed by Siemens and Halske. The endeavour to obtain alternate poles with a single exciting coil by interpolating the horns has proved unsuccessful, owing to the great length of the magnetic circuit and the excessive magnetic leakage.

Most field-magnet systems differ but slightly from the old Lontin type of 25 years ago. To economise space and windings it would probably be advantageous, especially where a large number of poles is desired, to have field coils dropped into slots forming consequent poles, and preventing a smooth surface, very much the same as the original Westinghouse alternator armature. There appears to be no reason why the field system should not be of this type, closely resembling the armature by having coils dropped into slots. It is not necessary to have long field magnets, as the air-gap to be bridged is very small. The slots need only be deep enough to permit of sufficient ampere turns to enable the field to be so stiff as to prevent serious armature reaction. There would, however, be less cooling surface and air churning.

There appears to be no doubt that the greatest output per unit weight can be obtained from a two-phase machine with external fixed ring armature and internal revolving alternate poles (Figs. 3 and 5). If the same machine is intended for three-phase, one-third more poles must be used, which incidentally has the effect of proportionately increasing the periodicity if speed is kept the same, but


Volts
200 Volt
Voltage drop with a Watt Load: cos ϕ = 1 and Constant Excitation
Shortcircuit Current Curve
Amps. Shortcircuit per Phase
Shortcircuit Current
1450 Amps.
Voltage drop with a Wattless Load and Constant Excitation
45 Amp. Excitation
Excitation with a Wattless Load and Constant Voltage
Normal Full Load
32%
Amp. Load
Amp. Excitation at Shortcircuit

Short-circuited, 7·5 amperes excitation gives 1,450 amperes per phase, the full load current. Short-circuited, 22 amperes excitation (the no-load value) gives 4,200 amperes per phase

FIG. 7.—Three-phase Generator. 215 revs. per min.; 500 kilovolt amperes; 200 volts between terminals; 50 periodicity; 115 volts; 1,450 amperes per phase.

does not add to total output; in fact, a somewhat greater exciting power must be employed. I recently had the opportunity of experimenting with two three-phase alternators with external fixed armature and internal revolving field, made abroad, and was agreeably surprised with their performance. Facilities for running at full voltage on an adjustable load were lacking, and, therefore, one was unable to obtain sufficient data to plot curves of magnetising current and output to show regulation. By the courtesy of the manufacturers, however, I have been supplied with a diagram (Fig. 7) showing the inherent regulation and short circuit curves of their machines. It will be noticed that with constant speed and excitation the voltage fell off 7 per cent. between no load and full load (inductionless). (A coreless machine curve (see Fig. 8) shows a drop of 5 per cent.)

The short circuit current curve in Fig. 7 shows that the full load current is obtained with 7·5 ampere excitation. If the excitation is arranged for no load and 200 volts, the short circuit current is three times the normal. If arranged for full load of 500kw. (inductionless) the current is 3·4. times the normal. I have been unable to obtain information as to the short circuit current with coreless machines, but should consider it would be a much greater proportion than the above. The capability of short-circuiting an alternator, without an enormous current passing, is of but little real importance in practice, as the engine or turbine driving it would in any case slow down, owing to excessive overload. Also, if the exciter happened to be coupled direct to the generator, the field current would die away and prevent the generation of very heavy currents.

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The parallel running of these machines coupled to Belliss engines left nothing to be desired; there was hardly a noticeable synchronising current passing between them, and the load could be easily adjusted to suit their capacities, or could be transferred from one to the other. The following most severe test was applied:—One machine was running on a heavy load, and the second machine was run up to synchronism and 'bus voltage, and was *switched in when dead out of phase*. The effect was to give a momentary movement to the voltmeter needle, but was too fast to affect the filaments of the lamps, and the incoming machine settled down to work steadily in step with the other. There was no grunting or other noise which is so noticeable a feature in bad phasing of other kinds of machines. When switched in when properly in phase no variation in voltage was, of course, apparent.

Unlike coreless machines, the magnetisation of the field does not cause any objectionable hum, with or without load, which noise is so annoying when alternators are running independently and periodically approaching and passing synchronism. After several hours working at full load, the machine showed no appreciable heating, either of windings or pole pieces. A good mechanical feature of these particular machines is that the armature frame is made easily adjustable in height to allow for re-centring the polar system as the bearings wear.

The armature connections can be coupled in star or mesh as desired. Probably the former is preferable, as it admits of the centre being earthed, thereby reducing the voltage between any line and earth to 0·58 that between wires. Also, each leg of the star can be

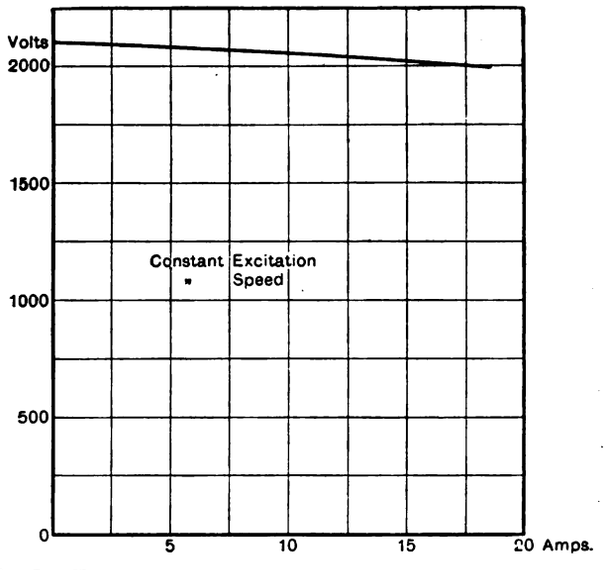

FIG. 8.—Characteristic Curve of Mordey Alternator, 35,000 watts.

used as an independent source of alternate current, and the centre being earthed permits the use of ordinary concentric cables, the outer being coupled to the earth centre, and the inner being one of the lines. This, of course, effects no economy in mains, being exactly on a par with a single-phase system, but it might be convenient in utilising some existing concentric lines. A disadvantage peculiar to armatures connected in mesh is that the three sides may be exposed to varying conditions due to imperfect magnetic or electrical balance, thus producing a current circulating within the closed armature circuit.

An eminent authority on alternating-current machinery recently stated his opinion that the alternate-current motor of the future would be single, not multiphase. Whether this is eventually the case or not, it certainly appears of great importance that the generators should be of two or three-phase, as being adaptable to either or both varieties of motor.

To those about to lay down a new plant capable of dealing with varied electrical demands, and at all reasonable distances, there can be no doubt of the superiority of the polyphase system of generation. The choice of phase and voltage at generation are quite subordinate details, as the phases can be changed from two or three more phases, and vice versa, as may be found desirable, and the voltage ratio transformed up or down as required. Any error in judgment can easily be rectified so far, but in choosing the periodicity one is absolutely committed once for all, and therefore the subject calls for careful deliberation. In the early days, when electric lighting *only* was called for from alternating current supply mains, high periodicity, such as the American practice of 133, that of the Brush Company of 100, and of Ferranti of 83 were employed and worked well, as the transformers were of small size. This high periodicity, when used in connection with long underground cables, gave rise to curious effects, which were not easily explicable at the time, and which we are certainly better without.

The present German practice is to use 40 to 50 cycles per second, and the American 25 only, and this no matter for what purpose or purposes the plant is to be used. Fifty periods appear to be the highest at which one can work rotary converters with any degree of safety and satisfaction, but if one wants certainty of action, no dropping out of step, and perfect parallel running, it is necessary to be much lower than this, say 25. The capability of parallel running of rotaries is determined chiefly by low periodicity, secondly, by even turning moment of prime mover, and thirdly, by design of machine. With 25 cycles and steady torque, rotaries work very sweetly and give no trouble.

Rotaries versus motor generators for transforming alternating into direct current is a question that still admits of much argument. Though many devices have been introduced to enable one, where using rotaries, to vary the voltage ratio between the incoming alternating and outgoing direct current, they cannot compare with motor generators, in which the two machines are entirely distinct from an electrical point of view. Further, rotaries call for transformers, as no one wants a constant direct-current pressure of several thousands of volts; whereas the alternate-current motor of a motor generator set can, whether the motor be of synchronous or induction type, be wound for high pressures, except in the very small size. Still, in designing a plant for universal application, if one can choose a periodicity suitable for rotaries, without detriment to other translating devices, it should certainly be adopted.

High periodicity means high speed of induction and other motors coupled to the circuit, and this is a point which is far more serious in practice than one at first sight imagines. It is all very well to say that a horse-power is the product of speed and torque, and that whether you have a high speed and a small torque or large torque and slow speed is all the same. This only holds good if you want your horse-power at the particular speed at which the motor is prepared to give it to you, but this is very seldom the case, and otherwise there is a considerable loss.

Motors of small power, say 1 H.P. to 3 H.P., are usually speeded at 2,000 to 1,500 revs. per min.; now what mechanical machines are there in the market taking 1 H.P. and requiring a speed of 2,000 per minute? Very few indeed, I think. Such a motor would probably be called upon to drive a lathe or drill at 60 revs. per min., and it would be necessary to gear down from 2,000 to 60 revolutions, and then what proportion of your original horse-power is left? Fancy adopting a 5 H.P. motor, running at 1,200 revolutions, to work, say, a turntable at a speed of 1 rev. per min.!

Taking most machines to which the application of electric motors is desirable, the vast majority do not call for a speed of over 100 revs. per min., and many of them much less than this; but alternating-current motors, even in large sizes, run at 350 or 500 revolutions, and all need gearing down. A direct-current motor can be built for any speed without much trouble, but an alternator must run (at its full speed) at some fraction, minus the slip, of the impressed periodicity; therefore the only practical way of keeping the speed of the motor low is to reduce the periodicity. For this reason, if motors only are to be used in the circuit—this is assuming a most exceptional case—12 to 15 cycles may be used.

If some lighting is likely to be called for, 25 cycle has been found satisfactory, as this is about the lowest at which incandescent lamps will run without appreciable flickering. I have seen thousands of 8 c.p. 110-volt lamps working very satisfactorily off such a circuit. I am not sure that pulsation would not be visible if 5 c.p. 220-volt lamps had been used. It is certain, however, that at 30 periods, the critical point at which the persistence of vision comes in, the light from an incandescent lamp would be perfectly steady, however thin the filament might be. Therefore, if you are likely to require rotaries, induction or other motors and incandescent lighting at 110 volts off your mains, you are safe in using 25 periods. If you require higher voltage lamps, it is preferable to go as high as 30 periods, but beyond this it is not desirable to go, unless the lighting is by far the greater portion of the total load, motors being negligible. But even if lighting is at present the mainstay, one must always be prepared to tackle the motor question when it arises.

No doubt arc lighting would be very unsatisfactory at a periodicity of less than 50 cycles, but very few people are in favour of alternating current arcs, either in groups at low pressure, or in long series direct off the high-tension main. The General Electric Co. of America have introduced a constant-current transformer for this latter purpose which works satisfactorily, but the light from an alternate-current arc even with reflectors, cannot be compared in effective luminosity with that of an open direct-current arc. If arc lamps are required in any number, it would be best to use motor generators separately controlled, and use direct current either of high tension for long series working, or of medium pressure for four to eight in series.

The substitution of modern polyphase plant for the original single-phase with which many English generating stations are fitted is a formidable undertaking, as it means that to obtain the best result,

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almost all the original plant must be thrown out. No doubt this is the chief reason why one sees so many obsolete alternators at work, and why they are still being constructed by leading English manufacturers. To change over from a single-phase 100-cycle to a three-phase 25–30 plant, let us briefly see the alterations that would be necessary.

The original generators could not be utilised without re-winding, and even then their original output would be reduced to such an extent that they would occupy more space than they were worth, especially as the engines driving them would also be working at a most uneconomical speed. It is better, therefore, to get rid of the old plant altogether. Then as regards the mains, if they are concentric, they can be utilised by using one cable per leg, which is equivalent to having a star distribution with three earthed neutrals. This, from an economical point of view, is also absurd, as it neutralises all benefits to be derived from the use of a three-phase circuit. Also, if the capacity of the different branches do not balance trouble would ensue. It is true that where lighting and motors are employed simultaneously, it is sometimes considered advisable to use a fourth wire from the centre of the star and use only outer and neutral for each lamp circuit. This has the advantage of better regulation of the lighting circuits when they are unbalanced, and allows the use between the outers of 1·73 times the actual voltage supplied to the lamp. The latter, however, is more or less an imaginary benefit, as one can always save copper by raising the voltage of the lines, and also transform down as low as required before reaching the lamp. Few people attempt to save copper in interior wiring of buildings, whether the voltage is 110 or 220.

A special cable for three-phase working has been introduced in which there are three main conductors and three smaller ones, the latter acting as a combined neutral. The lamp circuits are tapped into one of the mains and any one of the three neutrals. Such a cable, however, would be complicated in the jointing, and it is doubtful whether the fourth wire is worth the extra trouble involved. As a rule, with fair balance on the three legs of an ordinary three-phase system, the lights are found in practice to be sufficiently uniform, especially when three-phase transformers are used as against grouped single-phase. To return to the question of utilising a high periodicity single-phase plant, we have seen that the generators are useless, and that the concentric cables that are assumed to exist, could be utilised, but it would be far better to discard them for three or four core cables. The other important part of the plant to be considered is the transformers, and the question arises can transformers built for, say, 100 cycles be used on a 25 or 30 period circuit? I have not been able to try the actual experiment, as although I can, of course, run my machines at any periodicity desired, I cannot simultaneously obtain the full voltage. I anticipate, however, that the ratio of transformation on open circuits would remain the same; but owing to the quantity of iron being insufficient to take up the increased magnetic flux, the voltage would drop off as the load came on, very much the same as if the transformers had a high internal resistance. It might be feasible to run two transformers in series, giving, of course, only half their original output, but this at best would be a miserable makeshift, and would sacrifice the valuable balancing properties of polyphase transformers. It appears, therefore, that if one has a high periodicity single-phase plant, and wishes to change over to a low periodicity three-phase system, the original alternators, the concentric cables, and the transformers must one and all be discarded.

Those who provide the funds, whether a company or a government, naturally wish to assure themselves, before taking such a drastic step as to throw out the whole of a plant, that the system about to be adopted will not, in its turn, become obsolete in a few years to come. This guarantee one would be very loth to give, but the polyphase system seems to possess such flexibility that it leaves little to be desired. Advances in generators, motors, &c., are to be anticipated, not as regards efficiency, but output for weight and price and increased power-factor.

What promises to be a valuable addition to polyphase stations is the ingenious motor designed by Mr. Heyland, and described in *The Electrician* of Aug. 16, 1901. This is neither a synchronous nor an asynchronous motor, but possesses the advantages of both, though the drawback of re-introducing brushes exists. It is claimed that a machine constructed on this principle can be used as a self-exciting generator. I have not heard of any such machine being actually in use, but we would all welcome the day that relieves us of the exciter, which in all cases is a weak link in the chain.

In concluding this short Paper I wish to explain that I do not claim to have discovered anything new, though I hope I have brought forward one or two points that might not be universally known. Everyone ought to know that multiphase alternate-current machinery possesses inherent advantages over single-phase, but the knowledge does not appear to be so universal as it deserves to be, or one would not see, as one can at the present day, large single-phase sets passing through the shops of the leading British manufacturers. To show the prejudice still in favour of single-phase, I have heard of a case in England where two-phase generators are installed, but only one phase is used at a time; the other phase is *standing spare*.

I should like to mention just two more points: One is that I hold no brief for any Continental or American manufacturer, nor am I advocating others to adopt a similar system to the one I have charge of. Quite the reverse; the plant in use here is the least satisfactory of all the types discussed, and I long to see it finally discarded. The other point is that the greater part of this Paper was written nearly 18 months ago. Since then Mr. A. C. Eborall, in his very valuable "Howard" lectures before the Society of Arts, has dealt with much the same subject, but in a far more exhaustive and scientific manner than I can ever hope to attain.

THE FUTURE OF THE TELEPHONE IN THE UNITED KINGDOM.*

BY J. E. KINGSBURY.

To the members of the British Association the telephone and its applications cannot fail to be of interest, for they must ever recall with pride that it was at the Glasgow meeting of the Association in 1876 that Alexander Graham Bell's invention was first introduced into this country by the Sir William Thomson of that time and the Lord Kelvin of this. The telephone then was a scientific marvel, and attention was centred on its improvement as a talking instrument. Some of its possibilities were foreshadowed, but its principal application was not foreseen. At the meeting of the Association at Sheffield in 1879 an exchange was shown in operation coincident with the opening in London of public telephone exchanges. From that time the science of the telephone has been the science of telephonic intercommunication.

Like all the more recent practical applications of scientific principles, it is in itself a composite art calling to its aid not only acoustics and electricity, but of late years more particularly the heavier branches of mechanics and engineering, since the modern telephone exchange has anticipated the power schemes by producing at one centre the electrical energy required to signal and to talk between thousands of stations over lines mostly placed underground at a considerable cost and requiring much engineering skill. Any one of the elements of this composite art would afford interesting subjects for discussion. But they have been and will be dealt with elsewhere and at other times, and will be only very casually touched upon in this Paper. The future progress of the telephone in the United Kingdom does not depend upon scientific developments, but upon common sense. In this it does not differ from most engineering questions, for I take it that engineering is a means to an end—that an engineer would derive little satisfaction from the construction of a bridge, however beautiful its proportions, if the approaches rendered it of no utility.

There are at the present time some impediments on the approaches which need removal. They are of a political, economical and social nature, and they exist, as I think, largely on account of the lack of public recognition of the peculiarities which differentiate a telephone exchange system from other works of practical utility. It is my object in this Paper to attempt to remove some of the popular misunderstandings which undoubtedly exist, and by placing before you some of the features upon which telephone service depends draw some conclusions as to its future. You will, of course, be prepared for a considerable dip into the past and some reference to the present before the future is reached.

It is necessary to bear in mind that in 1870 various companies undertaking the transmission of telegrams were acquired by the State, and the work which they undertook was combined with that of the Post Office. The Act of 1869 extinguished competition in telegraphs, and conferred on the Postmaster-General the exclusive privilege of transmitting telegrams. The Post Office had been carrying on this business for six years when the telephone was invented. Its development and application to purposes of profit in the United Kingdom took another three years, so that telephone exchange companies began operations in London in 1879. The Post Office claimed that the service rendered by the telephone companies was an infringement of the powers conferred on the State by the Telegraph Act of 1869. The telephone companies contested this claim, but it was decided in favour of the Post Office in the suit of The Attorney-General *v.* The Edison Telephone Co. of London (Ltd.), tried before Mr. Baron Pollock and Mr. Justice Stephen in 1880.

The reasonableness of the decision is even now sometimes questioned, mainly because the act was passed in 1869 and the telephone invented only in 1876. But distinction needs to be drawn between (1) a service which the State reserved to itself the sole right of undertaking and (2) improvements in apparatus for, or in the means of carrying out, that service.

The service reserved by the State was the transmission of telegrams, and in Mr. Justice Stephens' very careful judgment he shows that,

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within the definition of the Act of 1869, "any apparatus for transmitting messages by electric signals is a telegraph whether a wire is used or not, and that any apparatus of which a wire used for telegraphic communication is an essential part is a telegraph whether the communication is made by electricity or not." Thus the telephone was only an improvement in, or an accessory to, the service of which the State held a monopoly.

Counsel for the company gave notice of appeal, and the Attorney-General, on behalf of the Crown, stated "that, of course, the Postmaster-General is fully alive to the advantages derived by the public from telephonic communication, and whatever result this litigation may lead to care will be taken in the interests of the revenue, and also in the interest of the public, that nothing shall be done to stop telephonic communication so far as it is required by the public." This statement foreshadowed the policy which the Government had considered it advisable to pursue—viz, to work the telephone exchanges through the medium of private organisations or public companies acting under licence. Licences were issued for a period of 31 years conditional on payment of 10 per cent. of the gross receipts. An indication of the Government's intention to resume the working of the system at some period is given by a condition of the licence that the Government were to have the right to purchase the licensee's business at septennial periods upon giving six months' notice, and subject to arbitration in event of disagreement on price. The first licences limited communication to 4 or 5 miles from a defined centre, the State providing trunk lines between the areas. The limitation was found to be inconvenient. It was removed in 1884, and trunk wires between towns were erected by the companies. In 1896 the trunk wires were purchased by the Post Office, and the companies' work limited to "telephone areas" based on the requirements of localities.

Efforts have been made to obtain a reduction in the Post Office royalty, which has been denounced at various times and has been complained of as a tax on communication, as the newspaper stamp was denounced as a tax on knowledge. But even the sufferers by it did not universally condemn that objectionable tax, for Addison, in the *Spectator* of the day preceding the application of the stamp, intimated that he would glory in contributing his utmost to the public weal, and remarked that, "It is a received maxim that no honest man should enrich himself by methods that are prejudicial to the community in which he lives, and by the same rule I think we may pronounce the person to deserve well of his countrymen whose labours bring more into the public coffers than into his own pocket." In this mildly ironical way did Addison convey the information that of the price paid by the purchaser one-half went into the public coffers. The telephone royalty is more moderate, and it cannot be said that the labours of the Telephone Company put more into the Treasury than is distributed amongst their shareholders, but the amount is a substantial one, for during the last 10 years the company has paid in Post Office royalty £916,000 in round figures. For the past year the royalty was about £150,000. The royalty is a part of that protection of the revenues of the State to which the Attorney-General referred, and so far as the companies are concerned it may be regarded as a payment by means of which they are enabled to earn dividends, since, without a licence, it would not be possible for them to undertake the business at all.

The Post Office not only reserved the right to compete, but in some places actually did compete, and in others granted licences freely to competing companies. The inference to be drawn from their attitude is, that they were careful not to create monopoly outside themselves, regarded freedom of action as tending to the public benefit, and were satisfied to let ordinary laws work out the solution of the problem so long as their sovereign rights were maintained and their tribute paid. The service was a new one; there had been no previous experience of its working, and no reasonable forecast could be made.

The competition which existed between the Bell Company and the Edison Company in 1879 ended by the amalgamation of the two into the United Telephone Co., in 1880, before any considerable work had been done, and resulted rather from the advantage of combining patent rights than extinguishing any extensive business competition. But, as a subscriber to the Edison Company, I am able to bear witness to the advantage of the increased capacity of communication which resulted from the amalgamation, small as that would seem now. Shortly after the amalgamation a company called the London and Globe Telephone Co. established an exchange in London, proposing to charge a reduced rental of £12 per annum, instead of £20, the rate then ruling. The company discontinued its operations after a few hundred subscribers had been connected, because it was unable to obtain instruments free of the Edison patent. As a subscriber to the London and Globe Company, I can also speak from experience of the advantage of the reduction in telephone subscriptions which resulted from the cessation of a duplicate service. The other principal competitive exchanges during the patent era were at Dundee and Sheffield, and in anticipation of the expiry of the patents, an exchange was started in Manchester by the Mutual Company.

The Dundee Company was purchased by the National Telephone Co. at an early stage in its career; the Sheffield Company was eventually absorbed, and the Mutual Company lived but a comparative short period.

The popular view of these amalgamations is well known. The real reason has been overlooked. Before formulating it, I will ask you to consider what a telephonic conversation is, and how it is obtained.

Let me make a comparison between telephone exchange service with which we have been familiar for a little more than 20 years and other services which have existed for much longer periods. There are no longer any competing telegraphs in England, but let us suppose there are. I desire to send a telegram to any town. I can take my choice of lines. There is no restriction whatever on the delivery of my message to any inhabitant of that town I may desire to communicate with. In the same way I may take advantage of railway competition by choosing the cheapest or quickest route, or I may prefer to take the longest or most expensive route on account o its natural beauties. What would be thought of the advantages of a railway competition from London to Liverpool if the latter city were divided into two portions, and it were ordained that for a destination on one side ot St. George's Hall it would be necessary to travel by the North-Western, and for a destination on the other side by the Midland Railway. Let us suppose the issue of season tickets. With one season ticket a passenger would be able to reach one-half of Liverpool. If he desired to reach the other half as well he would require two season tickets, and would need to take a different route for either destination. By the division I do not mean a policeman outside the station to direct your cabman by a given street, which order he can evade at the next turning. You must please to imagine an impenetrable barrier. You regard this undoubtedly as a preposterous proposition, but it is exactly analogous to the conditions prevailing under competition in telephony. There are a restricted number of possible correspondents for distinct services or double season tickets if you wish to enlarge your area of communication to the fullest possible extent. The reason why competing services have ceased in the past, is because the absurdity of such a situation becomes obvious when put in practice.

Let us see how the subscribers of the lapsed companies fared in the combinations which have been made. The Dundee Company, at the time of the amalgamation, had 332 subscribers; 152 of these subscribers belonged to both companies, and thus had two season tickets. Each subscriber to the local company paid £5. 10s. per annum. He thus paid 3 975d. per annum each for the opportunity of communicating with 332 subscribers. On amalgamation the subscriptions of the 152 were slightly reduced and of the 180 largely increased, but the annual cost of the right to speak with each other subscriber was reduced from 3 975d. to 2·919d., and with the increase in subscribers this reduction was continually growing in favour of the original subscribers. In addition to the larger number of possible correspondents in their own locality, the amalgamation gave the subscribers to the local company access to other localities, thus adding considerably to the value of the telephone to them. The influence of a widespread "telephone net"—to adopt a Continental expression—may be compared with the force of gravity. Sooner or later the smaller local body if it do not evaporate altogether must be attracted to the larger body. And if the repellant force natural to competitors should retard unduly the operation of this attractive force, then the latter will inevitably be assisted by some superior power in the interest of the public weal, for it must be remembered that the proprietors of exchanges and the subscribers thereto are not the only people concerned. The general public experience some of the drawbacks of this competition. As an example, I may cite an instance from Scandinavia—a part of the world frequently referred to in connection with the advantages of competition in telephony. About the time of the competitive services in Dundee, rival companies were giving the citizens of Christiania the same advantages when (August 20, 1884), "The Municipal Council resolved, in accordance with the proposal of the Executive committee, to notify the International Bell Telephone Co., and the Christiania Telephone Association, that after two weeks they shall not be allowed to run new telephone lines over the public streets, squares, &c., and the Council appointed Messrs. Birch, Reichenwald, Anderson and Christopherson to aid the Executive committee in negotiating with the telephone companies an amalgamation into a single company." The round-table conference succeeded in its efforts, the competition ceased, the number of subscribers grew rapidly, and the exchange has since been acquired by the Government.

The experience of Dundee was not repeated in the United Kingdom for a number of years, because the National Telephone Co. were protected by patent rights. On the expiry of the patents a number of public-spirited citizens of Manchester combined to remove from their town the stigma of being dependent on a telephonic monopoly, and to demonstrate to their predecessors of Dundee the iniquity of being bought up at a profit. They formed the Mutual Telephone Co. of Manchester.

The Mutual Company was in due course acquired by the National Company. At the time of the amalgamation 492 of the 1,349 subscribers of the Mutual Company also subscribed to the other company.

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The ratio of subscription to number of subscribers—that is, the cost of the opportunity to communicate—was 1·320d. per subscriber per annum. On amalgamation it was reduced to 0·567d.

In the Parliamentary Committee report of 1895 it is shown that the average payments of the Mutual subscribers were £7. 8s. 6d. per annum. The average rate of the other company is not given. The normal rate was £10. The average would probably be slightly higher. The total payments by the people of Manchester before and after amalgamation were, approximately, as follows:—

Before amalgamation—			
National	3,374 at £10 0 0	.....	£33,740
Mutual	1,349 at 7 8 6	.....	10,016
	4,723		£43,756
After amalgamation—			
Combined subscribers ...	4,723		
Less duplicates	492		
	4,231 at £10 0 0	.....	£42,310

Whilst the latter total is lower, yet in the absence of definite information as to the National Company's average the figures must not be taken as more than an indication that, to the then existing subscribers, there was no very material change in the total cost of the service. But this, even if admitted, does not go far with the advocates of competition. The contention is that the lower rate was a paying rate, and that all subsequent subscribers have been overcharged by reason of the absence of competition.

The claim that the lower rate was a paying rate is based on the assertion that, during the existence of the competing companies, they were able to make both ends meet. I neither confirm nor combat the assertion, but I wish to correct an impression which is very natural to the mercantile mind. It is that on the fixed subscription plan every additional subscriber is a monetary gain. A new subscriber adds to the working expenses, in that he not only makes calls himself, but increases the calls of other subscribers. With the growth of the exchange there is an increase in the apparatus or plant used in common, such as junction wires and switchboards, as well as in the number of operators. Hence, with the same class of equipment, the increase in subscribers leads to a disproportionate increase in cost of plant and working expenses.

The reason why the working costs at the present time are not considerably higher than in earlier years is, because the class of equipment is not the same. Improved appliances have been introduced, additional plant has been erected or old plant reorganised, enabling the work to be done more economically. But these improvements have cost money, and it will at once be seen that upon these early exchanges, which are so often referred to, further expenditure would need to have been made without an increase in revenue, and from this may be seen the importance of making an allowance for depreciation before arriving at the cost of the service. Depreciation in telephone plant must not be confounded simply with the wear and tear of ordinary machinery. Certain portions may be claimed to be practically indestructible in themselves and yet require considerable depreciation allowance. This arises from the changes caused by growth whereby plant is displaced even though capable of continued use. No rule can be laid down for universal application. There are instances of 5 per cent. and of 15 per cent. being allowed, but the medium figure is more general.

As I have said, the real lesson of the amalgamation was never learned. The apparently profitable nature of telephone enterprise, the invariable maintenance of the rates at the higher level, conveyed an impression which has been sedulously fostered that the absorbing telephone companies were simply seeking, in 'Addison's words, "to enrich themselves by methods that were prejudicial to the community," and Parliament determined by the Act of 1899 to develop, by the aid of the ratepayers, that competition which had so far failed under private enterprise. Two municipalities, Glasgow and Tunbridge Wells, have taken advantage of the permission, and history is repeating itself in its usual way.

The first annual report of the Telephone committe of the Glasgow Corporation shows that £192,693. 14s. 3d. has been spent in equipping an exchange for 5,494 stations. "The stations are subscribed for by 4,697 persons and firms; of these 2,059 have never been telephone subscribers before." This may be taken to mean that all the other subscribers to the municipal exchange are also subscribers to the company's exchange. The average capital expenditure per person or firm (not per station) is £41, but the total expenditure includes work which is very properly undertaken in advance of requirements, and it is a reasonable inference that with a comparatively small additional expenditure sufficient subscribers could be added to reduce materially the above average. It is futile to take only the cost of the useable lines, because there always will be considerable excess. I want only to make a comparison between the useful and the useless expenditure. At a capital outlay of £35 each, 2,059 new subscribers give a useful expenditure of £72,065, and 2,638 a useless expenditure of £92,330. It is not necessary for me to suggest how very much more useful that useful expenditure would have been if it had widened the field of the new subscribers.

In Tunbridge Wells the same results of duplicate subscribers and duplicate subscriptions are found, as was inevitable.

The necessity of anticipating demand, and the supply of plant largely in excess of that actually used, is inherent in telephone service. Conduits in anticipation of cables, cable in anticipation of subscribers, switchboard equipment in excess of immediate requirements; all these necessarily exist in any well-planned exchange.

Every subscriber must bear his proportion of the excess, since, of the revenue obtained from the subscribers, a portion must be devoted to interest on capital. Duplicate the system, and, if they are equally well planned, you double the surplus plant, the capital expenditure therefor, and the subscribers' burden thereon.

Compare the action of these municipalities with the admirable arrangement concluded by the Postmaster-General in London, where every subscriber to the Post Office system is in communication with all the 40,000 subscribers to the previously existing system, so that duplicates are unnecessary and no expenditure is wasted. Competition is a check—a means of preventing undue profit being made by the producer of a commodity or the supplier of a service, and the maintenance of the check requires the continuance of the competition. Technical advocates of competitive telephony realise its temporary character, as will be seen from the published report of the Glasgow engineer recommending another English municipality to undertake competitive service. Dealing with the question of intercommunication between the rival exchanges, he says, "Intercommunication locally from the beginning would render the development of the Corporation exchange difficult. . . . . But when the Corporation's exchange has become larger the conditions will be reversed. . . . . On reaching that point, intercommunication might be insisted upon by the Corporation with every advantage, for the effect would be to complete the ruin of the opposition system."

It might be argued that it is not the province of a municipality "to complete the ruin" of an enterprise rendering a useful service to any of its ratepayers. It might be suggested that the attempt to destroy sometimes results in being destroyed, but I prefer rather to approach the consideration of municipal telephones in a spirit of sympathy with the municipal ideal, and a realisation of the advantages which may sometimes be obtained by collective effort. It is not surprising that, in the absence of an accurate conception of the nature of telephone exchange work, a municipality should be regarded as a suitable body to undertake it. The first idea that occurs to one is that the municipality is the local authority, and yet, as applied to a telephone area, a municipality is only one of several authorities, for whilst the business centres throughout the kingdom have grown, the municipalities remain to a very large extent simply extensions of the old parochical system, and the extensions have not been carried far enough. The telephone area is the whole district over which the business and social relations of the locality naturally flows, but in its flow it covers numerous ownerships. There is no rivalry equal to the rivalry of neighbouring municipalities; there is not a common interest, and in the absence of identical interests there is difficulty in obtaining agreement in policy or on the details of carrying out of a policy.

Agreement may sometimes be obtained as the result of an enthusiasm against what is regarded, rightly or wrongly, as a common foe; it may be continued while the contest lasts. Assume that the ruin of the opposition is completed, will the cohesion continue? Localities change their condition. The fashionable quarter to-day is the business quarter to-morrow. It is the interest of the outlying district to develop its resources. It is the interest of the older and larger municipality—the predominant partner in the telephone area—to retain its prestige, to prevent the development of its rivals. The telephone will be an important factor in such rivalries. Unless it be in independent hands it is easy to foresee a splitting up into smaller units, adding to the confusion, increasing the cost, and generally working to the detriment of the service.

The successful supply of electric light, for example, by municipalities must not be regarded as any criterion of a similar result in the case of telephone exchanges. An electric light station contains a producing plant, the streets carry distributing mains, the service is from the centre outwards, and the entire plant from centre to extremities is under one control. A policy may be initiated and enforced without regard to outside considerations. Telephone exchange service, on the other hand, requires that the system should work in with other systems.

Traffic between two places calls for provision for outgoing calls at one exchange and provision for incoming calls at another exchange. Independent views at either exchange are incompatible with successful working. Neighbouring municipalities running tramway services might so arrange that there could be no through communication, but the inconvenience occasioned to the passenger would be only that of stepping out of one car into another. The equivalent in telephone service would be the stoppage of communication altogether.

One of the arguments urged for local control is that a large percentage of conversations are local. But compare the value of a local conversa-

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tion with a long-distance conversation, and it will be seen how important it is that no impediment, either of an engineering or administrative nature, should be placed in the way of such communications. Experience shows an almost inevitable tendency to local or individual preferences, both in the way of engineering and management, and experience shows also not only the practical difficulties arising from such preferences, but also the greater difficulty of applying a remedy.

It is sometimes assumed that competition is necessary in order to increase the number of subscribers. I will give an example of phenomenal increase without competition. On January 1, 1894, there were about 10,000 stations in New York. On January 1, 1902, there were 72,189 stations in only a portion of the area which was included in the 1894 figures. This considerable increase over the previous progress is attributed to the adoption of a rational system of charging. Up to 1894 there was a "flat rate," the same subscription for large user and small user. In 1894 the message-rate system was applied, with the result that the telephone service has become available to the small user and enormously increased in value to all subscribers by widening the field of communication. This method has also been adopted for the Post Office system in London. It was proposed for adoption some years ago by the National Company in Sheffield, but the subscribers rebelled against it.

I have remarked on the extent to which the future has to be anticipated by present expenditure. Each new subscriber involves capital outlay, and new present work invariably includes some margin for future use.

The amounts expended during the past five years in adding to the exchange construction and equipment of existing services by similar organisations in the United Kingdom and the United States compare as follows :—

	National Telephone Company.	Licensees of American Bell Telephone Company.
1897	£460,937	£973,063
1898	682,506	1,489,499
1899	742,151	3,189,892
1900	834,772	4,382,908
1901	536,793	4,400,000
	£3,257,159	£14,435,362

In making these comparisons, I wish rather to draw attention to the yearly growth than to compare the totals. In the United States there is considerable growth in new expenditure from year to year. In the United Kingdom there is a fairly gradual increase to 1900, and a decrease for 1901. The difference suggests some reason.

I think it will be found in the fact that in the United States the companies supplying the service have no limit to their existence. In the United Kingdom the company supplying the service dies in 1911, or, to put it more accurately, its right to continue the business dies then. To the Parliamentary Committee of 1898, Mr. Forbes stated that it would be the policy of the company not to embark on new expenditure after 1904, but to maintain their existing system in the best condition till the expiry of the licence in 1911. By the Telegraph Act of 1899 it is provided that the licence of the National Company shall be extended in those areas in which competitive services are started, the restrictive barrier against intercommunication being gradually broken down. With longer life the hesitation to undertake further expenditure disappears, for the longer period in which returns may be obtained warrents new investment by the company.

Corporations can borrow easily and cheaply. We thus have financially a most anomalous situation. Money can be spent on competitive systems, which are the most wasteful, which give the maximum of inconvenience with the minimum of public benefit, but money cannot be spent on developing the existing system to which additions can be made at a minimum of cost with a maximum of benefit. The future of the telephone depends very much on the present, for equipment for present subscribers includes some provision for future subscribers, and present starvation means future weakness.

The engineering and construction work should be on a scale that provides for considerable growth, and of a kind that will give reasonable expectation of satisfactory results when that growth is attained. On sound financial principles work on such a scale cannot be undertaken on the terms of existing licences. The best that could be expected with a sole tenant is a reasonable surplus on present requirements. The best that can be expected from competitive services with unremunerative rates and short tenure is hand-to-mouth construction work and speedy dilapidations.

The existence of duplicate services designed and operated without regard to one another necessarily means that on the expiry of the licences it may be found better and cheaper for the State to lay down a new system than to attempt to combine the existing ones. I regard it, however, as extremely doubtful that competitive systems will continue to the end of the licence. It seems to me that the result of the competitions now in progress may be easily foretold. I venture the suggestion that competition by municipalities was provided for under a misapprehension of the nature of telephone exchange service, and a misconception of the results, direct or indirect, which might be expected. I venture further the suggestion that those municipalities which have undertaken such competition have done so under a mistaken view of the benefits to be obtained and the cost of obtaining them. But I have too great a faith in public opinion to doubt that as the lessons are brought home the result of existing competition will be the same as previous competitions. Duality will give way to unity as the only reasonable method of conducting the work. Unfortunately, the disadvantages must be apparent and realised before they are regarded, and probably much expenditure will be incurred before the mistake is recognised. In the meantime the future progress in the practical use of the most beautiful and most useful application of science which the past century produced will be seriously impeded.

The "removal of any disadvantages of a public kind which impede the progress of science" is one of the objects of the British Association. The impediment is so much of a public kind as to be fraught with peculiar difficulties, and to involve important considerations of imperial and local politics which are out of our province. I can only hope that the subject may be considered solely from the point of view of the "public weal," and that scientific inquiry may have some share in reaching conclusions. If that be the case, I do not hesitate to express my own belief that the future of the telephone in the United Kingdom will be free from competition, free from the expense and waste of war, developed by the certainty of permanent utility, and cheapened by the economy which unity of control and permanent work will attain.

ON LUMINOSITY AND THE KINETIC THEORY.*

BY J. BUTLER-BURKE, M.A.

The object of this Paper is to show that the phenomena of luminosity are accompanied by or dependent upon the formation of large molecular aggregates which act as centres of intense molecular force ; and that the luminosity results from the bombardment of these by the free corpuscles in the luminous body, which in virtue of these powerful centres of force acquire a great velocity under their attraction, and produce collisions of considerable violence. In the case of phosphorescent bodies, the time during which these aggregates continue to exist is very much longer than in ordinary non-phosphorescent substances when they are broken up almost instantaneously. The effect of the molecular forces in the phenomena of phosphorescence is doubtless one of great importance, as solids are far more phosphorescent than liquids, and these far more so than gases, in which the phenomenon of phosphorescence is of very rare occurrence.

There is conclusive evidence that separate molecules exist during the process of the change of refrangibility of light. This can be shown by Stokes' method of crossed prisms, by which means it is found that the period of the phosphorescent light is entirely independent of that of the exciting light ; the exciting rays may be very high up in the ultra-violet and yet the spectrum of the phosphorescent light is the same as if the exciting light were in the blue or violet. This is a most remarkable fact and proves that the luminous vibrations are not forced. Again, from the change of absorption during phosphorescence (see Burke, *Phil. Trans.*, Vol. CXCI. (A)) it can be deduced that the luminosity is due to the formation for the time being of new periods under the influence of the exciting light, either by dissociation or by association. An explanation is given, based on this theory, of large aggregates of the Newall "pressure" glow and of the discharge of negative electrification by phosphorescent bodies.

The existence of separate phosphorescent molecules is shown by the fact that the after-glow in a gas can be greatly increased in brilliancy and duration by letting the phosphorescent gas diffuse through narrow metal well-earthed tubing from the bulb in which the discharge is produced into another similar bulb. The phosphorescent molecules, therefore, do not appear to carry a free charge of electricity.

The existence of separate molecules of an ephemeral nature during luminosity, to which it is due, shows that the free periods in a luminous gas need not be the same as those in a non-luminous one, and, therefore, that the ratio of the specific heats, as determined for a non-luminous gas, need not give the number of degrees of freedom when the systems of molecular aggregates exist, during which brief interval of time the physical and chemical properties of the substances are for the time being altered. The ratio of the specific heats for a gas in this state of molecular aggregation, must be quite different from that of the gas in its ordinary state. The molecular condensations may be brought about by the action of violet or ultra-violet light or by the passage of an electric discharge through the gas, or by chemical actions, as in the case of flames.

The "pressure" glow shows that, if a discharge is sent through a gas, it is not until the free path has reached a certain value that the gas begins to glow—that is, that it is not until the work done by a group

* Abtract of a Paper read before Section A of the British Association at Belfast.

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of molecules on a corpuscule, as it moves towards them through its free path, has reached a certain amount, that a collision of sufficient violence to excite phosphorescence occurs; in other words, it is not till a certain vacuum is attained, which, in the case of oxygen, is 0·7mm.

The effect observed by Lenard and Wolf of the analagous behaviour of a phosphorescent liquid to a metal plate such as zinc when negatively electrified is a necessary consequence of the condensation of molecules into groups, since the number of independent molecules is dimished and likewise the number of collisions, as the free path is so much increased notwithstanding the increase in the molecular sphere of action. Consequently under the influence of ultra-violet light the corpuscles will be more free to move about and to escape from the body. When a phosphorescent body is illuminated, condensation of molecules is thereby produced, which causes emission of corpuscles for the body, a result that agrees with experiment. The Newall "pressure" glow requires that the number of molecules in each group must be very great, and it is possible that each aggregate may contain 10^6 molecules.

The phenomena of phosphorescence depends upon the presence of impurities, and the formation of these molecular agglomerations can be effected by a process of the nature of catalytic action.

THE PREVENTION OF SMOKE.*

BY JOHN S. RAWORTH, M.INST.C E.

I have not hesitated to bring this subject before the Association, for no one will deny that, though "Coal has made England, smoke has marred it." No one who has not travelled knows how to appraise the natural beauty of England nor the artistic ugliness of her manufacturing towns. In such towns smoke spoils everything, and were it not for the natural antagonism of the Englishwoman to Satan and all his works, we should soon be lost in dirt. If the Metropolitan Railway were managed by women they would scour it or die; they would not consent to live in such an environment of filth. Happily, we have hope that the modern Hercules will soon clean out this Augean stable, and substitute sweetness and light for dirt and darkness. At one time I harboured a great hope that electricity would cure the smoke evil, or at least take it right away outside our towns, but that was before the days of the municipal craze, and I did not foresee that corporations would necessarily plant their works within their own area, and thereby increase the density of the pall that reduces summer to a mere warm variety of winter, and makes winter more miserable than a place we have read of but not seen.

I think I have found a cure for smoking chimneys, or, to be more precise, I have found a man who knows the inventor of a new process for this purpose—viz., the Wilson smokeless process. It did not take me long to get an introduction to the process itself, which I discovered consisted in squirting a mixture of air and nitrate of soda solution on the fire. I fitted up a Babcock boiler at Kidderminster and gave the system a trial. The original installation was both crude and expensive, but it cured the smoke. It had plenty to cure, for the coal in that district is both soft and dirty, consequently the numerous chimney-tops emit dense clouds of smoke. The action of the solution of nitrate of soda appears to be somewhat obscure. My theory is that it creates nuclei of intense heat which fire the gases and enable the injected air to combine with them. I have had experience with nearly all known methods of smoke prevention; many of them are good, but usually a good stoker can give equally good results without them; the defect of both of them and the good stoker is that they diminish the output of the boiler and its thermal efficiency owing to the fact that they let into the furnace a larger amount of air than is necessary for perfect combustion. My first desire, therefore, after the success of the Wilson process in preventing smoke had been demonstrated, was to ascertain how it affected the output of the boiler and its evaporative efficiency. For this purpose I instructed Mr. H. Wall Wilkinson, A.M.Inst.C.E., to conduct a series of tests to ascertain—(*a*) The output and efficiency under existing conditions; (*b*) with air-blast only; (*c*) with the complete Wilson process. The results are given in the appended report, from which it will be seen that, assuming existing conditions as 100, (*a*)=100 plain furnace; (*b*)=108 air injected; (*c*)=122 Wilson process. It is necessary to state that Mr. Wilkinson was entirely sceptical as to the value of the process, and made numerous other tests to satisfy himself that the results obtained were correct. The engineer of the power house was equally sceptical, but when he found that the coal bill was actually reduced he asked to have all his boilers fitted with the process (which was done).

Other instances of the successful application of the process have come under my notice—one at Durham, where the chimney of the power station in the valley disgorged smoke under the windows of houses on the hill side, and another at Windermere, where the electric lighting company was subjected to proceedings in Chancery for nuisance. In this case the smoke was smoke in name only—there was no black smoke—but the process removed the last vestige, and the Chancery suit has been withdrawn.

The Wilson smokeless process is extremely simple; it consists in the injection of a very minute quantity of nitrate of soda in solution into the furnace, in combination with sufficient air to produce perfect combustion of the gases. The cost of the nitrate of soda used is from 3d. to 4d. per ton of coal burnt.

REPORT BY MR. H. WALL WILKINSON, A.M.Inst.C.E.

March 15, 1902.

I visited the works of the Electric Traction Company at Kidderminster on May 22nd, 1901, for the purpose of making a series of tests on the Wilson smoke-consuming process, the apparatus having been fixed to one of the boilers at those works. The boiler is a Babcock and Wilcox water-tube boiler having 27 sq. ft. of grate area, 1,218 sq. ft. of water-heating surface, and 142 sq. ft. of steam superheating surface. It is fitted with the so-called Scotch furnace, and works at a pressure of 120lb. per square inch. It was fitted with Meldrum's forced draught apparatus, but this was not used during the tests. The feed water was passed through a Green's economiser on its way to the boiler. The tests were made on the boiler while performing the ordinary work of supplying steam to the traction engines, and the load varied, therefore, from time to time, and was not the same on all the four days over which the tests continued. The process consists in forcing jets of air over the surface of the fire, the air carrying with it in the form of spray a solution of the chemical supplied by the inventor. The air is introduced through cast-iron blocks built into the furnace walls at the four corners, the chemical being sprayed in at the two front corners only. Steam jets were used for inducing the supply of air to the blocks. The chemical was made into a strong solution and supplied by pipes from an overhead tank. The coal was thick slack from the Hawkins colliery, Cannock.

On the first day I confined myself entirely to observations of the top of the chimney stack, carefully noting the difference in the amount and quality of smoke after each firing, both with and without the process. When working under the usual conditions a good deal of dark brown smoke was visible, lasting for about two minutes after each firing. I may here mention that the firing on the "spread" system was well and carefully done, about three to four shovels' full being put on about every four minutes. With the process in full operation a very slight coloured haze was produced which lasted about 15 seconds after each firing. With the air jets in operation, but with the chemical cut off, there was a very light brown smoke lasting for about 30 to 40 seconds.

On the second and following days I made a series of evaporative tests both with and without the process, and also a test with air jets only, without the chemical. The results of these tests are appended hereto.

After the test on the first day had commenced, an intermittent leak from the relief valve of the economiser was discovered, so this test was repeated again on May 30th. Every care was used to get as accurate results as possible. The coal was weighed in boxes of 56lb. each. The contents of five of these were emptied on the floor at one time, and no more was weighed out till this was all used, the time being noted. The feed water was measured in two barrels which had been carefully calibrated, and which were emptied alternately into the tank from which the feed pump drew. The fire was cleaned about one hour before commencing the test, and then burnt low. It was cleaned again in three hours after the test was started, and again about one hour before it ended. At the end of the test the fire was burnt low again so as to bring it to the same condition as at the beginning. The firing was done by the regular stoker employed by the Traction Company. All tests lasted over seven hours.

(Signed) H. WALL WILKINSON.

Summary of Results of Evaporation Tests on Boiler at Kidderminster fitted with the Wilson Apparatus.—May, 1901.

Date of test.	May 23 (with air & chemical).	May 24 (with air only).	May 25 (ordinary conditions).	May 30 (with air & chemical).
Duration of test	7·08 hours.	7 hours.	7·42 hours.	7 hours.
Av. pressure of steam	113·3lb.	115lb.	117·7lb.	115·3lb.
Av. temp. of steam (superheated)	469°F.	473°F.	459°F.	466°F.
Av. temp. of steam feed	143°F.	140°F.	146°F.	150°F.
Factor of evaporation	1·228	1·235	1·22	1·219
Total coal	2,856lb.	3,416lb.	3,248lb.	2,744lb.
Total coal per hour	403lb.	483lb.	438lb.	392lb.
Total coal per hour per square foot of grate	15lb.	18lb.	16·2lb.	14·5lb.
Total water	19,520lb	19,485lb.	17,680lb.	17,886lb.
Total water per hour	2,755lb.	2,784lb.	2,334lb.	2,555lb.
Water evap. per lb. of coal (actual conditions)	6·83	5·7	5·32	6·52
Water evap. per lb. of coal from and at 212°F.	8·38	7·01	6·5	7·95

NOTE.—An intermittent leak from relief valve of economiser was discovered after the first test was started. It was, therefore, repeated on May 30th.—H. W. W.

* Abstract of a Paper read before Section G of the British Association, at Belfast.

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ALTERNATOR DESIGN.

The Paper read last April by Mr. J. DENHAM at Cape Town entitled "Some Notes on Alternator Design," is of interest on account of its being the first original communication presented to this particular section of the Institution. The Paper is fairly elementary in character, and its chief value is that it calls attention to a matter which will necessitate a good deal of thought from certain engineers in the near future. As will be seen from the reprint of the Paper on another page in this issue, it sets forth the superiority of polyphase plant in general, and urges the advisability of converting our existing old-fashioned, inefficient, alternating-current supply stations in such a manner that modern requirements can be adequately taken care of. It may, perhaps, be said that the truth of all these matters is so apparent that it is unnecessary to attempt to demonstrate it once more at this time of the day; as the author rightly observes, however, the large amount of single-phase work in the shops of British manufacturers at the present time shows that the prejudice against polyphase systems and apparatus still survives. Although Mr. DENHAM evidently fully realises that the old high-frequency single-phase system has had its day, and that both the so-called "copper," and inductor types of alternator possess serious disadvantages over the present day machines, still we think he has not yet fully grasped the entire significance of certain essential features in the design of polyphase alternators. We propose, therefore, to discuss briefly one or two portions of the Paper which are open to criticism; others will, undoubtedly, present themselves to the designer of the modern alternator.

First, with regard to the constructional difference between two and three-phase generators. It is certainly not the case that the former possess a better weight efficiency, and that the excitation losses with the latter are 80 per cent. greater, the comparison being made, of course, upon two machines of similar construction, and built for the same conditions of output, speed, &c. As a matter of fact, standard polyphase generators give precisely the same output, under practically the same conditions of heating and pressure drop (the two factors which alone influence the design), quite irrespective of the number of phases. The design of the field system is the same whether a two-phase or three-phase generator is required, and the only difference lies in the armature stampings and windings. One does not (as Mr. DENHAM says) take a given armature and alter the field system to suit, according as a two or three-phase machine is required—the change merely consists in re-arranging practically an equal weight of copper on the armature core. As a general rule (particularly for very high pressures) the advantage is altogether on the side of the three-phase generator.

The relative advantages of slot and hole-wound armatures for polyphase machines have been pretty thoroughly discussed lately in this country, and it will suffice here to point out again that the whole matter really turns upon the question: Are the advantages of easily replaceable former-wound

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coils or bars (necessitating open slots and laminated pole-shoes) equivalent to the advantage brought about by the use of solid pole-shoes in connection with parallel running, which form of pole-shoe can, of course, be used with hand-wound hole windings? For the case of very large generators, and for all high-pressure generators, we think this must be answered in the affirmative. If it is anticipated that the flywheel effect provided may not sufficiently diminish the cyclic irregularity of the engine, the logical procedure would certainly be to provide special damping devices on the laminated pole-shoes, and to use replaceable coils in the slotted armature core. Needless to point out, with high speed or turbine-driven sets, no dampers are necessary, and former-wound coils in open slots follow as a matter of course on high-pressure machines. On the other hand, such coils are not essential with low-pressure machines, as the bars used will rarely require replacement; so that here the cheaper construction of hand-wound windings in holes, with solid pole-shoes, can quite well be employed. We disagree, however, with Mr. DENHAM'S broad statement that it would be possible to use one bar per hole for a generater of 3,000kw. at 6,000 volts; this would not be possible with a slow-speed set—compare the new Kolben generators at Willesden with five conductors per slot. Again, such a winding would usually be arranged with several bars of smaller section, connected in parallel, for several reasons, one of them being convenience in manufacture. The author, in speaking of the question of the insulating of such high-pressure polyphase generators, falls into a common error; the slots, or holes, themselves are easy to insulate, because the slot insulation itself will rarely break down, unless the armature winding is damp or the micanite tubes defective. The danger of arcing to the frame is principally at the ends of the coils. It is for this reason that the micanite tubes in a 10,000-volt armature must extend about two inches beyond the armature core.

Mr. DENHAM'S suggestion with regard to a new form of field system for a revolving field generator is, we fear, impracticable. He suggests constructing the rotating field system with consequent poles, the field coils being wound in slots (in a similar manner to the coils of the original type of Westinghouse alternator), the field system, in fact, being smooth all round. With such a construction, not only would it be difficult to arrange for the proper relation of the pole-width to the pole-pitch (0·5 to 0·7), but it would be impossible to get the necessary copper into the available winding space. In connection with the latter point, it must be remembered that, in spite of the small air-gaps usual with modern generators, the ratio of field ampere-turns to amature ampere-turns is usually of the order of 3·5 : 1. Modern standard machines are always well saturated (from considerations of pressure regulation), and in these circumstances, not only are the no-load ampere-turns high, but, in addition to the necessary compensation for armature reaction and armature leakage, the increase of field-magnet leakage from no load to full load becomes quite important, and must be allowed for. To carry the excitation necessary at highly-inductive loads, comparatively long bobbins become a necessity; as a matter of fact, with small machines of the revolving field pattern, it sometimes becomes a difficult matter to get the necessary space for the exciting ampere-turns, on account of the small pole-pitch, due to the small diameter of the internal revolving magnet wheel. It was this difficulty which caused Mr. C. E. L. BROWN to get out his well-known construction of (small) magnet wheel, in which each *alternate* pole is wound (which construction may be termed, for want of a better name, a consequent pole field), such as recommended by Mr. DENHAM. It is not particularly good, magnetically, however—the unwound poles are always weaker than the rest (on account of leakage), which gives rise to unsymmetrical E.M.F. waves; moreover, the field flux is especially liable to be considerably weakened and distorted by the armature reactive flux, especially on inductive loads.

Although we agree with Mr. DENHAM that the revolving-armature type of alternator has little to recommend it in ordinary circumstances for machines of a fair size, we would point out that a comparatively high cost of construction is not one of its disadvantages as compared with revolving-field alternators. The weight of the field system is considerably less, it is true, when this is internal to the armature and arranged to rotate, yet, on the other hand, when the armature core is external its weight is greater, and, being laminated, it has to be held in a cast-iron case specially designed for great rigidity. It is possibly for this reason that the Westinghouse Company still builds such generators in the largest sizes, the cost being still further decreased by the casting in of the laminated field poles into the magnet yoke, which method could certainly not be used if the field system had to rotate. Again, we believe that few engineers who have made a practical study of alternate-current working will agree with Mr. DENHAM that the limiting of the short-circuit current of a polyphase generator has no real importance under modern working conditions. The modern iron-cored generator, having a short-circuit current of three to four times the normal full load current, can invariably furnish this for a sufficiently long period to take care of the faults commonly met with in power transmission work, without injury to itself—circuit-breakers, of course, permitting; at short circuit the armature current is very much out of phase, the load on the machine corresponding only to the total losses, and hence the driving engines do not pull up. But the real point is the relation of the armature impedance of the generators to parallel running; this impedance must be of such a magnitude that the synchronising power of the generator is neither too small nor too large. Its bearing on the matter is nowadays well recognised, and it has been adequately set forth by various authorities on the subject during the last two years. It is for these reasons that the modern slow-speed generator has a pressure drop of not less than 16 per cent. on an inductive load (say, a power factor of 0·8), although it would be perfectly easy (with still greater saturations, &c.) to reduce this to 12 per cent., corresponding to 2 to 3 per cent. on a load of power factor unity. But such small drops are purposely avoided, and hence we have the iron-cored generator, with a short-circuit current not exceeding three or four times the full load current.

THE FINANCIAL BASIS AND DESIGN OF ELECTROLYTIC METAL REFINERIES.*

BY ARNOLD PHILIP, B.SC., A.I.E.E., F.I.C.

(*Concluded from page 799.*)

Further Considerations on Current-density at the Cathode in Copper Refineries.—In all the foregoing discussion of the important question of current-density, it has been supposed that the only limit to the largeness of the current-density to be employed was that imposed by the prime cost, and interest and depreciation of plant, cost of energy, labour, fuel, copper, &c.; but besides these important factors there are two other limiting conditions which are as important as any. These conditions are, firstly, the alteration of the mechanical character of the electro-deposited copper on the cathode as the

* Copyright. From a forthcoming work by the Author, entitled: "The Electro-plating and Electro-refining of Metals."

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current-density alters, and, secondly, the alteration of the chemical nature of the copper under the same circumstances. In short, it is found that, unless some very special means are used, the copper which is electro-deposited with current-densities much above about 14 or 15 amperes per square foot tends to take a crystalline and loose formation, thus tending finally to long growths, which may short-circuit a vat. Further, if the electrolyte contains much impurity the high current-density is favourable to the precipitation of arsenic and antimony with the copper, thus much reducing its value. My aim has, however, been to call attention to the fact that, without considering any limiting conditions of this kind, the current-density must, even under conditions very favourable to the high current-density, be kept generally under 15 amperes per square foot, and usually lower than this, if the most profitable working of a refinery is desired. This fact is not popularly recognised, and very many efforts have been directed to the deposition of copper of a satisfactory character with high-current density. As is shown on p. 718, if the copper obtained is to be employed as raw copper from which articles will be subsequently manufactured, the employment of a high current-density, even if it yielded a mechanically and chemically satisfactory material, would not be economically correct. If, however, the deposited copper is directly formed into a manufactured article as it is deposited, such, for instance, as copper tubes, which have a higher value per ton than the pure unmanufactured metal, the current-density may economically be increased considerably. Although, generally speaking, the distance apart of the electrodes and the vat space required per ton of copper are quite different when tubes are to be deposited from what is adopted when electrically refined but unmanufactured copper is to be produced, yet the value of the best current-density may be obtained precisely, as on pp. 717 and 718, different constants being employed, however. The chief cause of the increased value of D being clearly due to the fact that P″, the value in pounds per ton of copper tubes, is very much higher than if unmanufactured copper alone were produced, whilst P and P′ remain constant.

Arrangement of Vats.—The vats in an electrolytic refinery may be arranged either in series or in parallel, or in some combination of series and parallel arrangement.

The amount of copper conductor employed *along* the vats is precisely the same *for a given copper output* whatever may be the number or arrangement of vats, or whatever the current-density employed in the vats; but the *connections of copper from the vats to the dynamo* is greater in direct proportion to the number of sets of vats in parallel, and the amount of copper in the form of conductors is also greater per ton output of copper the greater the number of vats employed for the output, because of the extra connections between each vat. Economy in copper employed in conductors is, therefore, attained, for a given output of copper, by using all the vats in series and having the vats as large as possible. Clearly, also, the amount of copper employed in the form of current conductors is less the greater the current-density employed in these conductors, but this density, which depend upon Lord Kelvin's law and need not be discussed here, is limited by other considerations of economy.

The electrical energy employed per ton of copper deposited is precisely the same whether the depositing vats are arranged all in series, or all in parallel, or in any combination of these two methods provided the current-density at the anodes is fixed, but the loss of energy due to leakage is certainly greater when the series arrangement is adopted than on the parallel system; and, in fact, these losses may be roughly said to be proportional to the square of the volts employed—that is, the losses are proportional to the square of the number of vats in series. The leakage losses can, however, by proper care, be indefinitely reduced, and the advantages obtained by the use of vats in parallel under this head need not, therefore, be considered as of any importance if proper precautions are employed in insuring sufficient insulation to each vat. At Anaconda, for instance, frames are built up of timber baulks. These frames are about 84ft. long, 5ft. wide and 3ft. deep. The framework is lined with pitch pine wooden boarding, and is divided up by transverse board partitions into 10 tanks, each about 8½ft. long. Every joint of the wood is caulked with insulating material, and all the wood has been soaked in paraffin or similar insulating substance. The vats are supported on wooden beams at a sufficient height above the ground to permit of inspection from below. The sides of the vats are also out of contact with the working floor of the gangways between the troughs. The tanks are all lined with sheet lead, and the cathodes, anodes and connecting copper conductors are, of course, carefully kept from all possibility of contact with this leaden sheath, the distance between the edges of the anodes or cathodes being about 2in. from the leaden lining of the tanks. The following are details of the arrangement of vats at different refineries:—

Anaconda: Six sets in parallel, each set consisting of 200 vats in series.
Boston, Montana: One set of 600 vats in series
Elkington, Pembrey: One set of 200 vats in series.
Elliott, Birmingham: Five sets in parallel, each set consisting of 48 vats in series.
Oker: Five sets in parallel, each consisting of 12 vats in series.
Marseilles: One set of 40 vats in series.
Biache: One set of 20 vats in series.
Hamburg: One set of 120 vats in series.

There is no doubt but that modern practice is never to employ less than 100 vats in series, unless compelled to do so by the fact that the works output is so moderate that a vat of the necessary size to take one-hundedth of the annual output would be inconveniently small. American practice is apparently in favour of employing the largest possible number of the largest possible sized vats in series, the limit of vats in series being apparently only limited by the size of the works. This policy is the necessary one to pursue, in order that the copper employed in the form of conductors connecting the dynamo to the tanks and interconnecting tank to tank may be a minimum, and may, therefore, reduce, as far as possible, the amount of capital locked up.

Size and Number of Vats.—The size of the vats employed in an electrolytic refinery must not be too small, or their cost per cubic foot, and the room which a plant designed for a given output occupies, will become excessive. On the other hand, the size of the vats should not be too great, and for two reasons. Firstly, because the difficulty of arranging and handling the anodes and cathodes becomes greater the greater the size of the vats employed, and, secondly, because, in the event of a vat either becoming short-circuited by accident, or being disconnected from the circuits for cleaning and putting in order, the loss of energy in the first case, or the loss of output in the second case, becomes excessive if the vats are unduly large. It must be remembered in this connection that the output in copper of a vat depends only upon two conditions with a given arrangement of anodes and cathodes, and these two conditions are, firstly, the current-density, and secondly, the volume of the vat. If the current-density employed is fixed and the distance apart of the anodes and cathodes is also fixed, the output of a vat depends only upon its volume. Clearly, a large vat is cheaper per cubic foot of contents than a small one, and a good general rule is that the vats must be made as large as possible, the possible largeness being only limited by the inconvenience of the vats of too great dimensions, and the fact that a given factory cannot afford to have more than at most about one-hundredth part of its output wasted at a time, by reason of accidental short-circuits occurring in the vats.

Thus, if it is desired to determine the number of vats to employ for a given output of copper, we may, firstly, decide that at least 100 vats shall be used in series, for then if one vat is being cleaned up, or if one vat is by accident short-circuited, the loss of output will only amount to 1 per cent. of the total output of the factory. If, then, we divide the annual output of the proposed factory in tons of refined copper by 100, we shall obtain the tons output per vat per year, and, as has already been shown (p. 679), a safe estimate requires about 60 cubic ft. of vat space per ton of copper output per year, at a current-density of 1 ampere per square foot of cathode surface, and, therefore, if we denote this current-density by D, the volume of each vat should be $\frac{60T}{Ds}$ cubic ft., where s is the number of vats employed in series, and T is the

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output of refined copper per annum. For certain outputs this may work out to very small vats, and, again, under other conditions the size of the vats thus determined will be too large. If it works out too small—say, under 25 to 30 cubic ft.—a smaller number of vats must be used in series in spite of the inconvenience this entails, as pointed out above. In fact, the vats should not, under any circumstances, be of smaller size than about 25 cubic ft., for if they are the cost of vat per cubic foot becomes excessive, as also does the floor space required and the volume of electrolyte. On the other hand, if the vat size calculated out from the above formula is very large, the vats become difficult to manage for shifting anodes, cathodes, &c., and cleaning up.

At Anaconda the vats have an internal capacity of 132 cubic ft. each, but in this case the copper is shifted by means of an overhead crane, and it is probable that a vat of a capacity of 80 cubic ft. is usually of quite sufficiently large size. If, therefore, the vat size as obtained by the above formula is over 80 cubic ft., it is better to run a larger number in series until vats of a size of about 80 cubic ft. are obtained. The sizes of vats at various works are as follows:—

—	Cubic feet.	Length. Feet.	Width. Feet.	Depth. Feet.
Biache	75·0	10·0	2·5	3·0
Anaconda*	132·4	8·2	5·0	3·25
Elliott	30·25	2·75	2·75	4·0
Elkington	42 0	4·0	3·0	3·5
Casarza	24·5	6·5	1·25	3·0

The tanks of the Boston Montana Copper Refining Co. have about the same volume each as those employed at the Anaconda works.

Voltage of Dynamos for Copper Refining.—The voltage of the dynamo employed for copper refining is ruled by the number of vats in series and the current-density employed. If the number of vats in series, as determined from the above considerations, is denoted by s, and if the current-density in amperes per square foot is denoted by D, then the required voltage, V, of the dynamo may be obtained with good approximation from the equation

$$V = 0{\cdot}042Ds.$$

Thus, if the current-density is 10 amperes per square foot, and there are 280 vats in series, the voltage of the dynamo required will be 75 volts. The dynamo must, of course, be either a shunt wound or a separately excited machine. If a shunt-wound machine, it is advisable to have it provided, as is usual in this type of machine, with a rheostat in its field magnet circuit which is capable of varying its voltage up or down by about 20 per cent. This permits of its voltage being kept constant at all loads without altering the speed of the driving engine, and also allows of a certain amount of flexibility in the number of tanks the dynamo can feed in circuit, whilst the current-density may be varied somewhat if desired. As the separately excited machine gives a greater flexibility, it is not unusual to employ such a dynamo, but as it must be run with an exciter dynamo or secondary cells it is not quite so cheap or simple as a shunt machine, unless a refinery is of very large output. At the Boston Montana Refinery, U.S.A., the dynamos are 180-volt separately excited Westinghouse machines having a normal current of 4,500 amperes, but the volts may be raised to 220. The exciters are 125-volt Westinghouse shunt dynamos. The current-density in the vats is probably about 14 amperes per square foot of cathode surface.

At the Anaconda refinery, where 200 vats are worked in series, the dynamos are Westinghouse shunt machines of 75 volts terminal pressure, whilst the current-density employed is probably about 12 amperes per square foot of cathode.

In conclusion I have much pleasure in acknowledging the assistance given me by Mr. J. H. Brinkworth, of Chippenham, in checking most of the large number of numerical results contained in this Paper.

* *The Electrician*, Vol. XXXVIII., p. 144, but in a recent Paper (*Electrical World and Engineer*, Vol. XXXVII., 1901, pp. 186-187), it is stated that the volume of the Anaconda vats is 140 cubic ft., the dimensions being 8 × 5 × 3·5ft. The vats are also stated to contain 4,000 litres of electrolyte (=134·7 cubic ft.).

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 1900
Accrington (Municipal)	July 25, 1902	Kensington & Knightsbr'(Co.)	Apr. 11, 1902
Ayr (Municipal)	Oct. 11, 1901	Kingston-upon-Hull (Mun.)	July 18, 1900
Barnsley (Municipal)	June 27, 1902	Kingston-on-Thames (Mun.)	June 20, 1902
Bath (Municipal)	April 20, 1900	Lancaster (Municipal)	July 25, 1902
Bedford (Municipal)	Aug. 8, 1900	Leeds (Municipal)	June 27, 1902
Belfast (Municipal)	Aug. 8, 1902	Leicester (Municipal)	Jan. 26, 1900
Birmingham (Company)	Sept. 15, 1899	Leith (Municipal)	May 17, 1901
Blackburn (Municipal)	Feb. 7, 1902	Leyton (Municipal)	Nov. 1, 1901
Blackpool (Municipal	Oct. 4, 1901	Liverpool (Municipal)	April 4, 1902
Bournemouth (Company)	April 18, 1902	London Elec. Supply Corp.	Sept. 5, 1902
Bolton (Municipal)	Nov. 29, 1901	Londonderry (Municipal)	Feb. 16, 1900
Bradford (Municipal)	July 12, 1901	Manchester (Municipal)	Aug, 29, 1902
Brighton (Municipal)	Sept. 12, 1902	Metropolitan Elec. Supply Co.	Apr. 25, 1902
Bristol (Municipal	Aug. 8, 1902	Morley (Municipal)	July 25, 1902
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	July 11, 1902	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	July 11, 1902	Norwich (Company)	Sept. 19, 1902
Cambridge (Company)	June 18, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Aug. 29, 1902
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 2, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 22, 1902	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 28, 1900	Richmond (Company)	June 20, 1900
Crewe (Municipal)	July 11, 1902	Salford (Municipal)	Jan. 24, 1902
Croydon (Municipal)	Nov. 22, 1901	Scarborough (Company)	Sept. 19, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	St. Helens (Municipal)	Jan. 10, 1902
Derby (Municipal)	Jan. 26, 1900	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Dewsbury (Municipal)	Feb. 15, 1901	St. Pancras (London) (Mun.)	Sept 5, 1902
Dover (Company)	May 2, 1902	Sheffield (Municipal)	Feb. 1, 1901
Dundee (Municipal)	Dec. 6, 1901	Shoreditch (Municipal)	Jan. 31, 1902
Eastbourne (Municipal)	Mar. 14, 1902	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Edinburgh (Municipal)	Dec. 6, 1901	South London (Company)	May 16, 1902
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 4, 1902
Folkestone (Company)	May 2, 1902	Southampton (Municipal)	Aug. 1, 1902
Glasgow (Municipal)	Sept. 12, 1902	Southport (Municipal)	Jan. 17, 1902
Gloucester (Municipal)	Aug. 30, 1901	Stafford (Municipal)	Aug. 16, 1901
Great Yarmouth (Mun.)	Dec. 13, 1901	Sunderland (Municipal)	Aug. 1, 1902
Greenock (Municipal)	Aug. 30, 1901	Taunton (Municipal)	June 16, 1899
Guildford (Company)	Oct. 19, 1900	Tunbridge Wells (Mun.)	Aug. 23, 1902
Halifax (Municipal)	Dec. 27, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hammersmith (Municipal)	Nov. 15, 1901	Walsall (Municipal)	May 23, 1902
Hampstead (Municipal)	Nov. 23, 1901	Wandsworth (Company)	May 9, 1902
Hanley (Municipal)	Aug. 9, 1901	Westminster (Company)	April 4, 1902
Harrogate (Municipal)	Jan. 25, 1901	Whitehaven (Municipal)	Feb. 8, 1901
Harrow (Company)	Dec. 21, 1900	Winchester (Company)	June 20, 1902
Hastings (Municipal)	July 18, 1902	Windsor and Eton (Co.)	July 19, 1901
Hereford (Municipal)	Jan. 17, 1902	Woking (Company)	Dec. 22, 1899
Hove (Company)	July 18, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Huddersfield (Municipal)	May 23, 1902	Woolwich (Company)	May 31, 1901
Hull (Municipal)	July 4, 1902	Worcester (Municipal)	April 18, 1902
Isle of Wight (Company)	Dec. 20, 1901		

The Isle of Wight Electric Light and Power Co. (Ltd.).

In our first table are grouped the records of operation in 1901 of electric supply in Ventnor, Bonchurch, Sandown Shanklin and Newport, Isle of Wight. The station supplying Ventnor and Bonchurch has completed its second year of working—supply having started in March, 1899. The works at Sandown and Shanklin were opened in April, 1901, and the accounts, therefore, cover nine months of working, while the Newport works were completed and started in operation in October, thus contributing only three months' figures. At the latter place no public lighting has yet been done.

Considering the conditions under which the cost figures were obtained, it would manifestly be unfair to criticise them too closely, but, nevertheless, they bear comparison with the general results obtained at other places of similar size very creditably. The cost of fuel and stores delivered at the works must be high in the Isle of Wight. The total costs come out at only about 0·4d. above the average of company stations with outputs equal to the joint output of the Isle of Wight stations. To have kept the costs down to the level they stand at, with the business cut up into three stations, and with a coal item of 1·56d. per unit, should be a satisfactory result. The only item which appears somewhat high, except, of course, fuel, is that of repairs at the station. Naturally, with a group of such stations the capital is very high in relation to the output, and it will require time to show to what extent this adverse condition will be remedied by the growth of the business. A satisfactory agreement has been entered into with the Corporation of Ryde for leasing their provisional order. A site has been obtained, and it is hoped to complete the station before the end of this year.

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	ISLE OF WIGHT.		GUERNSEY.	
Undertaking Worked by	Isle of Wight Electric Light and Power Co. (Ltd.).		Guernsey Electricity Supply Co.	
Date of Commencement of Supply	March, 1899.		February, 1900.	
System of Supply	3-wire continuous-current.		3-wire continuous-current, with batteries.	
Chief Engineer	A. E. Mayes.		A. G. Bird.	
YEAR ENDED	DEC. 31, **1900.**	DEC 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**
QUANTITIES—				
Units generated	140,653	247,486	—	135,419
" **SOLD (TOTAL)**	107,190	182,394[d]	49,225	90,104
" sold to consumers	77,181	128,246	49,225	88,687
" sold for public lighting, &c.	30,009	54,148[e]	nil	1,417
" sold for traction	nil	nil	—	—
" used on works	11,087	35,786	—	18,951
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	—	12·6	—	12·0
Actual maximum supply demanded	110 kilowatts	—[f]	94 kilowatts	120 kilowatts
Load factor	11·1%	—[f]	6·0%	8·6%
Number of public lamps	24 arc, 133 glow[a]	24 arc, 145 glow[g]	nil	4 (10 amp.) arc, 9 (25 c.p.) [glow
Number of consumers	174	—	104	250
Connections to mains in 8-c.p. lamps at end of year	7,200	18,167[h]	7,173	10,849
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	343	618	150	330
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	— / —	— / —	— / —	— / —
Share	£60,000 / £175	£60,000 / £97·1	— / —	— / —
Loan (including Debenture charges)	— / —	— / —	— / —	— / —
RECEIVED (TOTAL)	20,000 / 58·3	20,000 / 32·4	— / —	— / —
Share	5,000 / —	5,000 / 8·10	— / —	— / —
Loan (including Debenture charges)	15,000 / 4·37	15,000 / 24·3	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	— / —	— / —	— / —
Share (unissued)	55,000 / 160	55,000 / 89·0	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	— / —
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	36,559 / 107	106,700 / 173	£32,899 / £219	£45,321 / £137
Lands and buildings	4,478 / 13 0	15,102[i] / 24·4	6,297[a] / 42·0	7,048[d] / 21·4
Plant	15,507[b] / 45·2	48,442[j] / 78 4	13,676[b] / 91·1	18,841[e] / 57·1
Mains	13,622 / 39·7	35,556 / 57·6	9,961 / 66·4	13,918 / 42·2
Miscellaneous	2,952 / 8·61	7,599 / 12·3	2,966[e] / 19·8	5,514[f] / 16·7
BALANCE OF CAPITAL ACCOUNT	−16,559 / −48·3	−86,700 / −140	— / —	— / —
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	£2,109 / 4·725d.	£3,675 / 4·839d.	£1,153 / 5·390d.	£1,835 / 4·890d.
Revenue from supply	1,624 / 3·640d.	2,839 / 3·737d.	1,048 / 4·900d.	1,600 / 4·260d.
" meters, &c.	54 / 0·121d.	130 / 0·171d.	22 / 0·103d.	58 / 0·154d.
" public lighting	431 / 0·965d.	706 / 0 927d.	nil / —	14 / 0·037d.
" supply for traction	nil / —	nil / —	— / —	— / —
" miscellaneous sources	— / —	— / —	82[a] / 0·383d.	163[f] / 0·434d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£1,338 / 2·997d.	£2,546 / 3·350d.	£657 / 3·070d.	£1,161 / 3 091d.
TOTAL WORKS COSTS	993 / 2·226d.	2,042 / 2·686d.	571 / 2·669d.	977 / 2·603d.
Generation of electricity	*890 / 1·994d.*	*1,856 / 2·442d.*	*546 / 2·552d.*	*910 / 2·424d.*
Fuel (including cartage, &c.)	648 / 1·450d.	1,184 / 1·558d.	359 / 1·678d.	594 / 1·582d.
Oil, waste, water, stores	22 / 0·049d.	93 / 0·122d.	11 / 0 051d.	79 / 0·210d.
Wages at station	197 / 0·441d.	357[k] / 0·470d.	168[h] / 0·786d.	201[o] / 0·536d.
Repairs and maintenance at station	23 / 0 052d.	222[l] / 0·292d.	7[i] / 0·033d.	37[p] / 0·099d.
Distribution of electricity	*28 / 0·063d.*	*60 / 0·079d.*	*25 / 0·117d.*	*60 / 0·160d.*
Wages, &c.	6 / 0 013d.	30[m] / 0·039d.	22[h] / 0·103d.	19[k] / 0·051d.
Repairs, renewals of mains, &c.	22 / 0·049d.	30[n] / 0·039d.	3[j] / 0·014d.	41[q] / 0·109d.
Public lighting	*75 / 0·168d.*	*126 / 0·166d.*	— / —	7 / *0·019d.*
Attendance	9 / 0·020d.	126[o] / 0·166d.	— / —	7[r] / 0·019d.
Renewals	66 / 0·148d.		— / —	
MANAGEMENT AND PROPERTY CHARGES	345 / 0·773d.	504 / 0·663d.	86 / 0·402d.	183 / 0·488d.
Net rents	*136 / 0·305d.*	*38 / 0·050d.*	— / —	— / —
Rates and taxes		*106 / 0·140d.*	— / —	*1 / 0·003d.*
Management	*209 / 0·468d.*	*360 / 0·474d.*	*86 / 0·402d.*	*182 / 0·485d.*
Salaries	108 / 0·242d.	182 / 0·240d.	54[k] / 0·252d.	94[k] / 0·250d.
Stationery, &c.	44 / 0 099d.	69 / 0·091d.	19 / 0·089d.	39 / 0·104d.
Establishment charges	29 / 0·065d.	74 / 0·097d.	13 / 0·061d.	28 / 0 075d.
Law charges &c.	28 / 0·063d.	35[p] / 0·046d.	— / —	21[s] / 0 056d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap.exp'nded**	**Total.** / **% to mean cap.exp'nded**	**Total.** / **% to mean cap.exp'nded**	**Total.** / **% to mean cap.exp'nded**
WORKING PROFIT FOR YEAR	£1,123[c] / 3·58%	£1,326[q] / 1·85%	£722[m] / —	£695[u] / 1·78%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve Fund	— / —	— / —	— / —	— / —
Net interest on loans (incl. Debenture charges)	750 / 2·39%	1,484 / 2·07%	6 / —	— / —
Net profit for the year	373[c] / 1·19%	— / —	716[n] / —	— / —
BALANCE FROM LAST ACCOUNT	−188 / −0·599%	180 / 0 25%	nil / —	nil / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	180[c] / 0·573%	20 / 0·028%	716[n] / —	— / —
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	63·4%	69·3%	57%	63·3%
Expenditure per mean kilowatt capacity	—	£5. 6s. 2d.	—	£4. 16s. 10d.
REVENUE PER MEAN KILOWATT CAPACITY	—	**£7. 13s. 2d.**	—	**£7. 13s. 0d.**
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	—	**5s. 10d.**	—	**4s. 1d.**
Price charged for lighting, per unit	7d. to 4d.	7d. to 4d.[r]	7d. to 4d.[t]	7d. (1 hr.) to 3d.[t]
Price charged for power, per unit	4d. to 1½d.	4d. to 1½d.[r]	4d. to 1½d.[t]	4d. (1 hr.) to 1½d.[t]
Price charged for public lighting	Contract	Contract[s]	—	£18 (10 amp.) arc, 50s. (25
Receipts per unit for private supply	5·06d.	5·31d.	5·11d.	4·33d. [c.p.) glow
" " public lighting	2·85d.	2·57d.	—	1·19d.
" " traction	—	—	—	—

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Guernsey Electricity Supply Co.

The Guernsey Electricity Supply Co. is another offspring of Edmundson's Electricity Corporation (Ltd.). The accounts for 1901 are those for the first complete year of working, and though they record actually slightly lower total cost figures than do the Isle of Wight accounts, yet we do not think that the results are better in relation to the circumstances, though they may be considered satisfactory also. The output of the Guernsey undertaking is smaller and the coal supply probably dearer, but the business is less broken up than it is in the Isle of Wight. The management and property charges at the both places are very low, and especially so at Guernsey, but there the fuel charge appears higher, as might be expected.

Details of the disposal of the working profits are not available from the published accounts.

REMARKS TO TABLES.

ISLE OF WIGHT.—*a* 105 glow lamps are of 25 c.p., 27 of 32 c.p. and 1 of 8 c.p. *b* Includes £963 on public lamps. *c* Inclusive of profit on wiring £270 and rents of motors £82. *d* 141,059 in Ventnor, 11,416 in Bonchurch, 23,362 in Sandown and Shanklin and 6,557 in Newport. *e* 42,059 in Ventnor, 5,064 in Bonchurch and 7,025 in Sandown and Shanklin. *f* Maximum supply demanded, 128kw. and load factor 12·1 per cent. in Ventnor, 18kw. and 7·25 per cent. in Bonchurch, 75kw. and 6·1 per cent. in Sandown and Shanklin and 53kw. and 8·5 per cent. in Newport. *g* In Ventnor, Sandown and Shanklin 25 c.p. glow lamps, in Bonchurch 32 c.p. 9,600 in Ventnor, 839 in Bonchurch, 4,380 in Sandown and Shanklin and 3,348 in Newport. *i* £1,469 on land. *j* "Machinery and plant" £29,472, accumulators £5,872, meters £5,646, instruments £4,708, public lamps £2,744. *k* Proportion of salaries £67. *l* Buildings £222, plant and machinery £45, instruments and tools £126, accumulators £38. *m* Proportion of salaries £1. *n* Of mains £13, on consumers' premises £17. *o* Attendance and renewals £104, repairs £22. *p* Auditing £19, insurance £21, law £2. *q* After adding £196 "rental of motors and wires." *r* On maximum demand system. *s* In Bonchurch £3. 10s. per lamp per annum.

GUERNSEY.—*a* Lands £973. *b* Machinery £9,049, accumulators £1,713, meters £1,502. instruments £1,412. *c* "Concession" £332, wiring and motors £2,557. *d* Lands £987. *e* Machinery £19,348, accumulators £1,715, meters £7,901, instruments £1,648, public lamps £326. *f* "Concession" £332, wiring and motors £5,079. *g* Transfer fees. *h* Proportion of salaries £22. *i* Plant and machinery £4, accumulators £7. *j* Of mains £1, on consumers' premises £2. *k* Proportion of salaries. *l* Maximum demand system *m* Including £226 net profit from wiring account. *n* Transferred to Edmundson's Electricity Corporation (Ltd.). *o* Proportion of salaries £34. *p* Buildings £3, plant and machinery £20, instruments and tools £4, accumulators £10. *q* Of mains £6, on consumers' premises £35. *r* £7 on attendance and renewals. *s* Insurance £6, law £5, auditing £10. *t* Rental of motors and wires. *u* After adding £21 net from wiring account.

MAGNETIC DETECTORS IN SPACE TELEGRAPHY.*

BY PROF. ERNEST WILSON.

1. So far as I am aware Rutherford† was the first to make a scientific investigation into the effect which high-frequency electric currents have upon the magnetism of a bundle of wires previously magnetised. He wound an insulated conductor upon the wires and connected it to a receiver, and found that a magnetometer was affected when electric impulses were received from a distant transmitter. The effect was to demagnetise the bundle of wires. Experiments were made in the Siemens Laboratory, King's College, London, in 1897, the only published note in connection with which is in British specification 30,846, 1897, in which a local varying magnetising force is used during the reception of the electric impulses received from a distant transmitter. It is well known that if iron is taken through a magnetic cycle it is very sensitive to change in the magnetising force when on the steep part of the cyclical curve. This effect is very marked in pure iron,‡ so much so, that if the magnetising force be varied to a point at which the magnetism is on the steep part of the curve and be then kept constant, a tap will cause it to settle down still further, giving a considerable kick with a ballistic galvanometer placed in a secondary circuit linked with the specimen. To test the effect of high-frequency currents upon magnetism, two experiments may be mentioned—one on hard steel wire 0·025cm. diameter, the other on iron wire 0·0265cm. diameter, as received from the draw-plate. Each specimen was wound into a ring having 40 turns 3cm. diameter, and supplied with a primary and secondary coil for ballistic galvanometer tests. In addition, each was wound with three turns of stranded copper wire for connecting to a receiver. The latter consisted of a condenser and nine turns of copper wire 4ft. in diameter in the case of electromagnetic impulses, and two hard-drawn brass wires in the case of Hertzian waves. The distance between transmitter and receiver was 36ft. The magnetising force was varied by means of a liquid reverser,§ and kept steady when on the steep part of the cyclical curve of induction. Fig. 1 gives the cyclical curves for the iron and steel, and the force was varied to the points marked *a* in each case before application of the electric impulses. An apparent acquirement of 14 and 6 per cent. of the maximum intensity of magnetic induction was observed in the steel and iron specimens respectively—that is to say, the kick observed when the magnetising force was finally changed to its maximum value was less after the waves had been applied than it would have been without the application of waves. It is difficult to differentiate between true Hertzian wave effect and that due to electromagnetic induction, as both were present in the latter case. Probably all the wires attached to the rings helped to receive the impulses. It may be mentioned that the resonating circuit was tuned to the primary, and had a frequency of about $1{\cdot}5 \times 10^6$ periods per second. The values of maximum H in the steel and iron rings were 25 and 6·8, and the maximum values of B were 6,540 and 9,020 respectively.

2. A telephone of 139 ohms resistance was placed in circuit with a coil of 840 turns, and resistance 23 ohms, wound on the steel ring above mentioned. It gave sounds in keeping with the sparks at the

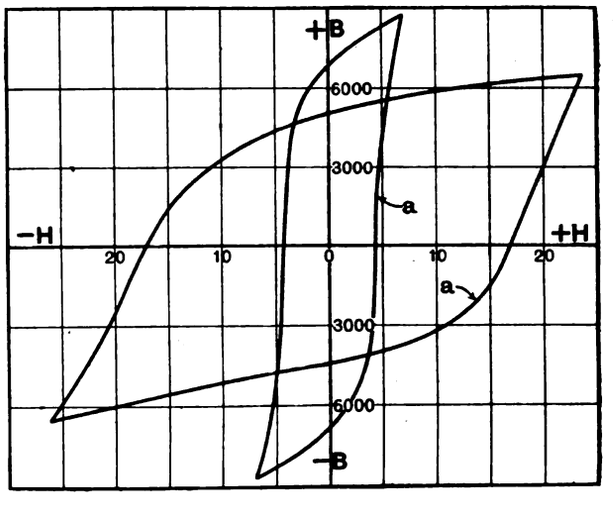

FIG. 1

transmitter very markedly, when, by means of the liquid reverser, the magnetism was changing along the steep part of the cyclical curve. A diagram of connections is given in Fig. 2, in which A is the liquid reverser having copper plates in dilute copper sulphate solution; B is a battery of storage cells with an adjustable resistance, C, in circuit; D is the magnetising coil wound on the experimental ring; E is the coil attached to the receiver, and F is a coil connected to a telephone G. In order that the effects of the variations due to the local magnetising force might be stopped in the telephone, two similar rings had their telephone circuits opposed so far as the changes due to the local magnetising forces are concerned, but helping as regards the magnetising force due to the high-frequency currents. Different values of the maximum intensity of magnetic

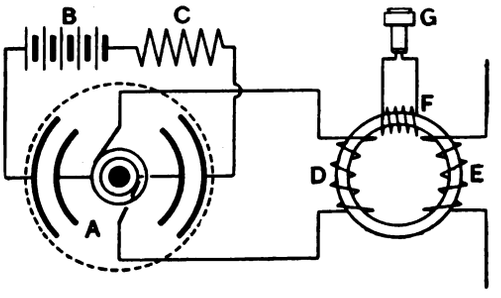

FIG. 2.

induction were tried, but it was difficult to say if an intermediate force was better than a larger one. The impression was that iron gave better results than steel.

3. A comparison was made between reversing by aid of an electric current in a magnetising coil and a permanent magnet. Here it must be noted that there may be a difference in the effects obtained by reversing the magnetism in the manner above described, and reversing by rotating a permanent magnet in front of a bundle of iron wires. In the one case the magnetism is reversed by passing through zero, and in the other it is reversed by turning round in a rotating magnetic field. So far as could be judged, there appeared to be equally good results whether the current in a magnetising coil wound on a bundle of iron wires bent into the form of a horseshoe was reversed; or whether the magnet was brought up to the bundle of iron wires, moved away, reversed, and again brought up; or simply rotated in front of the bundle of wires.

* Paper read at Section A of the British Association, at Belfast.
† *Phil. Trans. Roy. Soc.*, Vol. CLXXXIX. (1897), A., pp. 1—24.
‡ *Proc. Roy. Soc.*, Vol. XLVI., p. 269, and Vol. LXII., p. 369.
§ *Phil. Trans. Roy. Soc.*, Vol. CLXXXVI. (1895), A., p. 98.

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4. To try the effect of submitting the specimen to mechanical stress, a bundle of 50 wires of iron 0·0265cm. diameter each, was suspended from a wooden frame and wound with a magnetising coil having 22 turns per centimetre in which currents of 1 and ·5 ampere were reversed. A telephone circuit was placed over this. When the wires were stressed to the extent of 7·37kg. per square millimetre, and at the same time subjected to torsion the effects in the telephone were increased. Results were obtained with soft nickel wire 1·6mm. diameter when loaded to 9·76kg. per square millimetre. It is well known that by submitting nickel to a pull and twist stress the cyclic curve of magnetic induction is rendered very steep, so much so, that the sounds in the telephone due to the local variation of the magnetising force, which were small when not twisted, became very pronounced with a twist of 2deg. or 3deg. per centimetre of length.

5. To try the effect of heating, a bundle of 40 wires of iron, 0·0265cm. diameter each, was supported horizontally and connected to a battery of storage cells. The wires were first covered with a layer of asbestos, and wound thereon was an asbestos-covered wire used for the local magnetising current. A telephone circuit was wound above this on another layer of asbestos. The effects in the telephone were very pronounced when the iron had a temperature just below the critical temperature at which it loses its magnetism, and much less pronounced when at atmospheric temperature.

6. All the above experiments were confined to short distances. Mr. Marconi has already achieved wonderful success with rotating magnetic fields in signalling to great distances.

ELECTRIC RESPONSE IN ANIMAL, VEGETABLE AND METAL.*

BY PROF. J. CHUNDER BOSE, M.A., D.SC.

The effect of stimulus on living substances is usually detected by two different methods. In the case of *motile* tissues, stimulus causes a change of form. Mechanical response may thus be obtained inc ontractile tissues like muscles, but in others—like nerves, for example—stimulus causes no visible change. The excitation of the tissue may, however, be detected by a certainelectromotivechange. The advantage of electric mode of detecting response is its universal applicability.

Electrical Sign of Life.—The electric response is a measure of the physiological activity of the tissue. When the physiological activity is exalted by a stimulant, the electrical response will rise in amplitude. When the activity is diminished as by narcotics the electrical response is also diminished. When the tissue is killed, the electrical response disappears altogether. Hence it is said that "the most general and most delicate sign of life is the electrical response." These response-phenomena are considered due to some unknown super-physical "vital" force, and are regarded as beyond the region of physical inquiry. In the present Paper it will be shown that this conclusion is not justified; it will be shown that the responsive processes seen in life have been foreshadowed in non-life.

The gap between the animal and metal is very great; an investigation was therefore undertaken on the response in the transitional world of plants. For the demonstration of response I used (1) the so-called method of injury employed by physiologists and (2) a more perfect method—the method of block—devised by myself. For stimulation I used blows delivered by a mechanical tapper. A far more perfect method of stimulation, I find, is by means of vibration. For record of responses the following device is very perfect, and enables demonstration before a large audience:—Twin aluminium cylinders are kept revolving at a uniform rate by clock-work, an endless band of paper passing over the cylinders. The moving galvanometer spot of light, at right angles to the motion of the recording paper, is followed with a pen.

Plant Response, a Physiological or Vital Response.—I have obtained response in all plants and by all their organs. When the plant is killed by poison or hot water the electrical response disappears.

Inorganic Response.—The electric response, which is regarded as a sign of life, is not confined to living things, but is present in the inorganic bodies as well. Further, the responses in plants and metals are modified by the influence of external conditions exactly in the same way as the responses of animal tissues are modified. There is not a single phenomenon in the response in muscle and nerve that has not an exact parallel in the response of metal and plant. Out of these cases a few are mentioned.†

Uniform Response, Fatigue and "Staircase" Effect.—These three types of responses are found in vegetable and metal as in the animal. In muscle, fatigue disappears after a period of rest. The same is true in plant and metal.

Effect of Superposition.—In all the three classes, ineffective stimuli became effective by superposition. Again, rapidly succeeding stimuli produce a maximum "tetanic" effect.

Relation between Stimulus and Response.—In all the three classes the response at first increases rapidly with the stimulus, but for higher value of the stimulus, a limit of response is approached.

Electrotonus.—This effect is exhibited by ordinary plants in a manner similar to that of animal tissue.

Action of Drugs.—Just as the response of animal tissue is exalted by stimulants, lowered by depressors and abolished by "poisons," so also it is found that under the action of appropriate re-agents, the response in plants and metals undergo similar exaltation, depression or abolition.

Thus irritability or capacity for response is not confined to living tissues. The living response in all its diverse manifestations are but repetitions of physical phenomena exhibited by the inorganic. There is in it no element of mystery or caprice as is admitted on the assumption of a hypermechanical "vital" force, acting in contradiction or defiance of those physical laws that govern the world of matter. Nowhere in the entire range of these response phenomena—inclusive as that is of animals, plants and metals—is there any breach of continuity. The response phenomena are not determined by the play of an unknowable and arbitrary vital force, but by the working of laws that know no change, acting equally and uniformly throughout the organic and inorganic worlds.

* Abstract: A demonstration of electric response of ordinary plants given before Section K of the British Association at Belfast.

† For a more complete account see the following:—Bose, "Response of Inorganic Matter to Stimulus," Friday evening discourse, Royal Institute, May, 1, 1901. "Electrical Response in Ordinary Plants under Mechanical Stimulus," *Journal* Linnæn Society, 1902. "Response, in the Living and Non-living." (Messrs. Longmans.)

CORRESPONDENCE.

ELECTRICAL ENGINEERING IN SOUTH AFRICA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Now that the war is over in South Africa, very many gentlemen are coming out expecting to find positions as electrical engineers waiting for them, and numbers of wiremen, fitters, engine drivers and others arrive by every boat. It does not appear to be known in England that, although South Africa is a large country, the towns are very few and far between. If one fails to secure an appointment in Cape Town, on landing, one has to travel to the nearest towns, such as Kimberley, 650 miles, Port Elizabeth 840 miles, East London 900 miles, Johannesburg 1,000 miles, Pretoria 1,050 miles, Bulawayo 1,360 miles, or go on to Natal, before one can expect to find employment. The openings (?) for electrical engineers may be judged from the following list of electrical generating stations at present in operation or contemplation:—

Cape Town.—Municipal plant, Cape Tramways Co., Camp's Bay Tramway Co., Table Bay Harbour Board, Cape Government Railways, Suburban Electrical Syndicate.
Kimberley.—Municipal plant. De Beers Mines.
Port Elizabeth.—Cape Tramways Co.
East London.—Municipal plant.
Bloemfontein.—Municipal plant.
Johannesburg.—Municipal plant. Various plants on the different mines. High-tension transmission from power station at Braakpan.
Pretoria.—Municipal plant.
Bulawayo.—Municipal plant.
Schemes are before the Government for the lighting of King Williams Town, the Paarl and Uitenhage.

The above is pratically a complete list, and yet we have men arriving every week and expecting to jump into positions as electrical engineers! The largest amount of electrical work is carried out round Johannesburg, but owing to the native labour trouble, the disbanding of the volunteers, and other causes, the supply of skilled labour there is far in excess of the demand.

As far as wiremen and similar tradesmen are concerned, there are at present no openings in Cape Town. On an average 10 to 12 applications are received every week at my office, and have to be refused. Applicants are referred from one to the other of the three or four power stations existing round about here, and after their services are declined it is difficult to imagine what becomes of them. Hotels here charge from 15s. to 20s. per day, and the most ordinary boarding houses from £6 per month upwards.

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If you would be so good as to insert this letter in your journal it might have the effect of preventing some disappointment, and also obviate the painful necessity, at this end, of constantly refusing applications.—Yours, &c.,

JOHN DENHAM, Hon. Sec. I.E.E., &c.

Electrical Department, Cape Government Railways,
Cape Town, Sept. 3.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) and St. Marylebone Borough Council.

ARBITRATION.

Following the proceedings in this arbitration, recorded in our last issue, Mr. FREDERICK J. WALKER, general manager and secretary of the St. James' and Pall Mall Electric Light Co. (Ltd.), was examined by

Mr. CRIPPS: You have been general manager and secretary of the St. James' and Pall Mall Company since 1891, and general manager and secretary of the Central Electric Supply Co. (Ltd.) since its formation in 1897?—Yes.

What is the Central Electric Supply Co.; what is its business?—It was practically formed to conduct a power station under a special Act of Parliament for the supply of St. James' and Pall Mall and the Westminster Electric Supply Corporation. It has its works in Marylebone.

You are acquainted with the gross and net revenues of the Metropolitan Electric Supply Co., and you know that in Marylebone district they are the only company supplying electric current, and that all attempts at competition have failed?—Yes.

I want to show what your experience has been in your own district. I think the area of supply of your company is 162 acres, and on Dec. 31 last there were 3,134 houses?—That is so.

Out of those 3,134 houses 1,423 were either wholly or partially supplied with current by your company?—Yes.

Your company bounds the south side of Oxford-street, and Marylebone is on the north side?—Yes.

What has been your experience as regards the increase in the number of consumers, the equivalent in 8 c.p. lamps connected, number of units generated and sold from year to year since 1889, the year of the commencement of your company's supply?—The number of consumers average 161 per annum over the 11 years, the number for 1901 being actually 179. The number of 8 c.p. lamps connected has increased by an average of 17,652. In 1901 it was 25,480. The number of units generated has averaged 486,784. The increase for 1901 was 714,721. The units sold each year per customer has averaged 2,858, and in 1901 was 3,169.

Under all those heads the increase in 1901 has been in excess of the average?—Yes.

What has been your annual increase in gross revenue?—£8,139. It was £11,768 for 1901.

Then, although the conditions are very different in your case and the Metropolitan Company's case, you have been able to economise generation costs constantly, as your business has grown?—Yes, very considerably.

In your opinion, have you in any sense reached the limit of your market in the demand in your district for electric light?—Not by any means.

What I want to know is this. Do you find in your district, that where houses have taken the light, there is a tendency to increase the demand for the consumption?—Yes, you may take it that of our annual increase a third or more comes from existing consumers already supplied.

In your district you have competition, have you not?—Yes, with the London Electric Supply Corporation.

Whereas in the Marylebone district there is no competition?—No.

We have it at the present time that 23 per cent. of the inhabitants of the houses in Marylebone only are supplied, and that it is a district where the future is in the hands of one company. What do you say as regards the future?—I think it is a very low estimate; that that 23 per cent. can be very easily quadrupled in the next 30 years; that is, possible consumers and business generally. I think that estimate can be generally taken for all London electricity undertakings. Although we have, in our own company, got some 45 per cent. of the consumers in St. James, our engineers anticipate getting something like 500,000 lamps in the next 10 years. That is, practically doubling our present lampage connection for the 10 years only.

The UMPIRE: When you say 45 per cent., do you mean possible consumers, or the distribution of actual consumers between your own and the other company?—I am speaking of my own district—of the possible houses really. That is taken from the census returns.

Do you see that, in our tables, in 1901 we begin as regards units sold for lighting with 4,538,487, and that it goes on till in 1931 it is 24,850,000?—Yes.

Now, having regard to the conditions in Marylebone, and applying to that the experience you have gained in your own company, do you think that a fair expectation?—Yes, very fair indeed. I quadruple the output, and that brings it in round numbers to 20,000,000, but as I think the conditions are, if anything, more favourable in Marylebone, and there is a larger area for development, 24,850,000 is a very fair estimate.

Cross-examined by Sir EDWARD CLARKE: You said that in your district you had competition with the London Electric Supply Corporation. When did they obtain powers—since yours?—No, I think about the same time.

It is not an effective competition, is it?—I have no knowledge of what business the competing corporation are doing in our district. Their supply is an alternating supply, and we have much the larger business.

You have said that in Marylebone attempts at competition have failed. What attempts at competition have there been in Marylebone?—I think there were the County of London and Brush Co. and the Marylebone Co., of which I was the secretary. In 1897 we made our first application. That attempt failed, and we went to the Board of Trade later without the consent of the Vestry and obtained an order.

The UMPIRE: You dispensed with the consent of the local authority?—Yes.

Sir EDWARD CLARKE: And obtained an order?—We obtained an order, and it was thrown out in the House on the second reading, although supported by the Board of Trade. We have now entirely abandoned any idea of going for a competing order in Marylebone.

Is the Marylebone Company still in existence?—No, it was transferred to other individuals, but what they have done with it I do not know.

Then, as I understand, you would probably have succeeded in 1897, or, at all events, you expected to do so, if the Vestry had supported your competitive system, and in 1900 you actually got the order?—Yes.

Was there, to your knowledge, at that time an agreement entered into between the Vestry and the Metropolitan Electric Supply Co.?—Yes, and with knowledge of that agreement existing we withdrew from any further effort.

Your own company has had a satisfactory experience, I think. Has its progress been regular?—Do you mean from sales of current or gross revenue?

Whichever you like. Say, units sold?—The works were only started in 1889, so that in 1890 it was quite in its initial stages. In 1890 there were 421,105 units sold; in 1891, 1,067,996; in 1892, 1,186,000; in 1893, 1,211,000; in 1894, 1,569,000; in 1895, 1,846,000; in 1896, 2,401,000; in 1897, 3,028,000; in 1898, 3,448,000; in 1899, 4,201,000; in 1900, 5,127,000; and in 1901, 5,842,000. I think such variation as there is in this upward tendency is due most to the weather, which has a large effect upon the revenue.

What is the maximum generating capacity of your company in kilowatts?—5,400.

The percentage of electric current generated you actually sell?—This varies. From 1896 to 1901 it varied from 89 to 91 per cent.

Mr. CRIPPS: Do you mean that out of every 100 generated you get 89 to 91 accounted for?—That is so.

Sir EDWARD CLARKE: What percentage does your company allow for depreciation and reserve—the percentage on the capital, I mean?—About 3 per cent.

Rather more than that, is it not?—For 1896 it is 4·22 per cent.; 1897, 13·89; 1898, 4·06; 1899, 4·24; 1900, 3·65; and 1901, 3·29.

Re-examined by Mr. CRIPPS: Your company has been a very prosperous one, has it not. For a series of years you have paid 14½ per cent. on your ordinary shares, I think?—Yes.

Under those circumstances it is possible to be exceedingly generous as regards reserve fund to assure a high average dividend?—I look upon it as a prudent reserve.

On Dec. 30, 1900, the capital you had then expended was £390,231. 1s. 10d. Your system is the low-tension continuous-current system, is it not?—It is.

And you are one of the companies who were fortunate enough to begin on the right lines at first?—I think that was our good fortune.

What is the proportion of your working expenses to gross revenue?—49 per cent. in 1901, but they have been as low as 41 per cent. in 1896. I think you might take 45 per cent. as being a fair average, not including depreciation.

Of course, in such a business, as the amount of business done increases there is a tendency to decrease the proportion of working expenses to gross revenue. Our estimate is that when we are supplying something like five times what we are now supplying, the working expenses on the low-tension continuous-current system would be about 40 per cent. Is that a right estimate?—I think it a very fair estimate.

I think you have shown there is one very special point as regards the low-tension continuous-current system in what you have told us—namely, that in every 100 units generated you account for 89 to 91?—Yes, practically 90 per cent.

Now, as to competition. First as regards your own company's case. Did the London Electric Supply Corporation get their powers in 1889, at the same time as did the St. James' Co.?—I think so.

One element in parcelling out London at that date was to have the alternating and continuous system in competition, and that was done in the St. James' district?—Yes.

When in 1897 you made seductive overtures to the Marylebone Vestry, that body, in spite of the influential support you had secured, turned a deaf ear to you?—Yes. I found them very hard people to tackle.

There was, therefore, not much chance of competition in Marylebone, according to your experience?—No, certainly not.

Mr. LIONEL HERBERT HORDERN, manager of the Westminster Supply Corporation (Ltd.), was next examined by

Mr. CRIPPS: You joined your company in 1892, were assistant manager in 1896, and manager in 1900?—Yes.

Your company obtained their order in 1839, and you commenced supply towards the end of 1890?—Yes.

The UMPIRE: Your area lies south of Marylebone and west of St. James and Pall Mall?—Yes.

Mr. CRIPPS: Have you competition?—Yes, with the London Electric Supply Corporation.

What is your experience as regards the increase of consumers year by year?—The increase is, of course, as a percentage, decreasing, but the actual increase is rather higher now than it was before, but not so much so far as consumers are concerned. In lamps the increase is larger during the last five years than it was before. In units sold the same.

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I see that, taking 1901, your increase in units sold was exactly 1,646,774?—Yes.

What percentage of the houses in your district are already supplied?—In Mayfair there are 3,106 houses, of which 2,869 are in occupation, and there are supplied 1,834 out of the 2,869, but of course they are not fully supplied.

Do you find, in your experience that, apart from having new houses to supply, you get increased consumption in the houses already supplied?—Yes, certainly.

Applying the experience you have gained in Westminster to the conditions in Marylebone, as far as you know them, do you think the estimate presented by Mr. Conacher is a fair expectation?—I think it perfectly fair. I should put it perhaps a little higher as regards motor power.

To a certain extent Marylebone is almost a virgin field for electrical enterprise?—Yes, for motors.

Now, as to motor power, we have not heard much about that. What is your experience as regards the supply in the future of motor power?—At the end of last year the equivalent in 8 c.p. lamps connected in Westminster was only 26,785, but this year there will be an increase of at least 50 per cent. in the last four months, bringing this up to at least 40,000. Electric lifts are increasing very much. Indeed, people are taking out hydraulic lifts and putting in electric, and builders are increasing their use of electric motors in place of steam. There is also a great demand commencing for motor car charging. We have one company just starting which expects to have 800 carriages. The carriages in our district would use about 2½ million units in the year. Last year our motors used 350,000 units, and this year will use about 600,000 units; and I think in another three years there will be probably 3,000,000 units sold for motors.

We have not been in a position to deal with motor power with our system of supply?—No.

You look forward to a time when motor power will become a very important part of the electric supply business?—Yes, certainly. I believe there are instances, but not in London, where it has become the main portion of electric supply.

You supply on the low-tension continuous-current system. What quantity of current did you actually supply last year?—We sold 8,927,883 units—that is, we actually sold 87 per cent. of the current generated.

What is the lowest proportion to which you have ever reduced your working expenses as compared with gross revenue?—38·1 in 1896.

Now in Marylebone we ultimately hope, by a reasonable expectation, to be supplying altogether in units sold 32,800,000. Assuming that that is given on the low-tension continuous system, do you think 40 per cent. is a fair estimate to which we might ultimately reduce our working expenses?—Taking 3·8d. as an average price—3·8. It would be somewhere about 45 per cent., I should say it would, of course, depend entirely upon the price.

What is the capital invested in the Westminster Company's undertaking?—At the end of 1901 it was £585,792.

How many inhabited houses are in your area?—In 1901 12,596 inhabited houses, but that does not count houses in occupation. The census table is divided into two classes—houses inhabited and houses in occupation. The houses in occupation is rather an important matter too.

You mean houses where no one sleeps on the premises?—Yes, for instance, the Army and Navy Stores. They are in occupation. I find the census gives the houses "in occupation" at 835. That would bring these figures up to 13,400. The population was 120,655 in 1901. 133,000 was the population in Marylebone. There is not very much difference in the number of houses or population of the two districts.

What has your dividend been in recent years?—The last five dividends have been 12, 12, 13, 10½ and 10½ per cent.

The UMPIRE: What is your number of consumers?—6,195 at the end of 1901, using about 9,000,000 units of current.

Cross-examined by Sir EDWARD CLARKE: During the last six years the percentage upon your capital allowed for depreciation and reserve has averaged about 3·3?—In 1896, 2·73 for depreciation and sinking fund. The reserve fund was not taken out of revenue. The reserve fund was premiums on a new share issue, and we do not touch that. In later years it is 2·69, 2·85, 2·80, and 3·06.

An interesting table you have put in shows the statistics of your company for 10 years, with regard to each of which you can test the increase. Do you notice the extraordinary difference between the increase of the first five and the second five years?—Yes, the increases for the first five years aggregated come to 177·5 per cent., and the increases of the second five years are 79.

Do you observe that, if that process were continued, by the time you got into the latter part of your 30 years you would have scarcely any increase at all?—No, I do not think that follows. That is a percentage increase. The actual increase is much more in the last five years. The percentage increase must necessarily be smaller as time goes on.

Then the consumers in the first five years increase in percentage—64·5, 38·1, 30 4, 27·9, 18·5, and in the second five years they are 16·1, 12·8, 11·6, 9·7, 10·6?—Yes.

If that process went on in the next five years, it would show you a very small percentage of increase of consumers?—A smaller percentage, certainly, as a percentage, but not in number of consumers.

There is also great irregularity in the increase of percentage of units sold, is not there?—Yes, the increase in units sold runs thus:—1894, 40, 27½, 30 and 24. That is for the first five years. Then 24, 16, 25, 15, 22½ for the second five years. It partly depends upon the kind of year it is and partly upon the sort of consumers you supply. The last increase was in 1901, and part of that is due to street lighting, which we have taken up.

And as to the number of units sold per lamp and the average number of lamps connected, I see that in the first year 18·6 units were sold for each lamp connected, and in your last year 17·8 only?—Yes, but the first year is rather misleading, as there were not so very many consumers then.

Re-examined by Mr. CRIPPS: Taking your own figures, as shown in the tables, and judging us by your standard, our estimates of increases are very reasonable indeed?—I think so.

As regards the amount you have allowed for depreciation and reserve, one member of this tribunal knows that, in other classes of cases, it is the luxury of the wealthy to put a good deal on depreciation and reserve. And you know that?—It is so, I should say, and also as a matter of book-keeping to some extent.

Mr. JOHN CONACHER was now recalled and cross-examined by Mr. Fletcher Moulton, K.C. (for Marylebone Borough Council), who first obtained from the witness dates and particulars of the orders under which the Metropolitan Company claimed to work throughout its entire area. This showed that the company's powers were granted by Parliament in 1889 and 1890.

Mr. FLETCHER MOULTON: Will you tell us the steps which the company took to perform its obligations in these early years. What part of its undertaking did the company develop first?—The St. Martin's area, from Whitehall Court station. The supply was being given from that station before the Metropolitan Company acquired that portion of the undertaking. The Metropolitan Company was first registered in 1887 as the South Metropolitan Electric Supply Co. (Ltd.), but it had not statutory powers. These were obtained in 1889.

Then the company and the supply of current started at Whitehall Court in 1887 without any statutory powers?—I understand that in the early days supplies were being given without powers at all equivalent to the existing statutory powers under which companies work.

Mr. CRIPPS: The company started earlier. There was a difficulty about getting a confirmation order owing to what is called a technicality. Then an undertaking was given by the President of the Board of Trade that, as regards that area, we should be allowed our own act. All that is stated in the preamble to our act. The company was really constructed in connection with Whitehall Court.

Mr. MOULTON: When did the company commence the mid-London supply?—October, 1889, from Sardinia-street station.

Were the accounts of these separate orders kept separately?—Yes.

And the separate stations?—The expenses of each station have always been kept separate. The production at each station has been kept separate, but the cost of production for each area has not. The accounts show the cost of the current produced at each station.

Are there no accounts showing the cost of distribution?—Since the company began to work the system as a whole the expenses of all the stations have been divided amongst all the areas in the proportion of the revenue derived from each area. But for the distribution from each station no record has been kept.

It seems rather important to examine into this question of the distribution of the product from each station. Have not you got plans showing what district at each time was being supplied by a particular station for distribution purposes?—Certainly, we know, of course, what portion of the Marylebone area and what portion of the mid-London area has been supplied from Rathbone-place. We know, in the same way, with regard to Amberley-road, what portion of Marylebone it has been supplying in addition to its work in Paddington.

Did the whole of the supply of a particular district always come from the same station throughout the day?—No; that is to say, it was not generated at the same station.

At what date were these stations coupled?—The Board of Trade approved that method of working in 1896. A note has just been handed to me that the trunk mains were laid as early as 1892, but I will have that confirmed.

From the date of laying the trunk mains you say a district might receive part of its supply from one station and part from another. Would records be kept of that?—I believe in late years records have been kept.

Before you can tell the expense of generating at any station you must know that, must you not?—Not necessarily. The cost of generating at each station measured per unit, for instance, is the total cost incurred at that station divided by the number of units generated at that station, irrespective of where that energy went to.

Have you uniform prices throughout all your areas?—No.

Before you can make the return from the generation at each station you must know how the product has been used, and in what districts?—Yes, but we only take the return of each area, not of each station.

Your records of these transactions show what?—The cost of each station, the production of each station, the output of each station at each hour of the day, &c. But the log books from which these particulars are made up go to the engineer, and not to me.

Are the accounts of the payments for current kept under the head of districts?—Certainly, and quite independently of the origin of the supply.

When you joined the company were the generating stations all of the present size?—No change has been made in the generating power; that is, the capacity of the generating plant remains as when I went there. The plant, without altering its capacity, has been changed from alternating to continuous current.

Let me take those that do not generate but only distribute. Did those all exist when you came?—No.

Which did not exist?—Tower-street. Norfolk Crescent-mews was in course of construction, but was not at that time in work. Manchester-square, as a sub-station, has been considerably enlarged in the South-street section, and the North-street sub-station has been commenced. Additions have been made to the sub-station at Amberley-road, and further additions are now being made to the sub-station at Marylebone-passage.

Leaving out the distributing plant which deals with current from Willesden, has there within your time been any addition to the other distributing plant?—Yes.

Do your records give the distribution of Willesden current?—Not in any reliable form. The company are anxious to get wattmeters that can des

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with this current, and they are having these manufactured now with a view to their being introduced if they are found satisfactory.

Have you any record of what current is tapped off from Willesden at each station en route?—Yes, we have endeavoured to form a record, but we do not think it very reliable at present. It will be better when we get proper instruments to measure it.

Do you keep records of the distribution of the transformed current?—I think that current is sent to the switchboards with current generated at the stations and distributed in common, but I speak with reserve upon that point. I will find that out.

If you have no records of the amount tapped off, you can have no records of loss by transmission of Willesden current?—We know what the losses ought to be, and these we treat as the actual losses until we are in a position to determine the actual amount of current sent out and the actual amount of current received.

Would a portion of a district be supplied from the same generating station both day and night?—Not necessarily, because a local station might be closed during the night, or during the time of light load during the day, and receive all the current necessary for supplying its own distributing area from Willesden, or from one of the other local stations.

You have said that during some part of the night a distributing station may be shut down?—No, a generating station. The method of distribution is necessarily the same during the night as during the day, but the source of supply for the purposes of distribution may either be at the local station from which the distribution is made or from some other station.

The UMPIRE: The records you have spoken of would show for the whole of your area the several districts into which, for purposes of distribution, it is divided, and the stations served in each district. But the current supplied to, say, the Rathbone-place network, may be generated at Rathbone-place, Willesden, Manchester-square, Amberley-road, or Sardinia-street, but not Whitehall Court?—Yes, and I will see if records of these supply origins exist.

At any rate, houses in that network are supplied varyingly from Rathbone-place or Sardinia-street?—Yes, there is that peculiarity about this particular network.

Does the Tower-street station give no supply there?—Not yet, but this station is to take over all the outside area supplied from Rathbone-place before the transfer of the Marylebone undertaking takes place.

Do you contemplate throwing out of use the Whitehall station?—No, we propose keeping it as a reserve, just as we contemplate using other town stations in that way.

Tower-street is to be purely a distributing station?—Yes.

You said that your prices for current are not uniform. By what official or officials is the question of price determined?—There is a scale of charges generally applicable which I will have put in. The printed scale is 6d. per unit.

Actually you make special contracts in all your areas?—Under some circumstances, and copies of these can be put in.

What other competition have you in the various areas?—The Charing Cross and Strand Co. and the County of London and Brush Co. The Charing Cross Company obtained powers in St. Martin's in 1889, and in the Strand district in 1896; the County of London apparently in 1898.

You have records of the generating plant put in at each station from time to time, the cost of that plant, and its lamented decease when it is no longer in existence?—Yes.

Now, will you please turn to the book of tables which have been put in. Table 1 purports to give a list of machinery and plant at the stations and sub-stations of the company in Marylebone at Dec. 31, 1902, and dates of erection. Have you ever made a similar table for Dec. 31, 1901?—No, that is the only table we have prepared of this kind. It is the plant at Dec. 31, 1901, as it will be supplemented and altered.

What are the dates of the contracts for the Manchester-square new continuous plant?—1900, I believe, but I will give you a copy of the contract. The same applies to the 570 motor-generators in the Manchester-square sub-station, and the nine 50kw. static transformers of the Marylebone-passage sub-station.

At what tension did the alternating generators of Manchester-square produce current?—1,000 volts.

What will these with continuous current machines generate at?—220.

Are the continuous-current generators in Rathbone-place 220?—I believe they are. There is one machine described as suitable for supply at either 100 or 60 periods. The number of periods in all the turbo-generators at Manchester-square is the same, 100.

Is 60 periods the frequency at Willesden?—Yes.

But of no other part of your system?—No, except that we are altering what will be the only remaining alternators we shall have in the town areas to 60 periods, in order that they may be the same as Willesden. Those are in Amberley-road, which will soon be the only alternating-current generating station we shall have in London.

For what frequency are the 100kw. static transformers for Manchester-square sub-station in South-street built?—60 or 100, I believe; but I will inquire.

Some of those were built in November, 1898; you had got no 60 frequency at that date?—No; but Willesden station was expected to be completed in the winter of 1898, and the six transformers which are dated November, 1898, and the two February, 1899, are part of the equipment for Willesden as at first received.

You have not laid, I believe, the distributing mains, have you?—We have laid three-fourths of all the feeders in this area. We have also commenced the distributing mains.

When were those feeders put in?—They were began about 15 months ago—certainly a year ago.

Taking the Rathbone-place sub-station, what do those 50 100kw. transformers transform to?—From 10,000 to 1,000. They are identical with the Manchester-square transformers.

At the Marylebone-passage sub-station there were static transformers for 100 periods, intended to work from alternating current supplied by Rathbone-place?—Yes.

From machines which did not exist there on Dec. 31, 1901?—No. These static transformers at Marylebone-passage are provided for the purpose of reducing in bulk alternating high-tension to low-tension in order to avoid the losses which previously took place in the house transformers in the district supplied from Marylebone-passage.

Now take Table 2. This says "length and description of mains in Marylebone, other than the extra high-tension mains for Willesden current, at Dec. 31, 1901, together with an estimate of additions to be made in 1902." Are the additions in 1902 mixed with the other in the figures?—Yes.

For instance, if I take the first item, the total number of miles is 117 miles 690yds., and all but 5 miles were there on Dec. 31, 1901, and you expect to add 5 miles in 1902?—That is so.

Now let me take the high-tension trunk mains. Those are for utilising your alternating generators at Manchester-square?—Yes, and they were originally for utilising also the alternating generators at Rathbone-place before they were changed.

Those mains will be useless excepting to send to Marylebone-passage when you have made your Manchester-square continuous?—No, they could be used even then for passing Amberley-road alternating current through to Sardinia-street.

The trunk main between Rathbone-place and Sardinia-street is a trunk main that will be useless when severance takes place?—Not necessarily. The Borough Council may supply the London Company with current at Grosvenor Gallery just as the Metropolitan Company has done.

Is the Grosvenor Gallery outside the Metropolitan?—Yes.

Now, Table 3 relates to your charge for current, but refers only to the Marylebone area. Have you ever prepared a similar table for the other areas?—No, not completely.

But the materials exist, do they not, for making a similar table with regard to the other portions of your area?—Yes, we could prepare one.

Mr. CRIPPS: But we should not prepare a similar table without some special reason. It means a good deal of work?—Yes.

Mr. MOULTON: But it is somewhat important, is it not, to consider the price at which you are selling in other portions of your area?—I do not see the bearing upon the value in Marylebone of the revenue in the other portions of the undertaking.

There was an agreement made, was there not, between your company and the parish of St. Marylebone, dated Oct. 1889?—Yes. (Copies of agreement handed in.)

Clause 8 says:—"The price to be charged for electricity supplied to ordinary consumers and the Vestry shall be regulated in accordance with the West London order. But the scale of prices charged in the parish shall not exceed the scale for the time being in force in any other parish or district in which the undertakers are authorised to supply energy under any provisional order or act passed in the present session"?—I am aware of that provision.

Now, the question of the price charged in your Paddington district under the pressure of competition is important in order to see what prices you were entitled to charge in Marylebone?—The scale of charges is the same in other areas as in Marylebone.

But why "the scale of charges." Supposing a person says "I will take 10,000 lights," and the reply is, "Very well, if you take 10,000 lights we will charge you so much per unit." You cannot refuse that to another person who takes 10,000 lights?—No, but our scale of charges is different from that. We have a scale for private lighting at a certain price, and a scale for business lighting at a certain price, and special rates varying according to circumstances.

Those special rates may not occur so often that you would print them in your ordinary scale of charges, but they are part of your scale of charges all the same?—I do not think so. The scale of charges is the scale generally applicable, but within the limits of that scale and under the powers which we possess to make special agreements.

Mr. CRIPPS: This is rather a legal point, and I may call to your mind the fact that the question was raised, and when it was raised the borough took a different view from what we did. It came under the terms of settlement at the time.

Mr. MOULTON: We do not take that view; so we had better get the information out. Now, take first the printed scale you referred to a little time ago. That is, I suppose, for the whole of your area. There you say: "The charge for electric energy to be 6d. per unit. Where the energy is used for trade purposes, a reduction is made to 5d. per unit when the average quarterly consumption exceeds five units per 8 c.p. lamp wired, or its equivalent in other candle-powers. In every case where the total quarterly consumption does not exceed 20 units, the consumer shall pay the minimum charge of 13s. 4d. for such quarter"?—Yes. That option has been abolished.

Yes, I know. How many special contracts have you got?—A good many, but I could not say without inquiry.

You will, of course, have no objection to our accountants seeing those and taking extracts?—I must leave that in the hands of counsel.

Mr. CRIPPS: I do not think there is any objection at the moment, but I must consider that. You are dealing with names of parties outside this room.

Mr. MOULTON: But there is a question as to whether or not the prices you have been taking, for instance, were prices which were the same as in Holborn, and what effect will that have on the future price.

Mr. CRIPPS: But there is a preliminary question, whether the agreement made between us on May 8, 1901, was specifically drawn so as to

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cover this point. That was the matter in issue between us, and you took one view and we took another.

The UMPIRE: We ought to have the agreement. (Agreement handed in.)

Mr. CRIPPS: That document was issued on March 12, 1901, by the Borough Council, and then the agreement which was to stop all litigation, as we say, between the parties, and to let these questions rest was dated May 8, 1901, of which we have handed in a copy. We are asked to give information which might affect customers and third parties. Your own agreement stops us from going into the point, and we could not do it.

Mr. MOULTON: We contend that that has no effect whatever upon you with regard to this point, and that all the previous agreement remains in force.

Mr. CRIPPS: You are suggesting as to whether the same scale of charges—to use that term—is applied in Marylebone as outside, and we have already said yes. But you raised a question about it, and issued a writ on March 12, 1901, and then when the terms of the bill were settled, and you were to become purchasers, the arrangement was made of May 8, 1901, and that, in our view, settled the question once for all. It says that, in consideration of the company withdrawing their opposition to the present bill, and on the completion of the agreement and confirmation by Parliament, all questions are to be treated as settled.

Mr. MOULTON: In our view that did not touch the obligations, but only settled the question of the relationships after the transfer with relation to past breaches.

The UMPIRE: If there is any difficulty we shall want to know what the materiality of the information is, and deal with it accordingly.

Mr. MOULTON (to Witness): That scale was introduced at what date?—As it relates to private house lighting on Jan. 1, 1898, and as regards business lighting, on March 25, 1896.

What was the price for private lighting prior to that date?—7½d. That was the original charge made by the company, except that in the early years they had several contracts under which they supplied current at so much per 8 c.p. lamp. And in 1893 there was an arrangement for a reduction to 5½d., both private and trade, for all units in excess of a consumption of 8 units per 8 c.p. lamp per quarter. There was, further, a lower charge introduced on Jan. 1, 1899, for municipal lighting other than street lighting, that charge being 4d.

When did you first make a special charge for power?—I cannot say, but I will ascertain, and will also ascertain to what extent these charges applied to other parts of our district, and whether there were charges in other parts different in date or amount from these.

Now comes rental of meters, house transformers and switches. Tell us how you charge for house transformers and switches?—It is according to size, very much on the same lines as for meters. But the charges for transformers and switches was a thing of the past when I joined the company.

(To be continued.)

Charges for Electric Current.

At Manchester on Friday last the stipendiary magistrate, Mr. F. J. Headlam, heard an action brought against Messrs. Gilchrist & Co., electrical engineers, by the Manchester Corporation for the payment of £8. 11s. 8d., alleged to be due for electric current for the quarter to June 30 last.

Mr. W. WOOD, collector in the electricity department of the Corporation, said he had demanded payment of the amount. He was not aware that Messrs. Gilchrist had made repeated complaints, or that the Corporation had refused to test their meter. He did not know Mr. Gilchrist had offered to pay for the testing of his meter. He could not explain why in the June quarter the consumption came to £8. 11s. 8d. while in the March quarter, when more current would ordinarily be consumed, it was only £4. 19s. 2d.

Mr. W. A. JACKSON, installation inspector, said he inspected Messrs. Gilchrist's installation early this year, which was connected with the Corporation mains in January. They had the equivalent of 29 lamps. He inspected it again in June, and found they had increased to an equivalent of 275 lamps. This would mean a large increase in consumption. It was a Corporation regulation that notice must be given of additional lights being put on, but no notice was given by Messrs. Gilchrist, and the increase was first discovered by an inspector on going his rounds. The department were basing their claim on the fixed charge and on the increase in the number of lamps for the June quarter. It was not necessary for the department to know they were used. When Mr. Gilchrist applied for current he arranged to pay so much for energy. If he were to put up a thousand lamps and did not use them he would have to pay.

Mr. SOMERS (for defendants): Therefore, supposing Mr. Gilchrist on oath denies that he used a single lamp more than in the winter quarter, would he still have to pay because he had the lamps?

WITNESS: We have a recording instrument, and we know the exact number of lamps that are consuming the current. We charge for the current actually used. In case of a disputed account the consumer, by paying a fee of half a guinea, could have his meter tested, and, in case of an overcharge, that amount was refunded. He was not aware that Mr. Gilchrist had tendered the fee.

At this stage the hearing was adjourned till Oct. 3.

Universal Microphone Co. (Ltd) v. Nye and Another.

On Monday Mr. Justice Jelf ordered that this matter should stand over until the second motion day next sittings.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Proceedings of the Royal Society." No. 466, Vol. LXX. (London: Harrison & Sons.) 2s.

"Report of the International Engineering Congress (Glasgow, 1901). Proceedings and Abstracts of the Papers read." Edited by Prof. J. D. Cormack. (Glasgow: William Asher.)

"Electro-Plating and Electro-Refining." By Watt and Philip. (London: Crosby, Lockwood and Son.) 12s. 6d. net.

"The Elements of Electrical Engineering." By T. Sewell. (London: Crosby Lockwood & Son.) 7s. 6d.

"Designing Ironwork." By Prof. Henry Adams. Part 3, second series. (London: Published by the Author). 2s.

"Distanze Esplosive Nell'Aria, Negli Olii ed Altri Liquidi Isolanti." Lecture by E. Jona. (Torino: N. Bertolero.)

"L'Electricité à l'Exposition de 1901." Edited by E. Hospitalier and J. A. Montpellier. No. 13. (Paris: Vve. Ch. Dunod.)

"Das Selen, und seine Bedeutung für die Elektrotechnik." By Ernst Ruhmer. (Berlin: "Der Mechaniker.") 2.40m.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Technical Instruction committee of Cork Corporation require a teacher of chemistry and physics. Salary £120. Some particulars will be found in an advertisement. Applications to the head master, Mr. E. A. O'Keefe, B.E., M.I E E., Emmet-place, Cork, by Oct. 4.

The committee of Croydon County Polytechnic invite applications for the post of head of the department of electrical engineering. Applications to secretary (Mr. S. W. Bickell) by Oct. 8. See advertisement.

A demonstrator and assistant lecturer is required in the electrical engineering department of Heriot Watt College, Edinburgh. Applications to principal before Oct. 4. See advertisement.

Wimbledon District Council have a vacancy for an engineer-in-charge at their electric lighting station. Applications to chief engineer (Mr. H. Tomlinson Lee) by Oct. 2. See advertisement.

Coventry Corporation require an improver to act as switchboard attendant. Applications to the manager (Mr. Joseph A. Jeckell), Corporation electricity works, Coventry. See advertisement.

A switchboard attendant, with experience in three-wire continuous current system and care of accumulators, is required at the Kendal electricity works. Applications to the works by Oct. 4. See advertisement.

Canterbury Electric Lighting committee require a shift engineer. Applications to chief engineer (Mr. C. A. Blascheck) by Oct. 6. See advertisement.

Huddersfield School Board require a science demonstrator. Applications by Oct. 2.

Mr. George Balfour (of Lowdon. Bros. & Co., Dundee), has accepted an appointment with Messrs. J. G. White & Co. (Ltd.) as commercial engineer.

Mr. H. G. McHaffie, of Rugby, has been appointed resident electrical engineer to the Hoylake and West Kirby District Council.

Croydon Corporation have appointed Mr. C. Barkham to the position of mains superintendent.

Out of the applicants for the position of chief assistant engineer at Doncaster, Messrs. A. J. Bousfield, of Gateshead, and Norman E. G. Little, of Bolton, were selected to appear before the chairman of the Electricity committee and the borough electrical engineer (Mr. W. Wyld), who selected Mr. Little for the position.

Mr. Frank Broadbent, M.I.E.E, for 11 years chief superintendent engineer to Messrs. J. H. Holmes & Co., has been appointed demonstrator of electrical wiring, &c., at Walthamstow Technical Institute.

Mr. R. Ferguson, B.Sc., has been appointed demonstrator in engineering, and Mr. A. Stephenson, B.A., has been appointed assistant lecturer in mathematics at Sunderland Technical College.

EDUCATIONAL NOTICES.

City and Guilds Technical College, Finsbury.—The new session for evening classes begins Monday, Oct. 6. Prospectuses from the College, Leonard-street, Finsbury, or the head office of the City and Guilds of London Institute, Gresham-street, London, E.C. See advertisement.

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Glasgow University.—The 1902-3 session commences on Oct. 16. The new James Watt engineering laboratories are now open, and complete courses of instruction are provided in civil, electrical, mechanical and mining engineering. Further particulars are given in an advertisement.

Merchant Venturers' Technical College, Bristol.—Courses in civil, mechanical, electrical and sanitary engineering are given at this college; also for matriculation and intermediate and final B.Sc. of University of London. See advertisement.

Royal Technical Institute, Salford.—Special courses of lectures in engineering estimates and specifications, dynamo and electrical machinery design, electrical distribution, mains and central stations, iron and steel structures, &c., will commence in October. See advertisement.

Walthamstow Technical Institute.—The 1902-3 session commenced on 15th inst. Instruction is given in mathematics, physics, electric wiring, chemistry, machine construction, applied mechanics, &c. Prospectuses from the secretary and principal, Mr. Jos. S. Bridges, B.Sc., F.C.S., Hoe-street, Walthamstow.

From our advertisement columns it will be seen that Prof. Andrew Jamieson, 16, Rosslyn-terrace, Kelvinside, Glasgow, has arranged for special winter courses in electrical and mechanical engineering science by correspondence.

American Electricity Statistics.—We referred in our last issue to a group of statistics which have been prepared by Mr. T. Commerford Martin relating to the volume of the trade of the United States in relation to the manufacture and supply of all classes of electrical plant, apparatus, accessories and materials for 1900. We are able to supplement these particulars. It would appear that in the United States there were, in 1900, 580 establishments engaged in the manufacture of this class of goods, of which 167 were individually owned, 102 were firms of limited partnership and 311 incorporated companies. The total capital employed was $83,130,943. The total salaries paid by these firms and corporations to officials and employés (other than artisans and labourers) for 1900 was $12,489,113, the total number of officials receiving these salaries being 14,445, including 687 females. The total number of artisans, labourers, &c. (classified as wage-earners), including piece-workers, was 50,389, the average employed in the industry during the year at any one time being 40,890, the total wages paid was $20,190,344, the total value of the products of the 580 establishments being $91,348,889. The total horse-power used in 490 establishments reporting was 63,856, of which steam was represented by 34,018 H.P., gas 1,695 H.P., water 835 H.P., electric motors 20,182 H.P., other power 60 H.P. In addition to the above figures there was electric power rented to the extent of 4,074 H.P., other powers 2,992 H.P. Of the total of 580 establishments six employed over 1,000 hands, six over 500 and under 1,000, 21 over 250 and under 500, 49 over 100 and under 250, 60 over 50 and under 100. These statistics are the first compiled at any United States census on the subject of electrical manufactures. The values of these products at the respective censuses of 1880, 1890 and 1900 were $2,655,036, $19,114,714 and as before stated $91,348,889. The particulars accompanying the statistics are interspersed with 31 tables giving a large variety of interesting information, the totals in each case representing the aggregate of the various States forming the Union.

Anglo-French Telephone Service.—The convention between H.M. Government and the French Republic regulating the telephone service between Great Britain and France, which was signed at Paris on July 29, has now been issued. The convention provides for, among other matters, telegraph circuits being used by mutual agreement for the exchange of telephonic communications. The unit of time adopted for the duration of conversations and for the collection of charges is a three-minute period. State communications are given priority in the same manner as are telegrams under the International Telegraph Convention, and the duration of time for State communications is unlimited. The telephone area is divided into two zones in each country, the rates being 5fr. (4s.) in the first zone, and 7fr. 50c. (6s.) in the second. These rates are reduced by one-half for conversations exchanged during the night, by subscription, and the minimum duration of each conversation by subscription is six minutes. These subscription conversations have certain circuits allocated to their use, and can only be conducted during certain hours. Provision is made for either of the two administrations establishing telephonic relations with "another country" through the telephonic system of either administration. In the terms of the International Telegraph Convention, the contracting parties to this convention reserve the right to suspend, totally or partially, the telephone service, without liability for indemnity. The present convention cancels all existing agreements between the parties, and is to remain in force for one year after its denunciation by either administration. As in the case of international telegraphs, "service regulations" are to be prepared for the conduct of the Anglo-French telephone service. The tariff provided under the new convention, it will be seen, materially reduces the previous charge per conversation over the Anglo-French telephone lines.

Ashford.—The Council further discussed electric lighting last week. The chairman submitted the outlines of a scheme for leasing the proposed electricity works to a company which would pay interest and sinking fund on the capital expended. The matter was adjourned for further consideration.

Aston.—The foundation stone of the power station was laid by the chairman of the Tramways committee (Councillor J. J. Gittings) on Tuesday.

Ashton-under-Lyne.—An unopposed inquiry was held here last week into the application of the Council to borrow £30,000 for electric lighting extensions. The town clerk (Mr. Bromley) said that the Electricity committee contemplated a considerable extension of the station buildings and the installation of new machinery, and laying additional mains, to meet the increasing demand for current. £19,382 was to be spent in additions to the buildings and plant, including two sets of generating plant and a surface condenser. Evidence was also given by the borough electrical engineer (Mr. Appelbee). £34,200 has already been spent on the works.

Automobile Volunteer Corps.—The members of this new corps of volunteers, which is being formed with the approval of the military authorities, have taken head-quarters premises in King's-road, Chelsea, London, where garage will be provided for 100 cars. The quarters will be well equipped for repairing motor vehicles belonging to the corps, and are lighted throughout by electricity.

Barnes.—The Council have received sanction to a loan of £1,900 for electric lighting.

Barnstaple.—The municipal buildings, science and art schools, music hall, market and Guildhall are being wired.

Bermondsey (London).—The Borough Council have decided to apply for a provisional order for the districts outside their present area of supply (the parishes of St. Olave and St. Thomas and St. John, Horselydown.)

Birmingham.—The town's meeting to consider the proposed General Powers Bill, which will include provisions as to the municipalisation of the tramways, will be held after the November municipal elections.

Bradford.—The arbitration proceedings to determine the conditions and terms for running tramways within the Shipley district by the Bradford Corporation will commence on Monday.

Brighton.—The Corporation have adopted the recommendation of the Tramway committee to obtain powers to construct three additional tramway routes at a total cost of £37,156.

Bristol.—The Watch committee have received a further report from the chief constable on the adoption of fire alarms, and it has been decided to fix 25 alarms in different parts of the city, and Mr. Allbutt has been requested to invite tenders from the National Telephone Co. and Mr. A. C. Brown, 7, Queen's-square, London, E.C. (for Saunders-Brown instruments).

Brussels-Antwerp Electric Railway.—The scheme for the construction of an electric railway between Brussels and Antwerp has been revived. The project has been examined by the Superior Council of State Railways, and the decision is said to be favourable to the construction of the line. The railway would be built on an 85 years' concession, the Government reserving the right to take over the undertaking at any time on terms. After allowing for working expenses, amortisation charges and reserves, 40 per cent. of the remaining receipts would be paid over to the State in return for a guaranteed fixed minimum interest of 2½ per cent. per annum on the proposed capital of £2,000,000. The distance between the two cities is about 26 miles, and the journey by the proposed line would occupy 20 minutes.

Burton-on-Trent.—Acting on a report from their consulting engineers (Messrs. Kincaid, Waller and Manville), the Council have decided not to proceed further with the question of the adoption of the Lorain surface contact system of traction, and the tramways are, we understand, to be equipped on the overhead trolley system.

Canterbury.—The sanatorium is to be wired for the electric light under the supervision of the city electrical engineer, Mr. C. A. Blascheck.

Cardiff.—At a recent meeting of the Finance committee the estimates of the electric lighting and tramways department for the next six months were considered:—

The Electric Lighting committee's accounts showed a net profit of £1,121. 15s. 2d., of which it was proposed to allocate £500 as reserve. The MAYOR questioned the propriety of this course. He did not think it was legal, and doubted whether it was advisable. The borough electrical engineer and tramways manager (Mr. ELLIS) said that next year there would be some heavy repairs at the Canton power station, and the committee thought it advisable to reserve money to meet part of the cost.

The Tramways committee's accounts showed that the estimated expenditure for the year would be £78,624. 2s. 7d., of which £2,889. 18s. 11d. would go to depreciation. The receipts would be £69,500, and there would be other charges. £9,299. 2s. 7d. must come out of the rates. Mr. ELLIS said the receipts for the past five months were already above the estimate, and rather more than half the amount put down for the whole year. A

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large portion of the loss was caused in the early months of the year, when the service was disorganised owing to reconstruction. The MAYOR proposed that the depreciation item on tramways account and the reserve item on the electric lighting account should be passed upon the understanding that it should not be taken as a precedent, and that the whole question of depreciation and reserve funds should be specially considered by the Finance committee. This was agreed to.

Clydebank.—The Council have come to terms with Glasgow Corporation in regard to the construction and working of electric tramways under the Clydebank tramway order.

Companies to be struck off Register.—The following are to be removed from the register of joint stock companies in three months unless cause is shown to the contrary :—

Adams Electrical Generator Co.	Smoke Preventer and Fuel Economiser.
Bowen Mfg. Co.	Volt Electrical Co.
British Electric Railways.	West of England Electric Installation Co.
General Acetylene Syndicate.	World Gas and Electric Syndicate.
Medical Battery Co.	
Midland and Hertford Electric Lighting and Power Co.	

Coventry.—The Corporation electricity department is loaning out electric motors on easy terms. Current is supplied at 1¾d. per unit. The charge for hired motors is as follows :—½ H.P., £1. 13s. 6d. per annum ; 1 H.P., £2. 5s. ; 2 H.P., £2. 12s. 6d. ; 3 H.P., £3. 5s. ; 4 H.P., £3. 17s. 6d. ; 6 H.P., £4. 7s. 6d. ; 9 H.P., £5. 17s. 6d. ; 10 H.P., £6. 15s. ; 12 H.P., £7. 10s. ; 16 H.P., £9 ; 20 H.P., £10. 10s. ; 25 H.P., £11. 17s. 6d. ; 35 H.P., £14 ; 50 H.P., £25. Intermediate sizes pro rata. This rate does not include wiring or fixing motors, which has to be done by the hirer.

Dumfries.—A proposal to establish electricity works and to construct an electric tramway to Glencaple was discussed by the Council on Tuesday.

Edinburgh.—The year's financial statement was submitted to the Council on Tuesday. On the electric lighting department there was a surplus of £7,605 after paying off last year's deficit.

Edmonton.—The Council on Tuesday resolved to ask Mr. Robert Hammond and Mr. W. C. C. Hawtayne to submit reports and estimates of the cost of alternative schemes for carrying out the Council's provisional order, offering each expert a fee of 50 guineas.

Electric Traction in Russia.—A syndicate has submitted to the Department for Means and Communications a scheme for the construction of a normal gauge electric railway in the district of the Lake of Ladoga at an estimated cost of about 3,000,000 roubles.

Faversham.—An inquiry has been held into the application of the Council to borrow £24,190 for electricity works. Since the date of the inquiry was fixed the Kent Electrical Power Co. had submitted terms for the supply of electricity in bulk. There had been no opportunity for considering the company's proposal, but it was stated that if the council found that the company could supply current at a cheaper rate than the Council could generate it, the latter would doubtless not proceed with their scheme. There was some opposition by ratepayers, who alleged that those ratepayers in favour were to a large extent those occupying houses of £10 rateable value, who did not directly pay rates and who would not be customers. The consulting engineer (Mr. H. Talbot) estimated that the undertaking would pay when the equivalent of 7,500 8 c.p. lamps were connected, and he saw no reason why this number should not be connected within two to three years.

Finland.—At Tammerfors a number of extensive waterfalls exist, and power is taken from these to drive the machinery in a large number of mills in the district known as "Finlayson" mills, named after a Scotsman who settled in the country some 80 years ago. About 4,000 workpeople are employed in these mills, which are lighted entirely by electricity, employing about 5,000 lamps, current being obtained from the Finish Electric Light Co., whose principal offices are at Helsinfors. The same company supplies the municipal buildings at Tammerfors, the small town of St. Michael, and the well-known Putilov works with current for electric lighting and power.

French Submarine Cable Enterprise.—We have previously fully reported the steps taken by the French Government to organise a system of all-French cables connecting the French oversea possessions with Paris. According to a correspondent of the *Financial News*, the Ministries of Commerce, Posts and Telegraphs and Finance respectively have now decided to invite public tenders for supplying and laying the following submarine cables :—(1) Brest to Dakar ; (2) Tamatave to Réunion and Réunion to St. Morice ; (3) Saigon to Pontianak, at Borneo. Tenders are to be sent in by Oct. 21, 1902. The Brest–Dakar cable is to be working in 11 months, shorter periods being fixed for the two other lines.

Garston.—The charge for electric current for private lighting has been reduced by the Liverpool Corporation from 5d. to 3¾d. per unit.

Gillingham.—Sanction to a loan of £52,000 has been obtained by the Council, and of this £26,659 is to be devoted to the purchase of so much of the undertaking of the Chatham, Rochester and District Electric Lighting Co. as is within the area of the Council. The balance will be expended in erecting buildings, providing additional generating plant, extensions of mains, &c.

Glasgow.—At the Corporation meeting last week, the Electricity sub-committee, appointed to consider the expediency of providing one or more large gas engines as an auxiliary or emergency stand-by, reported that the chief engineer (Mr. W. A. Chamen) made a verbal report on the information he had obtained from various gas engine makers regarding the adoption of gas engines for dynamo driving. Mr. Chamen had also reported that the supplementary supply from the tramways department would not provide for the cases of emergency referred to, and that it would take between two and three years to make and deliver engines of the description contemplated. The committee recommended that Mr. Chamen be authorised to visit (at the same time as he accompanied the deputation which had been appointed with reference to street lighting by means of incandescent electric light and gas) certain cities in England, Belgium and Germany to obtain further information on the subject, and also to visit and inspect one or more of the largest installations where gas engines had been adopted as motive power for generating current, and to report thereon. The report was adopted.

Glossop.—The Council propose to wire the public buildings, taking current from the local electric supply company.

Hackney (London).—The offices of the electricity supply and refuse destructor department were opened on Monday. The entire buildings have cost £44,741 (including £6,000 for offices). The total cost of the electric lighting and dust destructor scheme is £384,867. Already 118 miles of mains have been laid, and there are 670 consumers connected.

Halifax.—The Council have instructed Sir Douglas Fox to report as to the desirability of constructing a "lift" tramway at Salterhebble, or, alternatively, a circuitous route line, so as to connect the tramway system with the intended extension to Greetland.

Japan.—*Engineering* has published some interesting details relating to telegraphs and telephones in Japan. From these the Japanese appear to have taken full advantage of Western methods. The official report for the year 1900–1 shows a total length of telegraph lines 6,038 ri (a ri is nearly equal to 2½ miles), and the total number of messages for the year was 16,737,150, or 35·64 per 100 inhabitants. In 1895–6 the total length of lines was 3,881 ri, and the messages 9,097,102, or 21·54 per 100 inhabitants. In addition to land telegraphs, there is a considerable length of submarine cables not included in these figures. In 1900–1 there were 273,924 "international" telegraph messages received and 294,085 dispatched. In 1895–6 the numbers were 148,071 and 165,053. The use of the telephone has increased at an even greater rate. In 1900–1 the number of telephone employés was 1,529, of subscribers 18,668, and in 1896–7 311 and 3,232 respectively. These advances have been the outcome of a scheme approved some years ago, and a further project for bringing both telegraphs and telephones into more general use is now under consideration by the Government. It is proposed that this second period of construction of telephones and telegraphs shall cover five years, and that the works shall be carried out at a cost of 5,000,000 yen for telephones and 3,500,000 yen for telegraphs, excluding the Governmental ordinary expenditures under these items. The programme comprises the establishment of new telephone exchanges in Tokaido, Kokura, Hakata, Kagoshima, Utsunomiya, Hirosaki and Okayama, and of telephone call offices in about 30 places. Other places are also to be connected up to the main telephone service of the country. New telegraph connections include a submarine cable between Tamsui (Formosa) and Nagasaki, and between other important ports in Japan proper.

Leeds.—The Board of Trade have called upon the Corporation for a reply to a petition of Mr. Marriner against the overcrowding of tramcars. The tenour of the Tramway committee's answer is that the concensus of opinion in Leeds is in favour of passengers being allowed on cars over and above the seating capacity of the vehicle, and that the committee's policy is in accordance with this view.

Leith.—The annual accounts were presented to the Council last week. The capital expenditure on electric lighting was £20,839, bringing the total to £76,247, with a balance of borrowed money on hand of £9,752.

Leyton.—The Council propose notifying the Lea Bridge, Leyton and Walthamstow Tramways Co. of their intention to acquire so much of the company's lines as are within the Leyton district.

Light Railways.—The Walthamstow and District Light Railway order has been submitted to the Board of Trade for confirmation. Objections by Oct. 10.

Maidenhead Town Council propose to apply for an order for the construction of a light railway from the Great Western station to various points in the borough, and Messrs. Burstall and Monkhouse have been appointed consulting engineers for the scheme.

Camberwell (London) Borough Council have referred back a report recommending the Council to support the Crystal Palace light railway scheme.

Liverpool.—The Tramways committee have made an arrangement with the Cheshire Lines Committee whereby a direct service between St. Helens and Southport will be established by the South Lancashire Electric Tramway Co.

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A special committee has been appointed by the Corporation to consider and report upon the contracting business of the electric supply department.

Lodz (Russia).—H.M. Consul at Warsaw has recently paid a visit to Lodz, and describes the city as one teeming with busy commercial life. With a population of nearly 500,000, this is the fifth largest city of the Russian empire, but appears to be entirely outside the pale of British commercial enterprise. A well conducted and admirably managed electric tramway service provides an easy means of locomotion, the telephone is installed all over the city, and railway and tramway development in the district is everywhere apparent. The system of credit adopted in dealing with citizens of Lodz appears to be entirely on German lines, and the language of the place is German almost exclusively. There seems, however, to be a specially good opportunity for English merchants and manufacturers to find a market for their goods in this part of Russia.

Macclesfield.—The Electricity committee have been authorised to visit various towns in order to obtain information on electric lighting and traction and refuse destruction.

Maidstone.—Extensions of the electric light mains were authorised by the Council last week.

Mechanical Lorries for Military Purposes.—Some time back the military authorities advertised for tenders for the supply of self-propelled lorries for military purposes. Trials were made of these vehicles in December last at Aldershot, and a report was recently published on the subject:—

The trials consisted of (1) an inspection of the competing vehicles; (2) a preliminary march of 60 miles with full loads, 30 miles being covered on each of the first two days; (3) one day's rest for overhaul and inspection; (4) a march of 197 miles, with full loads carried out on six consecutive days on roads specially selected for hills, including twice crossing the Hog's Back, where the steepest gradient was 1 in 7·2, the ascent to Hindhead, and others. The state of the roads during this march varied from very hard (frost) to soft, and in some places they were very muddy and heavy. (5) Rough country trials, with full loads over a selected piece of ground in the Long Valley, where streams with steep approaches and a stretch of boggy ground had to be crossed; and (6) opening up and examination of engines and boilers at conclusion of the trials. There were five competitors for the prizes of £500, £250 and £100, and the first prize was awarded to the Thornycroft Steam Wagon Co., the second to E. Foden, Sons & Co., and the third to the Straker Steam Vehicle Co. The report states that the trials have shown that steam lorries are good and serviceable machines, and likely to be of great advantage to the transport service in countries where fuel and water in sufficient quantity is available. The committee at the same time call attention to the great possibilities for military purposes of the internal combustion lorry burning heavy oil, as shown by the lorry built by Messrs. George F. Milnes & Co. The committee strongly advise that steps be continued to develop such lorries. Compared with horse-drawn vehicles, the trials prove that self-propelled lorries can transport 5 tons of stores at about 6 miles an hour over very considerable distances on average English hilly roads under winter conditions. The committee declare it to have been demonstrated that mechanical transport has many advantages, and is worth a much more extended trial. Regarding the type of lorry, the disadvantage of the trailer type of vehicle in preventing the lorry from moving freely backwards when required was clearly demonstrated, and the committee considers that for handy and rapid work of distribution a lorry without a trailer is preferable, while for the heavier work of moving stores in large quantities to depôts a powerful tractor, drawing a train of wagons, will be found most suitable. The committee, therefore, advises that it be empowered to take steps to obtain for trial a lorry or lorries on the following lines:—To carry 3 tons, driven by an internal combustion engine burning heavy oil only; of as light weight as is consistent with due adhesion; wheels large and broad, and fitted with a means for rapidly applying numerous "spuds" for use on boggy ground; speed up to 8 miles an hour; large platform area. The report concludes with a reference to the demonstration afforded by these trials of the entire harmlessness to roads of vehicles considerably exceeding in weight and road-speed the limits allowed by present regulations. It has been proved that the existing regulations are unnecessarily restrictive, while they stand in the way of the development of a most important method of transport and branch of industry. The committee consisted of Lieut.-Cols. F. R. Elmslie, R.A., H. C. Holden, R.A., R. E. Crompton, E.E.R.E., Col. C. H. Scott, and Capts. C. H. H. Nugent, R.E., and F. Lindsay Lloyd, R.E. [The complete report of the committee, illustrated, can be supplied, price 9d., post free.]

Menzies (Western Australia).—The ratepayers have passed a resolution calling upon the municipal council to establish electricity works, and to raise the necessary funds for carrying out the scheme.

Municipal Telephony.—Swansea Council have accepted a tender for the erection of municipal telephone exchange buildings, and application has been made for sanction to a loan of £16,000 for providing a municipal service. In the discussion on the proposal to apply for a loan, Mr. Solomon said there had already been received promises from 529 subscribers. They had the Postmaster-General's licence, and there never had been a case where, with such a licence, the Local Government Board had refused their sanction to a loan.

Cambridge Corporation have instructed Mr. A. R. Bennett to furnish a report, with estimates of cost, on the establishment of a municipal telephone service in their district.

Nagasaki (Japan).—The great works and yards of the Mitsu Bishi Dockyard and Engine Works, which are the most extensive and completely equipped works of the kind in the Far East, are gradually superseding the steam plant by the introduction of electric driving. The proprietor of this establishment is a man of great enterprise, and he is introducing into the works every modern improvement calculated to extend their sphere of operations in connection with shipbuilding, ship repairing, marine and hydraulic engineering, &c. During 1901 a large number of cranes and other machines have been installed, all driven by electric power. A large quantity of this machinery and other plant is of British manufacture. The works employed, at Dec. 31, 1901, 5,175 workmen.

Newton Abbott.—Recently the Urban Electric Supply Co. offered to undertake the street lighting at the price at present paid for gas (£978 per annum). This has induced the gas company to offer a considerable reduction in the charge for public lighting (from 3s. 6d. to 2s. 10d. per 1,000) and to provide and maintain 155 incandescent gas burners at 8s. per year each, and 123 ordinary burners at 1s. 3d. each. The company also offers to do work hitherto done by the Council. The revised estimate for gas is £693. 17s. a year, and the company guarantees light to the extent of 51,000,000 c.p. per annum, compared with 30,000,000 previously.

Pangbourne.—The Pangbourne and Whitchurch Electric Lighting Co. propose to apply for a provisional electric lighting order.

Parcels Post to U.S.—In connection with the recent establishment of a parcels post service between this country and the United States of America, it is important that senders should make themselves fully acquainted with the regulations, as additional instructions have now been issued concerning customs declarations, clearance and sample office fees, &c.

Personal.—Mr. O. W. Brain, electrical engineer of the New South Wales Railway department, has left Sydney for London on the "Australia," on a trip to the motherland on departmental business.

Rochester.—Mr. E. Rotter has been appointed consulting engineer to the Corporation electric tramways.

Radstock.—The Somerset and District Electric Syndicate has intimated its intention of applying for a provisional electric lighting order.

Repairing Telegraph, Telephone and Trolley Line Poles.—The *Cement and Engineering News* (U.S.A.) for August states that an entirely new industry has been established at Battle Creek, Michigan, in the manufacture of a durable cement footing for telegraph, telephone and trolley line poles, whereby old poles, which have hitherto been regarded as useless, being rotten at the butt and consequently too short if cut off and re-set, can now be rehabilitated and made more lasting than entirely new poles without the cement butt. The rotted poles are cut off at the decayed point and reseated on a permanent cement footing, which restores the pole to its original height. It is said that a line of poles in actual service can be re-butted without disturbing the overhead lines. This is claimed to effect a saving of from 35 to 55 per cent., and the process enables new poles to be purchased 5ft. shorter than those ordinarily specified for, the cement butt being added to give the required length. Cement butts have been in use for two years, and are said to show no deterioration.

Russia.—The electro-technical industry in this country has, until recently, made but slow progress, one of the principal causes being the absence of educational establishments where instruction in electro-technical subjects was available. Of late, however, there has been a considerable development in this direction, and special schools have been established by both the Government and by private companies carrying on the electrical industry in Russia. It will be in the memory of our readers that much of the early practical work in electricity emanated from Russian sources, especially in connection with arc lamp developments. Public electric lighting in Russia has made giant strides in recent years, and the adoption of electric traction in the chief cities of the Russian Empire is becoming general. The huge industrial and factory establishments are nearly all lighted electrically, and the application of electric driving in these works is a notable feature of present-day enterprise. The application of electrical working to mines in Southern Russia is developing in a marked degree, and industrial electro-chemistry is now a firmly-established industry. The invention, design and manufacture of plant and apparatus within the Russian Empire has not, however, at all kept pace with this advance, and Russia is dependent, in the first place, upon Germany, and, secondly, upon Switzerland, Great Britain, the United States, France and Belgium for her necessary supplies. A recent report on the trade of Russia shows that in no less than 50 towns is public electric lighting already established, and since 1893, when the first electric tramway was constructed and operated at Kiew, great developments in electric traction have proceeded. So far back as in 1898 312 miles of electric lines were being operated. The utilisation of the water power available almost throughout Russia in Europe is receiving attention, and several large schemes are under consideration, notably the utilisation of the water power of the Volhov rapids and the waterfalls of Marva and Imatra.

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The concession recently granted by the Government to a company at St. Petersburg for electrical enterprise involves the expenditure of nearly £3,000,000 sterling. Transmission will be over a distance of 188 miles. In this latter project the force of the Dnieper waters are to be utilised. The importation into Russia of electrical plant, apparatus and material is already on a very extensive scale, and recent reports indicate that the demand in the near future for these goods will be very active, the factories already existing in the country for the manufacture of these goods being quite equal to the probable demand. Nearly all the instruments and apparatus used in connection with electric lighting, power and traction are imported.

South Shields—Last week the Council resolved to apply for powers to construct a network of electric tramways. The system of traction to be adopted has not yet been decided.

Tadcaster.—Public electric lighting was inaugurated on Saturday last.

Wirksworth—The Derbyshire and Notts. Electric Power Co. offer to supply electricity in bulk to the Council from their Matlock generating station at 1½d. per unit for 250,000 units per annum, mains being laid by the Council at an estimated cost of about 7s. 6d. per yard. The transforming apparatus, costing from £500 to £600, could be put in by the Council, or the company would do the work and charge a percentage. A provisional order would have to be obtained, but the company would bear the expense of obtaining it. Some further particulars are asked from the company.

Wolverhampton.—Through tramway communication has been provided between Wolverhampton and Bilston.

Woolwich.—This week the undertaking of the Woolwich District Electric Light Co. passes into the hands of the Borough Council. The purchase price has been fixed at £101,000, sufficient to enable the return to the ordinary £1 shareholders of considerably over £2 per share.

Electro-Harmonic Society.—The 17th season of this society will commence with a smoking concert on the evening of Friday, Oct. 10. Owing to the rebuilding of the banqueting hall at St. James's Restaurant, where these concerts have usually been held, the executive committee have made arrangements for this season's concerts to be held in the Crown Room of Holborn Restaurant, London, W.C.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Rochford District Council invite tenders for the supply, delivery, erection and maintenance for one month of electrical transmitting and recording instruments, and about 1¼ miles of overhead wire, poles, &c., for communication between the water tower and South Benfleet, Essex. Specifications from the consulting engineers (Messrs. James Mansergh & Sons), 5, Victoria-street, Westminster, and tenders to the clerk. Mr. Frederick Gregson, solicitor, Southend-on-Sea, by 10 a.m. 30th inst. See advertisement.

Rotherham Corporation invite tenders for steam pipes and valves, feed pipes and valves, feed pump and economiser, exhaust water and drain pipes and valves and switchboard extensions. Specifications, &c., from the town clerk (Mr. H. Hampton Copnall), and can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster. An advertisement contains further particulars. Tenders to the town clerk by noon Oct. 16.

Batley Corporation invite tenders for the supply and erection of a storage battery of 240 cells and accessories. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, and may be obtained from the latter office only. Tenders to town clerk (Mr. J. H. Craik) by Oct. 10. See advertisement.

Bradford Corporation require tenders for the supply and delivery of electric motors (semi-enclosed type) of 4½, 7 and 10 H.P. for twelve months commencing Dec. 1. Specifications from city electrical engineer (Mr. R. A. Chattock), and tenders to town clerk (Mr. Frederick Stevens) by Oct. 2. See advertisement.

Manchester Tramways committee invite tenders for the supply of steel tramway poles. Specifications from the general manager (Mr. J. M. McElroy), 55, Piccadilly, Manchester, and tenders to chairman by 1 p.m. Oct. 4. See advertisement.

Wigan Corporation invite tenders for the construction of a short length of new tramway, and for the re-construction of a portion of existing tramways. Specifications, &c., from the borough engineer (Mr. Wm. Bolton), and tenders to the town clerk (Mr. Harold Jevons) by Oct. 20. See advertisement.

Wigan Corporation also invite tenders for the electrical equipment of a short length of new tramway and of a portion of the existing tramways, and for 18 bogie cars, double-deck four-motor equipment. Specifications, &c, from the borough electrical and tramways engineer (Mr. James Slevin), and tenders to the town clerk by Oct. 20. See advertisements.

Swindon Corporation invite tenders for wiring consumers' premises within the borough. Conditions, &c, from the town clerk, Mr. Robert Hilton, to whom tenders, accompanied with specimens of wires and fittings, by Oct. 7. See advertisement.

Swindon Corporation also invite tenders for station lighting and motor wiring, and testing instruments and accessories. Tenders to town clerk by Oct. 4.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for the supply of stores during the 12 months ending Oct. 31, 1903, including copper nails, rivets, ironmongery, indiarubber, oil, reflectors, tools, twist drills, tin and zinc sheets, &c., also permanent-way materials. Further particulars and forms of tender at the Stores Department, Osborne-street, Manchester, and tenders (addressed to the directors) to the secretary, Mr. R. C. Irwin, Hunts Bank, Manchester, by 10 a.m. Oct. 6. An advertisement contains additional information.

Ipswich Corporation invite tenders for main switchboard, motor booster and connections, and overhead construction for tramways. Specifications, &c., from the town clerk (Mr. Will Bantoft), and may be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, London, S.W. Tenders to Mr. Bantoft, Town Hall, Ipswich, by Oct. 22. See advertisement.

West Ham Borough Council invite tenders for 46 combined arc lighting and traction poles, with side brackets. Specifications, &c., from the borough electrical engineer (Mr. James K. Bock), Abbey Mills, West Ham, after 22nd inst., and tenders to town clerk (Mr. Fred. E. Hilleary), Town Hall, by 4 p.m. Oct. 7. An advertisement contains further particulars.

Ilford District Council require dry-back, semi-marine-type boiler, superheater and accessories and motor feed pump; steam feed and low half pipes and feed filter; and surface condenser, cooling tower, motor pumps, hot well, grease extractor, exhaust steam and water pipes. Tenders to chairman by noon Oct. 6.

Hyde, Stalybridge, Mossley and Dukinfield Tramways and Electricity board invite tenders for Lancashire boilers, economisers and ironwork for flues, surface condensers and pumps, &c., steam, feed, blow-off and drain pipes, feed pumps, &c., and travelling crane. Tenders by Oct. 13.

The directors of the *North-Eastern Railway Co.* invite tenders for the complete electrification of about 37 miles of standard gauge line (mostly double track) in the neighbourhood of Newcastle-on-Tyne. Tenders to secretary, York, by noon Oct. 7.

Maidenhead Corporation invite tenders for complete electric lighting installation for the Guildhall. Tenders to town clerk by 4 p.m. Oct. 6.

Burton-on-Trent Corporation invite tenders for supply and laying of electric mains, conduits, junction boxes, &c. Tenders to town clerk before noon Sept. 30.

Middlesex County Council require tenders for permanent way construction of about 10½ miles of light railway. Tenders to Guildhall, Westminster, S.W., by Oct. 7.

Belfast Gas and Electric Light committee invite tenders for electric motors for 12 months. Tenders to town clerk (Sir Samuel Black) by noon Oct. 10.

Huddersfield Corporation require tenders for high and low-tension cable. Tenders to town clerk by 30th inst.

Peterborough Town Council require a Lancashire boiler. Tenders by Sept. 30.

Aylesbury District Council invite tenders for erection and maintenance of electricity works for a term of years. Tenders by Oct. 8.

Sheffield Tramways committee require 500 poles and 400 bracket arms for overhead line construction. Tenders by Sept. 30.

Bury Tramways committee require tenders for rail bonds, &c. Tenders by Oct. 14.

London County Council invite tenders for two electric car traversers. Tenders by Oct. 21.

Messrs. Preece and Cardew are authorised by *Shanghai* Municipal Commissioners to receive tenders for the supply and delivery (c.i.f.) of two 500kw. steam alternators, switchboards, two condensers and circulating water pumps. Tenders to Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, by noon Oct. 30.

Tenders are invited until Oct. 8 by the *Belgian State Railway* authorities, Brussels, for 33,000 telephone insulators, 58,000 telegraph insulators, 109½ tons galvanised iron telegraph wire, 606km. copper wire and 2,000 metres six-conductor submarine cable, &c., for the telegraph service.

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The *Madrid Gazette* of Sept. 14 invites tenders for the taking over of certain electric lighting plant, &c., belonging to the municipality of Irun, tenderers at the same time undertaking the electric lighting of the town on a 25 years' concession. Tenders are due by 11 a.m. Oct. 19.

Particulars are given in the *Madrid Gazette* for Sept. 11 of the conditions under which the town of Huéscar is prepared to grant a concession for the electric lighting of the city for a period of 25 years. The municipal authorities will receive tenders until Oct. 13.

[Copies of the *Madrid Gazette*, containing the conditions and other particulars of the above matters, may be seen, by appointment, at (but are not obtainable from) the offices of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London.]

TENDERS RECEIVED AND ACCEPTED.

We gave in our last issue the tenders accepted by Ipswich Corporation for electric light and power and electric tramways plant and apparatus. The tenders were for specifications Nos. 3 (engines and dynamos), 4 (storage batteries), 5 (overhead hand travelling crane), 6 (feeders, mains and road work), 7 (permanent way construction and tramways). For No. 3 166 tenders were received from 31 separate firms, of these five tenders were from continental firms through their British agents. The lowest of the 166 tenders was £6,504. 10s., the highest £10,077. The accepted tender (the Allgemeine Electricitäts Gesellschaft, Berlin) was £6,564 5s.. Reavell engines being contracted for. For specification No. 4 18 tenders were received, the lowest being £819. 6s. 3d, the highest £1,952. The accepted tender (Tudor Accumulator Co., London) was £1,256. The two lowest tenders in this group were received from German houses. For specification No. 5 10 tenders were received, the lowest (Ransomes and Rapier, Ipswich)—£350—being accepted. The highest tender was £640. No foreign tender sent in. For specification No. 6 18 tenders were received, the lowest being £12,697. 6s. 6d, the highest £16,854. 18s. 4d. The tender of Messrs. Johnson and Phillips Electric Cable Works, for £12,901. 8s. 6d. was accepted. No foreign tender sent in. For specification No. 7 10 tenders were sent in, ranging from £40,337. 15s. 10d. to £54,344. 14s. 7d. The tender of Messrs. Dick, Kerr & Co., London (British rails), for £41 220. 2s. was accepted. Tenders were also invited (specification No. 8) for arc lamps, but, as previously announced, no decision as to these has yet been made.

Messrs. Belliss and Morcom (Ltd.), Ledsam-street works, Birmingham, have received orders for the supply of a 385 H.P. engine to the Japanese navy, and three 400 H.P. engines to the Ayrshire Gold Mine and Lomagunda Railway Co., South Africa.

Gillingham District Council have accepted the following tenders:—

British Thomson-Houston Co. (three high-speed engines and 250kw. tri-phase alternators, switchboard, &c.)	£7,672
H. Harris (buildings)	2,870
Babcock and Wilcox (boiler, superheater, mechanical chain grate smokeless stoker and economiser)	1,785
Jas. Carrick & Son (overhead traveller)	273

Messrs. Willans and Robinson have obtained an order (through Messrs. Thomas Parker, Ltd.) for the supply of a 100 H.P. Willans engine for direct coupling to a Parker dynamo for Hampstead; also for two 360 H.P. Willans engine for direct coupling to B.P. dynamos for the South Wales Electrical Power Distribution Co.

Lanchester Council have accepted the offer of the Hamsteels colliery for providing and erecting six 32 c.p. incandescent electric lamps for public lighting at £40 and 45s. per lamp per annum for supplying current to and maintaining the lamps.

Ilford District Council have accepted the tender of the British Electric Car Co. for the supply of a combined track-watering and sweeping car on maximum truck, with combined electrical equipment, at £800.

Harrogate Corporation received 18 tenders for the supply of about 600yds. of light railway, the amounts varying from £1,070 to £1,802. 5s. The tender of Mr. A. Koppel, at £1,227. 18s. 4d. has been accepted.

Harrogate Corporation have also accepted the tender of John Walsh (Ltd.) for wiring the kursaal at £749.

Swansea Town Council have accepted the tender of Mr. H. Billings for erecting telephone exchange buildings at £2,297.

St. Helens (I.W.) District Council have received an offer from the I.W. Electric Lighting Co. to light the western district of the town with 30 c.p. incandescents (with 10 60 c.p. lamps at important corners) for £2. 10s. per lamp per annum. The local gas company's quotation is £3. 4s. 6d. per lamp.

Barking District Council have accepted the tender of W. M. Griffiths & Co. (Ltd.), for the supply of rails, fishplates, and bolts at £1,221. 6s., and for tramway permanent way construction at £6,100. 7s. 9d.

BUSINESS NOTICE.

Messrs. Baxter and Caunter, London agents for the Newton Electrical Works (Ltd.), the Electric and Ordnance Accessories Co., the Premier Electric Lamp Co., and the British Insulated Wire Co., have removed to 86, Charing Cross-road, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

A supplemental dividend of 11s. 8½d. is payable at Byrom-street, Manchester, in the bankruptcy of G. H. Bentley, electrical engineer, formerly trading at 18, Market-street, Earlestown.

A first and final dividend of 7s. 2½d. is payable at the O.R.'s, 33, Carey-street, London, W.C, in the liquidation of the Autocar Supplies (Ltd.), 66 and 66A, Great Russell-street, W.C.

Meetings of creditors and shareholders of the Electric Lamp Regenerating Co. (Ltd) were held on Friday at the London Bankruptcy Court.

Mr. H. Brougham, O.R., reported that he had in hand a sum sufficient to pay the company's debts in full. The company was formed in March, 1901, nominal capital £80,000, to carry on business as lamp manufacturers and electrical and mechanical engineers. The promoter and vendor was Mr. C. Williamson Milne, and the company acquired from him certain British and foreign patents for improvements in the manufacture and repair of incandescent electric lamps. No remuneration had been paid to any of the directors, who were properly qualified. No prospectus had been issued. The whole of the capital had been issued, £20,000 against cash subscriptions, and £60,000 credited as fully paid in part payment of purchase consideration. Of the subscribed capital £17,000 was provided by Mr. Milne and his friends. The purchase price was fixed at £68,750, payable as to £8,750 in cash and £60,000 in shares, the company undertaking to discharge the obligations (not exceeding £5,000) of the syndicate to pay for two factories—one in France and the other in Spain. The profit made by Mr. Milne on the re-sale of the property to the company appeared to be £15,000 in shares The company traded at a loss at all three places. Working capital being exhausted, the shareholders were invited in May last to subscribe to a loan, but the subscriptions fell short of the minimum amount (£4,000) required, and it was decided to reconstruct, but before this could be effected a winding-up order was made. Failure is attributed to insufficiency of working capital, bad management and difficulty of working the two Continental factories from London. It was open to creditors in both France and Spain to realise the property there for their own benefit, without regard to the claims of British creditors. Negotiations were, therefore, entered into with the view of disposing of those assets, and an offer of £2,000 in cash for the whole of the company's assets in France and Spain, the purchaser discharging all liabilities, was accepted. This practically provided sufficient to pay off all the company's liabilities and left the other assets, estimated in the accounts at about £2,000, available for shareholders. Resolutions were passed for the O.R. to act as liquidator, with a committee of inspection. The contributories' account shows a total deficiency of £77,645.

To Let.—Particulars will be found in an advertisement of business premises to let on lease by Messrs. Edward Deane & Sons, 16, Friar-street, Reading, centrally situated and well adapted for factory purposes.

Plant for Sale.—Particulars of some electric lighting plant for sale are given in an advertisement. The plant includes two Crossley 16 H.P. gas engines, one E.C.C. and two Morley compound-wound dynamos, a Pritchett and Gold Battery, &c., and can be seen by appointment at Messrs. Jones Bros., Oakwood-court, Addison-road, London, W.

White Bros. & Co., engineers, High-street, Stratford, have for sale a boiler (loco type), a pair of high-pressure compound horizontal Ruston-Proctor engines, a Crompton dynamo, and a Ruston-Proctor feed heater. See advertisement.

Catalogues.—The Paterson Engineering Co., 77, Queen-street, Glasgow, forward a newly-prepared pamphlet dealing with various forms of apparatus for procuring pure water for steam-raising purposes on a system which is claimed to secure the absolute removal of oil and grease from condensation water. In this company's system the tiny globules of oil which ordinarily become dissolved or emulsified with the water and so defy all ordinary filtering media are, in this system, entangled in a very fine gelatinous precipitate, which is claimed to secure absolute clarification. The system has been in use in several large lighting and power stations for some years, it is said with success.

The British Thomson-Houston Co. have ready a pamphlet giving particulars of the B.T.H. type of Edison incandescent electric lamp, in the manufacture of which it is claimed a new and perfect method of chemical exhaustion is employed. A sheet price list, No. 48, accompanies the pamphlet, giving prices of various types of this lamp.

"Interchangeable Enclosed Arc Lamps for Alternating and Direct-Current Circuits," "Motor-Driven Air Compressors," and "Twin Carbon Enclosed Arc Lamps" are respectively the subjects dealt with in pamphlets Nos. 115, 131 and 133, just issued by the British Thomson-Houston Co., Rugby.

A description of single and multiphase generators (for direct coupling) is issued by the Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C. The description is fully illustrated, with views of a number of these machines actually installed.

Messrs. Robert W. Blackwell & Co., 59, City-road, London, E.C., forward an advance catalogue of "Atlas" engines and boilers, for which the firm are sole agents in this country. In addition to Corliss engines, the list includes a small list comprising plain slide valve engines and also automatically controlled engines. The latter type of machine has a special feature in the shaft governor, which is

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claimed to give great economy in working. A price list accompanies the catalogue, and contains some useful tables for steam engine users.

The International Electric Co., 55, Redcross-street, Barbican, London, E.C, have just issued their main catalogue in its 15th edition. The catalogue is profusely illustrated, and contains prices and particulars of a vast assortment of plant, apparatus, materials and accessories for lighting, power and telephone work, the whole arranged with due regard to facility of reference, which is aided by a comprehensive index. The list consists of nearly 200 large 4to. pages.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Sept. 17 to 23, with the ports of destination :—

Africa—Alexandria, £140 ; Cape Town, £232 ; Chinde, £30 ; Delagoa Bay, £881 (including £841 telegraph material) ; Durban, £2,230 (including £174 telegraph apparatus) ; East London, £21 ; Lurache, £123 ; Port Elizabeth, £272. *Argentina*—Buenos Ayres, £584 (including £34 telegraph material). *Australasia*—Adelaide, £13 ; Auckland, £150 ; Melbourne, £26 ; Perth, £298 ; Sydney, £86 ; Wellington, £198. *Belgium*—Ghent, £10 ; Ostend, £40. *Channel Islands*, £10. *Denmark*—Copenhagen, £75. *Gibraltar*, £25. *Holland*—Amsterdam, £110. *India*—Bombay, £480 ; Madras, £352. *Japan*—Kobe, £53 ; Osaka, £569 ; Yokohama, £426. *North Atlantic*, £2,180 (telegraph cable). *Russia*—St. Petersburg, £147 (telegraph wire). *Sweden*—Gothenburg, £127 ; Stockholm, £65. Total £9,953, against £27,360 in the corresponding week last year (Sept. 18 to 24).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 31, 1902.

16,941. J. T. HARINGTON. Manchester. Automatically controlling the electric illumination of clocks and similar objects.
16,957. F. W. HAWDON. Newcastle-on-Tyne. Safety appliance for overhead wires.
16,962. P. KENNEDY. Wolverhampton. Switches or cut-offs.*
16,979. SIEMENS BROS. & Co. Transmitting the movements of a primary compass card to a secondary compass card at a distance. (Siemens and Halske A.G., Germany.)*
16,981. C. NORDÉN and A. H. ANDERSSON. Combined sounding telegraph and telephone.*
16,983. H. H. LAKE. Rail connections. (Continuous Rail Joint Co., of America, U.S.)*
16,984. P. A. GOUIN. Electrodes for secondary batteries.
16,989. W. T. HENLEY'S TELEGRAPH WORKS Co. and H. SAVAGE. Cables.
16,992. A. M. MARTIN and J. TENNANT. Liverpool. Signalling devices.
16,994. W. L. MCGOWAN. Sectional conduits.
17,002. V. LÖWENDAHL. Manufacture of conductors.*

August 1, 1902.

17,013. L. P. GREIG. Bury St. Edmunds. Induction system of electric traction.
17,073. W. P. THOMPSON. Liverpool. Trolley systems for electric railways employing a surface rail. (A. Watson, U.S.)*

August 2, 1902.

17,094. G. A. G. DAVIES, H. W. KENT, B. G. STEWART and G. EWING. Wall or floor coupling sockets.*
17,106. H. S. COWX. Manchester. Trolley conductors.
17,111. L. H. WALTER. Receiver for wireless telegraphy.
17,127. W. COPE. Birmingham. Conduits for electric tramways.
17,134. L. H. NEWTON and R. R. F. NEVILLE. Lampholders.
17,135. L. H. NEWTON and R. R. F. NEVILLE. Lampholders and switches.
17,136. L. H. NEWTON and R. R. F. NEVILLE. Incandescent lamps.
17,141 and 17,142. H. S. ADLER. Automatic switches.
17,143. H. S. ADLER. Systems and lighting and power.
17,173. F. LOSÁDL. Electric station indicators.*

August 5, 1902.

17,196. L. M. WATERHOUSE. Liverpool. Resistance devices for electric heaters.
17,202. F. T. WEIDAW and F. L. BARNEY. Holders for commutator brushes of dynamos.*
17,220. H. H. LAKE. Electric railways. (G. E. Co., U.S.)*
17,222. F. W. S. STOKES. Electric cranes.
17,255. F. ECKERT. Acid-resisting and non-conducting glove.*
17,260. H. MCGILLIVRAY. Electric lighting and apparatus therefor.*

August 6, 1902.

17,267. W. THOMSON (Baron Kelvin). Glasgow. Electrostatic high-pressure voltmeter.
17,271. T. F. RENFREW. Glasgow. Guards for electric cars.
17,324. J. C. FELL. Electric bonds. (M. M. Wood, U.S.)*

August 7, 1901.

17,380. C. LEUSCHNER. Electromagnetic separation.*
17,384. H. H. LAKE. Dynamo-electric machines. (G. E. Co., U.S.)
17,385. H. H. LAKE. Regulating electric circuits. (G. E. Co., U.S.)
17,386. H. H. LAKE. Electric condensers. (G. E. Co., U.S.)
17,387. H. H. LAKE. Combined carbon cutter and screwdriver for arc lamps. (G. E. Co., U.S.)
17,388. H. H. LAKE. Electrical distribution. (G. E. Co., U.S.)
17,389. H. H. LAKE. Insulation of high potential apparatus. (G. E. Co., U.S.)
17,390. H. H. LAKE. Clamps for trolley wires. (G. E. Co, U.S.)
17,392. G. HOOKHAM. Incandescent lamps.
17,396. LA COMPAGNIE FRANÇAISE DES TÉLÉGRAPHES ET TÉLÉPHONES SANS FIL. Receiver for wireless telegraphy and telephony. (Date applied for, Feb. 8, 1902, date of application in France.)*
17,406. A. BLONDEL. Carbons for arc lamps.

August 8, 1902.

17,419. W. THOMSON (Baron Kelvin). Glasgow. Recording mechanism.
17,431. E. BLUNDELL. Salop. Liquid cement for insulating wires.*
17,444. J. E. SLACK. Manchester. Trolley heads.
17,487. G. PATROUILLEAU and A. R. MONDON. Arc lamp with alternating currents.

August 11, 1902.

17,534. B. HOPKINSON. Electric locomotives.
17,538. W. JONES and J. H. HOWELL. Bristol. Automatic guard for electric trams.
17,548. G. P. WISDOM. Manchester. Rheostats.*
17,587. H. BAUER. Electrolytic incandescent bodies particularly applicable to Nernst lamps.
17,589. Sir H. E. COLVILLE. Movable electric contact.
17,611. C. J. MOBERG. Electric clocks.*
17,624. L. H. WALTER and J. A. EWING. Wireless telegraphy.

August 12, 1902.

17,633. A. MORRISON and J. W. BUTTERWORTH. Manchester. Securing shades, reflectors or the like.
17,667. C. J. EVANS. Maximum demand indicator for alternate currents.
17,676. R. B. BEATTIE. Stopping device for electric motors.
17,678. R. BÖHM and E. BÖHM. Electric lamp globes.
17,685. O. T. BLÁTHY. Electrical motor counters.*
17,687. H. H. LAKE. Maximum demand indicators. (G. E. Co., U.S.)
17,688. H. H. LAKE. Commutator brushes. (G. E. Co., U.S.)
17,689 and 17,690. H. H. LAKE. Arc lamps. (G. E. Co., U.S.)
17,691. H. H. LAKE. Armature windings for induction motors. (G. E. Co., U.S.)
17,703. R. A. FESSENDEN. Signalling by electromagnetic waves.*
17,704, 17,705 and 17,706. R. A. FESSENDEN. Wireless signalling.*
17,707. R. A. FESSENDEN. Transmitting and receiving signals.*
17,708. R. A. FESSENDEN. Signalling by electromagnetic waves.*
17,712. R. S. STEWART. Hot wire electric meters.*
17,722. J. W. BOWLEY. Overhead tracks.
17,745. J. A. HEANY. Water, acid and fireproof insulating compositions. (Date applied for, June 24, 1902, date of application in France.)*
17,746. J. A. HEANY. Insulating metallic surfaces and asbestos for same. (Date applied for, June 24, 1902, date of application in France.)*
17,747. J. A. HEANY. Manufacture of insulated wire. (Date applied for, June 24, 1902, date of application in France.)*
17,748. J. A. HEANY. Insulated wire. (Date applied for, June 24, 1902, date of application in France.)*

August 13, 1902.

17,755. A. E. HARDAKER. Lancashire. Trolley poles.
17,757. R. C. HARPUR and A. A. WHITLOCK. Electric automatic switches.
17,762. J. REYNOLDS. Liverpool. Automatic catch-point trolley.
17,784. J. L. NAPIER. Glasgow. Automatic point shifting gear for trolley wires.
17,794. SIEMENS BROS. & Co. Actuating controlling appliances of electric railway car motors. (Siemens and Halske A.G., Germany.)
17,811. K. S. LEMSTRÖM. Insulating apparatus for currents of high tension.*
17,812. M. L. SOLARI. Receiving and recording apparatus for wireless telegraphy.
17,822. E. DU BOIS. Time switch.*

August 14, 1902.

17,841. F. H. LORING. Producing and shaping electric current pulses.
17,847. A. B. BROWN. Glasgow. Telemotor apparatus working from a distance.
17,867. A. F. HAUSS. Moisture and water-proof fixture and guard.*
17,885. R. SCHARF. Germany. Producing currents of high frequency.*
17,886. H. BREMER. Arc lamps.
17,902. J. J. STRANGER. Curative treatment by acid of electricity and oxygen.
17,913. F. J. GREEN. Arc lamps.*
17,923. J. A. RIGNON. Arc lamp.*
17,924. H. LUTHY. Electric ignition for explosion motors.*
17,927. G. C. FRICKER and W. M. MORDEY. Electricity meters.

August 15, 1902.

17,952. B. NORTH. Liverpool. Electricity meters.
17,953. G. L. MARTIN. New York. Marine electric light fixtures.*
17,994. L. G. NILSON. Electric interrupters. (Date applied for, May 14, 1902, date of application in U.S.)*
17,995. L. G. NILSON. Driving mechanism for electric road vehicles. (Date applied for, May 14, 1902, date of application in U.S.)*
17,997. L. G. NILSON. Controllers for electric motors. (Date applied for May 15, 1902, date of application in U.S.)*

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each

1901.

13,583. ROUTIN. Regulating generation of electricity at generating stations. (Date applied for Dec. 22, 1900.)
13,747. MUSSO. Page printing telegraph.
14,423. STARK. Combined telephone, telegraph, electric light and power system.
15,069. KREBS. Lead fuse for electrical plant.
15,467. BOSE and BULL. Wireless telegraphy and other signalling.
15,579. BOULT (American Alkali Co.). Electrolytic apparatus.
15,880. BRITISH THOMSON-HOUSTON Co. (Hewlett). Electromagnetic controlling apparatus for surface-contact electric railways.
15,881. BRITISH THOMSON-HOUSTON Co. (Potter). Surface-contact electric railways.
15,882. BRITISH THOMSON-HOUSTON Co. (Case). Electric brakes.
16,036. CUBITT. Electrical speed-indicating apparatus.
16,123. JACOB. Terminal couplings for conductors.
16,150. LAWRENCE. Arc lamp safety winch.
18,228. ECKSTEIN and BELL. Testing electrical alarm systems.
16,319. SCIALPI. Electric rotatory speed indicator.
16,615. BOULT (Christensen). Controlling apparatus for electric motors.
16,628. NEWTON. Interrupters for induction coils.
16,710. COX. Switches.
16,847. WRIGHT. Cord grip for electric pendant lamps.
17,045. BÖHM. Driving gear for dynamos.
17,139. DEAN and INSTONE. Safety life-guards.
17,349. BÖHM and MENCKHOFF. Electric locomotives operated by accumulators.
17,621. GRINNELL and GOEPEL. Apparatus for hauling cables.
18,125. HICKLEY. Electric controlling switches.
18,430. BOSE and BULL. Detecting light, Hertzian or other radiations.
18,600. TAYLER. Paper insulation.
18,898. VON ZWEIGBERGK. Controllers.
18,947. VON ZWEIGBERGK. Current controllers.
19,440. HALLIWELL. Automatic cutout for trolley wires.
19,514. THOMPSON. Electromagnetic oscillating apparatus.
19,660. SHORT. Safety apparatus for trolley cars.
19,686. SHORT. Arc rupturing devices.
19,757. LEWIS. Controlling arc lamps.
19,770. DUBOIS. Demand indicators.
20,423. BURNAND. Transformers and the like.
22,152. HITCH. Cable conductors.
22,477. JOHNSON (Hartmann and Braun). Electricity meters.
22,898. CLAREMONT and HYDE. Lapping heads in cable machines.
23,446. HADDAN (General Incandescent Arc Light Co.). Automatic circuit breakers.
23,756. JOSEPH. Mechanical converters of electric current.
26,474. ABEL (Siemens and Halske A.G.). Electric valve for air brakes.
26,536. HOPFELT. Electrodes for arc lamps.

1902.

4,936. OATES. Conduits or pipes for electric cables.
5,043. HUNT. Trolley frame and head combined.
5,618A. CERVERA. Interrupters for induction coils. (Date applied for, March 6, 1902.)
9,317. GOWLLAND. Electric quantity meters.
9,325. MEIROWSKY. Insulating tubes.
9,360. ALBERTSON. Railway cars and magnetic appliances.
9,511. RANDOLPH. Insulating compounds.
9,800. ERICSSON. Ringing keys for telephone switchboards.
9,801. ERICSSON. Telephone jack-strips.
9,812. BOULT. (Siebert and Tempel). Electrolytic production of a bleaching liquor and caustic alkali lye.
9,825. HALL. Electric fuse boxes for street mains.
9,849. BARKER. Connecting electric lamps for temporary use.
9,977. BRITISH THOMSON-HOUSTON Co. (Churchward). Pole-pieces for dynamo-electric machines.
9,978. BRITISH THOMSON-HOUSTON Co. (Churchward). Pole shoes for dynamo-electric machines.
10,097. BARLOW and YOUNG. Conduits and jointing same.
10,342. MURPHY. Armature windings.
10,457. REDDING and DEERING. Storage batteries.
10,532. BRISTOL. Portable batteries, plates and the like.
10,538. STÖLL. Trolleys for overhead conductors.
10,594. RILEY and ROWING. Cleats.
10,856. NORDEN. Switchboards for illuminating electric signs and automatically actuating same.
10,888. CEREBOTANI and SILBERMANN. Electromagnetic devices for producing oscillatory motion.
10,943. GAGNE and BONNEAU. Trolley guards.
11,072. BRITISH THOMSON-HOUSTON Co. (Wood). Switches.
11,073. BRITISH THOMSON-HOUSTON Co. (Wood). Controlling electric circuits.
11,077. BRITISH THOMSON-HOUSTON Co. (Batchelder). Supports for high-tension conductors.
11,080. BRITISH THOMSON-HOUSTON Co. (Sargent.) Multipolar electric switches.
11,082. BRITISH THOMSON-HOUSTON Co. (Stewart). Third-rail insulators.
11,165. ADDENBROOKE. Switch-box apparatus for testing, standardising or calibrating electrostatic instruments and measuring currents.
11,290. LAKE. (Pinchard). Switches and regulating sockets.
11,339. HEYS. (Hutchinson Acoustic Co.) Portable telephonic apparatus for persons of impaired hearing.

COMPANIES' MEETINGS AND REPORTS.

Chloride Electrical Storage Co. (Ltd.).

The ordinary annual general meeting was held at the company's works, Clifton Junction, near Manchester, on 16th inst.

Dr. EDWARD HOPKINSON having temporarily taken the chair, said the shareholders would be surprised not to see the accustomed figure of Dr. Bowman in the chair. He regretted exceedingly to inform them of that gentleman's resignation, since the report was issued, of his position as director of the company and chairman of the board. Dr. Bowman's resignation had been accepted by his co-directors with great regret, he having held the office of chairman for six years, and devoted himself with much ability to the interests of the shareholders. Under the circumstances the board had elected as chairman Mr. William Bannister, J.P., of Cork, who had been a director for some six years. Mr. Bannister was loth to assume the duties of an arduous office, requiring a considerable amount of time, but he had agreed to accept the post, at any rate for a time.

Mr. Bannister having taken the chair,

The SECRETARY (Mr. H. Dell) read the notice convening the meeting and the auditors' certificate.

The CHAIRMAN said, with reference to the balance-sheet, as a shareholder he considered the figures to be eminently satisfactory in every way. The company had never been since its inception in so strong a position. The company had now acquired such a high position, technically and financially, that although up to the present shares had been unsaleable, there was now quite an inquiry for them. He considered the company was now in such a position that the shareholders might look to receiving a satisfactory return on their holdings. He then moved the adoption of the report and accounts.

Mr. HARVEY seconded the motion, which was carried unanimously.

The dividend on the 6 per cent. preference shares (less tax) was then declared, and a dividend of 8 per cent. on the ordinary shares (tax free) from April 14 (the date of the reduction of capital) to June 30, the end of the financial year. The retiring director, Mr. Bannister, was re-elected, as were the auditors (Messrs. Parkinson, Mather & Co.).

A resolution expressing the shareholders' regret at Dr. Bowman's resignation, and recording their appreciation of his services to the company, was approved, and a vote of thanks to Mr. Bannister for presiding was then passed, and the meeting terminated.

Willans and Robinson (Ltd.).

The seventeenth half-yearly report of the directors (for the half-year to June 30, 1902), states that, after writing off £4,804. 4s. 10d. as depreciation, and paying debenture interest, the balance credit (including £7,035. 11s. 2d. brought forward) is £33,449. 13s. 9d. The directors propose dividends on the 6 per cent. preference shares, and at the rate of 10 per cent. per annum on the ordinary shares, requiring together £26,666. 8s. The amount payable to the directors is £919. 7s. 2d., leaving an available balance of £5,863. 18s. 7d. £475 is put to reserve, leaving £5,388. 18s. 7d. to be carried forward.

Since the last report the Admiralty has ordered Niclausse boilers for two more first-class cruisers (H.M.S. "Carnarvon" and "Devonshire"), making four of this class in all, and more recently Niclausse boilers have been ordered for a new battleship, thus bearing out the previously-expressed expectation that the merits of the boiler must soon receive fuller recognition. These boilers, aggregating (with those of two small vessels not included in the above) about 100,000 H.P., are being constructed under licence from this company, pending completion of the new boiler works at Queen's Ferry.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH PROMETHEUS CO. (LTD.)—Reg. Sept. 17, capital £4,000 in £1 shares, to acquire patents relating to improvements in electrical resistances and the manufacture thereof, and in electric cooking, frying or roasting apparatus and heating devices, to adopt an agreement with L. M. Waterhouse, and to carry on the business of manufacturers of and dealers in electric heating and cooking apparatus and accessories, manufacturers of electrical apparatus, fittings, machinery and accessories, &c. The subscribers are:—H. Skipworth, electrical engineer, R. Crampton, engineer, T. W. Harvey, E. Sheppard, electrical engineer, C. E. Gunner, electrical engineer, G. H. Collins, engineer, and J. D. Morrison. L. M. Waterhouse & Co. are the first managers.

BURN'S PATENT TRAMCAR LIFE-GUARD SYNDICATE (LTD.)—Reg. Sept. 12, capital £2,000 in £1 shares, to acquire patents obtained by or on behalf of R. S. Burn in respect of a safety guard for electric tramcars and the like, to manufacture and deal in such guards and to carry on the business of ironfounders, electrical engineers, &c. The first directors are R. S. Burn, J. A. Brown, H. Colbeck, J. W. Powell, J. E. Walker and J. Watson. Reg. offices, 12, Bowlalley-lane, Hull.

LONDON MOTOR OMNIBUS SYNDICATE (LTD.)—Reg. Sept. 5, capital £3,020 in £1 shares (20 founders), to construct and work omnibuses, vehicles, &c., by electricity or other power. Reg. office, White House, 17-18, Telegraph-street, E.C.

W. T. SKELDING & CO. (LTD.)—Reg. Sept. 8, capital £10,000 in 1 shares to carry on the business of electrical and mechanical metal workers, manufacturers of electrical fittings and apparatus, &c. The first directors are W. T. Skelding and C. W. M. Adams.

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THUNDERBOLT PATENT GOVERNOR CO. (LTD.)—Reg. Sept. 2, capital £35,000 in £1 shares (15,000 preference), to adopt certain agreements for the acquisition of the business of a company of the same name, to acquire from E. Thunderbolt certain patents, and to carry on the businesses of engineers and metal founders and workers, tube and wire drawers, electrical engineers, &c.

UNITED WAGON CO. (LTD.)—Reg. Sept. 10, capital £100,000 in £1 shares (50,000 preference), to acquire the businesses carried on by Wheeler and Gregory (Ltd.) and the Albion Carriage Co. (Ltd.), and to carry on the business of builders, repairers and hirers of waggons, railway rolling stock, electrical and mechanical engineers, brassfounders and finishers, &c. Reg. office: 6, Great Winchester-street, E.C.

BRITISH ELECTRIC TRANSFORMER MFG. CO. (LTD.)—In return to Aug. 15 the capital is given as £50,000 in £1 shares, and £1 per share has been called up and paid on 20,000; 20,000 shares are considered as fully paid. Mortgages and charges, nil.

CHADBURN (SHIP) TELEGRAPH CO. (LTD.)—In the return to June 28 the capital is given as £120,000 in 60,000 preference and 60,000 ordinary shares of £1 each, all taken up, £1 per share has been called up and paid on 50,000 preference and 50,000 ordinary shares. £20,000 is considered as paid on 10.000 preference and 10,000 ordinary shares. Mortgages and charges nil.

CHILI TELEPHONE CO. (LTD.)—The return to July 31 gives the capital as £250,000 in £5 shares, of which 44,000 have been taken up. £5 per share has been called up and £220,000 has been received. Mortgages and charges, £56,000.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—The return to Aug. 13 gives the capital as £5,000,000 in 250,000 preference and 250,000 ordinary shares of £10 each, of which 180,527 preference and 180,527 ordinary have been taken up. £10 has been called up and paid on each. Mortgages and charges, nil.

LANGDON-DAVIES MOTOR CO. (LTD.)—The return to July 31 gives the capital as £70,000 in 20,000 preference and 50,000 ordinary shares of £1 each, of which 16,100 preference and 47,274 ordinary shares have been taken up. £1 per share has been called up on 17,907 shares and £17,907 has been received. £47,467 is considered as paid. Mortgages and charges nil.

MEXICO ELECTRIC TRAMWAYS (LTD.)—In the return to June 25 the capital is given as £1,000,000 in 500,000 ordinary and 500,000 preference shares of £1 each, all of which have been taken up. £1 per share has been called up on the preference and £500,000 has been received. £500,000 considered as paid on ordinary shares. Mortgages and charges £400,000.

THOMAS PARKER (LTD.)—According to the return to June 30 the capital is £75,000 in £10 shares, all of which have been taken up. £10 has been called up and paid on 5,750. 1,750 shares considered as fully paid. Mortgages and charges £58,700. (£200 debentures subsequently issued.)

SCHATTNER ELECTRICITY METER CO. (LTD.)—According to return of Aug. 26 the capital is £50,000 in 37,500 ordinary and 12,500 deferred shares of £1 each, of which 15,000 ordinary and 12,500 deferred have been taken up. 15s. per share has been called up and paid on 15,000 ordinary, and £12,500 is considered as paid on 12,500 deferred shares. Mortgages and charges, nil.

SIEMENS BROTHERS & CO. (LTD.)—The return to June 12 gives the capital as £600,000 in £5 shares, all of which have been taken up and paid for in full. Mortgages and charges £150,000.

SUNBEAM LAMP CO. (LTD.)—In the return to Sept. 10 the capital is given as £25,000 in £10 shares, 1,765 of which have been taken up. £10 per share has been called up on 908 shares and £9,080 has been received. 857 shares considered as fully paid. Mortgages and charges £5,150.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 6, 1902). Price of silver 23 1/16d. per oz. (Sept. 25). Consols (2¾ per cent.) 93—93⅛ for money, 93—93⅛ for account; 2½ per cent. 93¼—93⅜ (Sept. 25). Consols Pay day, Oct. 2; Stocks and Shares Continuation Days, Oct. 13 and 28; Ticket Day, Oct. 14; Pay Days, Sept. 26 and Oct. 15; Mining Share Carry-over Days, Oct. 10 and 27.

CALCUTTA ELECTRICITY SUPPLY CORPORATION (LTD.)—An interim dividend for the half-year ended June 30 at the rate of 6 per cent. per annum has been declared, payable Nov. 15.

DICK, KERR & CO. (LTD.)—The report for the year ended June 30 states that the profits amounted to £103,758. After paying debenture and loan interest and trustees' fees, and reserving the sum required for premium payable on redemption of present debenture stock, there is a balance of £97,074, to which is added £27,793 from last year, making £124,868. It is proposed to pay the dividend on the 5 per cent. preference shares (£6,000), to carry one-fifth of remaining profits (£18,215) to reserve, as required by trust deed securing debentures, also to carry a further sum of £21,785 to reserve, making £40,000, to pay a dividend of 10 per cent. and a bonus of 20 per cent. on ordinary shares (£48,000), and carry forward £30,868. The resolutions for acquiring the shares of the English Electric Mfg. Co. (Ltd.) were duly passed, and the exchange of shares will be carried out in due course. Steps will be taken to acquire the few outstanding shares, and arrangements will be made with the debenture-holders of both companies at an early date.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—It has been decided to pay, in addition to the dividend on the 10 per cent. preference shares, an interim dividend at the rate of 4 per cent. (tax free) on the ordinary shares for the half-year ended June 30, payable Oct. 1.

EASTERN TELEGRAPH CO. (LTD.)—Payment will be made on Oct. 15 of a dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock of this company for the quarter ending Sept. 30, and the usual interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the quarter ended June 30. The transfer register will be closed from Oct. 8 to 15 inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended June 30 of 2s. 6d. per share (tax free), payable 15th prox. The share register will be closed from 7th to 14th prox. inclusive.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—An interim dividend at the rate of 4 per cent. on the ordinary shares for the half-year ended June 30 has been declared, payable Oct. 1.

SLOUGH AND DATCHET ELECTRIC SUPPLY CO. (LTD.)—During the week this company has invited subscriptions for capital.

STOCK EXCHANGE NOTICES.—Oct. 1 has been appointed a special settling day for £150,000 4 per cent. debenture stock of the *Isle of Thanet Electric Tramways and Lighting Co. (Ltd.)*, and the securities have also been ordered to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Sept. 13	1,088	+ 266	15	17,461	+ 4,290
Ayr Corporation	„ 20	575	...	18	7,259	...
*Birmingham Tramways.	„ 20	4,951	+ 34	11	54,801	+ 1,723
*Blackburn Corporation..	„ 19	755	+ 3	26	21,834	+ 3,744
Blackpool Corporation...	„ 18	1,611	+ 38	25	30,789	- 267
Blackpool and Fleetwood	„ 20	1,144	+ 136	12	16,418	- 536
Bolton Corporation	„ 21	1,631	+ 129	25	41,155	+ 2,583
Bournemouth Corporat'n	„ 17	343	...	..	...	...
Bradford Corporation ...	„ 21	3,434	+ 2,120	24	81,827	+ 55,304
Brighton Corporation ...	„ 21	998	...	43	32,293	...
Brisbane Tramways.....	Aug. 6	2,271	+ 404	6	13,719	+ 2,720
*Bristol Trams & Carriage	Sept. 19	4,820	+ 691	17	56,722	+ 11,134
*Buenos Ayres & Belgrano	Aug. 24	2,630	+ 5	8	22,607	+ 1,635
Burnley Corporation ...	Sept. 20	676	+ 421	‡25	16,930	+ 7,238
Calcutta Tramways Co...	„ 20	R28.963	+ R7,854	12	R3 6.779	+ R60,770
Cardiff Corporation	„ 20	1,581	...	25	35,195	...
Carlisle Tramways Co....	„ 20	195	+ 15	†38	6,776	+ 450
Central London Railway	„ 20	6,324	+ 451	12	75,337	+ 6,246
Chatham & Dist. Lt. Rys	...	...	...	...	...	...
City & South London Ry.	„ 21	2,851	+ 811	12	33,216	+ 10,945
Cork Elec. Tramways Co.	„ 18	821	+ 256	§37	21,850	+ 4,000
Devonport & Dist. Trams	„ 12	501	+ 60	36½	15,928	+ 598
Doncaster Corporation...	..	...	...	...	...	...
Dover Corporation	„ 20	251	— 5	25	6,263	- 139
Dublin & Lucan Railway	...	...	...	...	...	...
Dublin Southern Dist....	„ 19	912	+ 29	12	14,409	+ 105
Dublin United	„ 19	3,794	+ 107	†12	47,579	
Dudley—Stourbridge ...	„ 12	911	+ 130	36½	27,555	+ 3,583
*Dundee Corporation ...	„ 17	787	+ 98	§17	13,810	+ 1,366
East Ham Council	...	...	...	...	...	...
Gateshead & Dist. Trams	„ 12	874	+ 249	36½	26,893	+ 4,594
Glasgow Corporation ...	„ 20	12,936	- 1,022	16	192,453	- 6,485
Gravesend	„ 12	234	...	6	1,353	...
Greenock & Port Glasgow	„ 12	609	+ 364	36½	18,474	+ 11,237
Hartlepool Tramways ..	„ 12	297	+ 24	36½	9,507	+ 1,182
Hull Corporation	„ 20	1,714	+ 55	25	44,140	+ 1,908
Isle of Thanet Co.	„ 20	1,265	+ 233	12	18,266	+ 18,499
Kidderminster & Dist....	„ 12	153	+ 18	36½	4,653	+ 12
Leeds Corporation	„ 20	5,227	+ 1,025	25	135,196	+ 12,615
*Liverpool Corporation...	„ 13	10 430	+ 780	37	359,314	+ 28,990
Liverpool Overhead Rly.	„ 21	1,514	— 51	‡12	19,332	— 1,199
Manchester Corporation	„ 20	5,378	+ 3,250	66	196,349	...
Merthyr.....	„ 12	204	— 33	36½	7,452	- 1,380
Middleton.....	„ 12	305	...	24½	7,793	...
Newcastle-on-Tyne Corp	...	...	...	...	...	...
Oldham, Ashton & Hyde.	„ 12	691	+ 200	36½	19,501	+ 951
Perth (W.A.) Elec. Trams	„ 19	934	+ 209	¶37	39,457	+ 6,727
Poole & Dist.....	„ 12	358	+ 140	36½	9,573	- 128
*Portsmouth Corporation	„ 20	1,831	+ 828	...	...	...
Potteries	„ 12	1,628	+ 32	36	53,472	+ 2,099
Rothesay	„ 12	201	+ 5t	3½	1,008	+ 300
Salford Corporation ...	...	..	...	...	...	...
*Sheffield Corporation ..	„ 21	4,238	+ 423	12	51,667	+ 11,133
Southampton Corp.....	...	...	...	...	...	...
Southend Corporation...	„ 17	366	+ 63	24	7,886	...
Southport Tramways ...	„ 12	338	+ 120	36½	9,582	+ 3,396
*S. Staffordshire Trams...	„ 12	746	- 166	36½	28,095	- 261
Sunderland Corporation.	„ 20	1,120	— 14	...	...	...
Swansea Trams.....	„ 12	536	— 6	36½	17,439	+ 1,118
Taunton Trams.....	„ 12	77	— 34	36½	2,470	- 159
Tynemouth & Dist.	„ 12	426	+ 108	36½	11,056	+ 1,238
Weston-super-Mare	„ 10	289	...	18½	4,618	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 12	339	+ 215	36½	6,971	+ 4,604

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, Sept. 17.		Price Wednesday, Sept. 24.		Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 24.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¼	¼	⅜	⅝		...	⅜	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.)	103	106	103	106	4 6 0	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	5 7 8	...	...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	102	105	102	105	4 5 10	...	...	...
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord	10¼	10⅝	10¼	10⅝	3 14 5	...	10 1/16	10½
20,000	5	3/6	Do. 7 per Cent. Preference	10¼	1 0⅝	10¼	10⅝	3 5 1	March and September	...	...
30,000	5	3/6	Calcutta Elec. Supply Ord. (1 to 30,000)	7	8	7⅛	8⅛	3 10 7	...	8⅛	...
10,000	5	...	Do. (30,001 to 40,000)	7	8	7	8		...	7⅛	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	108	105	108	3 14 8	...	10 3/4	...
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	9⅛	9	9⅛	5 5 3	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	6	5⅛	6	3 15 0	" "	5 1/8	5 1/16
40,000	5	..	Do. City Undertaking 4½% Cum. Pref.	4⅝	5⅛	4⅝	5⅛	...	...	...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	106⅛	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5⅛	5⅝	5⅛	5⅝	2 12 2	March	...	...
£140,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	9	10	9	10	5 0 0	February and August	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12½	13⅛	12½	13⅛	4 8 11	January and July	1 ⅞	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123	128	153	158	3 18 4	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 5 0	...	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8¼	9¼	8½	9⅜	4 4 3	...	9	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12⅛	11½	12⅛	4 16 0	March and September	12⅜	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	111	114	111	114	3 19 8	...	1 3	...
10,000	5	4/6	Folkestone Electricity Supply Co. Ordinary	6⅜	6½	6⅜	6½	3 12 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10½	11½	10½	11½	4 6 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6⅜	6⅝	6⅜	6⅝	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kenstn. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	105	108	105	108	3 15 0	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1⅜	2⅛	1⅜	2⅛	...	...	2	...
49,340	5	2/6	Do. 6 per Cent. Preference	4⅜	5⅛	4⅜	5	6 0 0	...	...	...
£350,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	96	99	96	99	4 1 2	Mar., June, Sept., Dec.	97⅛	96⅜
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15⅛	16⅛	15⅛	16⅛	4 4 10	April and October	16⅛	15 15/16
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	110	115	110	115	3 18 11	June and December	...	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99	102	99	102	3 9 2	...	101½	...
10,852	10	6/0	Notting Hill Electric Ordinary	13⅛	14⅛	13⅛	14⅛	4 2 9	March	...	...
12,194	5	2/6	Oxford Electric Ordinary	5	6	5	6	4 3 4	"	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	98	101	98	101	3 19 7	...	...	...
300,000	1	...	Rand Electric	⅜	⅝	⅜	⅝	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	103	105	103	105	4 7 0	April and October	...	...
40,000	5	5 0	St. James's and Pall Mall Electric Ordinary	15	16	15	16	4 10 8	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	" "	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98	101	98	101	3 9 7	...	99½	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2½	3	2⅝	3	...	...	...	...
30,000	5	..	Urban Electric Supply Ord. (£3 paid)	2⅞	3⅛	2⅞	3⅛	...	...	3	...
30,000	5	..	Do. 5% Cum. Pref.	2⅞	3⅛	2⅞	3⅛	...	...	3⅛	...
110,000	5	5 6	Westminster Electric Supply Ordinary	11	12	11	12	4 11 8	March and September	11⅞	11½
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	6	6¼	6	6⅛	3 16 11	...	...	...
			TELEGRAPHS.								
£67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98	102	98	102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅜	4⅛	3⅜	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£7,878,840	Stock	15/0	Anglo-American	47	50	47	50	5 17 0	Feb., May, Aug., Nov.	48	...
£3,105,580	Stock	30/0	Do. Preferred	92	94	91	93	6 3 2	" "	92⅛	92½
£3,105,580	Stock	2/0	Do. Deferred	7⅜	8	7⅛	7⅜	1 5 9	" "	7⅜	7 1/8
$13,333,300	$100	$12	Commercial Cable Capital Stock	160	170	160	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	95	97	95	97	4 2 6	" "	96½	95½
16,000	10	4/0	Cuba Submarine Ordinary	5½	6⅛	5½	6½	6 13 4	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 6	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅛	3⅛	2⅛	3⅛	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7	8	7	8	6 5 10	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞	103⅞	99⅞	103⅞	4 7 8	January and July	...	...
60,710	20	4/0	Direct United States Cable	10⅜	11	10⅜	11	5 18 2	Jan., Apr., July, Oct.	...	...
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	100	103	100	103	4 7 10	June and December	...	...
£4,000,000	Stock	65/0	Eastern Ordinary [to 1,200) (red.)	124	129	124	129	5 8 6	Jan., Apr., July, Oct.	127½	124
£1,555,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	90	93	90	93	3 15 8	" "	92⅛	90½
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108	111	108	111	3 13 0	May and November	108	...
300,000	10	2/6	Eastern Extension	12¼	12⅝	12⅝	12⅝	5 9 10	Jan., Apr., July, Oct.	12⅝	12¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 0	February and August	108	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 18 7	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞	104⅞	101⅞	104⅞	3 17 6	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen	25	27	26	27	5 11 1	January and July	...	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (with n Nos	99	102	100	103	4 7 5	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	38	42	38	42	5 19 1	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	101	105	101	105	5 14 3	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3⅜	4⅛	3⅜	4	...	...	...	...
30,008	2½		West Coast of America	⅜	⅝	⅜	⅝	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	97	100	98	101	3 19 7	January and July	...	...
88,321	10	...	West India and Panama	½	⅝	½	⅝		May and November	...	...
34,563	10	£/0	Do. 5 per Cent. 1st Pref.	4⅜	5⅛	4⅜	5⅛	11 8 6	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3	4	3	4	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	January and July	...	...
207,930	10	3/0	Western Telegraph (late Br zil'n Submarine)	11⅜	12⅛	11⅜	12⅛	5 14 3	Mar., June, Oct., Dec.	12⅛	11⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 10	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	98	101	98	101	3 19 9	...	100⅛	100½
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3⅜	4	3⅛	4	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1,0	2/0	1,0	2/0	15 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	⅝	½	⅝	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£1,983,333	Stock	6%	National Co. Preferred Stock	93	95	93	95	6 5 10	...	95	92½
£1,966,667	Stock	4½%	Do. Deferred Stock	55	57	55	57	7 17 10	..	57	55
15,000	£0	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	13	12	13	4 12 4	February and August	13½	...
10,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11	12	11	12	4 12 4	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	4⅞	5⅛	5 0 1	" "	5	4 15/16
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	96	99	96	99	3 10 10	June and December	96⅛	...
£600,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6	...	...	...
171,504	1	0/6⅔	Oriental	⅞	1⅛	⅞	1	6 0 0	April and October	...	...
58,000	5	4/6	United River Plate	4⅜	5⅛	4⅜	5⅛	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 16 2	June and December	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	6	5⅛	6	5 0 0	...	...	...
183,117	10	4/9	Globe Telegraph and Trust	9⅛	10	9⅛	10	5 5 0	Jan., Apr., July, Oct.	9⅞	9⅝
180,041	10	3/0	Do. 6 per Cent. Preference	13⅛	13⅞	13⅛	13⅞	4 7 3	" "	13⅞	...
17,789	8	4/0	Reuter's	6⅝	7	6⅝	7	5 14 3	April and October	...	...
11,108	£100 Cert	6%	Submarine Cables Trust	110	120	110	120	5 0 0	" "	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 17.		Price Wednesday, Sept. 24.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Sept. 24. Highest	Lowest
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
200,007	5	2/0	Anglo-Argentine Shares (1 to 200,007)	4½	4⅝	4½	4⅝	4 11 5	April and October	4⅝	4½
£320,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9	11	9	11	2 14 7	...	...	...
10,000	10	5/0	Do. 5% Cumulative Preference	9	10	9	10	5 0 0	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 2	...	...	...
15,000	10	4/0	Blackpool and Fleetwood Tramways	13	14	13	14	4 12 10	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3½	4	3½	4	...	...	3⅝	...
75,000	5	2/6	Do. 5% Cum. Pref.	4⅝	5	4⅝	5	5 0 0	...	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	103	106	103	106	4 5 0	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	20½	21½	20½	21½	3 14 2	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106	108	106	108	3 14 9½	February and August	...	...
30,000	10	4/0	British Columbia Electric Railway Ordinary	7	7⅛	7	7⅛	2 13 4	...	...	...
30,000	10	5/0	Do. 5% Preference	9	9½	9	9½	5 5 3	May and November	...	...
£260,000	40	4½	Do. 4½% 1st Mort. Debs.	103⅝	106⅞	103⅝	105⅞	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12½	13⅛	12½	13⅛	6 13 4	...	13⅛	12¾
100,000	10	6/0	Do. 6% Cum. Pref.	12⅛	13	12⅛	13	4 12 4	February and August	12⅝	12⅜
£500,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	125	128	3 18 1	...	127	126½
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝	1⅞	1⅝	1⅞	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	5	5⅛	5	5⅛	5 9 1	...	5⅛	...
27,500	5	10/0	Do. "B"	5	5⅛	5	5⅛	5 9 1	...	...	...
£310,000	Stock	5%	Do. 5 per Cent. Debentures	104	107	104	107	4 14 3	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	97	100	98	101	5 0 2	...	...	...
70,000	10	6/0	Calcutta Tramways	7⅞	7⅞	7⅞	7⅞	3 17 5	...	7 9/16	7 7/16
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	109	107	109	4 3 1	...	...	...
480,000	1	1/2½	Cape Electric Tramways Shares	2⅛	2⅜	2⅛	2⅜	6 14 9	...	2⅛	2 5/16
£1,810,014	Stock	4%	Central London Ordinary Stock	103	106	103	106	3 15 6	June and December	105	104⅞
£494,093	Stock	4%	Do. 4% Preferred Stock	105	108	106	108	3 14 4	...	108	106½
£491,993	Stock	4%	Do. Deferred Stock	103	106	103	106	3 15 6	...	...	...
£598,201	100	4%	Do. 4% Deb.	115	118	115	118	3 7 8	...	...	...
40,000	5	2/6	City of Birmingham Trams, Co. 5% Cum. Pref.	4⅜	5⅛	4⅜	5⅛	4 15 3	...	5⅛	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	5%	City and South London Railway Con. Ordinary	72	74	72	74	3 11 7	February and August	72⅝	7 ⅛
37,500	10	1/0⅝	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	" "	...	...
10,000	10	0/11⅛	Do. (60,001 to 70,000)	"		"		...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	131	128	131	3 16 6	" "	131⅝	...
£300,000	Stock	5%	Do. (1896)	126	129	126	129	3 17 6	...	...	...
£150,000	Stock	5%	Do. (1901)	121	125	122	125	3 19 7	...	124½	...
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	119	115	118	3 9 7	May and November	1 7½	116
80,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11½	12½	11½	12½	4 8 0	...	...	...
52,967	10	6/0	Do. 6 per Cent. Preference	14½	15½	14½	15½	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	96	99	96	99	3 10 8	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4⅜	4⅝	6⅛	4⅝	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	104	99	102	4 18 0	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8	9	8	9	3 6 8	...	8⅝	...
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	18½	18⅝	18½	18⅝	4 7 3½	" "	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	109	111	109	111	4 1 3	January and July	...	...
30,000	5	2/6	Isle of Thanet Elec. Trams and Light'g 5% Pref.	4½	4⅝	4½	4⅝	5 5 3	...	...	...
37,500	10	1%	Liverpool Overhead Railway Ordinary	4⅝	4⅞	4⅝	4⅞	2 4 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	9⅝	10½	9½	10½	4 17 7	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	99	101	99	1 1	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	11½	12	11½	12	4 3 4	...	11⅝	11⅜
30,999	10	2/3	Do. (£7. 10s. paid)	8⅜	9⅛	8⅜	8⅝	4 1 0	...	...	...
£665,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	108	110	109	110	3 12 9	...	109⅛	108
£169,659	Stock	18 0	Do. Prov. Certs. (£75 paid)	82	84	83	84	...	...	...	...
$3,500,000	$ 1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112	117	112	117	4 5 7	...	...	...
£60,000	100	4%	Montreal St'r't R'l'w'y St'r'l'g 5% Mort. Debs. (1906)	104	106	104	106	4 14 3	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	108	111	108	111	4 2 2	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3	4	7 10 0	May	...	...
£181,800	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	98	98	98	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd., 1st Mrt. Deb. Stk	101	105	101	103	4 16 5	...	103½	102½
18,824	10	8/0	Potteries Electric Traction Ordinary	8½	9½	8½	9½	4 4 3	...	9½	...
30,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	9	10	5 0 0	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108	111	108	111	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.							...	...
51,122	1	...	Do. 6% Preference (14/0 paid)						April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)						" "	...	...
480,800	Stock	...	Do. 4½% Debenture Stock (70% paid)						January and July	...	...
£540,800	Stock	3%	Waterloo and City Ordinary	90	93	90	93	3 4 6	June and December	93	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜	⅝	⅜	⅝	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	1/16	1/16	1/16	1/16	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	¼	⅜	¼	⅜	12 0 0	March and September	...	...
100,000	5	4/0	British Insulated Wire Ordinary	7½	7¾	7½	7¾	5 16 2	July and February	...	...
100,000	5	3/0	Do. 6 per Cent. Preference	5⅝	6	5⅝	6	5 0 0	January and July	5⅝	...
£250,000	Stock	4%	Do. 4½% 1st Mort. Deb. Red.	101	104	102	105	4 5 6	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	5⅝	6⅛	6	6⅛	4 13 0	...	6⅛	6⅛
£500,000	Stock	14,0	Do. 4 per cent. Mortgage Deb. Stock	103	105	103	105	...	...	104⅛	...
106,731	2	...	Brush Electrical Engineering	¾	1⅛	¾	1⅛	...	March	⅞	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1⅛	1⅜	1	1⅛	...	March and September	1⅛	1 1/8
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	100	103	100	103	4 7 7	March and September	...	...
£135,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	93	98	93	98	4 11 6	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15½	16½	15½	16½	4 10 11	" "	16	15⅝
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅞	6⅝	5⅞	6⅛	4 0 0	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109	113	109	113	3 19 8	November and May	...	...
1,650,000	1	0/0½	Castner-Kellner Alkali Co. (fully paid)	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	94	99	94	99	4 11 0	...	...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	9 2 0	March	...	...
35,000	3	1/0½	Crompton and Co. (Nos. 1 to 54,000)	2½	3	2⅝	3	6 0 0	January and July	2⅝	2½
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	101⅝	106⅝	101⅞	106⅞	4 14 4	" "	...	...
99,361	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜	⅝	⅜	⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1½	2⅛	1½	2⅛	...	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	74	78	74	78	5 3 0	June and December	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	78	83	78	83	6 2 10	...	...	...
50,000	5	4/0	Edmundson's Electricity Corporation Ord.	6⅛	6⅝	6½	6⅝	5 3 8	Half-yearly	6⅝	...
30,000	5	3/0	Do. 6% Cumulative Preference	6	6⅛	6	6⅛	4 12 4	...	6⅛	...
£40,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	107	110	4 2 1	...	10⅝	103
112,100	2	1/2½	Electric Construction Co.	1½	2	1½	2	6 0 0	January and July	1⅝	1⅝
31,390	3	2/0½	Do. 7 per Cent. Cumulative Preference	2½	3	2½	3	4 13 4	July	...	...
£ 82,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 19 1	January and July	...	...
122,985	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾	1⅛	¾	1⅛	...	...	...	...
35,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	10	10⅛	10	10⅛	4 15 3	...	10⅜	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	100	103	100	103	3 18 11	...	...	...
35,000	5	3/0	Henley's Telegraph Works Ordinary	16	17	16	17	4 14 2	February and August	16⅝	16½
35,000	5	2/3	Do. 4½ per Cent. Preference	5½	5⅝	5⅛	5⅝	3 18 3	" "	...	...
£45,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	100	113	03	113	3 19 8	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½	21½	20½	21½	4 13 0	" "	21½	...
£200,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	103	100	103	3 18 5	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½	15½	14½	15½	6 9 0	July	...	...
27,350	12	12/0	Telegraph Construction and Maintnce.	38	41	38	41	5 17 0	March and July	3⅜	3⅜
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	January and July	102⅞	...
66 666	5	3/0	Willans and Robinson Ordinary	...		...		...	April and October	...	...
66 666	5	3/0	Do. 6 per Cent. Cumulative Pref.	...		...		...	" "	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee have refused to grant these.

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NOTES.

WE have received from Dr. R. T. GLAZEBROOK, Director of the National Physical Laboratory, copies of the pamphlets which recently have been issued in connection with the testing work of the various departments of that institution. These "tests pamphlets" are admirably arranged, and they show that no time has been lost in organising the different sections of the laboratory. Naturally, in some of the departments requiring heavy apparatus, or more than usually delicate measuring instruments, there still remains much to be done. The arrangements for the Physics and Engineering departments are, as yet, only provisional, and the Executive Committee are desirous of receiving suggestions for the extension of the work and the modification of details.

IN the pamphlet devoted to the Physics department there are six sections, the first dealing with "Electricity and Magnetism," and the remainder with other branches of physics. What may be termed the standard tests are scheduled, the usual fee being stated. Thus, "for calibrating a bridge wire, per point tested," the fee is 1s.; or, "for testing insulation resistance of a cable at a definite temperature" the fee is 10s. Tests are arranged, among others, for accumulators, condensers, arc carbons, magnet iron and steel, &c., the fees being apparently fixed upon a very moderate scale. The department for engineering tests comprises tests of pressure and vacuum gauges, indicators and their springs, besides other forms of gauges, and, of course, engineering materials generally. A third pamphlet deals with the work at the Kew observatory.

UNLIKE the electricity works of municipal corporations, the supply system of the Midland Electric Corporation for Power Distribution has commenced operations quietly and without any official inauguration. As a matter of fact, the works are still in a somewhat incomplete state, and the supply initially is to one consumer only—viz., the Wolverhampton and District Electric Tramways. The company has made provision for a large and varied load, however, and the fact that this is not yet available detracts little from the detailed description of the power station plant which we publish in this issue.

ONE of the most interesting parts of this plant is the new Ferranti switch gear, employed for the first time at these works. The Ferranti high-pressure switchboard, with its cellular construction and the absence of any back or dangerously-exposed parts, has been widely appreciated in this country, and it has, in fact, become almost the standard in alternating-current stations. On the other hand, the switch gear for extra high pressures has so far been of different pattern in almost every extra high-pressure supply station that has been erected. Our readers will, therefore, study with interest our detailed description of the new Ferranti gear which, although embodying the advantages of the cellular, backless and single-pole construction, is at the same time applicable to pressures as high as any which are likely to be required in this country, and remains almost as compact as the ordinary Ferranti board.

ONE matter must not be lost sight of, however. Although the new switch gear bids fair to be successful from a purely engineering point of view, it is evident that its construction, even when it is standardised and made in quantities, is likely to be far more costly than the majority of high-pressure switch gears which have been seen in this country hitherto. The oil-break switch, for example, has no less than 20 electrical contacts in it, and in each case one element of these contacts is mounted on porcelain, so that the cost in the fitting must be considerable. On the other hand, it must not be forgotten that to a large extent our extra high-pressure practice must be different to that on the Continent. There the transmission lines are mostly overhead, while here they are underground, and their enormously greater electrostatic capacity must have its effect on the construction of the switch gear. In the United States there are cases in which long underground cables are employed and extra high

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pressures, and there it has been the custom to employ the electro-pneumatic switches which have been described in our columns on one or two occasions. These must entail considerable expenditure both in their construction and installation, and as they have been adopted in some of the more modern generating stations in America, it would appear that it has been found necessary there to spend more on the switch gear than had at first appeared to be necessary from the experience with overhead extra high-pressure transmission lines. The question of first cost need, therefore, not necessarily stand in the way of the new Ferranti gear if otherwise it shows itself suitable for use in connection with the large power distribution schemes which are now being developed.

"ELECTRO-CHEMICAL INDUSTRY" is the title of a new American periodical, the first number of which is now before us. The industry with which it deals is one of comparatively recent growth, even among electrical industries, but it is also one which—perhaps more in the United States than in this country—has attained to great magnitude and importance. Niagara Falls largely explain this, the cheap power there obtainable being turned to good account in a large and rapidly-increasing colony of electro-chemical factories. A copiously-illustrated article on "Niagara as an Electro-chemical Centre" is one of the chief features of this first number, which also contains a variety of interesting notes and articles on its chosen subject matter. We cordially wish our contemporary a long and successful career.

EXPERIMENTS are being conducted in connection with metal mine development work, to ascertain whether ore chutes can be located by electrical means. A Paper on the subject was read by Mr. E. D. OWEN at the American Mining Conference last month. It would undoubtedly afford an immense security in prospecting and mine development if a body of metallic ore could be located without the present great cost of excavating in order to search for it. We fear, however, that electrical or other scientific methods of ore location will have to be improved far beyond existing means before it will be safe to put final confidence in them. The particular method which seems to have resulted in a measure of success in a copper mine is a method of electrical conduction. Wires are run over the surface, and the current is passed between two distant points through the ground. The presence of large bodies of ore is said to be indicated by low resistance. Other electrical methods suggest themselves, especially for underground testing in the levels, as, for example, the use of a suitable modification of HUGHES' induction balance. Unfortunately, ore that is quite payable is often of no higher electrical conductivity than the country rock in which it occurs. Nevertheless, as a preliminary test, some form of electrical method might prove effective, in which case it would undoubtedly save much of the expense of developing and opening out.

Mr. J. BROWN contributes a letter this week in response to our criticisms on his all-stations express system, on which he read a Paper before Section G of the British Association. We are glad to give publicity to his reply; but, at the same time, we do not think he has succeeded in showing that his invention, ingenious as it is, is not deserving even of severe criticism. This we hope presently to show more clearly. Before doing so we wish to remove a slight misapprehension from Mr. BROWN'S mind. He appears to think that our judgment of his system is based upon the necessarily imperfect model which he exhibited at Belfast. That is not the case. We are prepared to ignore altogether the model, and yet adhere to our former judgment of Mr. BROWN'S system as applied to actual railway working.

EVERYONE must appreciate Mr. BROWN'S desire to bring express and local train services on railways into better correlation: for that is the guiding principle in his system. The utter lack of correlation in this respect is the most exasperating feature of steam railway travel. Railway directors, indeed, appear to be oblivious to the necessity for anything of the kind. We believe that the advent of the electric railway will go far towards putting this right, but we do not think the method adopted will be that of Mr. BROWN'S all-stations express. Without piling up detailed criticism, we will cite one individual condition which is alone sufficient to condemn Mr. BROWN'S system *in toto*.

LET it be supposed that a length of railway is equipped for working on Mr. BROWN'S system. We will assume that it is working quite perfectly at a particular section between two stations; the local car is speeding along, with the express train gently catching up to it at full speed. The science text-books and Mr. BROWN tell us that these two bodies, having practically the same velocity, &c., "are relatively at rest." This pious axiom ignores the presence of that huge body—the earth—which has a large relative velocity. All may go on happily so long as the car and train keep up their condition of relative rest. But let us suppose that the motorman on the car in front suddenly discerns a sleeper laid across the track, or some other similar defect. What is he to do? He is between the devil and the deep sea. Text-book notions of "relative rest" are a mockery to him. If he goes on he must be wrecked by the faulty track; if he applies his brakes the theoretically harmless train behind him will speedily be his destruction. How does Mr. BROWN propose to frame his traffic regulations to meet such a contingency?

Charge of Criminal Libel.—At the Mansion House (London) on September 19th Sampson Morgan was committed for trial at the next ensuing Sessions at the Old Bailey on five separate charges of libelling "The Electrician" Printing and Publishing Co. (Ltd.) and others. Bail was allowed in two sums of £100.

Royal Society.—We understand that Dr. Ludwig Mond has given £6,000 towards the cost of the international science catalogue.

Wireless Telegraph Conference.—It is stated that the international conference on wireless telegraph matters proposed by Germany, has been assented to by all the countries interested, and that the conference will probably take place shortly in Berlin.

Personal.—Mr. E. May, Controller at the Central Telegraph Office, St. Martin's-le-Grand, London, retired from the service on Tuesday on a pension. Mr. May has been connected with the telegraph office over 50 years, and when the Government took over the telegraphs in 1870 he was appointed deputy controller, and in 1898 succeeded Sir Henry Fischer as controller.

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Venezuelan Revolution.—The continuance of internecine troubles in Venezuela has led that Government to take a somewhat drastic step, inasmuch as the cable of the Compagnie Française des Cables Télégraphiques has been cut between Maracaibo and Curaçao, a censorship established at all the offices of the company in Venezuela, and the superintendent and staff have been put into prison. Vigorous representation was at once made to the Venezuelan Government authorities by the French Government on behalf of the company, and we now learn that the superintendent has been released.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
St. Lucia—Grenada	May 9, 1902
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Santa Cruz—Teneriffe	July 7, 1902
Puerto Plata—Martinique	July 10, 1902
Anjer—Kalianda	Aug. 2, 1902
Guantanamo—Mole St. Nicholas	Aug. 5, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Gibraltar—Tangiers	Sept. 19, 1902
Maranham—Para	Sept. 19, 1902
Maranham—Ceara	Sept. 19, 1902

Obituary.—We regret to announce the death of Mr. Fred Bathurst, which occurred suddenly on Saturday last from heart failure, following on an attack of asthma, to which trouble Mr. Bathurst had been subject for many years. He was a pupil of the City and Guilds of London Institute at Finsbury, under Prof. Ayrton, and later joined the staff of Messrs. Woodhouse and Rawson, with whom his connection lasted for several years. At this date Mr. Bathurst interested himself largely with the subject of interior wiring for electric lighting, and partly in this connection paid a visit to the United States, where, however, he decided to remain, having obtained a position at the Edisons Company's works in close connection with the personal staff of Mr. Edison himself and with his laboratory experiments. Some time later he was introduced to a firm who were exploiting a system of interior conduit for wiring, and, after negotiating, brought back the agency for this system to England and worked hard to make it popular. Mr. Bathurst read a Paper on "The Electric Wiring Question" before the Institution of Electrical Engineers in 1895, and occasionally spoke at the Institution on this subject. For a Paper read before the Society of Arts on "Prevention of Fires due to Leakage of Electricity" in 1897 he was awarded a gold medal and the Fothergill £25 premium.

Dessolle's Process of Copper Plating.—A description of this process, in which the electrolyte is projected under pressure against the metallic objects and the anodes, appears in the *Journal of the Society of Chemical Industry*. The metallic objects are first cleansed either in an acid bath or by means of a jet of sand driven by compressed air, which rapidly removes all impurities. They are next placed in a preparatory bath and subjected to the action of a current of 80 amperes per square metre. The composition of this "adhesion bath" is as follows:—Double cyanide of potassium and copper, four parts; potassium cyanide, 0·5 part; ammonia, 0·5 part; and water, 94 parts. On leaving this bath the objects are carefully examined, and any trifling holes in the deposit stopped with solder, or, if larger, with spongy tin obtained by electrolysis. They are next immersed in the principal bath, which has the following composition:—Crystalline copper sulphate, 12; free sulphuric acid (66deg), three; and water, 85 parts. Jets of this liquid are driven against their surface and that of the anodes. This effects a removal of gas and impurities from the bath and enables a strong current to be used, so that a perfectly smooth deposit of copper is obtained. In Dessolle's installation a current with an amperage of 750 is employed, and a deposit of $\frac{1}{10}$mm. obtained in 1½ hours, whilst this speed is stated not to have any prejudicial effect upon the quality of the deposit. The temperature is maintained at the required degree by means of steam jets—viz., at 50°C. in the adhesion bath, and at 35°C. in the final bath. The electrolyte projected by the jets falls into a central tank below, whence it is raised by means of wooden pumps to a reservoir fixed at a height of 5 metres above the level of the bath, and falls through the jets again under considerable pressure. Finally, the plated articles are dried and polished in the usual manner. The price of plating metals with a good deposit of copper does not exceed 2fr. per kilogramme of deposit, but the economic advantage of the Dessolle process is that there is perfect adhesion of the deposit, which can be made thinner and yet be durable.

New Cable-repairing Steamers.—On September 4th there was launched from the Elswick yard of Sir W. G. Armstaong, Whitworth & Co., a new cable-repairing steamer, the "Restorer," one of the two new vessels which are being built and equipped for the important submarine telegraph service of the Eastern Extension, Australasia and China Telegraph Co. The "Restorer" is a spar deck steamer, 377ft. by 44ft., with overhangs fore and aft for the convenience of cable sheaves. When loaded with 1,800 tons of cable, and carrying her full complement of fuel, &c., she will have a 21ft. mean draught. She is provided with four cable tanks, all designed and positioned in accordance with the best experience of this class of vessel. The "Restorer" is designed for a speed of 14½ knots on an extended trial. She is a twin-screw vessel, with triple-expansion engines, built and fitted by the Wallsend Slipway and Engineering Co. Special attention has been given to the quarters for the captain, officers, and the large electrical staff which the vessel is intended to convey. Capt. G. Pattison, Mr. P. L. Isaac and Mr. A. W. Gibbs represented the company at the launching of the "Restorer."

To-morrow (Saturday) the second of the new steamers which the Eastern Extension Company are adding to their fleet will be launched from the yard of Messrs. Wigham-Richardson & Co. This vessel has been named the "Patrol," and her length is the same as the "Restorer"—377ft. by 44ft., and she haa a mean draught when fully laden of 21ft. 3in. The "Patrol" is a twin-screw spar deck steamer, with triple-expansion engines, and is designed for a speed of 14½ knots. The weight allowed for cable machinery and gear in both the "Restorer" and "Patrol" is 70 tons.

Disturbances on Telegraph Lines Caused by a Three-phase Railway.—The Lecco–Colico–Chiavenna–Sondrio Railway, which has just been inaugurated in the north of Italy, is operated with three-phase current at 3,000 volts, the primary voltage being 20,000. The transmission lines consist of three wires in a vertical plane, and the secondary lines are two overhead trolley wires, while the rails form the third. When the first trial trains were run the disturbances on telegraph instruments were so intense that even communication had to be suspended, and in order to avoid these troubles the Adda river was made to form the return circuit of the telegraph lines. Later, some induction coils with closed magnetic circuits were connected in series with the telegraph lines, and finally a return circuit was added to each of these lines. The latter was the only remedy which proved successful and gave good results. Investigations revealed that all the troubles were caused by the secondary current at 3,000 volts, the primary current at 20,000 volts having no influence on telegraphic apparatus. Later, the telegraph engineers of the Italian Government combined all their returns in a single wire, but this idea was soon abandoned as the cable had to be of very large cross section. The wires were then doubled for all the telegraph circuits running along the railway lines. Over 700km. of wire was laid with all the necessary special work in crossing points, the poles were strengthened, and the whole work was accomplished in 16 days under the direction of an inspector of the Government telegraphs. Certain advantages resulted from the adoption of induction coils with closed magnetic circuit, but, on the other hand, it was found that the speed of transmission was considerably decreased. Therefore the use of the coils was not advisable with Wheatstone or Baudot apparatus. The practice of providing a separate return must not, however, be considered as a full solution of the question, because, although the change of single to double line has been possible in Lecco and Chiavenna, it would not be as easy in the main railway lines, where the number of wires is enormous, and where there are often two sets of poles, one being on one side and the other on the other side of the track.

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THE "MIDLAND" ELECTRIC POWER DISTRIBUTION.

The ideal system of economical power distribution when the engineer is dependent on coal for furnishing the energy in the first instance, is to have a power station at the pit's mouth and a supply district forming a circle whose centre is the power house and whose radius is the distance over which power can be transmitted economically by electrical means. This ideal should almost be fulfilled in the case of the Midland Electric Corporation for Power Distribution. Its power house is situated at Ocker Hill, near Wednesbury, in the heart of the black country. Although the company has not acquired a colliery of its own and planted the generating station actually at the pit's mouth, the position of the works enables coal to Midland has acquired its powers by provisional orders instead of by a private bill. Some of these provisional orders date rather far back, and, as a matter of fact, the company bought land for its generating station three years ago. Financial rather than engineering considerations have delayed the progress of the scheme, but now the power house, sub-stations and mains are far advanced towards completion, and the works and one of the sub-stations are already running on a small load.

The company's generating station is conveniently situated on the Birmingham Navigation Co.'s canal, from which a small basin has been diverted for the purpose of loading and

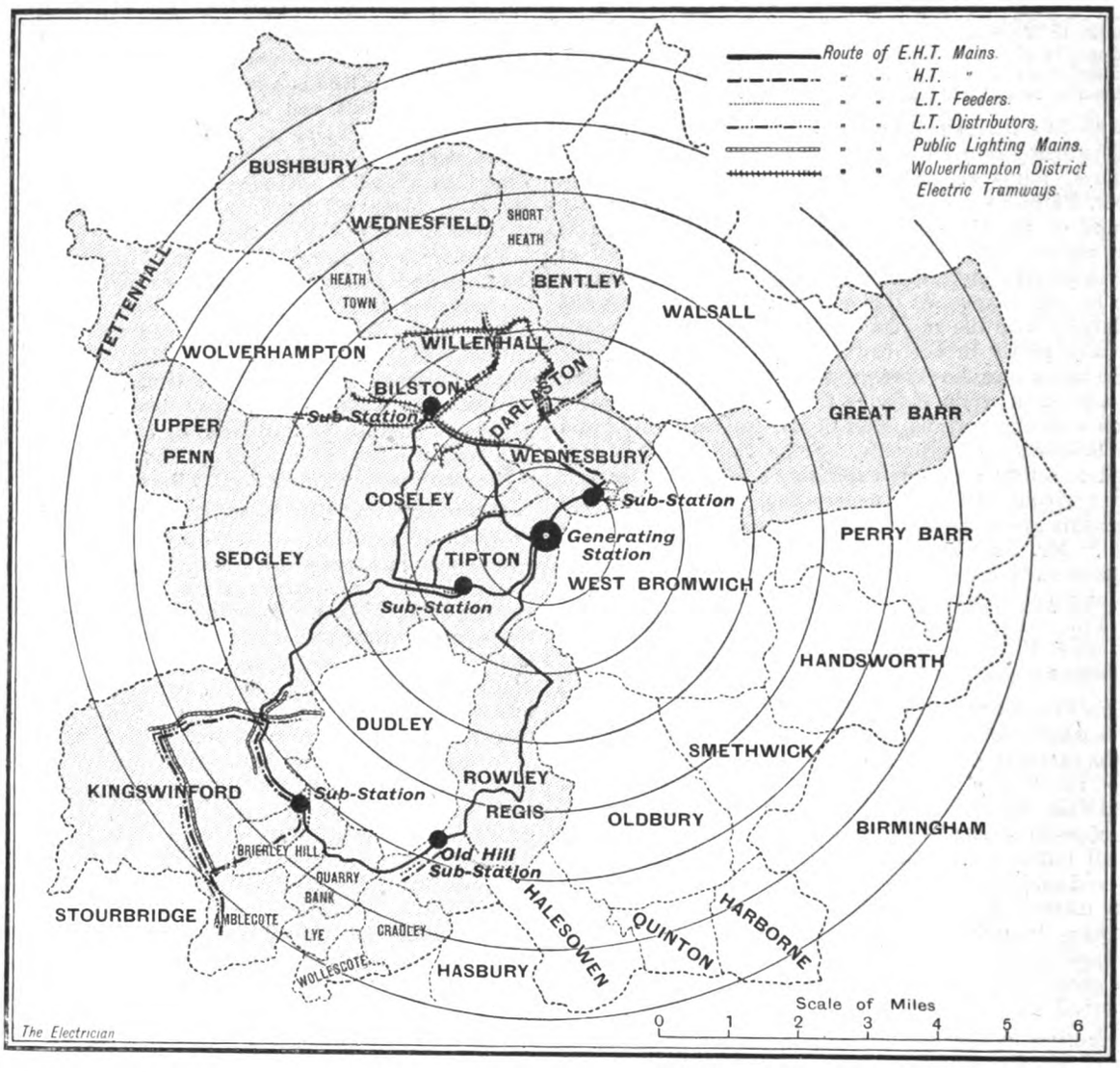

FIG. 1.—MAP OF THE MIDLAND ELECTRIC CORPORATION'S DISTRICT. (Only the shaded portions of the Map are at present acquired.)

be obtained at almost as cheap a price as anywhere in this country. The district which the company has acquired for its operations forms roughly a semicircle (see map, Fig. 1), with the power house at its centre, and contains, in addition to a network of tramways which takes its current from the company, numerous works which should before long abandon their present uneconomical steam driving in favour of electric driving. Finally, the radius over which the company supplies is about 7 miles, which may fairly be taken as the maximum over which underground electric power would be economical in view of the cheapness of coal all over the district.

Contrary to the practice of other power companies, the unloading barges directly to the coal conveyor; this basin is large enough to take eight barges of normal size, being 180ft. long by 32ft. wide. A branch line of the London and North-Western Railway also runs along one side of the works site, and it is proposed to make a siding in connection with it. The arrangement and dimensions of the buildings are apparent from the cross section and plan shown in Figs. 2 and 3, but it may be added that, owing to the shifty nature of the ground, special attention had to be paid to the foundations, which are of cement, strengthened with old rails. In some parts it was necessary to go down 40ft. in order to secure reliable foundations.

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The coal-conveying plant, seen in Fig. 4, includes a Hunt chain conveyor and a coal and ash elevator. The coal is loaded directly from the barge by a skip, which is then lifted by a two-phase motor and automatically tipped into a large hopper. Thence it drops into a second hopper just above ground level and this feeds it into the ascending buckets of the chain, and it is carried to the bunkers over the top of the boiler. The buckets on their return journey pass through the ash tunnel beneath the boilers and carry away the ashes from the ash pits. Owing to the fact that the elevator and coal and ash hoppers have been placed on the opposite side of the basin to the boiler house, without a corresponding alteration in the standard design of the Hunt elevator and conveyor, the ashes cannot be discharged simultaneously with the charging of the coal into the bunkers, as the rising side of the bucket chain carries both coal and ash. The conveyor can deal with from 400 to 500 tons of slack per day, and the bunker capacity is about 900 tons.

In the boiler house there are at present eight Babcock and Wilcox boilers arranged in pairs. Each boiler has an evaporative capacity of 12,000lb. of water from and at 212°F. The boilers are fitted with Babcock and Wilcox chain-grate stokers and superheaters. The usual arrangement of travelling shoots with weighing attachments is provided for filling the hoppers of the stokers. The chimney is of steel, 120ft. high and 9ft. 6in. diameter inside the fire-brick lining. Provision is made on the main flue for two fans to produce induced draught when this will be needed subsequently. The boiler pressure is 160lb. per square inch; and the steam is given 100deg. to 150deg. of superheat. The heating surface of each of the boilers is 4,780 sq. ft., and that of each superheater 454 sq. ft.

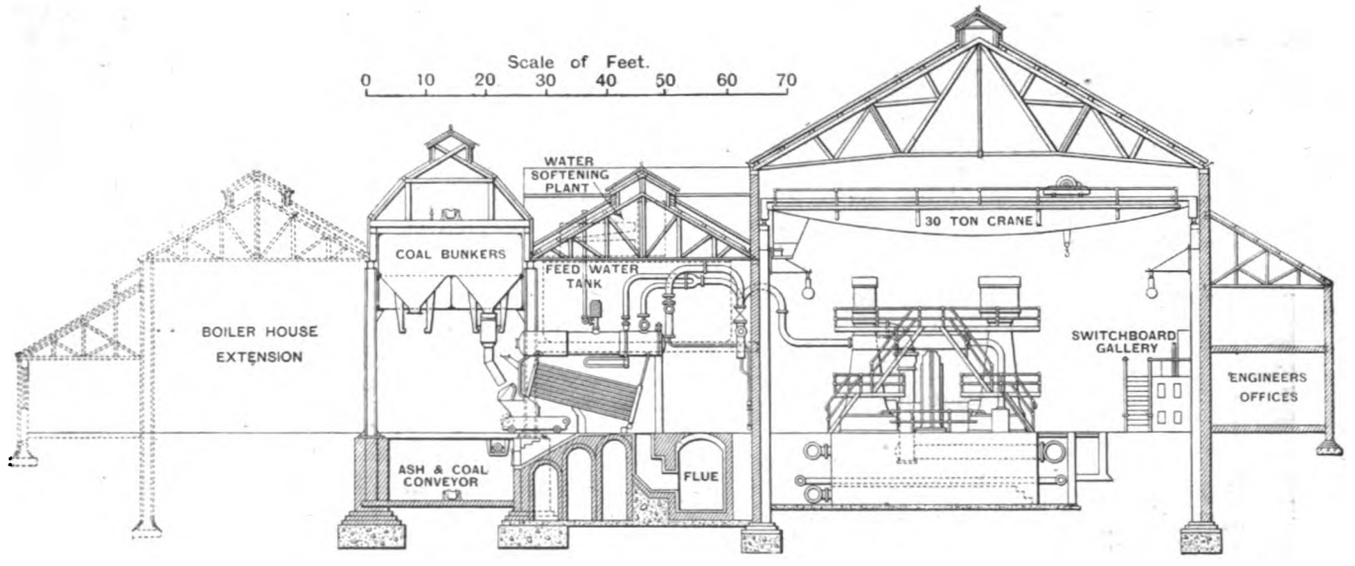

FIG. 2.—CROSS SECTION OF GENERATING STATION.

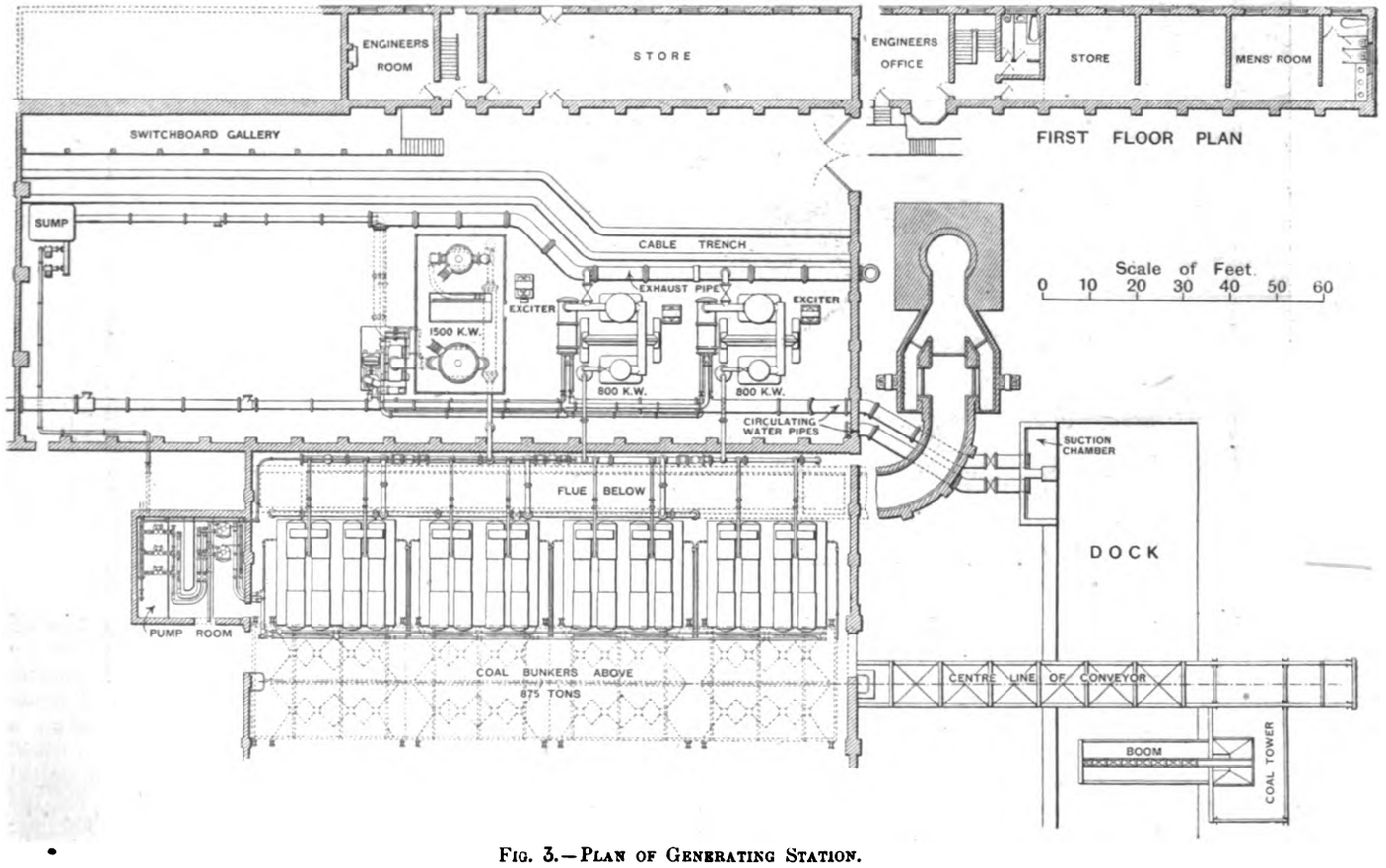

FIG. 3.—PLAN OF GENERATING STATION.

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So far the engine room contains only two 800kw. alternators and one 1,500kw. alternator, the latter being still under erection. There is space for two more sets of the larger size without prolonging the engine room, and there is sufficient land unoccupied to lengthen the engine room to three or four times its present size at least. The alternators generate two-phase current directly at 7,500 volts. All three are of Messrs. Ferranti's make, the two smaller ones being driven by Ferranti engines, and the larger one by a Yates and Thom engine. One of the smaller sets is seen in Fig. 5, and a drawing of the 800kw. alternator in Fig. 6. Both engines are of the vertical cross-compound type, the Ferranti having its usual slow-speed valve gear, and no re-heater between the high-pressure and low-pressure cylinder. The Yates and Thom engine will have a Corliss gear very similar to that described in connection with the engines at the Chatham and District Tramways power house (see *The Electrician* of July 4th, pp. 429 and 480) with the necessary difference in design necessitated by a vertical engine. The Ferranti engines run at 166 revs. per min. and the Yates and Thom engine at 90 revs. Each of the Ferranti 800kw. engines is to develop 1,300 I.H.P., and their main dimensions are:—High-pressure cylinder 25½in. diameter, low-pressure cylinder, 51in. diameter, stroke 21in. The reason for the low piston speed is, that the engines were designed to run at a considerably higher speed, and have been reduced in speed and output to suit the purchasers. According to Messrs. Ferranti's usual practice, the crank-shaft has only two bearings, these being spherically seated in the bedplates so that they cannot get out of alignment due to foundation settlement, unequal wear, &c. All the main parts of the engines are lubricated by oil under pressure supplied by valveless oil pumps driven from the crank shaft. The engines are fitted with automatic expansion, their speed being controlled by a high speed spring-loaded governor, which actuates a small valve controlling the supply of oil under pressure to a relay cylinder, this relay cylinder altering the point of cut-off in the cylinders. In addition, the engines are fitted with emergency governors positively driven from the crank shaft. These governors come into action at a higher speed than the main governors, and, if necessary, control the engines to a balance throttle valve.

As seen in Fig. 6 the dynamos differ but slightly in general design from Messrs. Ferranti's well-known moving magnet single-phase design. Their armatures are tunnel wound, the windings being cotton-covered and placed in micanite tubes. The magnets have cast-steel pole-pieces, and the magnet coils are wound with insulated copper strip on edge. The windings of the two phases on the alternators are kept quite independent. A frequency of 50 $\sim$ per sec. has been adopted. Each unit is capable of working continuously at 25 per cent. overload, with a power factor of 0·8. The flywheel consists of a central boss of cast steel shrunk upon the crank shaft. The rim of the wheel is of cast iron, and is in one piece. The spokes which connect the rim to the central boss are mild steel bolts screwed into the central boss. The method of building up is as follows:—The wheel is adjusted to come concentric with the shaft, the bolts being screwed up as tight as is possible by means of clamps on the centre portion of the bolts. The bolts are then heated so as to elongate them, afterwards screwed up whilst hot, and on cooling put a compressive stress in the rim of the flywheel. The wheel rim is then machined true, and the field magnets are bolted in position upon it. In the case of the 800kw. machines, the peripheral speed of the rim of the flywheel is 5,800ft. per minute, and the peripheral speed of the outer face of the magnets is 6,800ft. per minute. The stress in the cast iron due to the centrifugal strain put upon it by both the field magnets and its own centrifugal force amounts in the weakest section to 1 ton per square inch, assuming that no benefit is to be obtained from the initial compressive stress explained above. The stress on each bolt arm is only 3½ tons per square inch on the weakest section, to resist a centrifugal force of both rim and field magnets.

The 1,500kw. alternator is built on similar lines to the

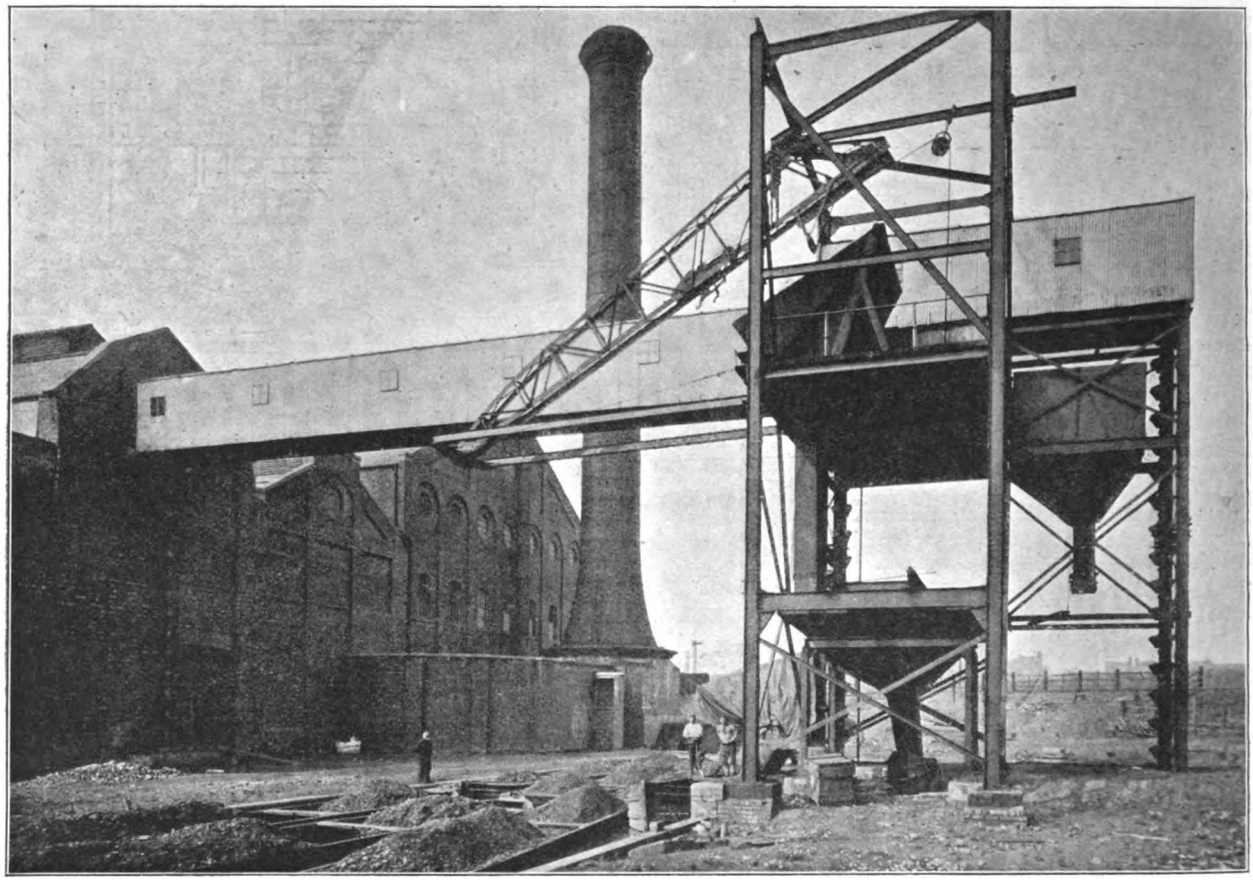

FIG. 4.—VIEW OF BUILDINGS, CANAL BASIN, AND COAL CONVEYING PLANT.

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800kw. as far as is shown in Fig. 6, but as in this instance both the engine and flywheel are supplied by Messrs. Yates and Thom the construction of the wheel is different.

On the two smaller sets, the exciters and the circulating and air pumps of the surface condensers are rope-driven from a pulley on the main shaft. The exciters are 100-volt, 60-ampere Parker machines, and one is seen in Fig. 5. Ropes from the same pulley on the alternator shaft pass underneath the engine room floor, over a jockey pulley, which drives the centrifugal circulating pump, to the pulley of the Edwards air pump. This arrangement brings the rope far too near to the alternator armature, in our opinion. As seen in Fig. 5, the alternator is at present running without guards, but these (which are made up of segments of thin cast iron) will shortly be put in place. The larger set does not drive its air and circulating pumps, these being separately driven by B.T.H. and Fuller-Wenström two-phase motors.

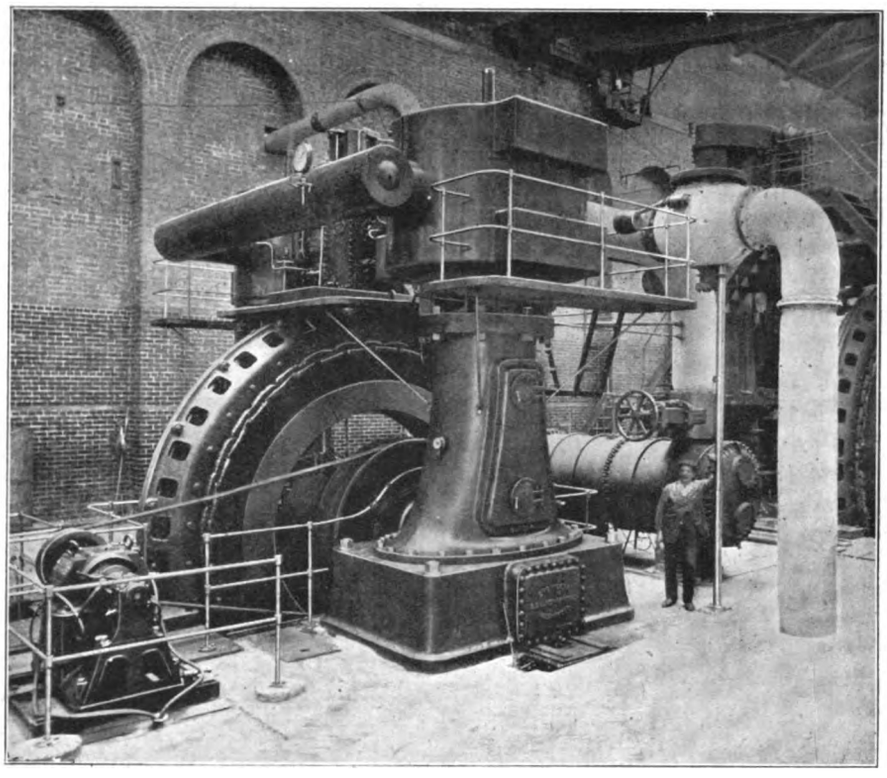

FIG. 5.—ONE OF THE 800KW. FERRANTI GENERATING SETS.

independent surface condenser of 20,000 sq. ft. cooling surface is placed behind each engine on stools standing on the engine-room floor. The centrifugal circulating pump, already alluded to, is 10in. diameter, and runs at a speed of 540 revs. per min. The cylinders of the Edwards air-pumps are 14in. diameter by 8in. stroke. They are driven at a speed of 180 revs. per min. The circulating water will be taken from the canal basin, and, as the canal company object to hot water being let into the canal, a cooling tower will be erected. Two Blake-Knowles pumps at the end of the engine room will pump up the water from a sump to the hot well through two Rankine Admiralty pattern filters. The hot well forms the central section of a cast-iron feed tank divided into three sections, each of 20,000 gallons capacity. There are three motor-driven Weir feed pumps in a pump room adjacent to the boiler house. The capacity of the filters is 10,000 gals. per hour each, and the feed pumps 19,000 gals. per hour each. The make-up feed is

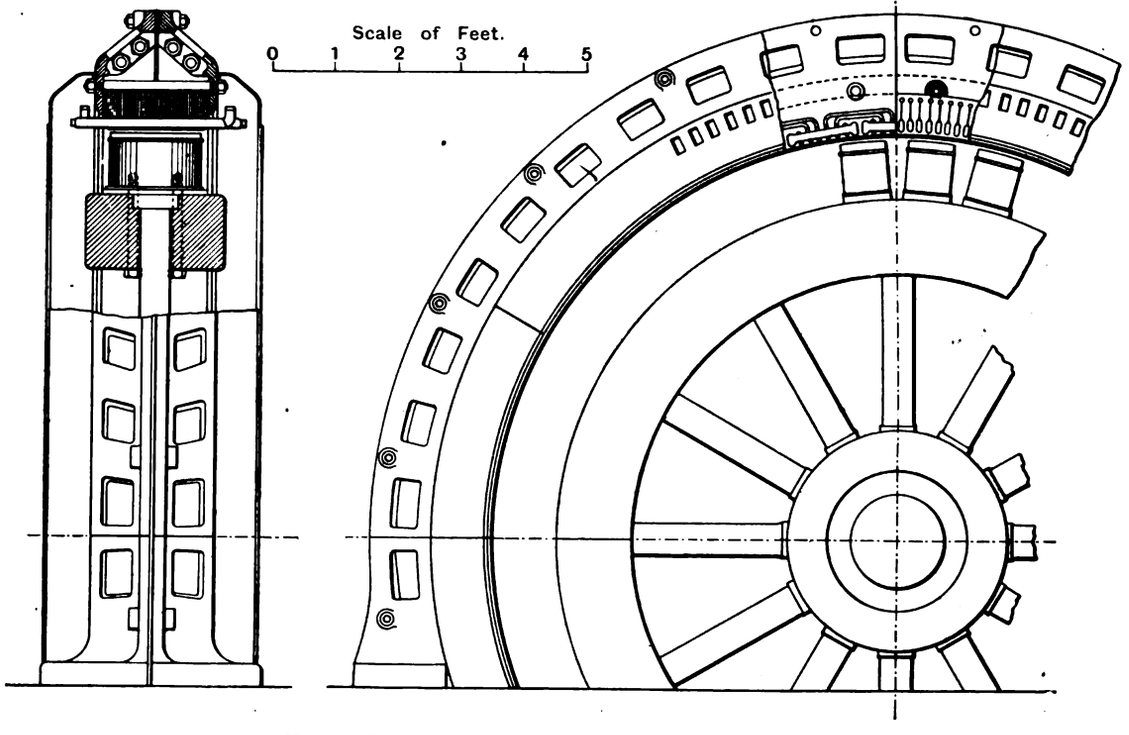

FIG. 6.—FERRANTI 800KW., 7,500-VOLT, 2-PHASE ALTERNATOR.

At present the engines exhaust into the atmosphere through a pipe, seen in Fig. 4, on the side of the building, the condensing arrangements not being quite complete yet. An taken from the public supply mains, and is passed through a Babcock-Wilcox water softener, in which it is mixed with soda ash, heated with live steam, and then filtered through

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wood wool. No economiser has been installed yet, but there is room for one at the back of the boilers.

There is a Higginbottom and Mannock crane spanning the engine room. It is worked by three two-phase motors, and is rated at 25 tons. Running the whole length beneath the engine room is a tunnel for cable, with openings to the machines and switchboard.

To electrical engineers who follow closely recent developments in this country, the most interesting part of the plant at the power house is the switchboard. The switch gear, which has been supplied by Messrs. Ferranti, includes oil-break switches of entirely new design, and a modification of the Ferranti oil-break fuse, both of which are employed for the first time at the "Midland" works, and we therefore give our readers full particulars of the construction of these pieces of apparatus. Fig. 7 is a general view of the switchboard, Fig. 8 is a photographic view of the new switch, fuse and the extra high-pressure ammeter, the switch being placed on its side, and Figs. 9 and 10 show in detail the construction of the switch and fuse.

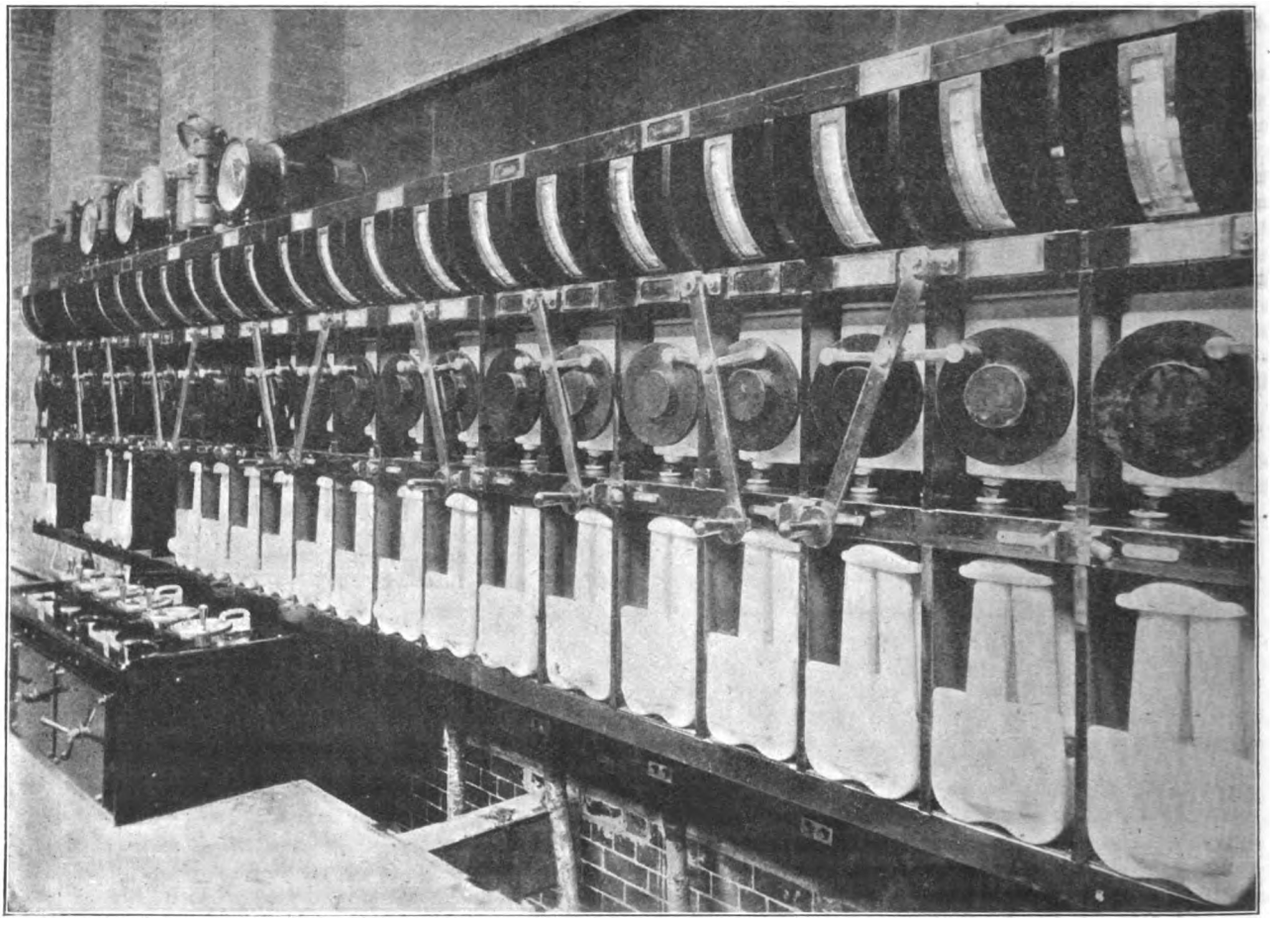

FIG. 7.—GENERAL VIEW OF EXTRA HIGH-PRESSURE SWITCHBOARD.

The switches are on the divided break system. The main contact outside the oil container breaks circuit first, and the final break is in shunt with this, and takes place at the seven blades within the oil vessel, each of the blades, together with the corresponding clip contact fixed to the interior of the vessel, constituting as it were a double-break switch, so that the spark is divided among 14 breaks in series and all under oil. In switching off, the handle, as it is turned to break the main contacts, winds up a spring, which releases suddenly, and rotates the ambroin sleeve carrying the contact blades. In switching on, there is a synchronising contact at half-cock, but the break does not pass through this intermediate stage. The box containing the oil and the shunt blades is of porcelain and is quite covered in, and the main break, being at the back of this and, therefore, at the end of the compartment of the switchboard containing the switch, is also quite inaccessible until the whole piece of apparatus is withdrawn, and contact is thus broken. To facilitate removal, the complete switch is provided with runners. The framework of the board is divided up into compartments similarly to the ordinary Ferranti board, and the two lugs protruding from the bottom of the oil container make contact with clips just as in the well-known Ferranti oil-break fuse for high pressures. Contact with the synchronising bar is made at the bottom in a more or less similar manner, and, as seen in the illustrations, the fixed contacts are part of the main body of the switchboard. It would appear that some difficulty might be anticipated in the accurate fitting of this contact, but so far everything has worked well, the only detail which has given trouble being the helical spring on the contact spindle, which appears apt to break. This can, however, only be a matter of the temper of the steel and is doubtless already remedied. Messrs. Ferranti inform us that the switch illustrated has a maximum capacity of 1,000kw., and that switches of this type are intended for alternating-current pressure between 7,000 and 15,000 volts.

The fuses are a modification of the well-known Ferranti oil type. In this case there are a number of breaks—four—in parallel, the fuse-wire in each case being bridged over the top of each pair of the upright porcelain tubes. The main body of the apparatus is made up of a porcelain holder, provided with a handle at the front for removing or replacing the fuse. Into this holder a gunmetal fitting is cemented, containing the necessary contacts for operating the fuse. A spindle, fitted with revolving drums, is placed in this casting, each drum having a clockwork spring fixed to it. A flexible copper conductor is also fastened to the drum at one end, and the other is provided with a suitable coupling, to which the fuse-wire is soldered. The porcelain tubes are clamped into the upper portion of the gunmetal castings by a suitable gland, the bottom of the tube being fitted with an iron plate having a slot cut in it for the passage of the flexible conductor. An

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insulating field rises between the sets of glands in order to prevent the passage of an arc across the nuts themselves as these form part of the high-tension circuit.

When made up in position the porcelain tubes just touch one another at the top, and across these joints the fuse wires are stretched and soldered to the ends of the flexible copper strip. Drawn out to their full extent these strips wind up these springs in the barrel on the spindle, and as soon as the fuse melts each strip is quickly pulled down into the oil, with which both the tubes and porcelain box are filled, and an arc is prevented. A lid extending the whole length of the fuse box covers up the fuse wires themselves, and also prevents splashing of the oil when the fuse blows. Each fuse is made up complete with jaws at the back for making connection to spring clips in the fuse panel itself, so that by these means the fuse may be readily withdrawn for examination or replacement. Where it is required to replace the fuse while in operation a short circuiting device in the shape of a plug can be fitted above the fuse itself. This, however, is not employed at the Midland power house, where a few reserve fuses are kept ready filled, so that the replacement only means the withdrawal of the one piece of apparatus and the insertion of another. The contacts at the back of the fuse are enclosed in separate insulating compartments which entirely prevent the possibility of any arc passing between the contact jaws themselves.

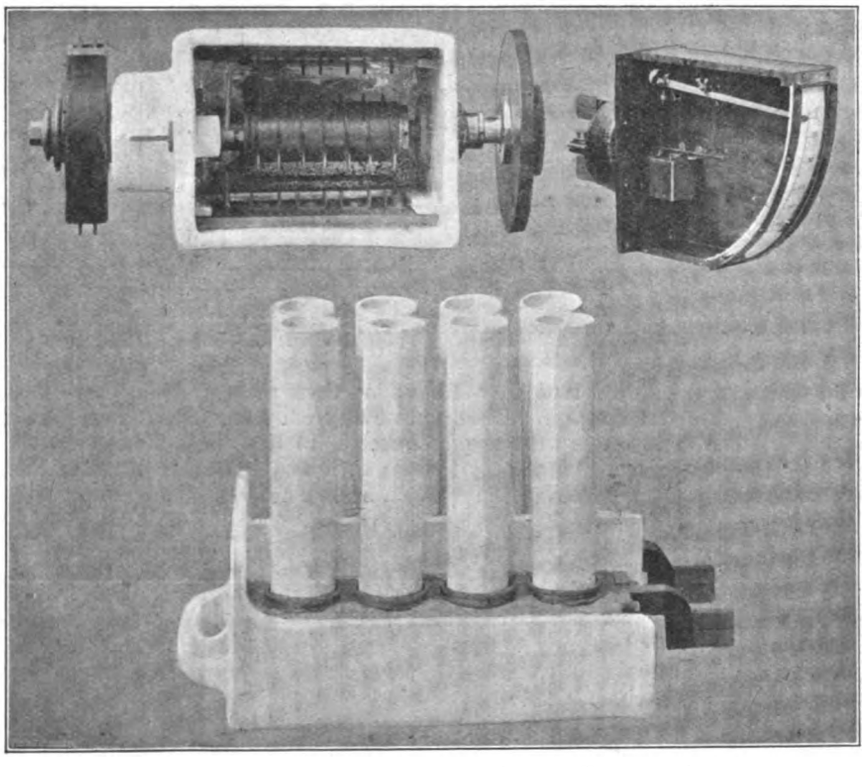

FIG. 8.—FERRANTI EXTRA HIGH-PRESSURE SWITCH, FUSE AND AMMETER.

The fuses at the Midland works have four pairs of porcelain tubes, but we understand that Messrs. Ferranti have now found that three pairs are sufficient for pressures of about 7,000 volts. The latest design differs slightly in some respects, therefore, from Fig. 10. This will lighten the apparatus somewhat, which will be a considerable advantage as the boxes are now very heavy for rapid handling. In cases where higher pressures and larger capacities are dealt with, the fuses are fitted with a greater number of tubes. In every case the apparatus is so constructed that it is impossible to receive a shock, even though an attendant may stumble against the board, as all high-tension portions are fitted at the back of the fuse, and in the case of the gland nuts the porcelain holder effectively prevents the possibility of accident from contact. The fuses have proved themselves quite efficient, and with them also the only trouble experienced at the Midland works has been due to the breakage of some of the springs of the fuses first sent out.

The ammeters, which are in the main circuit and not connected through transformers, are "edgewise" instruments in ambroin cases, and their simple link and dashpot mechanism is similar to that of the well-known Kelvin ampere gauges. As seen in Fig. 8, their coil is at the back, in a vertical plane parallel to the face of the board, and the contacts are arranged in accordance to the usual Ferranti switchboard system. The field regulating desks need no detailed description, as they are of the ordinary Ferranti design, except for the fact that their actual coils and contacts are below the gallery in the basement below the engine room. Messrs. Kelvin and White have supplied the electrostatic voltmeters, resting on foot terminals at the top of the board, as well as the ammeters already alluded to. To protect the electrostatic instruments in case of a short-circuit in them, a device is used which, although not new, is not widely known. It consists of a vulcanite handle with flat terminals pushing into contact clips, and resembling in shape the well-known "Bates" type of fuse. Instead of a fuse wire within the tube which forms the inner bar of the handle, however, there is a tube of water with electrodes sealed into the glass, and a small hole at the side near the top. If a short occurs, the water boils out, and the circuit is disconnected.

The two phases are quite independent on each dynamo, and a pair of lead-covered concentric cables leads up from each machine to the switchboard, rising vertically from below. The feeder cables are two-phase cables, however, with two cores and a common return concentric with the lead covering. These are also led up to the board, and just below the gallery there is a common earthed 'bus bar to which all the outers are connected. The cables end in small terminal boxes just below this bar, their outers as well as their lead sheathing being connected to the boxes, and short copper links connect the boxes to the outer 'bus bar. This is visible in Fig. 7. The switchboard is thus single-pole, the cables rising in the usual manner through the fuses, switches and ammeters. The two high-tension switches forming each pair are mechanically connected by a link as seen in Fig. 7, and are worked by the same lever; and the same type of switch, fuse and ammeter is used for connecting the feeder to the 'bus bar as for connecting the generator to the 'bus bar.

The 'bus bars rest on insulators on the top slate, and are completely covered in. The standard designs for this board allow of one to three bars being fitted, but in the case under consideration only two are required. Each bar is separated from its neighbour by ambroin division plates, and these are so arranged that it is impossible for any arc to start between the bars. An isolated plug of the expansion type is employed for connecting the panel below to the 'bus bar, so that at any time by withdrawing this plug each two-phase panel can be completely cut off from the bars for cleaning purposes, for inspection or for repair. Standing on the top slate in front of the 'bus bar chamber are the voltmeters and synchronisers, the latter being protected by oil-break fuses, and the former by the water resistance cutouts already alluded to. By the removal of the water resistance cutouts or the fuses the voltmeters and synchroniser can be removed from their terminals without fear of shock.

At present the "mains charger," which is to prevent the momentary rise in high pressure which a sudden switch-on would occasion, is not in position, and it is necessary to run up on the mains. The importance of this matter will be

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realised when it is mentioned that the capacity between each inner conductor and the other two conductors is 0·25 microfarad per mile in the largest cable, the longest feeder of this size is nearly 8 miles in length, and the working pressure is 7,500 volts. No arrangement has yet been made for applying the mains charger as a mains discharger when switching off,

There are two switchboards in addition to the main board above described, one the meter board and the other the works switchboard for distributing the current used for light and power on the works. The former is divided into two parts by a projecting horizontal shelf of black marble, the fuses protecting the meters being placed below the shelf. Above the

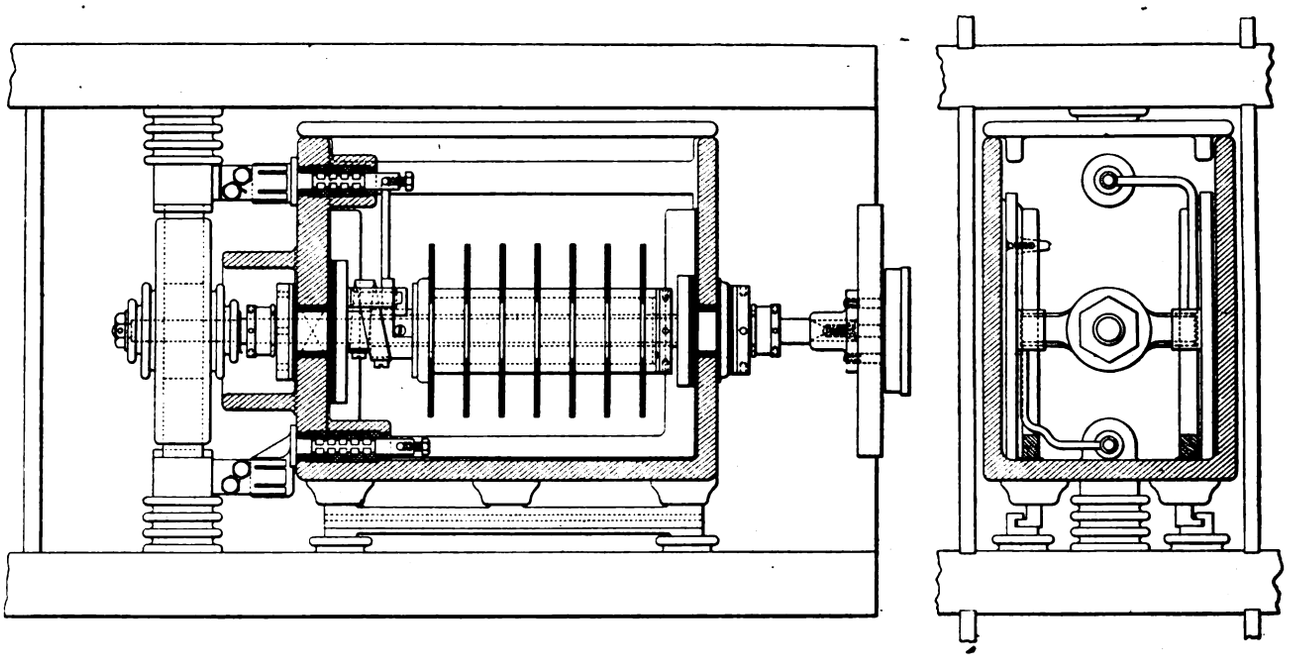

FIG. 9.—FERRANTI EXTRA HIGH PRESSURE OIL BREAK SWITCH. $\frac{1}{6}$ Full Size.

Messrs. Ferranti being of opinion, we believe, that there would be no undue rise in pressure when switching off. The mains charger is simply a water resistance in series with the cable, the plates dipping into the water being gradually lowered until the pressure on the feeder is the same as that

shelf are three pairs of Thomson meters to measure the energy delivered from each phase of each machine. They are each connected to the secondaries of two transformers, one in series with and the other in shunt with the mains from the machines. The low-tension power board is by Messrs. Kelvin

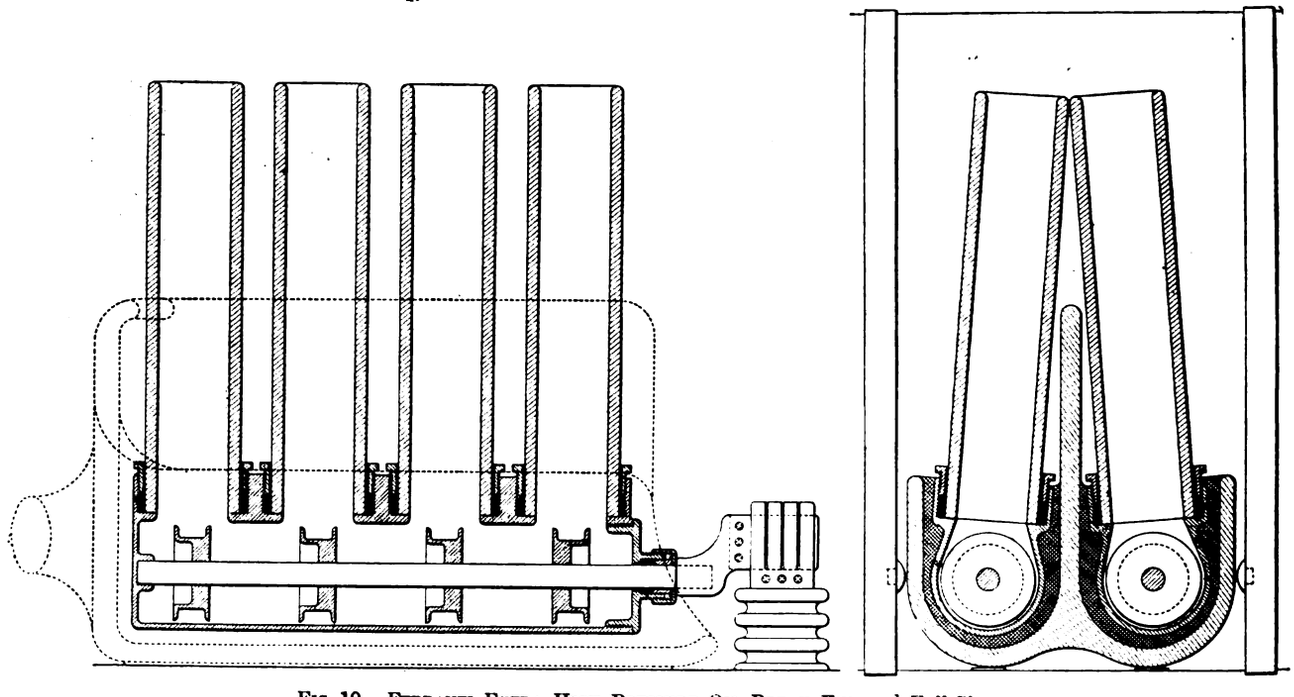

FIG. 10.—FERRANTI EXTRA HIGH PRESSURE OIL BREAK FUSE. $\frac{1}{6}$ Full Size.

on the generator. The synchronising contact of the feeder switches, which is, of course, not required for synchronising, is employed for this purpose, the cable being connected up through the water resistance when the switch is in this position. The principle of the mains charger was explained in *The Electrician*, Vol. XLIV., p. 784.

and White, and distributes two-phase current at low pressure. It is more or less a reproduction on a slightly smaller scale of the low-pressure, two-phase board at the sub-stations, one of which will be illustrated later.

(*To be concluded.*)

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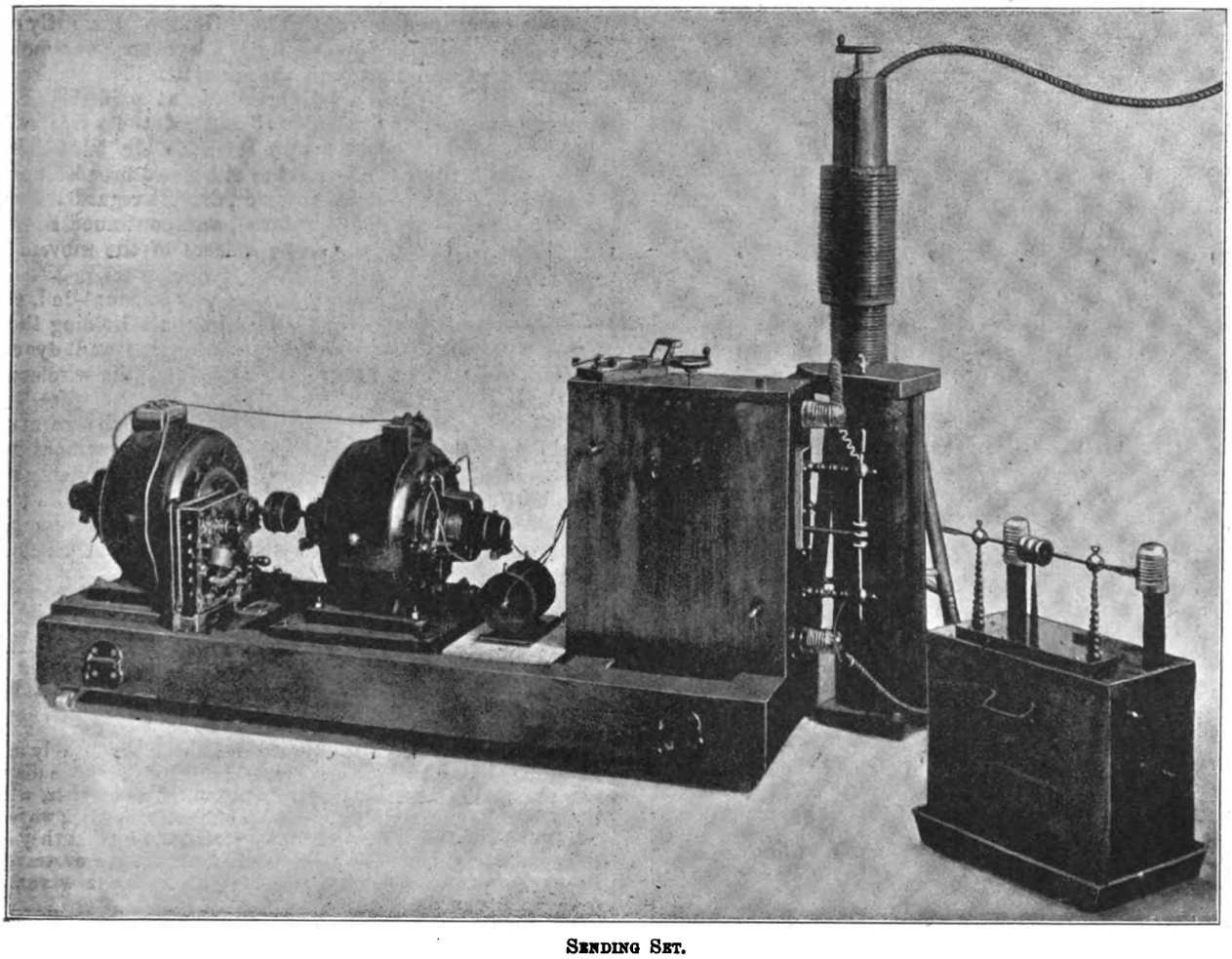
THE DE FOREST WIRELESS TELEGRAPH SYSTEM.

We are now able to give some further particulars of the De Forest Wireless Telegraph Co.'s system of wireless telegraphy, of which mention has been made from time to time in our columns. The most interesting part of the invention is the application of the Neugschwender anti-coherer principle to the reception of the signals. As the word coherer would be wrong to use for the receiving apparatus, and anti-coherer would be clumsy, the De Forest Company has adopted the name "responder," suggested some time ago in *The Electrician*. The construction of this apparatus and the principle underlying its action is described by the company as follows:—The device depends upon an electrolytic principle for its action. Between two electrodes of soft metal is placed a soft paste containing some electrolisable fluid, metallic particles, and some viscous material. Under the action of the local battery, minute conducting particles are torn off from the electrodes and made to bridge the gap. The resistance of the device is, therefore, ordinarily small, but under the action of the electric waves electrolysis is suddenly set up and minute hydrogen bubbles are generated at the cathode. This suddenly disrupts the conducting chains and greatly increases the resistance of the responder. The oxygen seems to combine with the anodic metal, and the hydrogen quickly combines with a depolarising agent mixed with the paste. The action is thus instant and automatic, and allows the use of a telephone for receiving instrument.

As a gauge of the sensitiveness of the responder, it is stated that it will respond to a $\frac{1}{64}$in. spark 45ft. distant with antennæ only 2ft. in height. The material in the gap should be renewed about once every third day, although in certain instances it has been in successful use for weeks without renewal.

In the De Forest sending apparatus no interrupters or coils are employed, but an ordinary alternating current. The set ordinarily used consists of a motor-generator (where alternating current cannot be obtained directly from the mains) delivering at 500 volts and 60 $\sim$ per sec. A special key breaks this circuit as rapidly as any Morse operator can send a wire. A speed of 48 words per minute (commercial message without coding) has, we are informed, actually been accomplished, and this, we believe, represents the record for speed of word transmission for wireless telegraphy. The alternating current from the generator is stepped up to 25,000 volts by a special transformer, and this is applied directly to the double spark-gap and a Leyden jar battery which is shunted to the gap. The capacity of this condenser is adjusted to suit the output of the generator used; with a 1kw. generator 6 or 8-quart Leyden jars are used in parallel. The terminals of the spark-gap are disc or mushroom-shaped instead of being spherical, and each of the two gaps is about $\frac{1}{2}$in. long. This arrangement, placed vertically, as seen in the illustration, is said to give a spark of exceptional clearness and power.



SENDING SET.

At the recent United States army and navy manœuvres, the signal corps installed two sets of De Forest apparatus, one at Fort Mansfield and the other on board the scout boat "Unique." These two sets were in working order a week before the manœuvres began, and continued to give uninterrupted service up to the end of the manœuvres. During this time the distances varied from 5 to 50 miles, but throughout, and under all conditions of weather, the system was in complete operation.

During the week of the manœuvres 72 official messages were transmitted from boat to shore. The "Unique" kept in constant touch with the movements of the enemy's fleet, and the De Forest operators at Fort Mansfield were continually in touch with them. These scout messages were trans-

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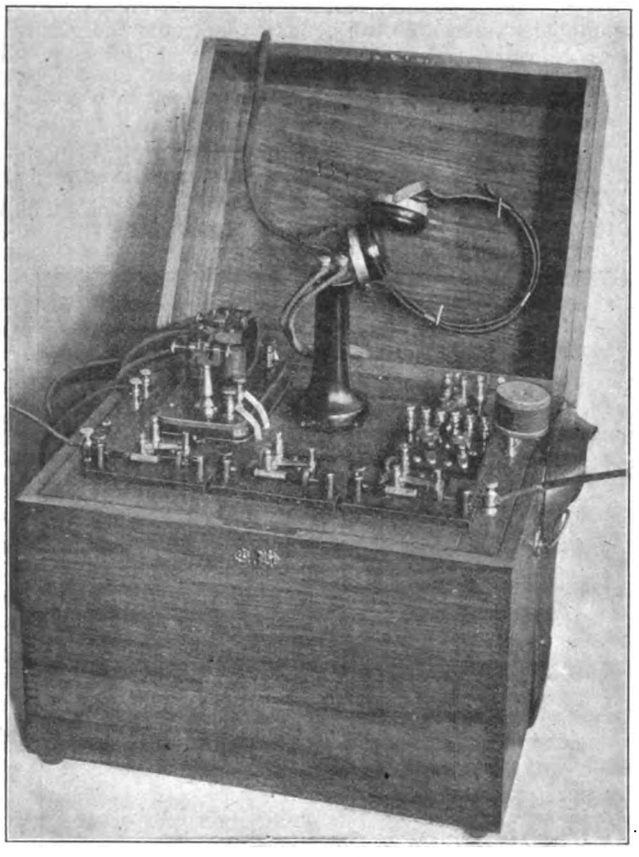
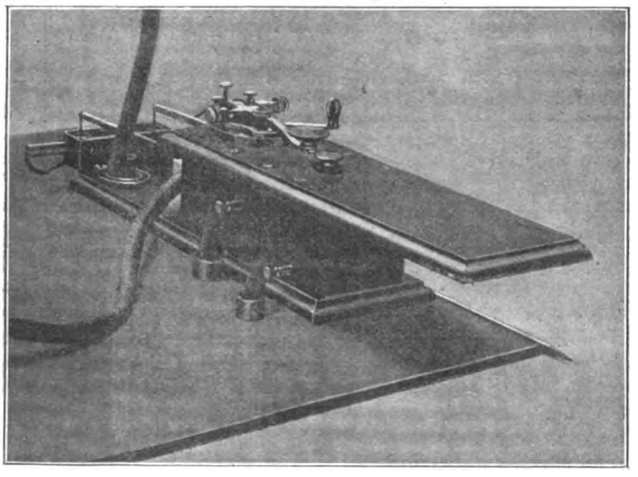
mitted by telephone to Col. Davis at the headquarters of the firing district at Fort Wright, to Gen. Greeley, chief signal officer, U.S.A., and to Gen. MacArthur at New London.

All in all 95 per cent. of the messages transmitted were received perfectly at the receiving station. The longest distance transmitted was on Thursday September 4th, when



Responder Set.

one of the operators in charge of the Fessenden apparatus on board a tug boat in Narragansett Bay sent the following message at the rate of 40 words per minute :—"Now is the time for all good men to come to the support of their party." Though unexpected, this was received by the De Forest operator at Fort Mansfield, and later verified by comparison



Transmitting Key.

with the Fessenden operators. The distance was between 50 and 60 miles, and the tug boat's mast was but 40ft. in height.

The apparatus at Fort Mansfield, and on board the scout boat "Unique," was identical; the sending apparatus included a small kerosene engine belted to an alternating-current generator, transformer, condenser and key. The antennæ on board the boat consisted of three parallel stranded wires 65ft. in length. That at Fort Mansfield was similar, and was hung from an 80ft. mast. The average speed of word transmission during the manœuvres was 20 words per minute, and no code or abbreviations whatever were used.

Throughout the manœuvres the performance of the De Forest system far exceeded the expectations of the army officers, and even of the De Forest Company as well. Gen. Greeley, chief signal officer, expressed himself as more than satisfied with the service rendered. The De Forest operators on board the scout boat "Unique" had a most exciting week of it. On three separate occasions the boat was "constructively" captured, sunk or completely destroyed by broadsides from the battleships. The navy soon learned that this innocent looking tug boat had on board apparatus of a nature most damaging to their plans, and were on the look out for her continually. On one night, during a dense fog, the battleship "Brooklyn" suddenly loomed up not 100yds. away from the tug. The "Unique" instantly showed her heels and began to send forth telegrams announcing the discovery of the fleet and the pursuit. The "Brooklyn" turned and gave her a full broadside at point-blank range, nearly knocking the "Unique" out of the water with the concussion. Not content with this, the big battleship gave chase, and turning, delivered her starboard broadside into the scout boat. The captain, however, did not regard the wireless outfit as "constructively" injured, and continued throughout the night to inform the army officers of the movements of the fleet.

On another night a severe storm was encountered, and the boat came near foundering. The topmast holding the aerial wires was swept overboard, and the engine and dynamo on deck drenched with sea water. This put the wireless outfit *hors de combat* for several hours.

The station at Fort Mansfield is now to be permanently established there, and the set from the scout boat will be stationed at some army post in the vicinity, probably at Fort Wetherill. This will mean a range of some 50 miles, mostly over land, and will be the first of a number of wireless installations at the various artillery districts of the United States army.

THE FESSENDEN WIRELESS TELEGRAPH PATENTS.*

BY A FREDERICK COLLINS.

Prof. Fessenden has not only evolved apparatus entirely different from that of his contemporaneous workers abroad, but has discovered new phenomena separate and distinct from those of Hertz, who gave to the world a physical demonstration of electromagnetic waves. The waves of Fessenden differ from those of Hertz "in that they are not complete waves, but only half-waves, and in that they travel over the surface of a conductor, and, hence, *unlike* Hertz waves, can be deflected from a straight line."

These Fessenden waves are described as "semi-free ether waves," and are yet different from those investigated by Lodge in metal conductors, in that they are not current waves. The portion of the Fessenden specification embodied in patent No. 706,746, relating to electromagnetic waves, is as follows :—"In the Lodge waves the electric energy is maximum when the magnetic energy is minimum, and all energy not absorbed by resistance losses is recoverable, while with the form investigated by me (Fessenden) the electric energy is a maximum at the same time as the magnetic, and none of the energy radiated is recoverable except by deflection. I have found that it is essential for the proper sending and receipt of these waves that the surface over which they are to travel should be highly conducting, more especially in the neighbourbood of the point where the waves are generated. I have found that this highly-conducting portion of the surface should extend to at least a distance from the origin equal to $\lambda/4$ of the wave in air, and in the direction toward the station to which it is desired to send the waves."

The arrangement shown in Fig. 1 is the physical method by which this is accomplished, and is, in Fessenden's terminology, a *wave-chute*. Briefly, 1 is the antenna or sending conductor, and 2, 2 is the grounded conductor leading across buildings and other obstacles to a $\lambda/4$ or more, beyond the limits of obstructions, when the terminals are earthed, as shown. The coils 3 and 4, forming guys from the mast, have a natural period of oscillation, different from

* From the *Electrical World* of New York.

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that of the sending conductor, and this, with the grounded conductor or wave-chute, eliminates outside interference of wave-lengths not in tune, and dissipates atmospheric potentials which ordinarily produce untoward effects in the reception of wireless messages.

Another novel feature of the antenna and oscillator system is due to the discovery of Fessenden—that if electromagnetic waves were produced in a medium having a specific inductive capacity and permeability to electromagnetic waves greater than air, the height of the antenna may be considerably reduced, since "the periodicity of oscillation is decreased compared with that of the same antenna in

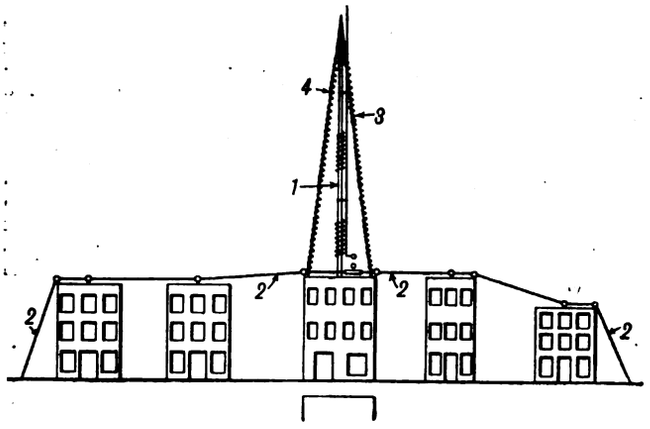

FIG. 1.—"WAVE-CHUTE."

air; and the radiation is, therefore, increased, giving the effect of a long conductor." The arrangement to accomplish this is quite simple. The antenna or conductor with the oscillator is placed within a second and tubular conductor, and this, in turn, is immersed in water or other liquid having an electric constant greater than that of air, and on which the emitted wave length depends.

In practice, Fessenden employs at the sending station a vertical wire, having a large capacity and low induction. The former can

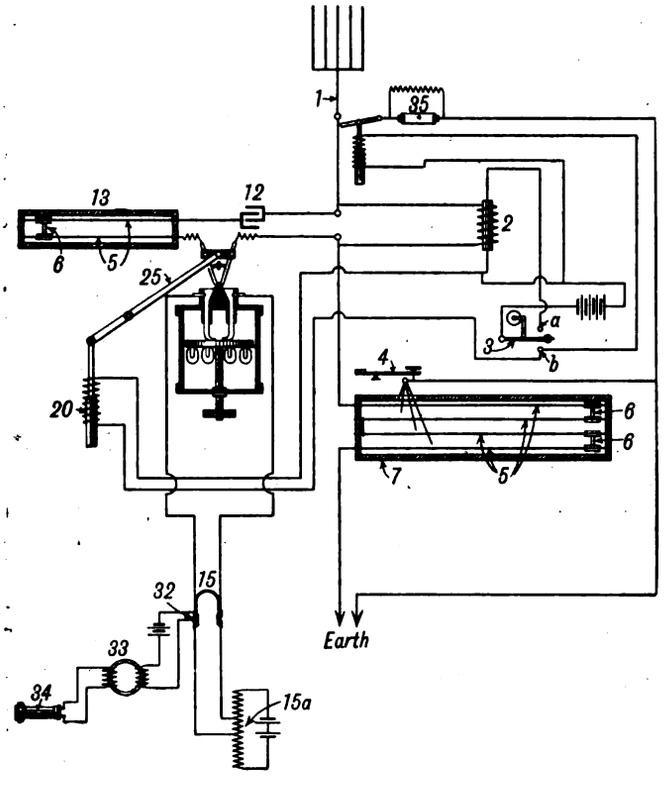

FIG. 2.—DIAGRAM OF SENDING AND RECEIVING APPARATUS.

be regulated by increasing the area of the antenna, and the latter by adding to the number of turns of wire connecting the vertical wire with the source of electromagnetic force.

One of the strongest points in Fessenden's apparatus is that by which he is enabled to send messages at an exceedingly high rate of speed—much higher than in the ordinary method of making and breaking the primary circuit; he has also found it possible to send signals over a much greater distance wiih a smaller expenditure of power than in any of the present systems. Again, a third factor is the absolute accuracy and certainty with which the receiver operates, enabling the code-messages and other difficult matter to be transmitted by wireless equally as well as by wire, and without fear of error.

The complete sending and receiving apparatus for accomplishing these extraordinary results is shown in Fig. 2. In the specification of his patent No. 706,742, Fessenden says: "In the practice of my invention I employ at each station a conductor, 1, connected to one of the terminals of the induction coil, 2, the other terminal being grounded. A switch, 3, is arranged in the controlling-circuit of the generator (induction coil) so as to permit of the generator being rendered inoperative when the apparatus is employed as a receiver. When sending, it is preferred that the generator should be kept continuously in action. When the generator is in continuous operation a key, 4, is employed by throwing the antenna out of tune, with the station to which signals are being sent. This is effected, not by making and breaking, but by short-circuiting, more or less, the tuning device, which is arranged in series with the conductor, 1, and preferably between the generator and the ground."

The tuning is accomplished by means of one or more pairs of parallel wires or strips, 5, forming a tuning grid, and one or more movable contacts, 6, forming an electrical connection with the wires of each pair. These wires are arranged in a box, 7, containing sufficient oil to cover the wires to a depth of an inch or so. This construction permits of proportioning the capacity and inductance so as to obtain a pure sine wave in order to give good resonance. To obtain pure sine waves the ratio of capacity to inductance per unit length should be the same as nearly as possible for all portions of the conductor. In this respect Fessenden's system differs sharply from those involving the use of coils suited to attain the greatest inductance with a given amount of resistance.

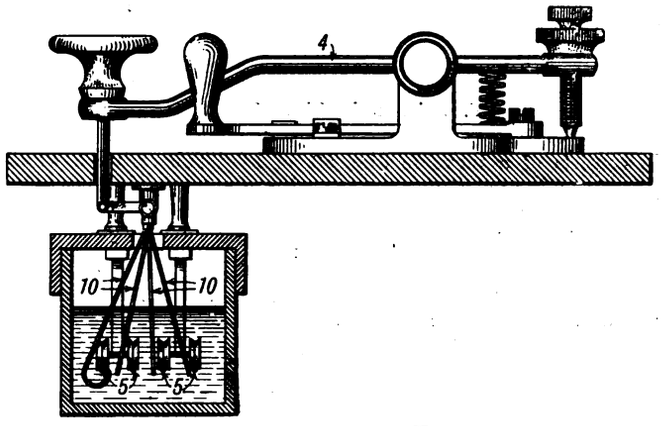

FIG. 3.—TRANSMITTING KEY.

In Fig. 2 the key represents an ordinary make-and-break device, but Fessenden prefers to operate the induction coil continuously, and by throwing the sending circuit out of tune, waves of a desired length only will be emitted. This is done by means of the key 4, shown in detail in Fig. 3; it is provided with a finger, 10, arranged to be pressed into contact with one of the wires, 5, by a movement of the key 4, which is connected with the ground, so that when the finger is in contact with one of the wires a shunt circuit is joined around a portion of the tuning-gird.

The receiving circuit consists essentially of the conductor 1 (Fig. 2), condenser, 12, a combined capacity and inductance forming a tuning-gird, 13; these are connected in series, but the condenser, 12, and the combined inductances and capacity, 13, are in shunt to the spark-gap, thus bringing them in parallel with the sending conductor.

In order to obtain speed, Fessenden has eliminated the cumbersome Morse registering device, and substituted the telephone receiver. This necessitates some form of a wave detector that is more rapid than the process of cohesion and decohesion. The Fessenden wave-detector is far more rapid in operation than a self-restoring coherer, and has the added advantage of utilising all the energy of the wave, whereas in ordinary coherers only that portion is used which is necessary to bring the potential to a certain critical value when cohesion takes place.

The Fessenden detector is shown in detail in Fig. 4, and its relation to the receiving circuits in Fig. 2.

This device is based somewhat on the principle of a bolometer, but instead of having a large radiating or absorbing surface in proportion to its mass, the Fessenden detector is just the reverse; so that the conductor losses will exceed the radiation losses; the heat capacity is exceedingly small, so that an infinitesimal amount of energy is required to heat it. To obtain these effects in practice, a short loop of silver wire, 14, having a diameter of 0·002in., and having a platinum core 0·00006in. in diameter is fastened to the leading-in wires, 16, which are sealed in the glass bulb, 17. The tip of the loop

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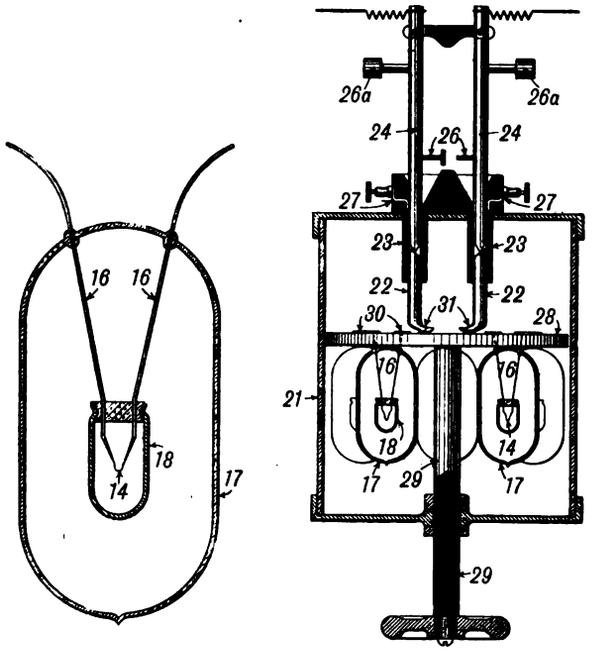
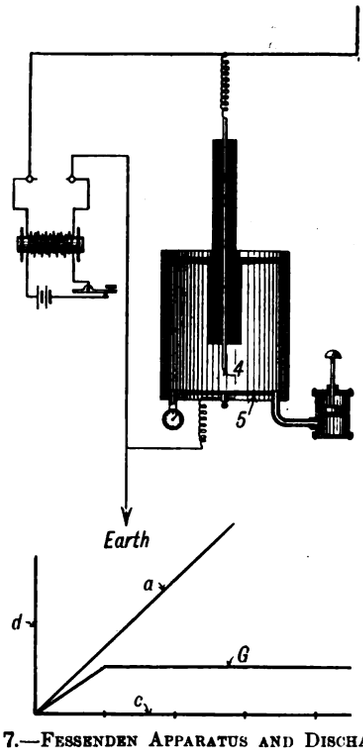
is immersed in nitric acid and the silver dissolved away, leaving the platinum exposed. To further decrease the loss of radiation by heat, the loop is enclosed in a silver shell, 18, as shown. The bulb may be exhausted to further increase the sensitiveness of the detector.

The device numbered 21 to 29, and shown in detail in Fig. 5, is a holder, arranged to contain a number of wave detectors just described.



FIGS. 4 AND 5.—WAVE DETECTORS.

It consists of a movable disc, 28, of hard rubber, upon which a number of the detectors are arranged, and any one of which may be brought into contact with the rods or leads, 23 and 24, and in case any one of the detectors becomes inoperative a fresh detector may be instantly substituted. The disc, 28, is supported by the rod 27; the whole receiving mechanism is then placed in the metal case 21, which offers additional protection to it. In Fig. 2, 20 and 25 represent an electromagnetic cutout, which becomes operative through the



FIGS. 6 AND 7.—FESSENDEN APPARATUS AND DISCHARGE CURVES.

switch *a b* 3, the lever 25 drawing the leading-in wires 24 in or out of contact, as the case may be. A double receiver-head telephone, 15, is connected in series with a pair of cables, 15*a*, having a slightly different E.M.F.

The call-receiver apparatus is shown in 32, 33 and 34, where 32 is a coherer, 33 a transformer, and 34 a telephone bell or other suitable indicating mechanism. To protect the apparatus from the untoward effects of atmospheric electricity, a coherer, 35, connects the antenna with the ground.

Instead of the wave detector shown, an earlier form employed by Prof. Fessenden prior to his leaving Allegheny may be substituted. It consists essentially of a silver ring resting on two knife edges of silver and a third edge of carbon. This forms a microphonic contact, and acts as a translator of electromagnetic waves into readable Morse. It is also the subject matter of a patent.

Another clever device is illustrated in Fig. 6, the object of which is to maintain a certain definite relation between the inductance, capacity and resistance, regardless of the potential employed. The disruptive discharge takes place in air under pressure, the spark-gap being formed between the part 4 and the plate 5. "In using this apparatus, the terminals are adjusted to about $\frac{1}{4}$in. apart when using a 12in. coil. By increasing the pressure the dielectric strength of the medium is increased, and the spark potential can be raised to almost any amount without any material loss in oscillatory power, as indicated by the line *a* (Fig. 7), whereas in air under ordinary pressure it is found that no matter how high the potential is raised, practically no increase in efficiency is obtained higher than given with a spark length, as indicated by the line G. The horizontal line *c* indicates spark potential in inches, and the vertical line *d* represents the radiation."

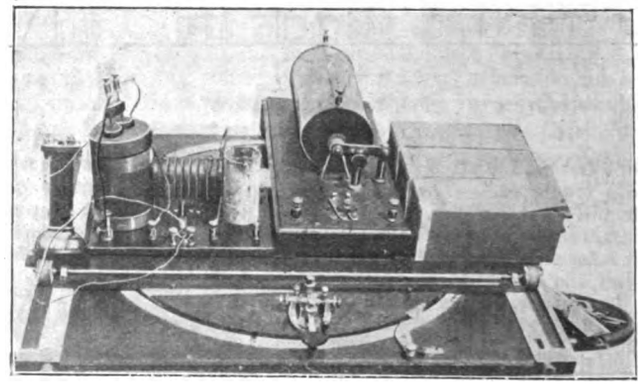


FIG. 8.—FESSENDEN WIRELESS TELEGRAPH APPARATUS.

We also give an illustration (Fig. 8) of the apparatus employed by Prof. Fessenden, which gives a spark of $\frac{1}{32}$in. when attached to the vertical wires 140ft. in length. No transformers or Tesla coils are used, and the speed of sending has been 35 words per minute. It is said that the apparatus will operate over a distance of 100 miles. The illustration shows a complete equipment of both sending and receiving instruments.

In all, there are 13 patents in the recent issue to Prof. Fessenden, containing 20 pages of drawings, 53 diagrammatic views, and 220 claims, the whole forming a most instructive and interesting memoir of the very latest advance in the art of wireless telegraphy.

SOME NOVELTIES IN ELECTRICAL APPARATUS.*

BY M. B. FIELD.

I have the honour of calling your attention to a few electrical instruments which possess, I believe, some novel features. I do not propose to occupy your time by a lengthy explanation of the working of these instruments, but will content myself with stating as briefly as possible what objects they are intended to serve. Detailed explanations may be found elsewhere by anyone who may happen to be specially interested.

Compensated Voltmeter.—This particular instrument is designed for indicating the voltage between either the positive or negative and the neutral main at the far end of a three-wire feeder—that is to say, the voltmeter, although connected to the feeder at the station end, indicates the voltage existing at the network end, being compensated for the feeder drop, no matter how much or how little the network may be out of balance. This instrument is compensated for the drop in a triple-concentric cable 1 mile long, the outers having a cross-section of 0·5 sq. in., the neutral 0·25 sq. in. No pilot wires are employed. The connections are shown in Fig. 1. It will be noticed the two views are identical as regards connections. R_1, R_2 are series resistances inserted in the mains. Two others, shunt resistances, are connected across the mains, the measuring instrument being connected to these shunts so as to divide them up into the four resistances I have

* Paper read in Section G of the British Association, at Belfast, September, 1902.

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marked 1, 2, 3, 4. The measuring instrument is merely a delicate milli-voltmeter calibrated to read the actual volts at the far end of the feeder. It will be seen that the arrangement corresponds to an unbalanced Wheatstone bridge, where P.D.s are introduced into two of the arms proportional to the drop of volts in the outer and neutral mains respectively. A little consideration will then show that the current through the measuring instrument will be proportional to the voltage of the circuit minus a certain multiple of the current in R_1, minus a certain multiple of the current in R_2, assuming the currents are flowing in the directions indicated by the arrows. It is

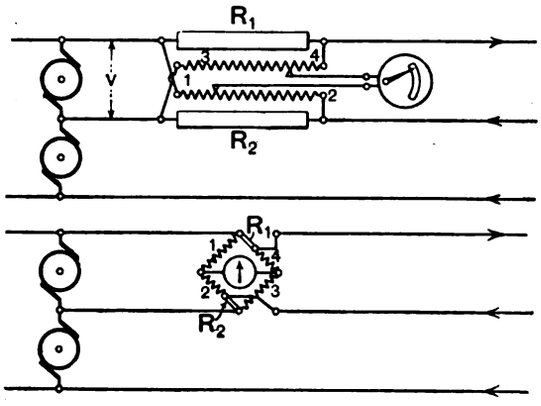

FIG. 1.

merely a matter of adjusting the ratio arms 1, 2, 3, 4 suitably, in order to get true compensation for the feeder drop of voltage.

In this instrument the resistances are as follows:—

Ratio arm 1.—	$10 \times 5{\cdot}6 = 56$	ohms.
Do. 2.—	$99 \times 5{\cdot}6 = 554{\cdot}4$	do.
Do. 3.—	$100 \times 5{\cdot}6 = 560$	do.
Do. 4.—	$9 \times 5{\cdot}6 = 50{\cdot}4$	do.
	$R_1 = 0{\cdot}000888$	ohm.
	$R_2 = 0{\cdot}0195$	do.

Hot-wire Wattmeter.—I have a hot-wire instrument which, when connected to an electric circuit, will read amperes, volts, true watts, hence power-factor, giving readings *consistent* with one another. The drop of voltage across the instrument does not exceed 0·5 volt, so that measurements can be made by it on motors or other apparatus while connected to their normal circuits—*i.e.*, no special provision of

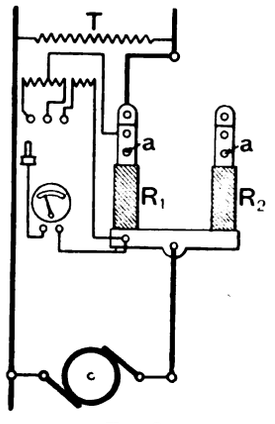

FIG. 2.

higher voltages is necessary when making such tests. The instrument is essentially for workshop and testing-room purposes, *not* for switchboard work. The connections of this particular instrument are those shown in Fig. 2. R_1 and R_2 are two alternative non-inductive resistances of different carrying capacities, either of which can be inserted in the main circuit. T is a potential transformer with three secondary windings giving equal voltages. A plug arrangement is attached to the instrument. The first two plug holes (from the left-hand side) give the necessary connections for the determination of watts; the third converts the instrument into a voltmeter; and the fourth and fifth, marked *a* in figure, into an ammeter, special calibration tables being employed. This instrument is really an outcome of the one previously described; for with the plug inserted in hole 1 we have practically the same arrangement as the compensated voltmeter modified for a two-wire circuit. Position No. 2 is the same, but with the secondary E.M.F. of the transformer reversed. If the instrument is calibrated to read the square of the voltage at its terminals in each case, the difference of the two readings is a measure of the watts. These instruments may be made up with two pointers moving over the same scale, and with a special attachment for taking both the power readings simultaneously.

Fault Indicator.—This instrument has been designed specially with reference to tramway circuits. As a general rule, all feeders for electric tramways are protected by automatic circuit breakers. These not infrequently open from unknown causes. The general practice in tramway systems after a breaker has come out is to close it again without taking any special precautions. If the breaker comes out three times in succession the line is reckoned to be short-circuited, and the fault must be searched for. Such a fault may be due to a short-circuit on a car, an earthed guard wire touching the trolley wire, a fallen trolley wire, an insulating bolt supporting trolley wire broken down, &c. The above-described method is, of course, crude in the extreme, and the practice of closing a circuit on a "dead short" is often fraught with considerable damage—damage which may only come to light some time afterwards. Now, the resistance of the feeder to earth should be a sufficient guide as to whether the feeder is "shorted" or not. If it be "shorted," the

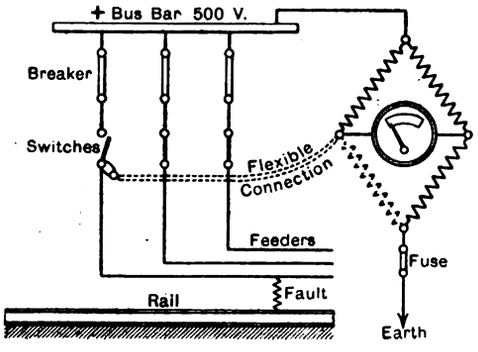

FIG. 3.

resistance will be well under 1 ohm; if, however, the "short" or overload disappear, the resistance will be fairly high. When the power is cut off any section, the motormen have instructions to at once turn off their controllers, switch on the lights, and wait for these to glow. The resistance to earth will, therefore, be merely the resistance of the lamp circuits. The fault indicator, then, is merely a Wheatstone's bridge where the feeder circuit forms the unknown resistance, the voltmeter on galvanometer and ratio arms being so proportioned that if the unknown resistance is less than 1 ohm, the needle goes hard over to the left, pointing to "Line blocked," and if over 20 ohms hard over to the right, pointing to "Line clear." The general arrangement is shown in Fig. 3. A relay may be fitted to the indicator to call attention to the fact that a line is "cleared" as soon as the fault is removed. The instrument may be kept permanently in connection with the positive 'bus bar, and plugged on at a moment's notice to any feeder, the breaker of which has opened. To a large tramway system, blocks and interruptions of traffic are most costly, and any instrument which will in any way minimise the duration of these is, I think, worth the consideration of all tramway engineers.

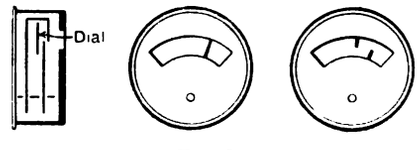

FIG. 4.

Synchronising Gear.—Some engineers prefer synchronising with voltmeters, some with lamps—for myself, I vastly prefer a dead-beat voltmeter. I am, however, very much in favour of installing a set of pilot lamps near the stop valve of each engine, so that the driver can watch the process himself, and open or close the stop valve intelligently as is required, till paralleling is accomplished. It is, of course, further necessary to adjust the voltage of the incoming machine to equal that of the 'bus bars to which it is about to be switched. The object of this synchronising switch is by a *single* setting to establish all the connections necessary for these indications—viz., it (1) puts into circuit the pilot lamps on the incoming engine; (2) puts into circuit the synchronising lamps on panel controlling the incoming generator; (3) puts into circuit the synchronising voltmeter; (4) puts into circuit a special voltmeter which shows at a glance whether the voltage of the incoming alternator is equal to greater or less than that of the 'bus bars (Fig. 4).

Operation No. 2, may, of course, be dispensed with, for with a synchronising voltmeter these lamps are not essential. They are, how-

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ever, always useful as a reserve method of synchronising. The special voltmeter mentioned in operation (4) is in reality a double one, with two pointers moving over the same dial. One pointer comes up the back of the dial (which is illuminated) and over the top: the other swings in front of the dial. There are no markings on the dial. The one voltmeter is connected to the incoming machine, the other to the 'bus bars. If the voltages of each is the same, the two pointers form a radial line across the dial. If the voltages be unequal, the line is broken. The synchronising voltmeter and the above double voltmeter are both mounted on a swinging bracket attached to the switchboard, so that both are in view simultaneously (Fig. 5). The synchronising switch itself has some novel features.

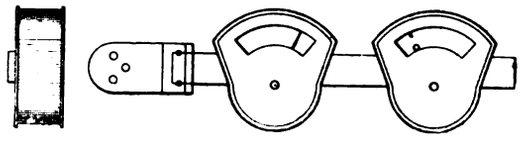

FIG. 5.

This one I have here is designed for four alternators. With this switch only four synchronising transformers are needed, one connected to each alternator—that is, the usual auxiliary transformer connected to the 'bus bars may be dispensed with. Again, if the dial of the double voltmeter be calibrated, it is really superfluous to supply each generator panel with a separate voltmeter. A synchronising bracket may be fixed at either end of the board, so that in case one instrument breaks down there is always a reserve one. A considerable simplification of the generator panels is thus effected.

ELECTRICITY WORKS ACCOUNTS.

Stepney Municipal Electric Supply Works.

In our first analysis this week are summarised the accounts of the Stepney undertaking since the commencement of supply in that or the Whitechapel district. The output has already reached to over a million units sold in the year—a rapid development in what was naturally looked upon as an unpromising field for profitable electricity supply.

In seeking an explanation of this growth, one naturally turns to the figures showing the average price and the tariff scale in force. The hand of Mr. Wright is evident in the tariff adopted, with its high initial price of 8d. and the low minimum of 1d. per unit sold. So far as the immediate fortunes of the supply undertakers are concerned, the results appear to fully justify the policy adopted, for although one result is the extremely low total average revenue of 2·47d. per unit, another result, doubtless attributable to the tariff system, is the high-load factor of 22·8 per cent. This is a phenomenal figure for an undertaking without a traction load, and suggests that the cream is being licked off the milk with a vengeance. The further development of this undertaking on these lines will be an interesting study, as showing to what extent the district served is capable of furnishing additional consumers of the present desirable class. The average price shown is a pleasing and an enticing one, and fully explains the splendid development which has marked the business of the undertaking, though we feel constrained to say that the policy pursued still remains an interesting but inconclusive experiment.

In studying the cost figures shown, it is necessary to bear in mind the fact that the electric supply undertaking is worked in conjunction with a refuse destructor, and that the relations of the two departments are adjusted through the fuel item by debiting it with £1,086 for steam supplied, in addition to the £989 spent on coal. The basis of this charge to the electricity department by the destructor department is interesting. We learn from Mr. Tapper that the destructor is worked quite independently of the electricity department, it being under the control of the borough surveyor and the Works committee. The steam generated by the destructor is conveyed into a separate range of pipes in the generating station, and one particular engine is always "kept running on this steam," the remainder of the plant being run on the station's own boilers. The amount of steam supplied by the destructor is measured by the units generated by the set thus separately supplied. The Works committee then make a charge to the Electricity committee of 0·8d. for every unit thus generated on the destructor's steam. Mr. Tapper says that "this figure was arrived at by taking the total *increased* cost to the destructor department, owing to the working of steam generating apparatus, over the cost which would have been incurred had the destructor been used for the destruction of dust only. On taking the estimated output of the destructor, it was found that 0·8d. would cover the whole of this additional cost."

We must say that this seems an earnest attempt to equitably allocate to the two departments their responsibilities. However approached, the problem of adjusting the relations of the electricity and refuse destructor departments is difficult, but on the above system a truer solution appears possible than on any other basis. The weak point is, however, the 0·8d. settled on, and confidence in it is rather shaken when we find that apparently there is no accurate account kept of the working of the dust destructor as apart from the works department taken as a whole. Favourable as the figure appears to work out for the electricity department, we do not think it is by any means too high from the works department standpoint.

As for the other costs appearing in our table, it may be said at once that, one and all they are remarkably low, even considering the value of the load-factor on which they are obtained. For a London undertaking the capital expended is most moderate in relation to the output—a result, no doubt, of the high load-factor. We think it must be admitted, however, that a working profit of no more than 5·4 per cent. of the mean capital points to too low an average price, especially when it is considered that the undertaking is now enjoying probably the best of the custom of the district it supplies. A net profit of £2,034 is shown, but in view of the deficit of £2,743 of the preceding year, and the fact that the loan repayments are suspended and did not commence with the borrowing of the loans, it is hardly possible to wax enthusiastic over the financial results.

Barking Town Municipal Electric Supply Works.

This undertaking is rapidly improving its position, and, notwithstanding that the engines were not run condensing until the middle of January last, the total costs are already, at 2·89d., but little in excess of what might be expected from our averages. The average revenue at 3·27d., from all sources is too low for sound financial results. Its adoption may possibly be justified as a means of increasing the business. The total management and property charges are most creditable, and so is the fuel item in relation to the circumstances of working. It would be unfair to criticise harshly the financial results of so young a concern.

REMARKS TO TABLES.

STEPNEY.—*a* Period of 15 months. *b* Land £13,085. *c* Accumulators £2,509, meters and demand indicators £9,435. *d* Accumulators £2,526, meters and demand indicators £3,663. *e* Over-expended. *f* 78,012 units at 8d. £2,600, 282,309 units at 1d. £1,176 and indicated lamps at 7d. per lamp per month £289. *g* 22,275 units at 8d. £743, 180,494 units at 1d. £752 and attendance and repairs £637. *h* Engineers' department £324. *i* Law £186, insurance £7. *j* After adding £770 "cost of temporary building to March 31, 1901." *k* Buildings £2, engines and boilers £45, dynamos, exciters, &c., £1², accumulators £3, other plant £12. *l* 169,050 units at 8d. £5,635, 555,487 units at 1d. £2,315 and indicated lamps at 7d. per lamp per month £326. *m* 24,9?7 units at 8d. £831, 258,578 units at 1d. £1.077, and attendance and repairs £854. *n* Including steam from dust destructor £1,086, coal £989. *o* Buildings £41, engines and boilers £57, dynamos, exciters, &c, £79, accumulators £1, other plant £32. *p* Engineers' department £334, wages of meter readers £31, accountant and staff £732. *q* Insurance £21. *r* After deducting £102 "cost of temporary building during year."

BARKING TOWN.—*a* Including units absorbed in batteries but exclusive of 38,211 absorbed in distribution. *b* In pairs of two 16 c.p. and two 8 c.p. *c* In pairs of two 16 c.p. and two 8 c.p., also Nernst lamps. *d* For power up to 100 units per month 3½d. per unit, between 100 and 200 units per month 3d., 200 to 500 units 2¾d., 500 to 750 units 2½d., 750 to 1,000 units 2¼d., 1,000 to 2,000 units 2d., 2,000 to 3,000 units 1¾d., and 3,000 units and upwards per month 1½d. per unit. Price for traction to be 2½d. at first. *e* The units absorbed in mains were 18,316 and in batteries 25,922. *f* Estimated. *g* Being suspense account and including £1,006 deficit on working of 1900-1. *h* No expenditure on land. *i* Machinery £3,?35, accumulators £543, meters £1,058, instruments £606, street lamps and fittings £1,443. *j* Free wiring £142. *k* Being suspense account and including the £1,006 in 1900-1 and £274 in 1901-2 deficits in working. *l* Machinery £5,443, accumulators £605, meters £1,779, instruments £734, lamp columns and fittings £1,949. *m* Free wiring £142. *n* Sales at 6d. per unit £178, at 2d. £2¼, at 4½d. £1,495, at 3½d. £235, by slot meters £19 and by private lamp £4; less £17 bad debts. *o* After deducting £80 received from baths for heated water in 1900-1 and £140 in 1901-2. *p* Buildings £3, engines and boilers £191, dynamos £6, accumulators £113, other plant and tools £3. *q* Of mains £17, meters, switches, fuses, &c., £13. *r* Attendance and repairs. *s* Engineers' department £239, collectors' department £19 and architect £10. *t* Insurance £17 in 1900-1 and £14 in 1901-2. *u* Through slot meters, 5d. per unit. *v* Carried to suspense account. *w* By meter at 4½d. £1,993, at 3½d. £185, at 3d £14, at 2d. £29, through slot meters £139, by private lamp £4 and from artisans' dwellings £20. *x* Buildings £3, engines and boilers £189, dynamos £65, accumulators £53, other plant and tools £1. *y* Of mains £2, of switches, meters, fuses, &c., £54. *z* Engineers' department £235, collectors' department £20.

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	STEPNEY.		BARKING TOWN.	
Undertaking Worked by	Metropolitan Borough of Stepney.		Barking Town Urban District Council.	
Date of Commencement of Supply	January, 1900.	[destructor.	May, 1899.	
System of Supply	3-wire continuous-current combined with dust		3-wire continuous-current.	
Chief Engineer	W. C. P. Tapper.		A. Hugh Seabrook.	
YEAR ENDED	MAR. 31, **1901.**[a]	MAR. 31, **1902.**	MAR. 31, **1901.**	MAR. 31, **1902.**
QUANTITIES—				
Units generated	665,738	1,149,114	277,927[e]	352,647
" **SOLD (TOTAL)**	563,080	1,008,037	224,156	285,916
" sold to consumers	360,321	724,537	107,398	128,795
" sold for public lighting, &c.	202,759	283,500	116,758[f]	157,121[f]
" sold for traction	nil	nil	nil	nil
" used on works	14,169	—	4,766	28,520[a]
UNITS SOLD PER MEAN 8-C.P. LAMP CAPACITY	—	34·2	35·9	30·5
Actual maximum supply demanded	301 kilowatts	506 kilowatts	146 kilowatts	204 kilowatts
Load factor	—	22·8%	17·5%	16·0%
Number of public lamps	85 arc, 5 glow	95 arc, 13 glow	15 arc, 376 glow[b]	18 arc, 438 glow[c]
Number of consumers	—	—	139	273
Connections to mains in 8-c.p. lamps at end of year	18,393	33,146	8,160	12,615
CAPACITY OF PLANT IN KILOWATTS AT END OF YEAR	670	1,220	200	400
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£79,000 / £118	£135,653 / £111	£30,870 / £154	£28,890 / £96·3
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	79,000 / 118	135,653 / 111	30,870 / 154	28,890 / 96·3
RECEIVED (TOTAL)	79,000 / 118	109,000 / 89·4	25,000 / 125	28,890 / 96·3
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	79,000 / 118	109,000 / 89·4	25,000 / 125	28,890 / 96·3
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	26,653 / 21·8	5,870 / 29·3	— / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	nil / —	26,653 / 21·8	5,870 / 29·3	— / —
REPAID (TOTAL)	169 / 0·252	287 / 0·235	897 / 4·48	1,499 / 4·99
RESERVE OR SINKING FUND	nil / —	nil / —	−1,950[g] / −9·75	−2,223[k] / −7·41
DEPRECIATION FUND	nil / —	nil / —	— / —	— / —
EXPENDED (TOTAL)	78,141 / 117	114,890 / 94·2	23,412 / 117	28,812 / 96·1
Lands and buildings	27,419[b] / 40·9	43,340[b] / 35·5	4,622[h] / 23·1	4,631[h] / 15·4
Plant	20,330[c] / 30·3	26,542[d] / 21·8	6,908[i] / 34·5	10,536[l] / 35·1
Mains	28,127 / 42·0	41,704 / 34·2	10,218 / 51·1	11,832 / 39·4
Miscellaneous	2,265 / 3·33	3,304 / 2·71	1,663[j] / 8·31	1,812[m] / 6·04
BALANCE OF CAPITAL ACCOUNT	859 / 1·28	−5,890[e] / −4·83	1,588 / 7·94	78 / 0·26
REVENUE—	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.
TOTAL	£6,347 / 2·704d.	£11,223 / 2·673d.	£3,795 / 4·065d.	£4,440 / 3·727d.
Revenue from supply	4,063[f] / 1·731d.	8,231[l] / 1·960d.	1,938[n] / 2·075d.	2,305[w] / 1·935d.
" meters, &c.	116 / 0·049d.	182 / 0·043d.	61 / 0·065d.	60 / 0·050d.
" public lighting	2,122[g] / 0·905d.	2,762[m] / 0·658d.	1,743 / 1·866d.	1,998 / 1·677d.
" supply for traction	nil / —	nil / —	nil / —	nil / —
" miscellaneous sources	46 / 0·020d.	48 / 0·011d.	53 / 0·057d.	77 / 0·065d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£5,768 / 2·458d.	£6,012 / 1·431d.	£3,632 / 3·890d.	£3,401 / 2·854d.
TOTAL WORKS COSTS	3,797 / 1·618d.	4,266 / 1·016d.	3,012 / 3·225d	2,859 / 2·400d.
Generation of electricity	*3,116 / 1·328d.*	*3,193 / 0·760d.*	*2,387 / 2·557d.*	*2,237 / 1·878d.*
Fuel (including cartage, &c.)	2,125 / 0·906d.	2,075[n] / 0·494d.	1,347[o] / 1·442d.	1,243[o] / 1·044d.
Oil, waste, water, stores	195 / 0·083d.	182 / 0·043d.	187 / 0·200d	171 / 0·144d.
Wages at station	721 / 0·307d.	725 / 0·173d.	536 / 0·574d.	509 / 0·427d.
Repairs and maintenance at station	75[k] / 0·032d.	210[o] / 0·050d.	317[p] / 0·340d.	314[x] / 0·264d.
Distribution of electricity	*54 / 0·023d.*	*220 / 0·052d.*	*69 / 0·074d.*	*76 / 0·064d.*
Wages, &c.	54 / 0·023d.	7 / 0·002d.	9 / 0·010d.	19 / 0·016d.
Repairs, renewals of mains, &c.		213 / 0·051d.	60[q] / 0·054d.	57[y] / 0·048d.
Public lighting	*627 / 0·267d.*	*854 / 0·203d.*	*556 / 0·596d.*	*546 / 0·458d.*
Attendance	627 / 0·267d.	854 / 0·203d.	422[r] / 0·452d.	436[r] / 0·366d.
Renewals			133 / 0·142[s].	110 / 0·092d.
MANAGEMENT AND PROPERTY CHARGES	1,971 / 0·841d.	1,747 / 0·416d.	620 / 0·664d	542 / 0·455d.
Net rents	nil / —	nil / —	*30 / 0·032d.*	*10 / 0·008d.*
Rates and taxes	*248 / 0·106d.*	*307 / 0·073d.*	*180 / 0·193[t]*	*202 / 0·169d.*
Management	*1,723 / 0·735d.*	*1,440 / 0·343d.*	*410 / 0·439[t].*	*330 / 0·277d.*
Salaries	1,091[h] / 0·465d.	1,097[p] / 0·261d.	318[s] / 0·341d.	255[z] / 0·214d.
Stationery, &c.	204 / 0·087d.	146 / 0·035d.	36 / 0·039d	52 / 0·044d.
Establishment charges	234 / 0·100d.	175 / 0·042d.	33 / 0·035d.	9 / 0·007d.
Law charges &c.	194[i] / 0·083d.	22[q] / 0·005d.	23[t] / 0·025d.	14[t] / 0·012d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£580 / —	£5,211 / 5·40%	£164 / 0·785%	£1,039 / 3·98%
Sum carried to Depreciation Fund	nil / —	nil / —	nil / —	nil / —
Sum carried to Reserve Fund	169 / —	117 / 0·121%	437 / 2·09%	602 / 2·31%
Net interest on loans (incl. Debenture charges)	2,384 / —	2,957 / 3·06%	732 / 3·50%	712 / 2·75%
Net profit for the year	nil / —	2,034[r] / 2·11%	— / —	— / —
BALANCE FROM LAST ACCOUNT	nil / —	nil / —	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	nil / —	2,034[r] / 2·11%	— / —	— / —
Deficit	*2,743[j]* / —	— / —	*1,006[v]* / *4·81%*	*274[v]* / *1·05%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO REVENUE	91%	53·5%	95·9%	76·6%
Expenditure per mean kilowatt capacity	—	£6. 7s. 2d.	£18. 3s. 0d.	£11. 6s. 7d.
REVENUE PER MEAN KILOWATT CAPACITY	—	£11. 17s. 5d.	£18. 19s. 7d.	£14. 16s. 0d.
REVENUE PER 8-C.P. LAMP CONNECTED MEAN	—	8s. 8½d.	11s. 0d.	8s. 6d.
Price charged for lighting, per unit	8d. to 1d.	8d. to 1d.	4½d.	4½d.[u]
Price charged for power, per unit	8d. to 1d.	8d. to 1d.	3½d.	3½d. to 1½d.[d]
Price charged for public lighting	8d. to 1d.	8d. to 1d.	Arcs £20, incan. £4 per	Arcs £20, incan. £4 per
Receipts per unit for private supply	2·71d.	2·73d.	4·33d. [ann.	4·30d. [ann.
" " public lighting	1·77d.	1·62d.	2·44d.	2·22d.
" " traction	—	—	—	—

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THE BRITISH ASSOCIATION.

Now that the excitement which annually is associated with the meeting of the British Association for the Advancement of Science has died away once more, it is a fitting time to consider calmly and in a judicial spirit the various criticisms and diversified comments which the recent meeting at Belfast has raised. Criticism, often enough sternly adverse to this Association, is not an infrequent concomitant of the annual gatherings; only, on the present occasion, the storm of denunciation has been, perhaps, somewhat more violent, and has echoed somewhat farther, than usual. And, like other storms, it has not been altogether coherent. Critics have been far from agreeing. Some say it is too popular—a mere picnic; others complain that its deliberations are too abstruse—over the heads of the audiences. Some assert that the British Association is useless—played out; that it has lived too long and should now be allowed by self-respecting leaders of science to die a natural death. We do not here intend to echo the question: Is the British Association still useful? The question is superfluous on the face of it. If the Association were not unquestionably useful it would not continue every year to draw together so many of the leaders of science, nor would it attract to its sectional meetings—nor even to its recreative gatherings—so many of the rank and file. The form in which we would present, and at the same time endeavour to answer, the question, is: What are the uses of the British Association?

As it is at present constituted, the British Association is a far more complex organisation than at its inauguration nearly eight decades ago. Accordingly, its uses are more varied, some of them being quite undreamed of by its original promoters. We do not mean that there is a greater number of sections, the result of the growth of new branches of scientific knowledge. At its inception, the British Association comprised principally the recognised leaders of science; and the popular element, as we know it to-day, found no place in its deliberations. But nowadays there are really two British Associations, an esoteric and an exoteric; or, rather, shall we say that the British Association has a dual consciousness? And although these two entities or functions operate simultaneously and at the same place, they are really totally distinct from each other and have little in common. Yet each is essential to the existence of the British Association, as much as mind and body are essential to the living organism. The esoteric or intellectual side of the British Association, it is scarcely necessary to say, comprises the leaders of science and the little band of earnest workers. These, numerically regarded, are in a small minority, even as the mass of the brain is less than the mass of the body; but they are the controlling centre of the entire organisation. No one who is familiar with the meetings of the British Associa-

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tion can have a shadow of doubt as to the immense benefits accruing to science from the annual meeting together of this small but earnest band. Consider the names only of the men with whose work our readers are most familiar: Lord KELVIN, Lord RAYLEIGH, Lord ROSSE, Sir OLIVER LODGE, Prof. J. J. THOMSON—these are the men who supply the intellectual stimuli during the meetings, and from whose assembling together they themselves and their earnest disciples derive lasting benefits. Shall it ever be said that the British Association, even though it never does more good than this, is played out? By no means. Nor is the usefulness of this band of true scientists in any way lessened by the fact that some of them like to spend their leisure hours with their wives and daughters at the garden parties, conversazioni, &c. Those who cavil at such entertainment are welcome to stay away.

We turn now to consider the crowd of other people who compose the exoteric portion or body of the Association. It is ever a mixed and motley crowd. Among it are the monomaniacs and faddists and cranks who are the parasites of science. Their faces, distorted with an exaggerated sense of their own scientific importance, their strange costumes and eccentric manners, betray them everywhere. Then, there are the idlers and mere dabblers in science, who have come to enjoy themselves lazily and because it is fashionable to be there. These all are a terrible trial, it is to be feared, to the real workers. They block up the passages; they scramble for the best seats at the lectures, before hard workers have had time to put in their claims for tickets; they fill all the seats in the writing rooms, scribbling correspondence seemingly all day long; they walk desultorily into and out of the sectional meetings, in the middle of a Paper or a discussion; they make long and irrelevant speeches during debates; and they get out early and devour all the food in the luncheon room. Unnumbered; in fact, are the disagreeable things they do. Yet are they useful, even essential to the prosperity of the British Association, and an increase in their numbers is a thing to be encouraged. Their membership swells the financial resources of the Association; their presence, merely by increasing the numerical attendance, gives the Association greater κυδος locally and in the eyes of the general public, besides adding to the total amount spent in the local hotels and boarding houses. All these people bring money to the coffers and grist to the mill.

The financial aspect of the British Association is one of considerable importance. Much of the scientific utility of this organisation depends upon its annual receipts. These, unfortunately, have been in the past a very fluctuating and uncertain quantity, falling to as low as about £1,000 in 1880 and rising to £4,836 at the immensely successful meeting at Manchester in 1887. Naturally, the sum total which the British Association in any year is enabled to grant to its Committees in aid of scientific research must rise and fall with these receipts. When it is remembered how great has been the assistance to scientific progress rendered for many years past by means of these grants of money, it will be readily understood that it is in the best interests of science that the British Association should encourage its popular side, and offer every inducement, even to the idler and the faddist, to put in his annual attendance and pay his annual fee. Indeed, we doubt if the Council does not sometimes pay insufficient heed to this important matter. At Belfast, for instance, there was little to attract the seekers after popular science and mere amusement. The excursions, we understand, were in some cases badly organised; but, doubtless, the inclement weather had much to do with the failure of this department. However, we think that if the Council would make a regular practice of securing a NANSEN or—we will not say a DE ROUGEMENT—some other lion of the season, the "draw" would add to the success of the meeting from the business point of view. But in thus encouraging the popular side it is of vital importance to guard against stifling or crippling the intellectual side. Much might be done to mitigate the evil effect of the popular members on the serious proceedings. The frequent and irritating interruptions should be abolished by giving strict instructions that no one shall enter or leave a sectional meeting room during the reading of a Paper or the progress of a debate. Faddists, cranks and self-advertisers who begin to spout irrelevant nonsense should be promptly and mercilessly suppressed. Moreover, chairmen should show less affection for red herrings than some chairmen we could name: at any rate, they should not allow these creatures to be drawn so often across the track of debate. But these, after all, are minor matters in the subject we have been considering; and it is gratifying not only to assert with just confidence that the British Association fills a large and varied sphere of usefulness in the interests of science, but also that there seems every prospect of its continuing to do so for many years to come.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Electricity in the Alizarine Industry.—Alizarine was formerly obtained from the root of *Rubia tinctorum*, but since Graebe and Liebermann discovered that alizarine is a derivative of anthracene, it has been manufactured from coal tar by treating anthracene with sodium bicarbonate and sulphuric acid. This gives anthraquinone, and according to the modern process, this is treated with fuming sulphuric acid, and the monosulphite is fused with caustic soda. To obtain anthraquinone from anthracene, sodium bicarbonate is necessary. Up to the present, the methods for recovering the chromium salt contained in the mother liquor as chromium sulphate have been very troublesome. The electrolytic recovery of the chromium has hitherto been hindered by the fact that between the two electrodes a diaphragm is necessary, and that no diaphragm was found capable of holding the strongly acid solution for any length of time. This difficulty has been overcome by Leblanc's invention of diaphragms consisting of 25 per cent. alumina and 75 per cent. silica, which not only are very durable, but also have a low resistance. One German aniline dye factory has been transferred to the neighbourhood of Augsburg, where there is sufficient water power to yield a cheap supply of electrical energy for the new process.

[H. T. SIMON, *Jahresber. Phys. Verein Frankfurt*, 1902.]

Weather Shooting.—The discharge of big guns as a preventative of hailstorms dates back to the 18th century, when it was very common in Austria, Bavaria and France, where the hail often did incalculable damage to the vineyards. In 1785 the Emperor Joseph II. issued an edict against the practice, and in 1811 the Munich Academy of Sciences declared it to be valueless and superstitious. The remarkable success of Albert Stieger, in Styria, in protecting his vineyards against hail since 1896 has stimulated further research, and the practice has been resumed, especially in Italy. H. T. Simon connects the effect with the formation of unstable temperature conditions and their timely readjustment by the shock of the shooting. A steep temperature gradient brings about the sudden exchange between the warmer strata of air below and the colder ones above. The ascent of the warmer strata leads to undercooling; the icicles fall through the undercooled stratum and precipitate further moisture, eventually reaching the ground as hail. The shooting may act by the sound-wave, by the impact of the air vortex, or by the upward projection

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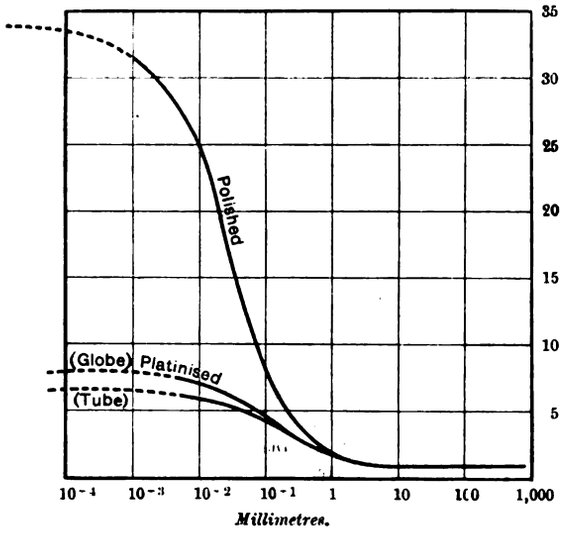
of dust or ions serving as concentration nuclei. In any case it hinders the formation of the unstable temperature condition described, and allows the condensed moisture to fall to the ground as harmless rain.

[H. T. SIMON, *Jahresber. Phys. Verein Frankfurt*, 1902.]

Vacuum Thermo-couples.—It is easily understood that thermo-couples in a vacuum tube are more sensitive than in open air, since the heat impinging upon them has less chance of getting dissipated. P. Lebedew has employed vacuum thermo-couples in his more recent experiments on electric waves. He finds that in the range from 1 atmosphere down to about 5mm. pressure the sensitiveness is practically constant. For lower pressures the sensitiveness rapidly increases with the exhaustion, and practically reaches its maximum at 0·01mm., not because that is the actual minimum of convection, but because at that pressure the use of windows cemented into the tube and transmitting the radiation under examination does not yet offer any practical difficulties. The sensitiveness is increased sevenfold for blackened couples, and 25 times for polished ones, as shown in the diagram. The increase is also greater



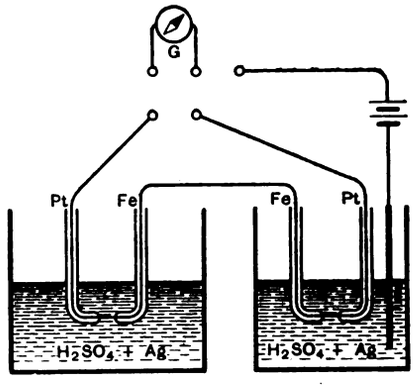
for couples enclosed in a bulb than for couples enclosed in a tube. At pressures below 10^{-4}mm. the sensitiveness is practically the same as at 10 times that pressure. The author employs, by preference, couples made of iron and constantan. He finds that, besides the increased sensitiveness, the thermo-couples also show an increased durability in a vacuum, which is very useful for Hertzian wave work.

[P. LEBEDEW, *Ann. der Physik.*, No. 9, 1902.]

The Mouth Barometer.—A few years ago P. Gruetzner described a simple and cheap barometer, on Hooke's principle, which has since been used for Alpine expeditions. It utilises the expansion and contraction of air under a diminution or increase of pressure. If the temperature is constant the volume of air is inversely proportional to the pressure. In the author's apparatus the constant temperature is obtained by putting the bulb into the observer's mouth. The temperature of the human mouth is 36·7°C., or 307deg. absolute, and does not vary, as a rule, by more than 1 per cent. It is, therefore, practically constant. The bulb of the mouth barometer is partly filled with coloured paraffin, which is driven into a tube provided with a scale, and serves to indicate the volume of the air in the bulb. The author now quotes a number of observations made with a mouth barometer and an aneroid, in which the maximum error of the former is 3mm. The mouth barometer has probably no advantage over the pocket aneroid, except its extremely low price.

[P. GRUETZNER, *Ann. der Physik.*, No. 9, 1902.]

Theory of the Wehnelt Interrupter.—Simon's theory of Wehnelt's interrupter supposes that the interruption is brought about by the sudden heating and evaporation at the anode, and the closing of the current by the cooling and condensation following the interruption. The heating is supposed to be altogether Joulean, due to the resistance of the liquid. Now, E. Klupathy shows that this Joulean heat would not even suffice to heat the liquid to boiling-point, much less to evaporate it. He finds the chief source of heat in the Peltier effect. A Peltier effect between liquids and metals was experimentally established by Bouty, Jahn and Gill. The Peltier effect produced by 1 ampere per second would be $1{\cdot}5 \times 10^{-3}$ gramme-calories at the junction between copper and copper sulphate. The same amount of heat would be absorbed at the cathode. In a layer 0·001mm. thick the heating would be about 100deg., whereas the Joulean heat would only be about 8deg. With



platinum in sulphuric acid, the heating would be about 200deg. The author proved the heating of the anode and cooling of the cathode by means of the "pointless interrupter" shown in the diagram.

[K. KLUPATHY, *Ann. der Physik*, No. 9, 1902.]

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

The American Invaders. By F. A. MCKENZIE. (London: Grant Richards.) 1902. 2s. 6d.

We commend this book to our British manufacturers and to all those of our readers who have had cause to consider the effects of the American industrial and commercial "invasion" of the mother country and its colonies and dependencies. Inaccurate as the author is in many respects, yet his unequivocal admiration and enthusiasm for American methods cannot fail to be in a certain degree convincing. This enthusiasm for everything American is, it is true, carried too far when it amounts to applauding the tactics in the Anglo-American "tobacco war," but, on the other hand, an infusion into our industrial system of more of the "push" and nervous energy which is characteristic of the American—retaining, however the traditional straightforwardness and integrity of British business methods—would not be unprofitable. What may, perhaps, be characterised as the upper middle classes of our manufacturers must be urged out of their present easy-going path. The younger generation is knocking at the door, and they must open to it. They must welcome the advent of modern systematised methods, of improved machinery, and of labour-saving devices, and they must invoke the newcomers' assistance to sweep away the fungus growth of the labour agitator who, by his successful efforts to restrict output and level away healthy emulation among the working classes, is sucking away the energy and vigour of our industrial system. And, so far as the electrical industry is concerned, it is not merely the individual who must be awakened—both the central and the local governing bodies of the country must be lifted out of the peculiar groove of semi-conservative, semi-socialistic thought which opposes any new undertaking if it suspects those who promote and develop it will take their share of the profits before the general community. The "greatest happiness of the greatest number" cannot be attained by discouraging individual effort.

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"The American Invaders" avowedly paints the results of the "invasion" in their blackest colours, and endeavours to show that we are being beaten in every branch of trade and commerce. That it exaggerates the actual damage which has been done to our prestige as an industrial nation there cannot be a doubt; but, nevertheless, as a general sketch of the methods employed in this "warfare," and as a suggestion of what may be the result if we disregard the warnings we are receiving, the book is worthy of serious perusal.

Monographien uber Angewandte Elektrochemie. Vol. I. "Die Elektrolyse des Wassers." By VIKTOR ENGELHARDT. 7 marks. Vol. II. "Die Gewinnung des Aluminiums." By ADOLPHE MINET. 5 marks. (Halle-a-S.: Wilhelm Knapp.) 1902.

These two volumes are the first of a series, dealing with the various branches of the electro-chemical and electro-metallurgical industries. Germany has been devoting herself now for some years to the study of electro-chemical and electro-metallurgical phenomena, both in the laboratory and works, and the series of monographs which are promised by the Halle firm of publishers indicates that, in their opinion, a public has been created sufficiently large and influential to support this new publishing venture, and to justify the belief in its pecuniary success.

Volume I. deals with the electrolysis of water for the production of oxygen and hydrogen, and is written by Viktor Engelhardt, chief chemist and engineer to the Siemens and Halske Co., of Vienna. In the 108 pages which are devoted to the subject, all the well-known forms of electrolyser are described and illustrated, and details of cost and utilisation are also given. Two pages of useful tables are provided, summarising the information relating to patents and costs, and from these we learn that 17 different types of electrolyser for the commercial production of oxygen and hydrogen have been patented, and that the capital outlay upon apparatus varies from 144m. to 1,805m. per kilowatt of energy. The cost of the oxygen and hydrogen produced depends largely upon the question whether one or both gases can be utilised on the spot without compression and storing. While this book does not add much to the information which was already available to those students of technical literature who knew where to look for it, it will, nevertheless, prove useful to electro-chemists and to those manufacturers who are adopting electrolysis for the production of their requirements of oxygen and hydrogen.

The second volume of the series is upon aluminium, and is written by Adolphe Minet, editor of *L'Electrochimie*, a monthly technical journal, published in Paris. This volume can hardly claim to be so complete or so valuable as Prof. Richards' classical work on "Aluminium," with which it must suffer on comparison. The author treats his subject under two leading headings—The Extraction of Aluminium, and Its Applications. All the patented processes for the extraction of aluminium are described, and since only two of these—the Heroult and Hall electrolytic reduction processes—are in actual operation, it would have been of advantage to readers if the author had devoted more space to them. Twenty pages out of the total 78 in this section of the volume are devoted to details of M. Minet's own process and the experimental work upon which it was based.

In the second part of the volume figures are given for the production of aluminium since 1885, and the aggregate output in the year 1900 is stated to have been 4,500 tons. We think the author's figures in this case are too low. Figures in our possession show a production of over 7,000 tons in the year 1900.

As regards the cost of aluminium, M. Minet gives a total of 2·79fr. per kilogramme, taking the electrical horse-power-hour at 1 centime. This is equivalent to 12·2d. per pound, and as the present sale price for 98·99 per cent. aluminium is about 14d. per pound, the margin for profit would appear to be small. Referring to the use of aluminium for electrical conductors, the author ignores the unsatisfactory results which have in many cases been obtained, and simply dwells on the greater lightness and lower cost of aluminium as compared with copper. The portion of the volume devoted to the alloys of aluminium is full and complete, and this is the section which will prove most useful to electro-chemists and electro-metallurgists.

Both volumes are well printed and illustrated, but suffer from the absence of alphabetical indexes of the subject matter.

Pipes and Tubes. By P. R. BJÖRLING. (London: Whittaker & Co.) 1902.

This book contains an amount of information that cannot fail to be extremely useful to engineers. Compressed air, gas, water, hydraulic, steam sewage and electric wire pipes and tubes are described and illustrated. The formulæ given with regard to the heating of rooms by steam or air and the rules for thickness of pipes for various purposes are not widely known, but are, nevertheless, of great importance. The effect of water in pipes is discussed at length, and various methods of cleaning and testing pipes are dealt with in detail. At the end of the book there are no less than 48 pages of tables of numerical data relating to various forms of pipes and tubes, and their uses, many of which no engineer should be unfamiliar with.

The Amateur Electrician's Workshop. By S. R. BOTTONE. (London: Guilbert Pitman.) 1s. 6d. net.

The instructions given in this book for the making of an electro-motor, batteries, wireless telegraph apparatus and induction coils are crude and bewildering to the "amateur." No explanation is given of the various technical terms, which must be quite unintelligible to the class of reader for whom the book is evidently intended.

HAND ADJUSTMENT OF THE GOVERNORS OF STEAM PLANTS IN ELECTRIC LIGHT STATIONS.

BY J. H. DALES.

Ten per cent. range of adjustment by hand is so common a demand of specifiers of steam plants that it is, perhaps, worth while to inquire what that means in a general way.

There are two principal elements which control the possibilities of fine governing, these being inertia and friction. The former is easily ascertained for any given change of velocity, but the latter is a very doubtful quantity, depending largely on mechanical design and excellence of workmanship, the latter especially in new plant. Every principle of construction and every modification of every principle has its own coefficient of friction, so to speak; and it is only by inquiring into the results of good examples of particular types that an approximately correct idea of what may be expected from a design can be had. As no really first-class governing can be obtained from anything but high-speed spring-load centrifugal governors, it is not worth while considering any other kind in any inquiry into the limit of possibilities. So, if vertical or horizontal right angular outside spring-load governors and shaft governors alone be considered, the object will be attained. The term "outside" is used as a distinction from shaft governors. Taking friction as the chief point of inquiry, it has been found, by careful experiment, that vertical right angular arm spring-load governors running at a moderate speed—say 200 revs. per min., and fitted with plain pin joints—have a friction of parts which is equal to about a $1\frac{1}{4}$ per cent. change of speed from a normal, which is an extreme of $2\frac{1}{2}$ per cent.

Practically, no change of position is involved in this amount—that is, only sufficient movement for purposes of observation; and if no work is required from such a governor it may be expected to perform its functions, which includes the effects of its inertia and range of motion, with a total variation of about 4 per cent. This has been found to be the practical result of experiments, both at the speed named and considerably over that. With light work in the way of governing, then, the limit of possibility in such a case may be taken at 5 per cent. It should be specially noted that these results are for plain pin joints, well designed, well fitted and well lubricated, the range of the governor slider being what an expert would consider to be a useful range—say, equal to a fourth of the length of the governor ball-arm. Short-range

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governors are of little value. The testing instruments were of the centrifugal type, of the best obtainable quality, but, of course, having errors of their own which would cause the record to be somewhat better than the actual results.

Governors of a similar type to the before-mentioned have been made with ball bearings to all the joints, and, moreover, have been constructed to run at a higher speed (400 revs. per min.), and were found on careful test to be greatly superior in every way to those having plain pin joints. Between the great diminution of inertia which the higher speed made practicable and the practical elimination of friction very remarkable results were obtained. No available instruments were sufficiently delicate to measure the friction with any certainty whatever, and it was impracticable when running the engine to which they belonged to bring the governor slider to a state of rest by the most careful manipulation of the stop valve when the engine was doing no exterior work. As might be expected from these statements, very fine governing was obtained from the engines to which these governors were fitted; in some which ran 220 revolutions, and had a flywheel of ordinary weight, to about 1½ per cent. total, and in a particular instance of an application to an old engine which had a very light flywheel, and where the maximum pulsation was 12½ per cent. per stroke, to 2½ per cent. maximum variation, under the most trying conditions which could be brought about—that is, by turning full steam into the standing engine with no load on. In this case the governor was assisted in working a heavy slide valve expansion gear, by auxiliary power, which was controlled by a differential lever motion and valve which followed the action of the governor, so that the latter had practically nothing to do but shift its own position.

Again, shaft governors have been made which would work a piston cut-off motion and govern a high-speed engine to 1½ to 2 per cent. under the extreme circumstances mentioned. All these were uncommon, and very uncommon, results and are cited for the purpose of getting at the "possible" in the matter of adjustment. It should be noted that the shaft governor case was one in which no extreme result was aimed at, the adjustment being made for ordinary every day work.

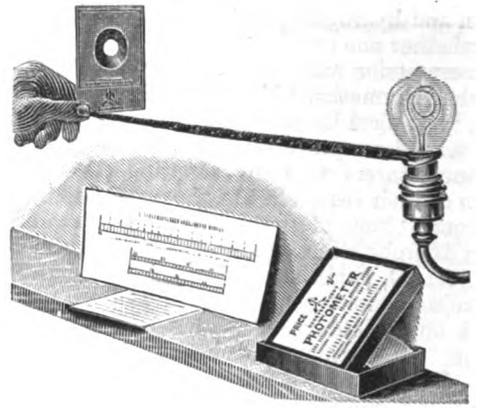
Now for the meaning of 10 per cent. range of adjustment. Taking the 2 per cent. governing as a medium instance, it may be reasonably assumed that 1 per cent. would be absorbed in friction and over action due to inertia, and that most of the other 1 per cent. would go to changing the position of the governor; in fact, such was the intention of the design, and outside errors of weight and workmanship may be said to be so. So it is quite clear that such a governor, adjusted to run to 2 per cent. total, could not be screwed up to *raise* the speed without causing racing, and careful trials showed that such was the case. Nothing, therefore, in the way of adjustment could be done where the governing was already fine but by lowering speed. The same remark applies to the first case mentioned, where the closest possible adjustment was 4 per cent. No work practically was taken off these examples, for even in the case of the shaft governor the engine did the work of shifting the gear; also, the centrifugal force of that governor was about 3,000lb. They might, in fact, be looked upon as scientific instruments, and therefore it is clear that any worse conditions would produce worse results than the conclusions hereafter arrived at. Between 1 and 10 per cent. increase or decrease of speed, it will be near enough for the sake of argument, and save complication of figures, to say that 1 per cent. increase or decrease of speed produces 2 per cent. difference of centrifugal force.

Now, suppose a load spring to be 20in. long, not compressed at all, and that in working it is required to have 5in. initial compression and, in addition, a 5in. range, which would make a total compression of 10in. as a maximum. To lower the speed at the maximum compression 10 per cent., 20 per cent. of the 10in. total compression would have to be relieved. This would decrease the initial compression by 2in., or by 40 per cent. of the initial compression. This 40 per cent. relief of the initial compression would drop the rising speed of the governor (that is, the speed at which it would come off the stop) by 20 per cent., and the variation of the speed of the engine through the range of the motion of the governor would be 10 per cent. This is without the "imperfections" variation of 1 per cent., so that the best possible results to be obtained from the best quality of governor, with a 10 per cent. hand adjustment, would, as an extreme reduction, be 11 per cent. variation of speed, through the full range of the governor, and at a mean no better result could be had than 5½ per cent. If a 3 per cent. "imperfections" variation be added to this 5 per cent. the variation becomes 8 per cent. at a mean.

Simple mechanism can, however, be applied to some governors which will admit of adjustment of speed without spoiling the quality of the governing. The hand adjustment of a governor in the ordinary way spoils the quality of the governing, because the stiffness of the load spring for fine governing must be made per inch of compression to correspond closely with the increase of radius of the centrifugal weights and its consequent effect in increasing the centrifugal force of such weights, allowance, of course, being made for the slight increase of speed necessitated by the change of position of the slider or equivalent. It is obvious that any change of the rate of revolution should be accompanied by a suitable change in the stiffness of the load spring, if the quality of the governing is not to be spoilt by altering the speed.

A NEW GLOW-LAMP PHOTOMETER.

Messrs. Everett, Edgcumbe & Co. have recently brought out a novel form of glow-lamp photometer. Whilst it is now easy to obtain an ammeter which will instantly indicate the current taken by an incandescent lamp, it is a very different matter when it is a case of the determination of the candle-power yielded. In fact, without the use of elaborate standards and a specially fitted-up photometer room it has, up to the present, been deemed an impossibility. As a consequence, the important question of candle-power has to be taken for granted by the buyer of lamps. Further, without a knowledge



of the candle-power, the measurement of the current consumption is of small value, although easily ascertained. The ingenious little apparatus (shown in the accompanying illustration) consists essentially of a modified form of Leeson disc photometer, which type possesses several marked advantages over the well-known Bunsen grease spot, particularly when lights of a somewhat different colour have to be compared, as for example, in the measurement of high and low-efficiency lamps.

Two lamp-holders are provided attached to an adaptor, so that connection can be made to any electric light fitting. In order to use the photometer, a divided scale, which is provided with a ring at each end that can be slipped over the lamp-holders, has only to be put in place and stretched tight. Having obtained a point of balance in the ordinary way, the required candle-power is readily found without any calculation whatever by means of an ingeniously-devised direct-reading logarithmic scale.

Two of the difficulties which have to be surmounted in glow-lamp photometry are, firstly, to obtain a handy and reliable standard, and, secondly, to regulate the voltage. In the photometer of Messrs. Everett, Edgcumbe & Co., the Gordian knot has been cut by making no attempt whatever to keep the voltage constant, and by employing a specially standardised lamp, which forms part of the outfit, as the standard. It is claimed that the relation between the light emitted by an incandescent lamp bears a perfectly definite relation to the pressure at its terminal, and that as both the standard and the lamp under test are run off the same supply, any increase or decrease of voltage will affect both lamps equally, and the point of balance

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will remain unaltered. The method has the further advantage that the candle-power so found is, no matter how much the supply voltage may vary, the candle-power which the lamp would give at the standard voltage, which is, of course, what is required. It is clearly best in practice not to use the standard lamp throughout a series of tests, but to standardise another lamp from it, and to use this as a sub-standard.

It is claimed that with this set no specially arranged dark-room is necessary, as any moderately screened position is all that is required; or, by hanging a few yards of black cloth over the photometer, an ideal photometric chamber can be readily improvised. When it is impossible, for any reason, to obtain a fair absence of light, a simple correction factor can be determined, once for all, as explained in the directions which accompany the instrument, by interchanging the standard and test lamps, and obtaining a second point of balance. This, however, will seldom be found necessary. The direct-reading scale already alluded to can be used to obtain the efficiency of the lamp in watts per candle-power, from the candle-power and measured current. This firm's lamp tester, which is useful for such a purpose, is so well known that no description need again be given. Suffice it to say that it has now been so far improved as to be perfectly dead-beat, so that the readings can be taken with the utmost rapidity. It should be mentioned that the same instrument can be used for direct or alternating-current, as required. In this case also, fluctuations of voltage will have but little effect on the result; and, unless extreme accuracy is required, no voltmeter need be employed. Every detail seems to have been most carefully worked out, and it may finally be remarked that not the least among the points in favour of this ingenious photometer is the marvellously low price at which it can be obtained.

STANDARDISATION OF PIPE FLANGES AND FLANGED FITTINGS.*

BY ROBERT E. ATKINSON.

(*Concluded from page 801.*)

Bolts.—The same principle of interchangeability has been adopted with regard to the number and position of bolts, the proposal being that what difference in strength may be required for the varying pressures should be made in the size of the bolts. The author holds

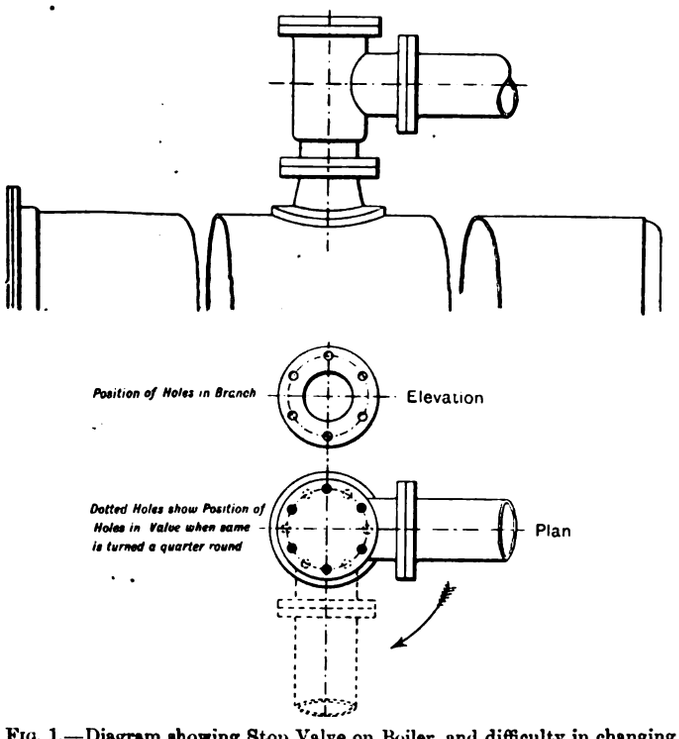
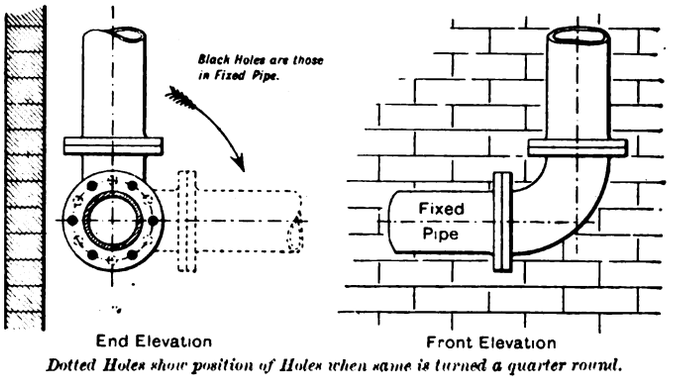

Position of Holes in Branch
Elevation
Dotted Holes show Position of Holes in Valve when same is turned a quarter round
Plan

FIG. 1.—Diagram showing Stop Valve on Boiler, and difficulty in changing the position of same when flange is drilled with six holes.

the opinion strongly that no standard can be satisfactory which does not allow for the number of bolts being a multiple of four; without this interchangeability is impossible. Fig. 1 shows the difficulty attending the use of bolts otherwise than upon this principle. In this sketch is shown a stop valve attached to a boiler, and the flange drilled for six bolts. In dotted lines is indicated the valve turned at right angles, from which will be seen the difficulty that arises, and that a new valve will be required if any alteration of position is desired. Bends, tees and other fittings require to be adjusted to alterations of position, and Fig. 2 shows a bend connected to a pipe line, and reveals the impossibility of varying its position, as shown in dotted lines, this fact being due to its having been drilled with



Dotted Holes show position of Holes when same is turned a quarter round.

FIG. 2.—Diagram showing Bend in Steam Main, and difficulty in changing the position of same when flange is drilled with six holes.

six bolt holes. In the case of tee-pieces, the flanges of which have 6, 10, 14 or 18 holes, it would be impossible to set the centre branch vertically if it had been drilled to suit a horizontal position. Fig 3 shows the position of the bolt holes in the proposed standard. In every case the nearest holes to the centre lines are arranged equi-distant from them. These centre lines would correspond with the

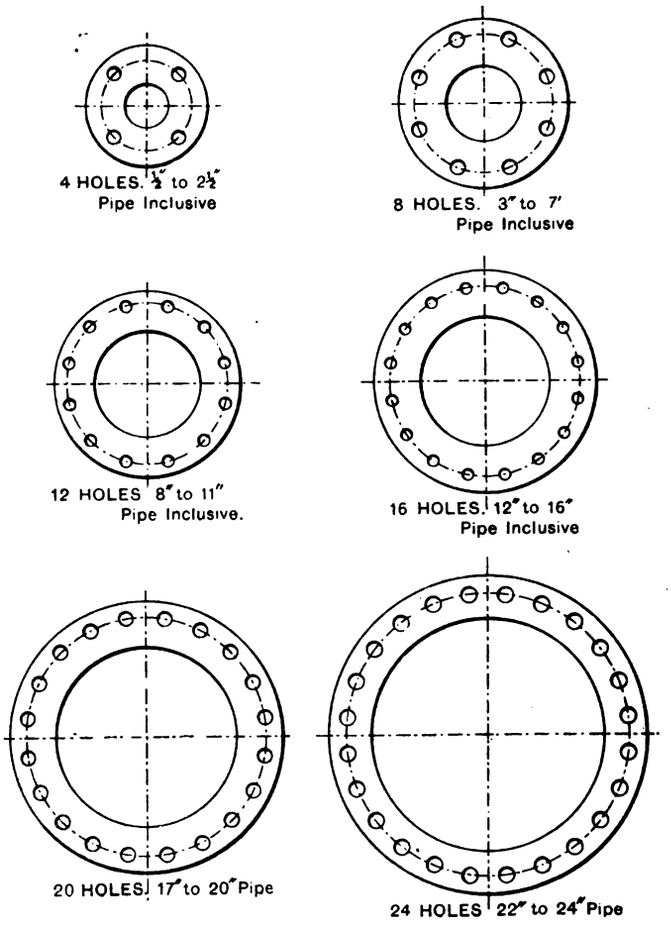

4 HOLES. ½" to 2½" Pipe Inclusive
8 HOLES. 3" to 7" Pipe Inclusive
12 HOLES 8" to 11" Pipe Inclusive.
16 HOLES. 12" to 16" Pipe Inclusive
20 HOLES. 17" to 20" Pipe
24 HOLES 22" to 24" Pipe

FIG. 3.—Diagram showing position of Bolt Holes in Flanges in the Proposed Standard Designs.

centre line of the spindle of a valve, the horizontal and vertical axes of a boiler, an engine, a pump or other machine, and be the same for pipes, valves, tees and fittings. In the case of valves, the top flange or stuffing box is likely to interfere with the insertion of the bolt, and it is, therefore, not advisable to arrange the holes on the centre lines. The same difficuly is met with in respect to a bend of short radius.

The sizes of bolts have been calculated assuming an average tensile breaking strain of wrought iron at 22 tons to the square inch

*Abstract of Paper read before the Institution of Mechanical Engineers.

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(as given for Dudley iron in Prof. Unwin's book on "Strength of Materials"), with a factor of safety of six as a minimum. In the smaller bolts, $\frac{3}{8}$in., $\frac{1}{2}$in. and $\frac{5}{8}$in., this factor of safety is much increased, as an altogether disproportionate strain can be placed on the bolt in screwing up. If special high-class bolts are used of a great tensile strength, the diameter can be proportionately reduced, but in average steam-pipe work ordinary merchant bolts are used, and this quality has been taken into consideration in deciding the sizes given in the table.

Various conditions arise which affect the decision as to the pitch of bolts, similar to those met with in deciding the thickness of flanges, and makes the point difficult to settle by theoretical calculation, owing to strains to which the joint is sometimes subjected, by contraction and expansion when the steam is alternately admitted and shut off. The jointing ring too is often affected by water of condensation acting upon it, and particularly so when the material is asbestos. Again, in the case of plain flanges without recesses, trouble frequently occurs by the displacement of the jointing rings when the centres of the bolts exceed this dimension. The recognition of a limit of 4½in. as the largest circumferential pitch of both, and the observance of the principle of the multiple of four with respect to the assemblage of bolts, together determine the number of bolts to be used in the various flanges. Thus for pipes from ½in. to 2½in. inclusive, four bolts are adopted; for 3in. to 7in. pipes, eight bolts; for 12in. to 16in. pipes, 16 bolts; for 17in. to 20in. pipes, 20 bolts; and for 21in. to 24in. pipes, 24 bolts. The change from four to eight occurring as it does on 3in. pipes necessarily makes the number of bolts more than is strictly required; but the only alternative is either to adopt a number not divisible by four, or to use only four bolts, which would make the circumferential pitch as much as 4·71in.; and this dimension would be altogether excessive for a flange when working at, say, 250lb. pressure.

The present proposals give flanges slightly in excess of those of the American low-pressure standard, but that in no case is the variation more than 1in. in the outside diameter. The American standard adopts the principle of the multiple of four in arranging the bolt-holes, but four bolts are used for pipes from 2in. to 4in. inclusive, whereas in the proposed standard four bolts are not used for pipes larger than 2½in. In respect to pipes above 4in. in diameter the two standards agree as to the number of bolts, except the 8in., 12in., 14in., and 18in. pipes, in which cases the American low-pressure standard contains four bolts less in each flange. In the high-pressure standard, the diameter of flanges in the present proposals are somewhat smaller than those of the American standard, varying from ½in. for 3in. pipes to 2in. on the 24in. pipes. There is agreement in the two standards as to the number of bolt-holes up to and including the 5in. size, and several above that size also agree. With the German standards, difficulty arises in making an exact comparison, owing to the different systems of measurement; but generally it will be seen that in the German standard the flanges are somewhat smaller in diameter for a given size of pipe than those proposed in this Paper. The difference is, however, but slight, as for instance, a pipe of 150mm. (or 5$\frac{1}{16}$in.) inside diameter has a flange 300mm. (or 11$\frac{13}{16}$in.) diameter, whereas in the proposed standard the flange for a 6in pipe is 12in. diameter. Unfortunately, the sizes of the flanges in the two German standards do not agree, except for pipes up to 80mm. (or 3$\frac{5}{32}$in.) inside diameter. For example, the difference in the size of flange on a pipe of 400mm. (or 15¾in.) inside diameter is but 30mm. (or 1$\frac{3}{16}$in.); and seeing that the amount of material saved by this small difference is so slight, it would appear that, all things considered, it would have been more economical to have made these two sizes agree. As to the number of bolt holes, the German standard does not agree with the one now proposed, except in a few sizes of pipes for the high pressures, and the German low-pressure standard is not interchangeable with that for the high pressure. So far as can be ascertained no firm has, up to the present, adopted, the multiple of four as a fixed principle. The difficulty in the differing systems of measurement must, of course, be confronted if an effort is made to institute an international standard for flanges owing to the present English system of measurement. But as already a close approximation is made, in many cases, to identity of measurement, it does not seem difficult to arrive at a working compromise, by disregarding the vulgar fractions as far as possible in the English system, and by departing occasionally from the existing Continental custom of even numbers in millimetres.

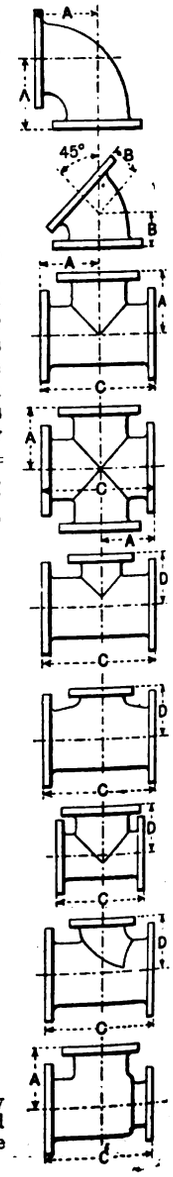
It is apparent from the foregoing that, with the continuous expansion of international trade, it is desirable that if possible a standard should be adopted which will be applicable at home and abroad. Recognising the various interests involved, and the many branches of engineering to which this subject is applicable, and considering the advantage of an interchange of ideas with other societies interested in the subject, it would seem essential that any arrangement to secure success should meet the approval of the principal engineering organisations interested.

Table V.—*Proposed Standard.—Dimensions of Cast-iron and Cast-steel Fittings and Connections.*

Inside diam. of pipe.	Diam. of flange.	Diam. of bolt circle.	No. of bolts.	A.	B.	C.	D.	E.
in.	in.	in.		in.	in.	in.	in.	in.
½	3½	2½	4	2⅝	6⅝	5¼	4	7⅝
¾	4	3	4	3	7½	6	4½	9
1	4½	3⅜	4	3⅜	8⅜	6⅜	5	10⅛
1¼	5	3¾	4	3¾	9¼	7½	5½	11¼
1½	5½	4¼	4	4¼	10⅛	8¼	6	12⅜
2	6½	5	4	4⅞	11⅞	9¾	7	14⅝
2½	7	5½	4	5¼	13¼	10½	8	15¾
3	8	6	8	6	15	12	9	18
3½	8½	6¾	8	6⅜	15⅞	12¾	9½	19⅛
4	9	7⅜	8	6¾	16¾	13½	10	20¼
4½	10	8¼	8	7½	18½	15	11	22½
5	10½	8¾	8	7⅞	19⅜	15¾	11½	23⅝
6	12	10	8	9	22	18	13	27
7	13½	11½	8	10½	24⅝	20¼	14½	30⅜
8	14½	12½	12	10⅞	26⅜	21¾	15½	32⅝
9	16	14	12	12	29	24	17	36
10	17	14¾	12	12¾	30¾	25½	18	38¼
11	18½	16¼	12	13⅞	33⅜	27¾	19½	41⅝
12	19½	16¾	16	14⅝	35⅛	29¼	20½	43⅞
13	21	18¼	16	15¾	37¾	31½	22	46¼
14	22	19	16	16½	39½	33	23	49⅝
15	23	20	16	17¼	41¼	34½	24	51¾
16	24	21	16	18	44	36	26	54
17	25	22	20	18¾	45¾	37½	27	56¼
18	26	23	20	19½	47½	39	28	58½
20	28	25½	20	21	51	42	30	63
22	30	27½	24	22	54½	45	32	67½
24	32	29½	24	24	58	48	34	72

The dimensions A = diameter of flange × 0·75.
Ditto B = A + D.
Ditto C = A × 2.
Ditto D = Diam. of flange + ½in. up to and including 2in. diam.; Ditto +1in. ditto ditto 15in. do.; Ditto +2in. ditto ditto 24in. do.
Ditto E = A × 3.

Do not drill bolt holes on centre lines, but symmetrically each side of it.



Cast-iron and Cast steel Flanged Fittings.

The want of uniformity is equally felt when considering the principal dimensions of these fittings. What has already been said in this respect with regard to flanges will be found applicable also to this branch of the subject; for it is as important to have inter-changeable dimensions for fittings as for flanges. At present it is the case that those made by one firm are not of use for replacing those of another firm, should such necessity arise; whilst in numerous other ways, needless to particularise, experience constantly reveals the loss and inconvenience from the existing diversity and confusion in the patterns commonly used. At the present time very few

Table VI.—*Dimensions of Cast-iron Flanged Fittings and Connections as used by Crane Company, Chicago.*

Inside diam. of pipe.	Diam. of flange.	Diam. of bolt circle.	No. of bolts.	A.	B.	C.	D.
in.	in.	in.		in.	in.	in.	in.
2	6	4¾	4	4½	2⅜	9	...
2½	7	5½	4	5	2 1/16	10	5
3	7½	6	4	5½	3 3/16	11	5½
3½	8½	6¾	4	6	3½	12	5¾
4	9	7¼	8	6½	3¾	13	5⅞
4½	9½	7¾	8	7	3 13/16	14	6⅛
5	10	8¼	8	7½	4 1/16	15	6 7/16
6	11	9¼	8	8	4⅜	16	7
7	12½	11	12	8½	5⅛	17	7½
8	13½	12	12	9½	5⅝	19	8 1/16
9	15	13	12	10¾	5 13/16	21½	8⅝
10	16	14¼	12	11½	5 15/16	23	9⅛
12	19	17	16	12¾	6 1/16	25½	10¼
14	21	18½	16	13¼	7 7/16	26½	11⅛
16	23½	21½	20	15½	8 1/16	30½	12 1/16
18	25	22½	20	16½	8½	33	13½
20	27½	24¾	20	18	9⅜	36	14 9/16
22	29½	27½	24	20	10½	40	15 15/16
24	31½	29½	24	22	11½	44	16¾

The dimension D is for a 2½in. branch, and will vary according to the diameter of branch. Flanges are drilled in multiples of four, so that fittings may be made to face in any quarter, and holes straddle centre line.

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manufacturers keep large stocks from which supplies can be drawn, and it was ascertained while procuring informative relative to existing practice in this country, that wherever a standard had been formulated it was of a purely arbitrary character, and no definite principle had been laid down; indeed, in some instances the same dimensions for bends and tees were adopted for 4in., 5in., and even 6in. fittings. An endeavour has been made by the following proposals to arrive at a definite uniformity with respect to these fittings, for which Table V. contains a series of standard over-all dimensions, and the guiding principles that have been observed are: (1) A minimum number of dimensions. 2. Interchangeability of the various types of fitting for each size of pipe; as, for instance, a bend should fit the position occupied by a tee, if required, and vice versa. 3. That the over-all dimensions should bear a proportionate relation to the size of the flange.

It may be interesting to note that the American Journal *Power* published as monthly supplements, from December, 1897, to November, 1898, a series of valuable tables, giving the dimensions and weights of cast-iron flanged fittings, as made by the four principal firms in America manufacturing them. These publications brought out the fact that the goods were not interchangeable; at the same time there did not appear to be any valid reason why this desirability was not secured. One of these standards is given on Table VI., that of the Crane Company of Chicago, and on Fig. 7, plate 4, is a diagram comparing this standard with the one now proposed. From this it will be observed that the Crane Company's standard and the one now proposed do not largely differ, while the merit of the latter lies in the fact of its being correlative to the diameter of the flange.

APPENDIX.—*Being Portion of a Communication sent to the Institution by Messrs. Lloyd and Lloyd, Albion Tube Works, Birmingham.*

Messrs. Lloyd and Lloyd recently wrote to upwards of 20 manufacturing private firms, or companies, in England, whom they considered to some extent representative of the trades interested in the subject of the standardisation of flanges. While they could not say that the list was as complete as possible, yet it was sufficient to prove that the engineers and manufacturers in Great Britain would welcome an attempt to standardise flanges.

Sixteen replies were received as follows:—

Query.	Reply.		
1.—Are you of opinion that a standard or standards for flanges should be fixed by the engineers and manufacturers in Great Britain?.....	Yes. 16		No. 0
2.—Should there be one standard for all pressures up to 200lb. steam per square inch?	Yes. 1		No. 14
3.—If you do not approve of one standard only, how many would you suggest for meeting all requirements, ranging from low-pressure gas and water to high-pressure steam?	No. of standards. Two. 6		Three. 8
4.—If not similar in details, should the diameter of the flanges be the same for all pressures? ...	Yes. 8		No. 5
5.—Do you consider it necessary to standardise thicknesses of flanges in addition to the diameters and bolt circles?	Yes. 7	No. 4	Perhaps. 2
6.—Should the number of bolt holes in all cases be multiples of four?	Yes. 4		No. 9
7.—Would you agree to recognise and to adopt *as far as possible* the standard or standards decided upon by the majority?	Yes. 15		No. 0

THE OSMIUM ELECTRIC LAMP.

The interest which has been manifested, both in incandescent gas-lighting and electric-lighting circles in England and Germany, as to the commercial possibilities of the osmium electric lamp, devised by Dr. Auer von Welsbach, will be somewhat deepened by a noteworthy article which has just been published by a leading Berlin newspaper. It has been claimed that the osmium lamp will effect a revolution in electric lighting in the sense that it will render for this industry similarly advantageous services to those afforded to the gas-lighting branch by the Welsbach incandescent burner system, and it is believed that when the former is placed on the English market it will be controlled by the British owners of the Welsbach incandescent gas-lighting patents. So far, however, the osmium lamp has not arrived, and the reasons as given by the Berlin *Tageblatt* are not without interest at the present moment.

It appears that at one time the shares of the German Incandescent Gas Light Co.—the Welsbach enterprise of the Fatherland, and the purchaser of the patent rights of the osmium lamp for Germany, Luxemburg and Holland—advanced to the almost unprecedented premium of 1,000 per cent., and that, apart from the heavy declines which have since occurred simultaneously with the drop in the very high dividends which were paid, a further fall to the extent of 50 per cent. took place during the month of September. The Berlin newspaper attributes this unfavourable circumstance partly to the fact that, in consequence of increasing competition, the company no longer plays the same important rôle as in former years, but mainly to the uncertainty surrounding the fate of the osmium lamp, upon which exceedingly sanguine expectations have been based. In support of the latter statement, the article refers to the company's report for 1900–1901 wherein it is stated that it is hoped so to increase the manufacture of the lamp in the winter season as to yield profits in the new year, and that from the measurements and experiments made the lamp would constitute a lucrative invention in the future. As recently as July last the company repeated the assertion that the lamp would be placed on the market in the coming season, and a few days ago it was stated by the company that the prices and conditions of sale have not yet been fixed, so that there is no information as to when the lamp will be brought out for commercial purposes in Germany, much less in England.

It appears, however, that notwithstanding the relatively small consumption of electric current, the construction of the osmium lamp is far more difficult than that of an ordinary incandescent electric lamp with a carbon filament owing to the metal osmium, apart from its comparative scarcity, being difficult of treatment, so as to obtain an equality of the metal forming the lamp filament. In fact, the principal obstacle is said to lie in the impossibility of constructing lamps having a sufficiently high electrical resistance, as the osmium wire is either so long or so thin that at white heat—that is, when at the incandescent stage incidental to ordinary use—it is unable to retain its original shape. It remains to be seen whether this difficulty can be surmounted, although the company claims to have done so now. The German company, which several years ago paid dividends up to as high as 130 per cent., and as much as 28 per cent. a year ago, announces that the financial year now closed will show a further decline in the amount of the distribution.

THE APPLICATION OF ELECTRIC POWER IN THE IRON AND STEEL INDUSTRIES.*

BY D. SELBY-BIGGE.

In the year 1894 the author had the honour of reading before this Institute two Papers dealing with the subject of electric power transmission, having regard especially to the driving of works machinery by means of electricity. At that time the subject was a comparatively new one to the owners of works in Great Britain. The Papers read were purely of a technical nature, and dealt with the methods the author then thought most suitable to be employed in driving works electrically. Since that date a great number of Papers have been read by well-known authorities on this subject. In bringing another communication before this Institute it is now the author's endeavour to read a Paper on somewhat different lines, and one which will prove not only of interest but of actual use to works owners and managers in England. The Paper, therefore, will deal chiefly with actual facts and figures and with data of a practical nature collected from a great number of different sources.

During the past 12 years the author has been almost exclusively engaged in the remodelling of the driving arrangements in engineering works, iron and steel works, shipyards, factories, and mining operations from steam to electricity, and he has almost invariably been met with the question: Can you show us by any facts or figures actual savings which can be directly attributable to the change from one system to the other? It has not, however, been possible for him to deal with this matter in the form of a Paper until the present time, as in the early days no data were available, and even in subsequent years accurate data have been most difficult to obtain. The following cases and figures may, however, prove interesting to the members of this Institute.

SAVINGS EFFECTED IN WORKS.

For the Hamburg quayside cranes the total working expenses were as follows:—Wages for cranesmen, coal or electric current, cleaning and oil (excluding, however, repairs) per 10 hour run per crane, taking the average during the year:—

1. Brown single steam crane..... 10s.
2. Steam-winch crane ..... 8s. (1893-94).
3. Steam crane driven through pipes from steam plant 12s.
4. Electric crane..... 7s. (1898).

The steam cranes are stoked with cinders only, which in 1893-94 cost about 11d. per cwt. The electric cranes take current from the public supply at about 2d. per kilowatt-hour. Nos. 1 and 2 have a boiler on the crane itself; No. 3 takes steam from a larger steam plant through pipes (about 20 are thus supplied).

* Paper read before the Iron and Steel Institute.

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In 1901 the working cost of 182 Brown's cranes came to 11s. 4d. per crane per 10 hour run, whereas that of the electric cranes was the same as in 1898—viz., 7s. In 1898 the steam cranes lifted 1,825,880 tons in 315,083 hours, the working costs amounting to £20,516. 4s., so that the cost per hour (inclusive of repairs) amounted to $\frac{410,324}{315,083} = 1{\cdot}302$ shillings, or about 1s. 4d. per working hour. The cost per ton lifted would be 0·2247 of a shilling, or nearly 2¾d. The electric cranes lifted, from Jan. 1, 1898, to Sept. 30, 1898, 77,697 tons in 10,190 working hours, the costs being 2,664 shillings for current (2d. per kilowatt-hour) and 4,462 shillings for wages, &c. Thus for one ton of goods lifted the cost is nearly 1d.

Taking next the case of the Westinghouse Air Brake Co., Wilmerding, Penn., U.S.A., the boilers in this shop were formerly driven in groups, 30 steam engines, aggregating 1,375 H.P. being used for the purpose. The engines were supplied with steam from the central boiler plant. For this system was substituted an alternating-current system, the generators supplying induction motors driven by Parsons steam turbines; the shafting used was divided into shorter lengths, and the 30 engines were replaced by 57 motors, aggregating 1,065 H.P. In order to have an accurate comparison of the two systems, several tests were made, extending over some days, with the following results :—The reduction in steam consumption was found to be 40 per cent. and the reduction in coal consumption $32\frac{2}{10}$ per cent.

Before a meeting of the Franklin Institute in 1901, Mr. Samuel Vauclain, superintendent of the Baldwin Locomotive Works at Philadelphia, U.S.A., stated that if electric driving in their works should be abandoned the manufactured product would cost 20 to 25 per cent. more for labour, and the floor space would have to be increased 40 per cent. to maintain the present output.

In an excellent article written by Mr. Alexander Richardson, upon Messrs. Vickers, Sons and Maxim's works at Barrow-in-Furness, and published in "Traction and Transmission," he says :—

No special data have been taken as to the cost of running this station separately, but it may be noted that the cost per unit generated during 1901 at the engineering works station was 0·77d., which includes coal, wages, water, repairs and all works costs. The economy resulting from the substitution of electric power for steam is shown by the fact that the average monthly coal consumption for three winter months in 1898, when only steam power was used in the shipyard, was 476 tons, whereas for the corresponding period in 1899, after electric power was adopted, the average coal consumption was 232 tons, being almost exactly half the total required for steam power. This, too, notwithstanding the fact that many new machines had in the interval been added to the platers' shed, and that the amount of lighting done had been more than doubled. The true saving is probably nearer 60 than 50 per cent. if this extra load be taken into account.

At a large colliery in South Durham the pumps were originally of the spear rod type, worked from bank, and the pumps delivered about 1,000 gallons per minute against a head of 400ft. Owing to the room which these pumps occupied in the shaft, and it being desired to put in another cage, which could not be done with the pumps in the shaft, the pumps were removed and in their place was substituted a horizontal compound coupled engine of 400 H.P., one 250kw. dynamo arranged to drive the two pumps at present installed, also an additional pump and the coal-cutting machines. This machinery was placed at a colliery where they were able to utilise coke oven gas. The colliery being 1,000yds. from the shaft where the pumps were originally installed, the current was carried overhead by cables and down the shaft to two sets of 11 by 18 three-throw pumps, each delivering 500 gallons per minute against a head of 400ft. It is estimated that the saving in fuel alone is over £1,000 per annum; in addition to this the shaft can now be used for winding, and the output of the colliery very considerably increased.

In one of the collieries in Northumberland the workings were pumped by means of seven single-barrel pumps, each set delivering about 100 gallons per minute, these pumps being driven by an endless wire rope from two hauling engines, steam being supplied by locomotive boilers underground. This plant was taken out, and in its place was substituted a horizontal engine with automatic triple-expansion gear driven on to a dynamo, and the existing pumps were utilised, the pumps being driven through machine-cut worm gear by 6 H.P. motors, and in all eight sets were so arranged. The total cost of the electric plant, exclusive of erection, was a little over £3,000, and the annual saving was from £1,500 to £1,800.

At a colliery in Scotland in which the workings were originally drained by means of (*a*) a spear rod pump to the shaft bottom, (*b* and *c*) two duplex pumps underground with steam pipes, the furthest pump being about 800yds. in-bye, it required seven men to attend to the pumps, and the consumption of coal was about 14 tons per day. The plant was taken out, and in its place there was installed a horizontal compound coupled engine of 250 H.P., 130 k.w dynamo, one set of three-throw pumps, 11 by 18, delivering 500 gallons per minute against a head of 600ft., and one 150 H.P. motor for driving same. The work with the new plant was done in eight hours per day, the consumption of coal was 2½ tons per day, and the whole installation was looked after by three men. It was estimated that the annual saving exceeded £3,000, so that the total cost of the plant, including erection and everything, would be paid for in less than two years.

With electrical driving of hauling gear at the Ewald Colliery, Germany, it has been found that, not taking into account depreciation, discharging one ton kilometre of coal from the mine costs about 3·39 pfennigs (⅓d.). A balance-sheet for July, 1895, shows a clear saving in cost against that of July, 1894, of 5,512m., the economy being effected by the electric hauling gear.

The quantity of coal discharged up to July, 1894, for 25 working days amounted to 107,000 truck kilometres at 0·6 of a ton per truck, 50 horses being at work, so that the monthly work of each horse amounted to $\frac{107.000}{50}$ = approximately 2,140 truck kilometres, or $2{,}140 \times 0{\cdot}6 = 1{,}284$ ton kilometres, without counting trucks carrying bricks, wood or lime, or running empty. The daily work of each horse was $\frac{2,140}{25} = 85{\cdot}6$ trucks per kilometre, or $\frac{1,284}{25} = 51{\cdot}36$ ton kilometres.

The monthly cost per horse is as follows :—100m. paid for hiring; 54m., wages for driver, proportion of expenses for stable boys, &c., together, 154m. for 50 horses; therefore = 7,700m., not counting 6m. per horse, or 300m. per month for 50 horses for shoeing, water, and amortisation of the underground stables. If, therefore, the daily work of the horses is 85·6 trucks per kilometre, there would be 51·5 horses necessary for the month of July, 1895, for the whole transport of 118,962 truck kilometres in 27 working days, which would mean a cost of $51{\cdot}5 \times 154 = 7{,}931$m.

Exclusive of amortisation of the capital the cost of the mechanical hauling gear is as follows :—

1	foreman	M.190·00
2	day attendants	197·75
4	night attendants	473·45
3½	men for rope repairs	328·07
175	different amounts for extra work, &c.	562·15
	Total of wages	1,751·42
	Extra expenses	145·82
	(320 volts, 110 amps. = 35·2kw.) for the steam engine $\frac{35{\cdot}2}{0{\cdot}7} = 50{\cdot}3$ H.P.	521·51
	(1 H.P. hour = 0·024m. monthly, 27 days × 16 hours × 50 3 × 0·24 = 521·51m.)	
	Total working costs	M.2,418·75

Not taking into account depreciation and interest, in the month of July, 1895, there would be a saving of 7,931m. − 2,419m. = 5,512m. against the same month of the year before. That amounts to $\frac{7.700\ 0}{107{,}000 \times 0{\cdot}6} = 12$ pfennigs (1·2d.) per ton kilometre if worked by horses, and for the mechanical hauling gear, $\frac{2.418{\cdot}73}{118{,}962 \times 0{\cdot}6} = 3{\cdot}39$ pfennigs (⅓d.). The costs of amortisation will no doubt be balanced on account of the saving of $51{\cdot}5 \times 12 = 618$ cubic metres of fresh air per minute for nine horses, because of the reduction in costs for repairs, &c., and above all, on account of the greater regularity of working.

If, therefore, it is desired to fix the working cost at say 150,000m. for running expenses, inclusive of reserves, 2,250m. per month, 18 per cent. for amortisation and interest would have to be taken into account and thus raise the total cost for the mechanical working to 2,419 + 2,250 = 4,669m. per month; or, in other words, a ton kilometre would cost $\frac{4,669\ 0}{713\ 772} = 6{\cdot}54$ pfennigs (a little more than ½d.), amounting only to half the cost of working by horses.

A good example of the great difference in cost of working will be found in the statement that the total cost of transporting 1 ton 3,280ft. if electricity is used amounts to only 0·3 of 1d., whereas if horses are used the cost amounts to 1·2 of 1d. The majority of us do not realise the great losses in driving shafting with all its bearings, pulleys, gears, and ropes; it amounts to several millions of horse-power every hour in the year. In a Portland cement factory in Westphalia it has been found that of the 400 H.P. of the steam-engine, 70 H.P. were used for driving shafting alone with no load, and since this factory is working day and night, we may say that during a year of 300 working days, $300 \times 24 \times 70 = 504{,}000$, or more than half a million horse-power hours are wasted, meaning to say ½d per horse-power-hour, a sum of £1,050 per annum. For driving a ventilator in a cement factory, 15 H.P. were transmitted a distance of 263ft. Two shafts, a reducing gear and four belts were used, and exact measurements showed that 8·1 H.P. were absorbed by shafting and belts. Since the ventilator had to work day and night, this small transmission caused a yearly loss of $8{\cdot}1 \times 24 \times 300$ (working days per annum) = 58,320 H.P. hours.

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COMPARATIVE COST OF WORKING HYDRAULIC AND ELECTRIC LIFTS.

Type of lift.	Load in cwts.	Source of power.	Travel in ft.	Cost of av. round trip up and down.	No. of trips per penny.	Remarks.
Electric	7	Manchester Corporation	50	0·159d.	6·3	Observed. Conditions unfavourable. Current at 2½d.
Hyd. suspended H.P.	7	Do.	50	0·29d.	3·45	Calculated from published scale.
Hyd. suspended L.P.	7	Do.	50	0·445d.	2·2	Calculated at 6d. per 1,000 gallons. Pressure 50lb.
Electric	9	Private supply	50	0·066d.	15·0	Observed. Conditions ordinary. Current at 2½d.
Hyd. suspended H.P.	9	London Hyd. Power Co.	50	0·277d.	3·6	Calculated from published scale.
Electric	9	Glasgow Corporation	50	0·061d.	16·4	Observed. Current at 2½d.
Hyd. suspended H.P.	9	Do.	50	0·212d.	4·7	Calculated from published scale.
Hyd. suspended H.P.	12	London Hyd. Power Co.	50	0·35d.	2·86	Observed.
Hyd. suspended H.P.	9	Do.	50	0·287d.	3·5	Observed.
Hydraulic ram. H.P.	12	Do.	50	0·42d.	2·4	Observed.

It has been found that belts of $\frac{3}{16}$in. thickness, at a speed of about 20ft. per second, and the usual pulley diameter waste about 2lb. per $\frac{3}{8}$in. of belt width. Simple cast tooth gears work with an efficiency rarely over 90 per cent., and worm gears hardly ever attain an efficiency of 50 per cent. If we take works driven by steam power we find that the losses in shafting alone are very considerable. In the case of a waggon works this was found to vary from 22 to 57 per cent., and in the case of an engine works it was found to vary from 25 to 70 per cent., the average being 42 per cent. At another engine works, where fairly long lines of shafting and comparatively a small number of tools were used, the loss was 75 6 per cent.

Given below in tabulated form are some particulars of the shafting losses in different works, from which it will be seen that the loss varies from 39 to 77 per cent. It is obvious that, other things being equal, the greater the average distances of the machine from the driving engine the greater is the loss in shafting.

Cost of Production.—The author has frequently been asked another very obvious and reasonable question, viz.—What is the cost of production should we adopt an electric plant in our works? In answer to this the author has drawn upon a number of cases of different kinds and in different parts of the country, showing the rate at which the works owner can generate his own electricity. These figures are taken from actual examples of everyday working, and are not in any way test figures taken for the purpose of this Paper. Taking these figures as a basis, it is an easy matter for a works owner, once having ascertained the total horse-power which will be involved in the driving and lighting of the entire works, to see for himself at what expenditure per annum he can run his works upon the new system.

COST OF ELECTRICITY DELIVERED ON SWITCHBOARD.

Test of 139½ hours, November 17 to 23, 1901, Britannia Works.

Mean current (amps.)	3,464	
Mean pressure (volts.)	125	
Mean power (watts)	433,000	
Mean electric H.P.	580·42	
Board of Trade units	60·403	
Weight of steam per B.T.U.	27·52lb.	
Weight of coal per B.T.U.	3·04lb.	
Cost per B.T.U.		Cost per week.
Coal 3·04lb. at 11s. 6d. per ton	0·187	£47 4 0
Water 27·52lb. at 3½d. per 1,000 gallons	0·00963	2 8 6
Stores	0·00995	2 10 0
Wages	0·06625	16 13 3
Repairs*	0·0159	4 0 0
Superintendence	0·01192	3 0 0
Net cost per B.T.U.	0·30065d.	£75 15 9
Interest and depreciation on £15,000 at 10 per cent. per annum	0·099d. per unit.	

Cost per E.H.P. per Hour.

Coal 2·27lb. at 11s. 6d. per ton	0·1395
Water 20·53lb. at 3½d. per 1,000 gallons	0 00718
Stores	0·0074
Wages	0·0494
Repairs	0·01185
Superintendence	0·0089
	0·22423d.

Mean I.H.P. at 75 per cent. efficiency, 773. Coal per I.H.P., 1·705lb. Water per I.H.P., 15·41b.

* Includes labour of keeping 134 arc lamps in repair.

The author is indebted to Messrs. Richardsons, Westgarth & Co., (Ltd.), West Hartlepool, for the following information on the subject of the economy effected by the introduction of electric driving into their works. The following is a rough summary of the changes which have been effected :—

These works were formerly driven by about 13 small and uneconomical steam engines scattered about in different places, the maximum aggregated indicated horse-power of which would approximately be, say, 300 to 400. Steam for these engines was furnished by a battery of 12 boilers, and the coal consumption for the driving of the works was approximately 100 tons of coal per week.

Five years ago the driving arrangement of the works was re-modelled by the substitution of electric motors for the various engines—a power house being built in a central position, and equipped with two boilers each 15in. by 10in., two dynamos each of about 400 I.H.P. and one small machine of about 120 H.P. The tools throughout the works are now giving an output at least of 30 per cent. in excess of what it used to be, and are burning 50 to 60 tons of coal per week in the generating station boilers.

The above facts speak for themselves with regard to the economies which have been brought about by the introduction of electric driving into the works. The machinery throughout was constructed by Brown, Boveri & Co., and is of the three-phase alternating-current type. The cost of renewal and repairs over the period during which the machinery has been running (five years) has been extremely small—certainly not 1 per cent. of the value of the installation.

The managing director of a large engine works informed the author that they are now running their works on 7½ tons of coal per day, and are employing 800 men. Their works consist of four distinct yards. All yards are driven from one central station, and in the old method a boiler would have to be placed in each department or else long lines of wasteful steam pipe. Their cost of production, including interest and depreciation on capital, is 0·46d. per unit.

At a shipyard on the north-east coast, using only 112 H.P., the cost of production of electricity has been found to be only 0 6d. per electrical horse-power per hour, this figure including all charges, interest, and depreciation.

At another shipyard on the north-east coast, the saving effected by the substitution of electricity for steam driving shows a saving of 43½ per cent. per £ wages paid by the adoption of electric power. The figures are as follows :—

Cost of Power per £ Wages paid.

Coal and Gas.	*Electricity.*
May 2, 1893, to April 24, 1894.	April 30, 1900, to April 30, 1901.
Wages £64,885	Wages £126,700
Cost of power 2,337	Cost of power 2,578
=8·66d. per £ wages paid.	=4·88d. per £ wages paid.

Taking the case of another shipyard which was previously driven by gas engines, the author has received the following particulars :—

We have no hesitation in saying that we are getting at least 30 per cent. more power out of our machines since we adopted electric power instead of the gas engines we used before. As far as the cost per B.T. unit goes, we have lately had readings taken, and find that last year's works out at about 0·8d., this is taking into consideration the depreciation on our plant, interest on capital, repairs, and, in fact, everything which we can possibly put down against this account.

The average output would not exceed 250 H.P. to 300 H.P.

The author is indebted to the managing director of another large shipyard in the North of England for the following statement :—

Some years ago, just about the time when we first introduced electrically driven machines, we put in new boilers in place of the old ones, and while it must be remembered that the new boilers are more efficient than the old ones, I would say in general terms that our coal consumption has

Nature of work.	Total H.P.	Per cent. to drive shafting.	State of load.	H.P. per 100ft. shafting.	H.P. per 100lb. shafting.	H.P. per bearing.	H.P. per belt.
Wire drawing and polishing	400	39	½	14·0	0·58	0·37	1·76
Steel stamping and polishing	74	77	⅜	9·8	0·35	0·84	2·4
Boiler and machine work	38	65	⅜	4·77	0·21	0·55	0·48
Heavy machine work	112	57	1	5·7	0·23	0·58	0·45
Light machine work	74	54	1	8·0	0·4	0·69	0·12
Manufacture of small tools	47	52	1	2·5	0·23	0·24	0·11
Do.	190	57	1	4·36	0·43	0·39	0·21
Screw machines and screws	241	47	1	6·33	0·38	0·63	0·23

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been reduced by some 40 per cent., although the amount of machines driven electrically is now greater than those which were formerly driven by steam, and consequently the reduction may be even greater than the percentage I mention above.

In a letter the author has received from Col. R. E Crompton, he states :—

In our own works, which are on a somewhat extended scale, the substitution of electric driving for the old shafting system has approximately halved our bill for power ; in fact, the whole of the driving of the works and tools for about 1,300 men is practically supplied by one 120kw. set fully loaded, and it is only when we are testing that we have to run two sets of this size, whereas by the old system we should have had to run two 200 H.P. engines continuously.

Another very interesting case, although not in full operation as yet, but one which shows conclusively the enormous advantages to be derived in driving works from their own central power station, is that of Messrs. Head, Wrightson & Co. (Ltd.), of Thornaby-on-Tees. In this case no fewer than 39 steam engines and 20 boilers are being replaced by two combined plants, with one as a stand-by, and by two boilers. The whole plant is designed upon the most modern lines, and advantage has been taken of every known device to reduce the cost of production to the lowest possible limit. The actual working results of this installation should be available in the course of a few months' time.

In summarising the above cases, it is obvious that the greatest economy results in the substitution of electricity for steam in those cases where the units of power, both in engines and boilers, are the most sub-divided. There are, however, enormous advantages to be derived, especially in the case of intermittently working machinery, where the load is of a very variable nature, and particularly so in all crane work, which plays such an important part in all our engineering industries.

(To be continued.)

CORRESPONDENCE.

AN ALL-STATIONS EXPRESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : In reference to the notice of my all-stations express in your issue of 19th inst., I agree perfectly with your remark that its working after the manner of the model shown at the recent British Association meeting "is not feasible commercially." Indeed, I pointed this out in my Paper in Section G. May I again emphasise that the model merely illustrated the general idea of the scheme, which is not, in the meantime at least, intended to be worked automatically as in the model, but by drivers controlling the cars, with the help of the signalling device to which you allude.

It is not, I may add, intended to run the trains at a speed greater than that usual on suburban lines and under such conditions, taking the Central London Railway as an example, the saving in passengers' time would be about 40 per cent.

To show the feasibility of the picking-up plan, I have sometimes demonstrated how easy it is to drive my electric car at a good speed after a horse-drawn vehicle and slow down close behind it, using only the motor control and leaving the brakes as a quite extra precaution on emergency. It is so easy that I am always inclined to apologise for assuming the need of any illustration.

The model should not have shown the shocks which you condemn, but it is difficult to find anyone here who will make a model, and impossible to convince such, when found, that he cannot perfect it in a month or two.—Yours, &c.,

Dunmurry, Belfast, Sept. 26. J. BROWN.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"The Royal Engineers' Field-Service Pocket Book." By Lieut.-Col. G. K. Scott-Moncrieff. 2nd edition. Edited by Capt. R. F. Edwards. (Chatham: W. and J. Mackay & Co.) 5s.

"Electric Waves" (an Adams Prize Essay, Cambridge). By H. M. MacDonald. (Cambridge : The University Press.) 10s.

"Galvanic Batteries." By S. R. Bottone. (London ; Whittaker & Co.) 5s.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) and St. Marylebone Borough Council.

ARBITRATION.

The cross-examination of Mr. JOHN CONACHER by Mr. Fletcher Moulton, K.C., was continued as follows :—

Mr. MOULTON : Now, as to consumers. Do you count consumers, if there are two houses supplied, as two consumers ?—No, as one, no matter how many houses he may have connected to the company's system in the district.

In lamps connected you reduce all to 8 c.p. lamps ?—Yes, including arc lighting.

What do you take as the consumption in an 8 c.p. lamp ?—32 watts.

How many 8 c.p. lamps do you call an arc lamp ?—I could not say, but I will give you the figure.

How do you deal with motors ?—They are converted into equivalent 8 c.p. lamps.

Now, there is one thing that puzzles me a great deal, and that is that I see in one part of your tables there are more houses than consumers, showing that you have sometimes taken two houses to one consumer, or more than that ?—Yes.

For example, take a house with a certain number of flats in it ?—We have a meter in each flat. We go every quarter and read that meter, and whether or not we send the account direct to each occupant of the flat, or, in the case of a flat which is covered by a bulk contract, the whole to the one person responsible to us, it does not alter the actual number of consumers.

Then the number of consumers is got from your meter readings ?—You may put it so. It is ultimately from the meter readings undoubtedly, but it is taken, in the first instance, from our ledgers.

Then what do you do when there are two meters to the same person. There might, say, be a motor meter, or one for a consumer's shop and one for his house ?—I do not think he would be reckoned as two consumers if his shop and house were at the same address.

As to "Proportion of possible estimated consumers at Dec. 31, 1901." You have taken an estimate of what you call possible consumers by taking the number of houses and increasing them in a certain proportion ; and the proportion is the proportion between the number of houses wholly or partially supplied to the number of consumers therein ?—Yes.

But that ratio is chiefly due to the existence of flats, is it not ?—Not entirely to flats. There are a great many buildings, the lower parts of which are occupied as shops and the upper floors of which are in separate occupations. In a case of this sort, apart altogether from flats, the company have more than one consumer. I have assumed the number of inhabited houses to be the same during the whole 10 years.

You do not say, if there is an increase of 175 per cent. in 10 years, that that is an increase of 17½ per cent. per year ?—No, it is an average increase year by year of 10·65 per cent.

Another table gives me a series of houses which are "new and reconstructed houses now in course of erection or ready for occupation, which are being or will be wired." Does that mean that there will be contracts for wiring ?—Yes, there are already contracts in some of the cases.

Now, as to units sold for lighting. How do you estimate the increase that you have put down there to the year 1931 ?—I take, first of all, the increase of the last five years, and you will find that the annual increases range from 541,674 in 1896 to 649,832 in 1900. These average increases of these five years is 587,420.

Have you taken that as the increase you are entitled to ?—I take that as the average which we have had during the last five years, and I take also the increase which we had in the year 1900—namely, 649,832, and, stepping over what we believe to be a very exceptional year, 1901, I assume that, having got an increase in 1900 of 649,000 odd, our increase during the present year will be 661,000.

You exclude a bad year and take in your best year, and increase that ?—Yes.

Mr. CRIPPS : It is projecting into the future our increase in the past. That is the basis of it.

Some discussion then arose as to the average figure of 587,420, which disagreed with a larger figure given by the witness earlier in his examination. It was explained that the previous figure was obtained in error from a table including the units supplied for power as well as for lighting.

Mr. MOULTON : Now, with regard to the average price. I see you diminish that by 0·3d. per year. How do you get that 0·3d. ?—It is the annual rate of decrease in the average during the last three years.

You are taking the average fall, starting after the year when you make a big reduction ?—Yes, certainly, and during those years we have made the largest increase to our business that we have ever done.

The price averaged 5·85d. in 1897, and in 1901, four years afterwards, it was 5·24d. That is a fall of 0·61d. in four years. That is a fall of 0·15d. per year instead of 0·03d., or five times as big. Now, you have taken, I see, that 0·03 all the way along ?—We have.

In the motor power and heating figures I see you multiply the units sold by 100 in the 30 years. You have been 10 years at work, and the total amount you are selling for motor power, heating, &c., is 78,757 units, and yet you take as your future annual rate of increase considerably more than that, and raise that rate of increase very shortly afterwards to 150,000 units ?—Yes, the reason being that up to the present time only 7 per cent. of the company's system in Marylebone has been continuous current, whereas by the changes now being made 67 per cent. will become continuous current. The whole character of the area for the purposes of developing a motor business will be completely altered.

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Now as to working expenses. Have you made up the working expenses of the separate stations?—Yes, generating expenses.

You could let us have them, perhaps?—For the stations in Marylebone?

And the others?——

Mr. CRIPPS: Why do you want the others?

Mr. MOULTON: Because it may be very important. Here you are getting working expenses and costs from the total of your system, and, if that be so, it is quite clear we must look into the costs of the whole of the system—every part of the system. There cannot be any doubt, both from the evidence that is given and from the tables that are put in, that we ought to have that. The details of every part of the system may be necessary for us for the purpose of checking these things. The moment you begin to bring in the total cost and apply the results of that to the sale of a portion, it is perfectly obvious we must examine into the circumstances of each part.

The UMPIRE: You cannot check these figures if you are confined to Marylebone accounts. That is quite clear.

Mr. MOULTON: No. Then other generating expenses. I understand you include oil, waste, wages, and what else?—Water and repairs chargeable against revenue.

Mr. CRIPPS: If you are to have the accounts, as the Umpire has indicated, in order to check these figures, the whole of our accounts will be at your disposal.

Mr. MOULTON: But I want to know how this table is made up. For instance, the life that many a dynamo has been living here has been perhaps four or five years, and it has become antiquated, and has had to be thrown out. If that is put down to capital expenditure, and not to generating expenses, it is quite clear that this does not give us the information we want.

Mr. CRIPPS: That will be clearly put, and if there is any question of principle involved, that will be subject for argument.

The UMPIRE: It would be very much more useful, in dealing with these points, if the checking were done before you entered upon the argument.

Mr. MOULTON: That is exactly my feeling. I am really calling attention here to the points where that is necessary.

Mr. CRIPPS: These tables have been in the hands of the other side about a fortnight, I am informed.

Mr. MOULTON (to Witness): Now, distribution and general powers. With regard to distribution, is there anything of capital outlay there at all?—No.

Then you have made certain calculations as to economies, &c., to be effected. The appliances set out for saving expense are not revelations of the year 1901, are they?—No; what caused us to use them was two explosions at Sardinia-street, which revealed to us an unusual amount of deposit of mineral matter in our boilers from the water which was being supplied to us by the water companies. We had never had so much trouble before, and as soon as it was clear that that was the cause we anticipated the recommendation of the Board of Trade that we should treat the water before supplying it to the boilers, and we set about doing it at all our stations.

Do not you think it had a little to do with the imminent decease of the Marylebone part of your undertaking?—The explosions certainly had not, and they were the causes of our adopting these appliances.

Now the estimated saving is on a percentage of 10 per cent.?—Yes; for the appliances which not only treat the water, but also raise the temperature before it is admitted to the boilers. In the case of the other appliances at Rathbone-place, we take credit only for 4 per cent., because that does no more than remove the solid matter from the water. I cannot, of course, say that 10 per cent. is the proper figure, but that is the figure we adopt on the best advice we can get.

Did your repentance come so late that you did not even put up Willesden properly?—No; the condensing appliances at Willesden were ordered, I think, three years ago, and they have been there working in a certain way for two years.

Or rather I should judge, from the language of your table, in an uncertain way?—Well, a certain very unsatisfactory way.

What seems to me so very strange is that, in all your anticipations of the savings to be made, you are quite satisfied that things will always behave well, and that you will get your 10 per cent. and 4 per cent. saving; but your previous experience, taking, for instance, this case, is that, excepting in arbitrations, appliances do not always work well?—Of course, things will go wrong sometimes. The plant which is and has been imperfect came from the United States, and we have had great difficulty in dealing with the manufacturers, who guaranteed that that plant would be a perfect success. If they do not make it perfect, then, of course, we shall use the plant which we have which worked satisfactorily on some of the existing engines. There is no difficulty whatever in securing those results. We know how it can be done, and all we are waiting for at the present moment is to compel the contractor to fulfil his guarantees on the other plant.

Now, banked transformers have been known for many years. Can you give any special reason why your company should not have used banked transformers before 1896?—No; I cannot explain that.

Now as to the total number of units sold?—The readings of the volts and amperes are taken hourly, the volts are multiplied by the amperes, the resultant being what we call apparent watts. Then apparent watts are divided by 1,000 to arrive at the apparent units, and when the apparent units have been arrived at a further deduction of 13 per cent. is made for the power-factor. So that instead of taking the apparent units, we take only 87 per cent.

Then how do you calculate the number of units sold?—By meter—they are wattmetered.

I see you add current used at works and in distribution, 16 per cent.?—Yes, we assume that 16 per cent. covers the loss in distribution apart from house transformers, and provides for the current used at the works.

That 16 per cent. is on what?—On the quantity of current which would have had to be sent to be generated but for the house transformer loss. It is arrived at by adding to the alternating high-tension current sold $\frac{19}{20}$ths. When the $\frac{1}{20}$ths is added to what is sold, you get the 100 per cent., of which you lose 16 before you get to your consumer.

You have taken 16 per cent. as the total loss, and that is in the mains?—Yes, in the mains, including also the meters, ordinary shunt current, and the current necessarily used in the company's own generating stations.

And in going up to the transformers in distribution?—No. It is what the loss would be if there was no house transformer.

It seems to me you make no allowance for the advantage of house transformers, and put it all on the loss?—I do not see the advantage of the house transformer. From my point of view the house transformer seems to be altogether a disadvantage so far as the question of working is concerned. It had its advantages originally in enabling the company to cover a widespread area at a less expense for mains than if they had adopted the low-tension system at the outset.

Then you put in a house transformer because it makes your mains cheap?—Yes.

But you have assumed that, without any further expense, and without any further loss, you get it to your house?—Quite so, but we give full effect to the loss which the existence of the new system would necessarily entail, and contrast that loss with the loss which at present exists, and we arrive at what must be the loss in the house transformer.

But apart from the question of interest on mains or anything of that kind, you have assumed that you could get your electricity at low pressure at the house with no more loss than you used to get it with high pressure?—We have assumed that loss at 16 per cent., and from the experience of the continuous-current supply companies we think it is a very ample allowance.

And you have taken the same allowance for loss in the mains without house transformers as with house transformers?—Yes, because when we have got rid of them the loss will be 16 per cent.—the total loss including what is used in the works and meters and lost in distribution, and, that being so, we have only to add that constant loss to the amount of sales of last year and deduct the total of these two figures from the actual generation of last year, and we get at the result which we are seeking to obtain in this table—that is, the house transformer loss.

The UMPIRE: We have not heard yet on what basis the 16 per cent. is arrived at.

WITNESS: That is an engineering point.

Mr. MOULTON: I see in your table "current used for banked transformers 8 per cent." What is that 8 per cent.?—That is composed of 6 per cent. current lost in the transformers with 2 per cent. for additional distribution which is entailed in sending current from the station to the consumer through the banked transformer—that is, it passes through the main from Rathbone-place, for instance, to the sub-station at Marylebone-passage, and, after being transformed, has to be conveyed from the sub-station to the consumer, and that is put at 8 per cent. in addition to the common losses of 16 per cent.

Then less 10 per cent. for transformation and transmission to town stations; what is that transformation?—The transformation up is from 500 to 10,000 volts at Willesden—the transmission at 10,000 volts to the sub-station in the local area and the transformation down from 10,000 to 1,000 volts in the sub-stations. These losses together come to 10 per cent. But I will ask the electrical engineers about these matters.

In another table, why do you deduct something for deficiency of generating plant? Is it your theory that you must estimate what the cost is of putting in the proper generating plant in Marylebone for Marylebone?—Not at all. The table shows to what extent our plant at Willesden is necessary to produce the business which existed in the Marylebone area at Dec. 31 last.

How can it do that? It is a question of capital sum to be deducted—to be deducted from what?—To be allowed off the value of the business of the company in Marylebone, having regard to the fact that with that business we are not able to hand over to the local authority the full amount of generating plant which is necessary to produce that business. There was a duty on the company to supply all consumers in Marylebone with current, which duty they fulfilled by certain machinery in the area and also by the use of certain machinery outside the area. We admit that, altogether with the plant which exists in the area, we ought to make the Borough Council a capital sum for this plant outside the area necessary for the supply of Marylebone.

I say that when you say that it must be deducted, it implies that you consider there must be handed over to the Marylebone authority a generating plant sufficient to supply Marylebone?—No, I cannot accept that.

Mr. CRIPPS: That is not it. Suppose you sell a business, and under the conditions a part of the plant from which that business is derived is not comprised within the terms of the purchase, you have to make an allowance therefor in favour of the purchasing authority.

The UMPIRE: You are not concerned with what Marylebone will do with this credit?

Mr. CRIPPS: No, that is the difference between us.

Mr. MOULTON: If you are going to consider what would be necessary to give us a proper generating plant, practically the whole of what is in Marylebone ought to be scrapped at this moment?—That is not my view, but information on that point would come better from an engineer.

Now, to take the details of this table. You take the maximum demand on any one day. There must be a generating plant equal to that?—There must be a generating plant somewhere within the control of the company which would equal that on the day of maximum demand.

You take the engines, dynamos and boilers in Marylebone. But if there is going to be any value in that, surely you must consider where the boilers are, whether they are at Rathbone-place or Manchester-square—Certainly.

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Then how do you get the deficiency?—By deducting from the maximum demand of 4,386kw. the capacity of Manchester-square and Rathbone-place stations.

In boilers?—Yes, what they have actually done in kilowatts, representing the highest output within the last 12 months. Of course, the capacity of the station is not what it happened to do on any particular day, but what it is capable of doing and has done.

Take Rathbone-place and Manchester-square. Can you give me the actual output of the various generating plant on the day of maximum demand in 1900?—No. But the maximum output of the Rathbone-place station was on Oct. 29, 1901, when it was 825kw., and at Manchester-square on Dec. 7, 1901, when it was 1,510kw., and these outputs make up the total of 2,335kw., which we state as the capacity of the local generating stations which either was or could have been utilised on Dec. 18 to produce a portion of the total demand of 4,386kw.

The UMPIRE: 825kw. is the total nominal capacity of the generators at Rathbone-place?—It is, and they are capable of being worked to the full capacity.

Mr. MOULTON: What do you say the power of the boilers was?—The same as the generators. But there is a deficiency of boilers at Manchester-square. 1,510kw. is the capacity of boilers and 2,100kw. is the capacity of the generators.

You take the whole of the generators, without any spares?—Not at Manchester-square; at Rathbone-place certainly, but not at Manchester-square, because the existing boiler installation at Manchester-square is not sufficient to utilise the whole of the generators. Our spare is in Willesden. In Manchester-square there is no spare at present, but we allow a sum of money to make the boilers equal to the generators. We have credited the Borough Council with a credit of £11,000.

I may take it the other areas are done exactly in the same way?—Yes.

Now, Willesden supplies other parts besides Marylebone. Do you take any notice of the demand of those other parts in your tables?—Certainly.

Suppose the whole of the other districts only required 500kw. and Marylebone required 1,470kw. Would you require Marylebone only to pay 1,470 parts out of the cost of 4,500 parts?—If we provided a superabundance of plant at Willesden that is our loss, but in any adjustment between ourselves and parties who become interested in a local area it seems to me we have to take the proportion required to make good the deficiency.

It beats me how the maximum demand on a particular day can decide what proportion of the cost of Willesden is to be charged to Marylebone?—It seems to me there can be no other way. The maximum demand is the measure of the equipment, surely, which the company must provide to carry on its business. We have a very large stand-by, and we apportion the cost for this particular area of Marylebone on the basis of what was really the deficiency in that area, bringing into that credit the due share of the surplus plant or spare plant we have at Willesden.

Then you include three-fourths of the cost of existing trunk mains. What trunk mains are those?—The whole of the trunk mains from Willesden to Tower-street. There are five of these. One we regard as spare; the remaining four are constructed to carry 1,500kw. each, so that these four are the proper equipment for an output of 6,000kw. There was an output of 4,500kw., and therefore we take three-fourths of the cost of the trunk mains as the amount applicable to the output at Willesden station at the end of last year.

Tower-street entirely demands on these mains?—Yes, or will do when it is opened. It is not open yet. Of course, all the stations benefit by having their current conveyed in one complete set of trunk mains rather than each having a separate set.

Now, taking one of your tables. You admit there is a large deficiency of generating plant in Marylebone. If you have an obligation to make your Marylebone portion self-contained you have not performed that obligation, have you?—We say the plant is not sufficient in Marylebone apart from any argument as to obligations.

Then apparently your table is based entirely on the maximum supply last year, and throughout deals with that maximum supply on the supposition that the plant due next December is actually installed in Marylebone?—That the existing plant as altered and completed will be there.

What a hybrid thing. You take a demand in December last and deal with the plant which you trust you can get in by December next?—All through these tables the assumption is that December next is the date from which the transfer is to take effect.

But it may be a very important point whether any of the plant put in this year is plant that we have to take. I am not, however, on that point. I want to know why you have taken a demand at that date, and dealt with it by the plant at another?—In the absence of any agreement between the parties as to the date at which the sale was to take effect, we had to select some date which should be the foundation of all our calculations. We selected Dec. 31 last, modifying it necessarily by the works in progress, and not by any new works which the company might have found it desirable to take in hand. We were actually making these alterations, and to get at the true deficiency it was necessary to take those into account.

The UMPIRE: Whatever re-adjustment you make elsewhere in this table you assume to a certain extent the borough would take over the plant as it will be at Dec. 31, 1902?—Yes, but the calculations are based on Dec. 31 last.

You assume a plant taken over which, to a certain extent, will be other than and greater than that available on Dec. 31, 1901.

Mr. CRIPPS: Certainly, we are bound to provide the equipment when we are selling an income, as is the case here, and this is how we calculate the way to make an equipment. Whether right or wrong my learned friends will discuss, but that is the basis of the table.

Mr. MOULTON: In these tables of what the Council is to receive and to pay for, to enable it to supply the Marylebone area, have you added on the whole cost of the North-street station, which has been all done this year, after you knew you were going to sell?—Yes; but that station was arranged for long ago.

But you are actually taking the foundations out there?—The contract for that work was let in September or October.

After you knew that the undertaking would be taken over?—No; after the act was passed, but we purchased part of that site in August, 1900.

You might have, but the contract for doing the whole of this work was let after the bill had passed?—No; only the contract for the building. The plant was ordered, and a considerable part of it ready.

Now what is the £62,000. Is that merely the cost of the building?—No, the cost of the building and all the plant. £27,676 is the cost of the building, £35,010 the machinery, making £62,887. The reason we paid so much on account of the machinery is we had to make advances to the manufacturer, because we were unable to take delivery owing to delay in the arrangements for receiving it. We have some stored at Willesden and the rest is still at Belgium, but is waiting to come forward.

Now, my next table deals with actual capital expenditure?—Up to a certain point.

I suppose the accounts of capital expenditure in years past all exist?—Oh, yes.

Down to 1897 you have separated the capital expenditure at Marylebone from the rest?—Yes.

Do not the Board of Trade, in their annual returns, require the capital on each area to be separately rendered?—Certainly, and we do show it, but the capital expenditure shown in the Marylebone area after 1897, of course, ceased to represent the whole capital the company was spending in respect of Marylebone.

Have you your return for 1898?—Yes.

What is returned there as the total capital expenditure?—£993,761 for the whole undertaking.

Now the next item—net amount representing deficiency of plant in Marylebone at Dec. 31, 1901. Is that estimated capital expenditure—the expenditure necessary in 1902 to make Marylebone a self-contained system?—No, it is the proportion of what we have or will have expended at Willesden which would be necessary to meet the increase of the business in Marylebone, bearing in mind that Marylebone is deficient in generating plant within the area.

You have taken £48,837, and have added that in 1902 as an estimated capital expenditure?—Yes.

It is not an estimate of expenditure?—It is a further proportion of the expenditure at Willesden.

The UMPIRE: If the undertaking had remained as a whole in the hands of the Metropolitan Electric Supply Co. they say for their Marylebone portion of it they would have expended at Willesden that amount of capital.

Mr. CRIPPS: That is what we say. We arrive at the figure by getting the cost to us of the expenditure at Willesden. In order to get what we call the capital estimated expenditure, you must make a proper allocation up to the end of 1901 of expenditure at Willesden, the fruit of which has been gathered in Marylebone, and to make provision for future estimates. You have to get, in our opinion, the true figure at the end of 1901, and put on estimates for 1902. You must get the initial figure, which can only be arrived at by making a proper allowance for expenditure at Willesden for supplying Marylebone.

Mr. MOULTON: That does not belong to 1902. This item of £48,000 is an allowance, and not capital expenditure in 1902 at all.

Mr. CRIPPS: It belongs to every period of time since Willesden started; it is a factor to be introduced.

Mr. MOULTON: Indeed it is not. He adds it up and gets it to £693,000, and then proceeds to deal with it as capital expenditure.

Mr. CRIPPS: If you want to exclude it it is intensely in our favour but very wrong in principle.

Mr. MOULTON: I do not think it will be when we come to deal with it.

The UMPIRE: I do not say if £48,000 or any other figure is right, but I suppose the whole process would have been this: for the year 1898 something would have been added to the capital expenditure which will appear in the Board of Trade return for 1898 under the West London Lighting Order, a further sum in 1899, a further sum in 1900, a further sum in 1901, and a further sum in 1902. This last sum they represent by this figure of £48,000, rightly or wrongly.

Well, then "Further proportion for 1902." I suppose that is a shot?—It is a way of estimating, as fairly as we can, what additional expenditure would be necessary for the additional business.

Now, "Connecting new consumers in 1902." Do you put connecting consumers to capital account?—Yes.

What expenses do you include there?

Mr. CRIPPS: Mr. Conacher has given us the cost of each connection.

Mr. MOULTON: Yes, but it was not the amount I was dealing with, but the heads which would go to capital account?—Taking a low-tension connection: Outside work; cutting in, jointing, fixing meters, joint boxes, and fitting; cement and other stores; service-pipe and reinstatement, and cutouts for inside.

I suppose when a customer gives up that is worthless?—The switch is taken out, that is all; if one customer goes another comes and takes his place. The taking out of the switch does not go to capital.

If a person discontinues using electric light, that is a dead loss?—I do not think we have any cases of that sort; the person may discontinue, but the house will not.

Now, "Further proportion of Willesden expenditure for 1903." What is that? Is that a calculation or an estimate?—An estimate. We take the further absorption, if I may so call it, of Willesden for that year as representing £35,000, and the further absorption of sub-stations as representing something like £10,000, altogether £45,000.

You can give us some further indication of how you get at such a figure as this?—We base it on 500kw. during the last three years, and the expenditure per kilowatt, including provision of spares and mains, was

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£70. We take that as the figure. It may be a little high, because we further utilise our plant at Willesden all round for the sake of getting at the capital expenditure for three years, and we think it is quite fair to assume £70 per kilowatt.

You have added £10,000 for sub-stations. What sub-stations were you referring to?—Of course, as you draw more from Willesden, you must make further provision in the local area for receiving and transforming Willesden current.

The UMPIRE: Willesden expenditure does not mean exclusively expenditure at Willesden, it is expenditure at or in connection with Willesden?—Yes; everything which represents the equivalent of local generating plant.

Mr. MOULTON: What is the meaning of capital expenditure? Suppose you put up a big transforming station, and pay for it this year, there is no capital expenditure, because you use it more next year?—No, but, in order to get at the proper amount to be credited from future profits from additional capital required to be brought in to meet the growing business, you must take the capital as it was at the time that the transfer takes place, which we do. We say the sum of £597,000 represents plant which the borough council will receive, and that £48,000 is a capital sum representing the extent to which the generating plant in Marylebone was deficient.

But why is further utilisation a capital expenditure?—Because we have spent the capital really.

And have charged it to capital?—No, we make the deduction afterwards.

Mr. CRIPPS: Let me explain. That amount is included originally in the £597,172. We then take it out, because it is in excess of the requirements at the date when estimating the plant which would produce the business at the end of 1901. Having taken it out, we put it in proportionately when estimating what is necessary in future years.

Mr. MOULTON: That explanation does not touch the point. I thought it would not. What I do not understand is that the further utilisation of what is bought and paid for and exists is a capital expenditure. But perhaps Mr Conacher will explain.

The WITNESS: I will endeavour to make it clear. The object of one of the tables is to ascertain how much additional capital the Borough Council will have to bring in year by year, because the interest on that additional capital is a proper deduction from the profits which we claim are likely to be earned. In the present year, although we are assuming the purchase takes effect on January 1st, the Council are not providing any capital at all, except that we say our claim is based on the repayment by them to us of the cost of connecting new consumers. But the company are providing all the capital for the additional business this year, and unless we included a further proportion of our Willesden outlay in the expenditure up to the end of last year, we should be swelling the amount of capital which the Borough Council are being allowed on this table, while they are providing no part of the expenditure at all. All they will provide will be the cost of connecting the consumers; but if you pass on to the next year, when we assume that the undertaking will be in their own hands, they will not only have to connect consumers at their own expense, but to provide means of doing the additional business which it will do. We measure that by the way we should do it ourselves. Willesden will be used to a still further extent, and therefore £45,000 or so would meet the case if the property remained in our hands, and that sum we assume is a fair measure of the capital which the Corporation will have to provide. So on year by year, the inclusion of that additional capital year by year in 1903 and 1904 works out as the table shows at the higher sum on which we allow them credit.

Mr. MOULTON: That does not meet the particular point about which I was asking, though I quite understand the general statement. Do you or do you not say that in arriving at the £35,000 you included anything in respect of the North-street sub-station?—We did not specifically, but we did indirectly.

Mr. MOULTON: Well, I think I have indicated my criticism sufficiently.

(To be continued.)

Shipley Tramways Arbitration.

At Bradford, on Monday, Mr. Alfred Baker, manager of the West Ham Corporation tramways, arbitrator appointed by the Board of Trade, sat to assess the rent to be paid by Bradford Corporation for working the tramways in the Shipley district from Frizinghall to Saltaire, which Bradford Corporation lease from the Shipley Council.

Mr. W. E. TETLEY, for Shipley Urban District Council, who were the nominal appellants, said the tramway, the subject of the arbitration, was reconstructed for electric traction by Shipley Council early in 1902, and was opened for traffic on May 17. Negotiations had taken place between Shipley Council and Bradford Corporation as to terms of lease by the former to the latter authority, but the parties had been unable to agree. What had passed between them would, of course, be outside the inquiry. His clients wanted a fair return for their outlay on these lines. It was provided by the Bradford Tramways and Improvement Act, 1897, sec. 22, that the terms and conditions upon which the Shipley tramway should be worked by Bradford Corporation should from time to time be settled by agreement between the two bodies, or, in default of agreement, by arbitration, but that, in any case, the Corporation should not be required to accept a lease of less than 21 years. He read that section to mean that these terms and conditions were to be subject to revision from time to time during the period covered by the lease. There were numerous contingencies which might make an alteration desirable, and it was only equitable that neither side should be bound to a set of terms and conditions for 21 years. He therefore suggested that the terms of the lease should be subject to revision at the end of five, 10 or 15 years. The permanent way cost of the double line of tramway in the Shipley area had been £15,096. 19s., overhead equipment £4,989. 11s. 4d., cables £4,959. 1s. 6d., engineering and supervision £1,042. 2s. 6d., printing and advertising £79. 1s. 9d., a total of £26,166. 16s. 1d. To this must be added a balance due to Shipley Council of £2,606. 4s. 2d. in respect of old track. Crediting £1,158. 5s. as the value of old material, the net cost of reconstruction had been £27,614. 15s. 3d. Street improvements were necessitated by doubling of track, and in respect of land already purchased and works carried out the Council had expended £8,127, and were committed to £9,934 further, making £18,061, bringing the total to £45,675. Shipley claimed from Bradford Corporation a sum equivalent to a return of 6½ per cent. on the £27,614. 15s. 4d. The Council's payments out of this amount, for interest and sinking fund, would bring it down to a margin for contingencies of 15s. per cent. In respect of expenditure on street improvements (£18,061) the Council claimed £4. 12s. 6d. per cent. per annum, and as regarded the maintenance of track he considered it reasonable the Corporation, as lessees, should bear the whole cost of repairs and renewals, or, in the alternative, that the lessors should make the repairs and charge the Corporation with the amount actually spent, or that the Corporation should pay an annual sum equal to £100 per mile of route, including permanent way, poles and cables, but not overhead equipment. The Shipley Council had their own electricity generating works, and the exclusive right to supply electric current in their area. For the supply of energy to the tramways the Council demanded 2½d. per unit measured at the works.

Mr. J. ROBERTS, chairman of the Shipley Gas and Electricity committee, considered the terms outlined reasonable and fair. The tramways were a veritable gold mine, and the Shipley Council were quite prepared to work the tramways themselves or seek other terms. He did not know that it had been asserted that Shipley was generating electricity at 0·696d. per unit. They did not desire to make a profit out of the trams, but to obtain a fair return on their capital outlay.

Mr. J. MIDGLEY, chairman of the Highways committee, said the road improvements had been carried out solely on tramways account.

Mr. I. LINDOW, clerk to the Council, said the moneys for the reconstruction of the tramways were borrowed at £3. 12s. 6d. per cent. Loans had not yet been obtained for the whole of the £27,000.

Mr. S. D. SCHOFIELD, borough electrical engineer of Shipley, submitted a statement of the electricity generated between April 1 and July 31, 1902, and the purposes for which it was used. The cost worked out at 3·281d. per unit, to which must be added a small sum for depreciation. With an increased output and a higher load-factor the price might be reduced by ·1d. or ·2d., but he had no hope of generating current at 2½d. per unit. He had never authorised any statement that the cost of generation at Shipley was 0·696d. per unit.

Mr. R. C. QUIN, consulting electrical engineer, said the tramway in question was reconstructed under his supervision and from his plans. He considered the terms proposed were reasonable. The cost of 1 mile of double track was £18,500.

Major CARDEW, R.E., consulting engineer, agreed that 6½ per cent. on capital outlay was a fair rate to charge, and having regard to the general price charged for electric current for tramways, 2½d. per unit was not excessive. At Gateshead it was 3d., and 2d. was a very common charge.

The TOWN CLERK of BRADFORD (Mr. F. Stevens), who represented the Corporation, said the contention of his Corporation was that there could not be any revision of the terms of the lease during the time that it was running, and that the shortest reasonable period for which the Corporation could be expected to lease the line was 30 years. The lease should be for the period of the loan. At Glasgow leases of 35 and 42 years were granted. If a 30 years' lease were granted, Bradford would pay Shipley interest at the rate of 3 per cent. on reasonable capital expenditure, and £100 per annum per mile of route for maintenance, but they ought not to be asked to pay anything in respect of sinking fund, because on the expiry of the lease Shipley would have the line. They would take current from the Council at the same price as was charged by the Bradford Electricity committee to the Bradford Tramways committee. He contended that the expenditure incurred by Shipley Council had been in some respects excessive. The overhead equipment of the line had cost four times what the same work had cost at Bradford, the permanent way about 25 per cent. more, and the street improvements, he urged, were not necessary for tramway purposes.

Mr. J. HILL, chairman of Bradford Tramways committee, said the terms offered by the Corporation would leave a margin of profit for the lessors of the line, whereas it was doubtful whether the Corporation had as yet made a penny out of the tramway.

Mr. J. H. COX, city surveyor of Bradford, said the Council's books showed that the amount expended on the tramway was £27,074, or £18,942 per mile of double track. The generally accepted figure for permanent way and overhead equipment was £15 500 per mile.

Mr. JOHN YOUNG, general manager Glasgow Corporation tramways, said Glasgow Corporation were constructing a line in a neighbouring district in respect of which they had obtained a 42 years' lease. It would not pay Bradford to work this line on a lease of less than 30 years.

At the conclusion of the evidence, Mr. TETLEY asked that the costs of these arbitration proceeding should be borne by Bradford Corporation as lessors of the line.

The arbitrator subsequently inspected the line.

Telephones in the Temple.—The Benchers of the Middle Temple have consented to the introduction of the Post Office telephone service into the Middle Temple, but the Inner Temple authorities have not yet given their consent. The latter suggested the use of overhead wires, but the Postmaster-General has informed the Benchers that unless the underground system be agreed to, the idea of introducing the service into the Inner Temple must be abandoned.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The committee of Croydon County Polytechnic invite applications for the post of head of the department of electrical engineering. Applications to secretary (Mr. S. W. Bickell) by Oct. 8. See advertisement.

Canterbury Electric Lighting committee require a shift engineer. Applications to chief engineer (Mr. C. A. Blascheck) by Oct. 6. See advertisement.

An assistant lecturer and senior demonstrator in electrical engineering is required at the Royal Technical Institute, Salford. Particulars and forms of application up to 14th inst. See advertisement.

A first-class electrical engineer is required for Glasgow Corporation tramways. Applications to the general manager, Mr. John Young, 88, Renfield-street, Glasgow, by Oct. 22. See advertisement.

An improver is required by the Walsall electricity department. Applications to borough electrical engineer (Mr. Alexander Wyllie). See advertisement.

A switchboard attendant, with experience in three-wire continuous-current system and care of accumulators, is required at the Kendal electricity works. Applications to the works by Oct. 4. See advertisement.

A chief assistant is required at West Bromwich electricity works. Applications by 13th inst.

Mr. Michael B. Field, at present electrical engineer to the Glasgow tramways, has been appointed to the position of contract engineer by Ferranti Limited. As announced above, Mr. F. Barnes Spencer, at present engineer to Wimbledon District Council, has been appointed to the position of sales manager by the same company. These gentlemen will jointly represent Messrs. Ferranti, with headquarters in London, where an office is shortly to be opened.

Mr. Morton Beales, formerly with Ferranti Limited, and latterly commercial engineer to Messrs. J. G. White & Co., has accepted a post on the staff of the British Westinghouse Company. His new duties commenced on Sept. 15.

Mr. H. Tomlinson Lee, chief assistant at Wimbledon electricity works, has been appointed chief engineer in succession to Mr. F. Barnes Spencer, M.I.E.E., who is leaving to join Ferranti Limited as sales manager at the company's London offices.

Mr. D. M. Kinghorn has been appointed borough electrical engineer at Leigh, in succession to Mr. John Foster, hitherto electrical, gas and water engineer to the Council, who has been appointed chief assistant gas engineer to Birmingham Corporation.

Mr. John Kerrigan, manager of the Dewsbury, Batley and Birstall tramways, has been appointed manager of the Peterborough tramways system, and Mr. Lionel Johnston, who has had tramway experience at Gateshead and Middleton, has been appointed to Dewsbury.

Fulham (London) Borough Council on Wednesday appointed Mr. F. P. Fletcher, of Canterbury, engineer-in-charge in succession to Mr. E. Perry resigned.

Mr. J. A. Crowther has been appointed assistant mains engineer to the Bristol electricity department.

Mr. L. Lownds, B.Sc., and Mr. J. Codrington Crocker, B.A., have been appointed demonstrator of physics and demonstrator of chemistry respectively at the South-Western Polytechnic, Chelsea.

EDUCATIONAL NOTICES.

Finsbury Technical College.—The Finsbury lectures this session are as follows:—Advanced course, Monday nights, Prof. Silvanus P. Thompson on "Three-phase" and later on "Dynamo Design." Wednesday nights, Mr. C. R. Darling on "Electrical Instruments," &c, and later Prof. Thompson on "Magnetism" and "Electromagnetic Apparatus." Friday nights, Prof. Thompson on "Light" (six lectures); the rest of the Physics course on "Heat" and "Thermodynamics," Mr. Darling. Mr. Simmons will take part of the advanced electrical course after Christmas.

University Extension Lectures.—Mr. E. Halford Strange, M.Sc., will deliver a course of 10 lectures on "Electric Power and Lighting," at Exeter Hall, London, on Friday evenings at 8 o'clock, commencing Oct. 10. Particulars from the secretary. See advertisement.

The new electrical laboratory at the Great Eastern Railway Mechanics' Institution, Stratford, was formally opened by the chairman (Lord Claud Hamilton) on 23rd ult.

Ayr.—During the first year's working of the municipal electric tramways 2,979,317 passengers were carried, and the traffic receipts amounted to £12,273. 14s. 9d., an average of 10¼d. per car-mile. The highest sum drawn in one week was £874. Power was supplied by the electricity department at 1½d. per unit up to 200,000 units, and 1d. after. Current used totalled 270,874 units, and the cost was £1,546. 6s. 2d. It is estimated that after meeting all charges, including depreciation and sinking fund, there will be a profit of about £2,000.

Barking.—The Local Government Board have informed the Council that the deficit of £2,300 in the electric lighting revenue account must be paid out of the next rate instead of spreading it over several periods.

Barrow-in-Furness.—An inquiry was held on Tuesday into an application for sanction to borrow £20,000. The loan is required, firstly, to meet the increased demand for electric current for lighting, and, secondly, to comply with the terms of the agreement with the British Electric Traction Co. for a supply of current for their tramways. The amount already borrowed is £58,575. It was asked that the repayment should be extended over 30 years, and be deferred for three years. The Inspector said he thought this would not be allowed, as the Local Government Board held they had no power to grant such a request.

Berwick.—The Urban Electric Supply Co. have acquired a site on Berwick Quay for an electricity generating station.

Birkenhead.—The report of the tramway manager (Mr. A. R. Fearnley) was presented and discussed by the Council on Wednesday.

Mr. DODDS said the receipts for seven months if averaged as for a year, came to £54,144, and the expenditure to £32,664 per annum. The total expenditure on capital account was £316,000, or with other sums rightly chargeable to that account £344,000, upon which interest and sinking fund amounted to £20,640. The annual expenditure was thus £53,304, against an income of £54,144, leaving £840 for depreciation. He criticised the management, and said that within a few months they would have to face a new competition which was bound to have an effect upon them. He urged upon the committee that they should address themselves seriously to the conduct of the whole tramway scheme.

A discussion ensued, and in reply the chairman of the Tramways committee (Dr. H. LAIRD PEARSON) said he hoped one result of the debate would be to strengthen the committee in refusing to adopt wild-cat schemes of extensions and alterations. They had a splendid undertaking, and one which he estimated would give a profit on the year of £5,000 or £6,000. The working expenses had gone down last half-year from 6·35d. to 5·92d. per car-mile. The average of 10·54d. per car-mile receipts compared very well with other towns, and in expenses they were the lowest in the kingdom, except Sunderland, while in the net profit per mile they also compared well.

The Electricity committee have drawn up a scheme for supplying electric motors on hire or hire-purchase. The charges for energy for power are to be 2½d. per unit for the first 500 units per quarter, 2d. up to 1,500 and 1½d. beyond 1,500 per quarter.

Birmingham.—The General Powers Bill of the Corporation, and particularly the tramway portion, is arousing considerable interest in local municipal circles. Two public meetings were held to discuss the matter last week, and at one a resolution in favour of municipalisation was adopted, while at the other it was resolved to ask the Council, before putting the bill to the vote of the ratepayers, to obtain an offer from at least one company prepared to work the Birmingham tramways, and particularly as to the annual payment they would be prepared to make to the Corporation, what percentage of gross profits, what system of traction they would adopt, how soon they would start working, and what fares they would charge.

A conference of representatives of the adjoining local authorities was held on Friday to consider how, in the public interest, the tramways could be most effectively worked having regard to the necessity for a continuity of service and the requirements of the surrounding districts in relation to the tramway system as a whole. The authorities represented were Aston Manor, King's Norton, Yardley, Erdington, Smethwick, Handsworth, and Sutton Coldfield. The general opinion was that it would be unwise for each of the authorities to work tramways independently, and it was resolved that the outside authorities should combine in dealing with the tramway question, and it was decided to ask the councils to appoint two representatives to constitute a permanent committee to deal with the matter.

Blackpool.—A deputation has been appointed to visit electricity works where cooling towers are installed, and will lay information before the Council.

Bromley.—The British Electric Traction Co. has notified the Council that it is preparing a scheme of electric tramways for the district, but the Council favour a municipal scheme.

Burnley.—The Electricity committee have been authorised to expend £3,500 on additional plant at the electricity works.

Burslem.—The Corporation will apply for a loan of £31,000 for electricity works. The Board of Trade are to be asked to extend the time of the Council's provisional order, which expires on Oct. 28 next.

Camborne-Redruth Light Railway.—Trial trips were run over this line on Wednesday.

Chatham Light Railways.—Strood Council favour the proposal of the Chatham and District Light Railways Co. to connect Gravesend with Chatham.

Rainham ratepayers have petitioned for an extension of the Chatham electric tramway system to that district.

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Cheshire Electric Power Scheme.—A syndicate proposes to apply for Parliamentary powers to incorporate a company, with a capital of £1,000,000, for the erection of electricity works and for the supply of electricity in bulk and gas for power purposes. The scheme affects Wilmslow, Alderley, Macclesfield, Stockport, &c.

Crewe.—On Wednesday the Council resolved to take up loans amounting to £32,402 for electric lighting and other purposes.

Cuba.—A New York syndicate, with a capital of $5,000,000, proposes to construct an electric railway from Havana across the island.

Dartford.—The Council have decided to obtain a report from Mr. W. C. C. Hawtayne on the question of constructing electric tramways and whether the Council or a company will best carry out the work.

Devonport.—A serious accident occurred on the Devonport and District electric tramway on Saturday, resulting in one death and in serious injuries to six other persons. A car was proceeding from Camelshead to Pennycomequick, and when descending the incline from St. Michael's-terrace by the technical schools into Paradise-road it got out of control. Though the driver applied the hand and slipper brakes the car gained momentum, and at the bend it jumped the metals. The accident occurred at the point at which a somewhat similar accident happened in June, and the Board of Trade have decided to hold an inquiry into both accidents to-day (Friday).

The accounts of the electricity department for the period from the commencement of supply in May, 1901, show a gross profit of £1,460. After providing for interest and sinking fund there is a deficit of £1,266.

Dundee.—The Electric Light committee offer to supply current to the North British Railway Co. for lighting the Tay Bridge passenger and goods stations, offices and yards at 4d. per unit for the first 20,000 units per annum, less usual discount, and above 20,000 units at 2d.

In a report on Sunday traffic on the municipal tramways the manager (Mr. P. Fisher) points out that Dundee is now the only corporation in the United Kindom without Sunday cars, and it is recommended that a seven-day service be introduced.

Eccles.—The Council are recommended by their Parliamentary committee to pay £20,000 to Salford Corporation on account of the expenses incurred in reconstructing the tramways to electrical traction.

Edinburgh.—The Electric Light committee have decided to recommend the Council to put the surplus on electricity account, amounting to over £10,000, to reserve, bringing the amount up to about £27,000. The committee also recommend that no change be made in the price for electric energy for the current year.

Exeter.—In moving the adoption of the report of the Electricity committee on Wednesday, the chairman (Mr. Wreford) said the net profit for the year ended Dec. 31 last was £879, and the accumulated profits to date, which were practically a reserve fund, were £3,617.

It was also decided to obtain Parliamentary powers for the construction of about 8 miles of tramways at a cost of about £52,000.

Exhibition.—A Lighting, Heating and Smoke Abatement Exhibition will be opened at the Crystal Palace, London, on Dec. 13.

Gloucester.—The Electricity committee have authorised the borough electrical engineer (Mr. W. J. Bache) to negotiate with the Great Western Railway Co. for the supply of electric current for lighting the company's passenger station and goods yard.

The City Council have decided, on the recommendation of Mr. Bache, to purchase arc lamps to be let out on hire at a minimum charge of 7s. 6d. a quarter for the use of lamp, trimming and attendance.

Grimsby.—An addition has been made to the arc lighting system by the erection of 10 arcs.

Halifax.—A smart piece of work was recently performed by the electricity department. On Sept. 22 the steam plant at a large factory broke down, and by Sept. 24 cable had been laid and a large motor fixed and connected to the town supply. By the following day another large motor was fixed and the whole of the mill in full working. But for this connection the mill would have been idle for some weeks.

The Council have resolved to construct additional electric tramways at an estimated cost of £6,498. Further extensions are under consideration.

Sanction to a further loan of £28,000 for extensions of the electricity undertaking is sought.

Hartlepool.—The Council have approved the draft agreement with the Northern Counties Electricity Supply Co. for the supply of current for public and private lighting and power.

Kingston-on-Thames.—Last week the Council were recommended to appoint Mr. H. R. J. Burstall, consulting engineer, to prepare a report on the present position of the electricity undertaking at a fee of 100 guineas, but it was decided by 14 votes to 13 to postpone the matter for six months.

Leeds.—The Council have resolved to apply for a provisional order authorising construction of six additional lines of electric tramway.

Leicester.—The accounts of the electric lighting department show that for the half-year ended June there was a profit, after paying interest, of £4,563. 3s. 3d. Sinking fund absorbed £2,545. 10s. 1d., leaving a net profit of £2,017. 13s. 2d.

Levenshulme.—As the Manchester Corporation are now able to supply electric current in this district, it is proposed to light the Council offices electrically.

Liverpool.—The Council are recommended to apply for a provisional order to construct an extension of the electric tramways.

Liverpool Overhead Railway.—Improvements in the service are to be introduced which will effect an increase of speed of the trains from 12½ to 19 miles an hour. The whole distance of 6½ miles, with 16 stops between the end stations, is now covered in 20·9 minutes. Each car is fitted with four 100 H.P. motors, made by the English Electric Mfg. Co. of Preston and supplied by Dick, Kerr & Co.

Llanelly.—The British Insulated Wire Co. have made arrangements for the transfer to another company of the electric lighting and tramway powers for Llanelly, and work in connection with the schemes will be started at an early date.

London Electrical Contractors' Association.—The balance-sheet for the first year's operations to July 31 has been issued, and in a note accompanying this members are informed that a standing committee has been appointed to deal with all questions of trade usage between electrical contractors and manufacturers, &c. Arrangements have also been made for monthly business meetings, when Papers on subjects of interest to electrical contractors will be read. The first meeting takes place on Oct. 7. The Association numbers 82 members.

London Tramway Extension.—The proposal of the London County Council to construct an electric tramway from Marble Arch to Cricklewood on the surface contact system is to be opposed by Marylebone Council.

Luton.—Last week the Council were asked to authorise application for a further loan of £5,000 for electric lighting extensions. The capital expenditure to date was £26,000. It was announced that an important firm outside the area of supply was willing to take current at 2d. per unit, and it was proposed to extend the mains at a cost of £5,000 to give a supply. Ten members voted for the loan and 10 against, and the chairman gave his casting vote for it. It was resolved to increase the resident engineer's (Mr. W. H. Cooke) salary by £50 per annum.

Macclesfield.—A report by Messrs. Medhurst, Page and Lloyd on electric lighting has been received and referred to a committee. The committee will visit certain towns in Great Britain.

Macclesfield-Stockport Electric Tramways.—A company is promoting a scheme for the construction of an electric tramway between Macclesfield and Stockport.

Manchester.—At the City Council on Wednesday, the Electricity committee's proposals included one to erect arc lamps in certain thoroughfares in order to carry out experiments as to the best form of electric street lighting :—

Mr. HESKETH, who moved the adoption of the report, stated that up to the present £35,000 had been expended in making provision for street illumination, and it was thought they should have an opportunity of justifying that expenditure. The committee wished to be allowed to make the experiments, but the matter would come before the Council again.

Ald. GIBSON, chairman of the Gas committee, criticised Mr. Hesketh's proposals, and complained that they were not told how many lamps would be required or what capital expenditure would be involved. He was under the impression that they had got altogether beyond the experimental stage. There were already 29 electric street lamps in use which had cost £45 to put up, and for the year ended March 31 last those lamps had cost the ratepayers £632, or £22 per lamp, against £4 per lamp for gas. There had also been a cost of £11 per lamp for maintenance, against £1 for gas, but how that cost could have been incurred passed his comprehension. He strongly objected to grant the committee the privilege of putting up these lamps when they did not tell them anything about what they were going to cost. He moved that the minutes be approved with the exception of that portion relating to the fixing of arc lamps for experimental purposes.

Mr. HESKETH said that if the committee were denied the privilege of making experiments in order to ascertain the best form of electric lamp for street lighting the Council must take the responsibility in the event of much capital expenditure proving unremunerative.

The amendment was ultimately adopted.

Municipal Telephony.—At a meeting of the Telephones committee of Hull Corporation, held on Friday last, the town clerk read a batch of correspondence which had passed between the Corporation and the National Telephone Co. One communication stated that the Corporation were prepared to allow the company's underground wires to remain until the expiration of the company's licence in 1911 on the following terms and conditions :—

1. That there shall be mutual free intercommunication between the subscribers of the Corporation and subscribers of the company from the

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commencement of the municipal service, including intercommunication with other towns, through the trunk wires of the Postmaster-General, without any terminal or other charge being made by either the Corporation or the company in respect of such intercommunication.

2. That the cost of the junction lines in the Hull telephone area necessary to connect the two systems for the purpose of local intercommunication shall be borne equally by the Corporation and the company.

3. That the terms and conditions under which the underground wires of the company shall remain shall be the same as those contained in the late agreement of March 18, 1899, with such modifications as the town clerk may consider necessary for protecting the rights of the Corporation.

The company had decided that these were conditions they could not accept. The company has served a writ on the Corporation, with the object of getting the opinion of the Court as to whether the Corporation's notice to the company is valid. A further meeting with the company's representatives has been arranged.

Nicolaieff (Russia).—This town is now lighted by electricity, the undertaking being in the hands of the municipality. There is also talk of the present horse-drawn tramways being converted to electric lines, but nothing is yet decided, the municipality being engaged in discussing terms with the local company, a Belgian concern.

Northampton.—The chairman of the Northampton Electric Light and Power Co. has addressed a communication to the borough accountant concerning the recent negotiations for the acquisition of the company's undertaking by the Council, and also the proposal to erect a power station in connection with the municipal tramway scheme. The directors maintain that the economy and other advantages of a combined lighting and traction supply are supported by independent testimony, which they adduce, and that a competent and impartial electric lighting authority would not consider £140,000 greatly, if at all, in excess of the value of the company's undertaking.

Nottingham.—The annual report of the Electricity committee will be presented on Monday. The report of the borough electrical engineer (Mr. H. Talbot) states that the plant at the Talbot-street station has been increased during the year by the addition of two 700 I H.P. steam dynamos, completing the equipment of the station, and increasing the horse-power of the plant installed to 8,925 H P. Three 700 I H.P. steam dynamos are being used for traction purposes, but the whole of the traction load will shortly be transferred to the new power station at St. Ann's Well-road. The distributing mains have been extended in 43 directions during the year, the total being 3·04 miles, bringing the total length of distributing mains laid to 36 miles. The number of applications received for supply of current on March 31 was 1,867, compared with 1,529 in 1901. The equivalent number of 8 c.p. lamps connected to March 31 was 170,826, compared with 136,137. The number of units sold was 4,094,897, compared with 2,312,557. Generation costs show a decrease in every item. The total engineering costs have been reduced from 1·45d. to 1·02d. per unit, and the total costs (including sinking fund and interest) from 2·43d. to 2·06d. The St. Ann's power station should be ready to take the traction load very soon.

The Lenton and Radford electric tramway route was opened for traffic on Tuesday.

Oldham.—At the meeting of the Council on Wednesday the chairman of the Tramways committee (Ald. Chadwick) said they were running more cars, carrying more passengers, and, with the developments at the electricity station, they were practically reducing the amount they were paying per car for energy. Whereas this formerly cost £7 per week per car, it was now under £6. The average number of cars on the system, working 16 hours per day, was 43, and the average earnings per car per week £23. The working expenses and the cost of energy, taking the past eight weeks as the basis of calculation, were £723 a week, and interest amounted to £340, making a total expenditure per week of £1,063, whilst the weekly earnings were approximately £1,000.

Perth.—The Council have revised the charges for electric current, which will in future be 4½d. per unit for lighting and 2l. for power, in lieu of 7½d. and 3d. respectively.

Rotherham.—The Corporation are recommended to apply for a loan of £10,000 for extensions of the electricity station buildings, generating plant and mains.

Rubber Combine.—It is stated that the United States Rubber Co., acting with Sir Martin Conway, is forming a large combine to control the Bolivian supply of rubber. It is estimated that the new company will produce 12,000,000lb. of rubber annually.

St. Helens.—The Corporation have applied for sanction to a loan of £5,600 for extensions of the electricity mains and £2,000 for alterations, &c.

Salford.—The General Purposes committee recommend that the thanks of the borough be given to Judge Parry for his services in presiding over the recent electricity inquiry and this proposal was unanimously passed at the Corporation meeting on Wednesday. Judge Parry will be asked to accept an honorarium of 100 guineas.

The electric tramway between Frederick-street, Patricroft Bridge and Field Green has been opened for traffic.

South Africa.—Some time ago the *Bloemfontein* Municipal Council invited tenders for electricity generating plant, but the matter was delayed owing to the tenders having had to be sent to South Africa for consideration. The *British and South African Export Gazette* now announces that the Council have decided to proceed, and their London agents (Messrs. Davis and Soper) have been instructed to accept one of the tenders received.

Ladysmith Town Council have accepted the tender of Messrs. Hubert Davies and Spain to erect and equip electricity works at a cost of £8,328, the work to be completed within seven months. Several tenders were submitted, the highest being £13,880.

Acting upon the report of the borough electrical engineer, the *Durban* Telephone committee decided to forward indents for cables, poles, and overhead wires, and the equipment of the exchange, and have sanctioned the proposal that the Telegraph Manufacturing (Colonial) Co., the Western Electric Co., and the L. M. Ericsson Co. be invited to forward particulars and prices. The report was referred back to the Council in committee for further consideration, the mayor remarking that the total cost would amount to £80,000. Friction has now arisen between the Government and the Corporation, as the former have in hand a project for establishing an exchange of their own to connect all Government departments and military and transport offices, and later on Maritzburg and all other Government departments in the colony.

The electric tramway concessionaire at *Lourenco Marques* (Mr. J. C. A. Henderson) has secured a site for the erection of a power station, and it is stated that orders for plant have been placed, and the work of erecting the station and constructing the permanent way will be commenced in two or three months' time.

Mr. R. A. Dawbarn, of Messrs. Mordey and Dawbarn, the consulting engineer recently appointed by the *Johannesburg* Municipality to report upon electric lighting and traction, has sailed for South Africa.

A company, entitled the *Newcastle* Electric Light and Power Co. (Ltd.), has been organised for the purpose of erecting electricity works upon the terms of the concession recently granted by the Municipal Council to Mr. P. Herd. It has been decided to adopt the continuous-current, three-wire system of distribution, with a voltage of 440 between the outers. The plant has already been ordered, and it is anticipated that the demand for current for private lighting will be at least equal to 2,500 16 c. p. lamps. The initial cost of the scheme will be about £5,000. The capital of the new company is £12,000.

Orders for electric coal cutters and electrically driven pumps are about to be placed by several *Newcastle* (Natal) collieries.

The South African General Electric Co. have secured the contract for the supply of the electric equipment for the machine tools in the *Natal* Government Railway's new workshops at Durban. About 125 motors are comprised in the order.

The substitution of electric for hydraulic cranes for the discharge of cargo at *Durban* is under the consideration of the Port Advisory Board.

South Lancashire Tramways.—Mr. A. P. Trotter and Major Pringle officially inspected the Leigh, Atherton and Tyldesley section of the South Lancashire electric tramway system on Thursday last.

South Shields.—The Corporation are recommended to include in their proposed Parliamentary bill powers to acquire and use land for electricity generating purposes, to supply electric fittings, and to make bye-laws in respect to electric fittings, to supply electricity in bulk and for traction, &c.

The opponents of the Council's tramway proposals have decided to withdraw opposition on condition that the Council will, when powers have been obtained, advertise for tenders for working the tramways; that the highest of these tenders shall be submitted to the decision of the public, and that they will act upon their decision as to whether the tenders should be accepted or not.

A lengthy report on various systems of electric traction has been prepared by the borough electrical engineer (Mr. J. H. Cawthra), and in his conclusions he favours the adoption of the overhead system.

Southampton.—A loan is sought of £7,000 for the purchase of 12 additional tramcars.

Stoke-on-Trent.—The Council have adopted a scheme for the erection of electricity and refuse destructor works.

Stourbridge.—The Dudley, Stourbridge and District Electric Traction Co. have notified the Council that, owing to the restrictions which the Council have imposed in regard to traffic through the High-street, the company cannot run through cars to Kingswinford from Stourbridge.

The Board of Trade inspection of the Enville-street and the Lye tramways took place yesterday.

Swansea.—On Wednesday the borough electrical engineer (Mr. C. A. Prüsmann) reported that there were 250 consumers connected to the mains, representing an equivalent of 29,306 8 c.p. lamps. He submitted a scheme for hiring electric motors to consumers, the proposed scale of charges ranging from £1. 15s. for ½ B H.P.

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to £8 for 15 B.H.P. per annum, the hirer to use current for power for not less than 12 months.

Telegrams for the Antarctic Relief Expedition—A short time back application was made by the Royal Geographical Society to the directors of the Eastern and Eastern Extension Telegraph Companies for a special reduced rate for telegrams to enable the commander of the s. "Morning," which has been sent out to bring back news from the National Antarctic Expedition, to exchange messages between New Zealand and the society in this country with reference to the progress of the expedition. We learn that the companies have agreed to transmit free messages up to an aggregate of 100 words.

Torquay.—A further discussion by the Council on electric tramway matters has resulted in a special committee being appointed to report.

Totnes.—The Totnes Electricity Supply Co. are applying for an extension of time to comply with the terms of their provisional order.

Wallasey.—The Council are again recommended to apply for a loan of £52,350 for electricity extensions.

The charge for electric current for traction has been reduced from 2½d. per unit to 1⅝d.

Wigan.—The Electric Lighting and Tramways committee decided that, in view of the loss sustained in the working of the Frog-lane tramway route, that line be closed for traffic after 1st inst.

Wood Green.—The Council have engaged Mr. W. C. C. Hawtayne to prepare plans and estimates for laying electric lighting mains in the compulsory area, &c.

Marriage.—On Thursday last Mr. G. Wilkinson, M.I.E.E., M.I.M.E., borough electrical engineer of Harrogate, and second son of Councillor Wilkinson, of Harrogate, was married to Miss Annie Ellis, only daughter of Mr. T. W. Ellis, of that town. The officiating clergyman was the Rev. J. Wilkinson, M.A., vicar of Brenzett, Kent, elder brother of the bridegroom. Occasion was taken by the staff of the Corporation electricity department to present Mr. Wilkinson with a handsome clock. The presentation was made on behalf of the staff by Mr. Neil McLean, chief assistant engineer.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

The directors of the *Great Western Railway Co.* invite tenders for supply of stores from Dec. 1, 1902, to Nov. 30, 1903, including telegraph instruments and apparatus, copper wire, G P. wire, &c., telegraph ironwork and tools, telegraph drysalteries, electric light carbons, incandescent electric lamps, telegraph poles in yellow pine, wire, copper tubes, steel tools, ironmongery, brasswork, &c. Further particulars are set out in an advertisement, and samples may be seen at Swindon from 7th to 16th inst. Specifications, &c., of the Stores Superintendent, Swindon. Tenders to secretary (Mr. C. K. Mills) by 20th inst.

Rotherham Corporation invite tenders for steam pipes and valves, feed pipes and valves, feed pump and economiser, exhaust water and drain pipes and valves and switchboard extensions. Specifications, &c., from the town clerk (Mr. H. Hampton Copnall), and can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster. An advertisement contains further particulars. Tenders to the town clerk by noon Oct. 16.

Wigan Corporation invite tenders for the construction of a short length of new tramway, and for the re-construction of a portion of existing tramways. Specifications, &c., from the borough engineer (Mr. Wm. Bolton), and tenders to the town clerk (Mr. Harold Jevons) by Oct. 20. See advertisement.

Wigan Corporation also invite tenders for the electrical equipment of a short length of new tramway and of a portion of the existing tramways, and for 18 bogie cars, double-deck four-motor equipment. Specifications, &c, from the borough electrical and tramways engineer (Mr. James Slevin), and tenders to the town clerk by Oct. 20. See advertisements.

Dudley Corporation invite tenders for the supply of arc lamp carbons. Specifications, &c., from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, and tenders (addressed chairman, Electric Lighting and Tramways committee), to the Town Hall, Dudley, by noon, Oct. 18. An advertisement contains further information.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for stores during 12 months ending Oct. 31, 1903, including copper nails, rivets, ironmongery, indiarubber, oil, &c., also permanent-way materials. Tenders (addressed to directors) to secretary, Mr. R. C. Irwin, Hunts Bank, Manchester, by 10 a.m. Oct. 6.

Hyde, Stalybridge, Mossley and Dukinfield Tramways and Electricity board require boilers, economisers and ironwork for flues, surface condensers and pumps, &c., steam, feed, blow-off and drain pipes, feed pumps, &c., and travelling crane. Tenders by Oct. 13.

Ipswich Corporation invite tenders for main switchboard, motor booster and connections, and overhead construction for tramways. Tenders to town clerk by Oct. 22.

West Ham Borough Council invite tenders for 46 combined arc lighting and traction poles, with side brackets. Tenders to town clerk by 4 p.m. Oct. 7.

Middlesex County Council require tenders for permanent way construction of about 10½ miles of light railway. Tenders to Guildhall, Westminster, S.W., by Oct. 7.

Barrow-in Furness Corporation require tenders for two batteries of accumulators, two automatic reversible boosters, switchboards, &c. Tenders by noon Oct. 15.

Belfast Gas and Electric Light committee invite tenders for electric motors for 12 months. Tenders to town clerk (Sir Samuel Black) by noon Oct. 10.

Aylesbury District Council invite tenders for erection and maintenance of electricity works for a term of years. Tenders by Oct. 8.

Bury Tramways committee require tenders for rail bonds, &c. Tenders by Oct. 14.

Batley Corporation invite tenders for a storage battery of 240 cells and accessories. Tenders to town clerk by Oct. 10.

Bootle Corporation require tenders for wiring the refuse destructor works in Pine-grove. Tenders by 14th inst.

Bootle Corporation also require tenders for wiring the new fire station in Strand-road. Tenders by October 18.

Swindon Corporation invite tenders for wiring consumers' premises within the borough. Tenders to town clerk by Oct. 7.

London County Council invite tenders for two electric car traversers. Tenders by Oct. 21.

TENDERS RECEIVED AND ACCEPTED.

Devon County Council have accepted the tender of the Northern Electric Co. for installing the electric light at the County Lunatic Asylum for £1,065. 18s. 11d.

Southampton Town Council have accepted the tender of the British Thomson-Houston Co. for tramway poles at £5. 17s. 6d. each; that of R. W. Blackwell & Co. for bases at £1 each, and that of Macartney, McElroy & Co. for scroll work at 14s. per cwt.

Dublin Lighting committee recommend the acceptance of the tender of Mr. J. Donovan for the erection of an underground transformer sub-station building at £721.

Southampton Corporation received seven tenders for the construction of an electric tramway in Onslow-road, Bevois Valley, and Bevois-road, and the lowest (that of Messrs. Coston & Co. at £2,283) has been accepted. The highest tender was £3,317. 11s. 11d., and the engineer's estimate £2,813.

Stockton-on-Tees electricity department have accepted the tender of the Triumph Stoker Limited, 39, Victoria-street, London, S.W., for mechanical stokers, &c., for five boilers at £620, and that of A. J. Cooke for foundations for two engines, &c., at £670.

Hampstead Borough Council have accepted the tender of Messrs. Rowland Carr & Co., 6 & 8, Lime-street-square, London, E.C., for 28 arc lamp columns and brackets.

Wrexham Town Council have accepted the tender of Messrs. Babcock and Wilcox for boiler at £1,596. 15s. 6d.

Coventry Town Council have accepted the tender of Mr. D. Reynolds for wiring the pavilions at the City Hospital for £40.

BUSINESS NOTICES.

Mr. Philip Dawson, A.M.Inst.C.E, M.I.M.E., M.I E.E., notifies that he has become a partner in the firm of Kincaid, Waller and Manville, consulting engineers, 29, Great George-street, Westminster, London, and that the style of the firm will in future be Kincaid, Waller, Manville and Dawson.

Messrs. W. A. Stevens and R. A. Barker, electrical engineers, Maidstone, have dissolved partnership. Debts by Mr. Stevens, who continues under the old style of Stevens and Barker.

BANKRUPTCY.

An adjourned first meeting of creditors of Dr. Frederick H. Bowman, consulting engineer, 39, Victoria-street, Westminster, was held at the London Bankruptcy Court yesterday (Thursday). Debtor attributed his failure to losses and liabilities in connection with a company, in respect of which he stated he received no consideration. The statement of affairs showed liabilities £12,528, of which £8,371 was expected to rank, and assets estimated to produce £1,846. No offer of composition was submitted, and his affairs remained in the hands of the official receiver.

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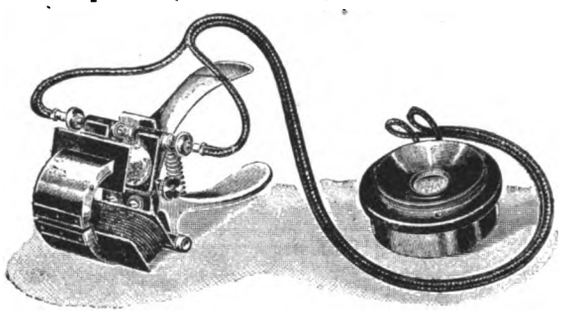
To Let.—Particulars will be found in an advertisement of business premises to let on lease by Messrs. Edward Deane & Sons, 16, Friar-street, Reading, centrally situated and well adapted for factory purposes.

Plant for Sale.—Shipley Electricity committee invite offers for the purchase of a 45 I.H.P. compound engine, direct-coupled to a 25kw. compound-wound dynamo. Tenders to the chief engineer (Mr. S. D. Schofield), Electricity Works, Dockfield, Shipley, by Oct. 8. See advertisement.

Plant Wanted.—Two electrical three-throw pumps, to deliver 150 gallons per minute against 150lb. pressure, are required. Further particulars from the borough electrical engineer, Mr. C. Turnbull, Tynemouth electricity works, North Shields.

Instruments for Insulation and Fault Tests.—Messrs. Hartmann and Braun have issued an interesting catalogue of their various sets of instruments for the measurement of insulation resistance and the localisation of faults. Among the newer patterns may be mentioned a cheap and portable set for insulation testing in which the battery as well as the galvanometer is included, a slide-wire bridge especially intended for the localisation of faults, and apparatus for tracking out faults by the induction method. In the latter category is a new pattern (see illustration) of search coil, designed by



Herr Dietze. This consists of an iron clip on a hinge, with a coil placed on each jaw so that the inductive effect of the circuit is employed to the utmost. It is also suggested that the apparatus may be made use of for measuring alternating currents in a cable without cutting it, by substituting for the telephone a hot-wire instrument, calibrated for the purpose, which can be supplied with the Dietze apparatus.

Electric Timepiece.—Messrs. S. Smith & Son, 9, Strand, London, W.C., who rank amongst the best known metropolitan firms of high-class watch and chronometer makers, are introducing, in connection with their registered "Strand" motor timepiece, a case fitted with an electric battery and lamp, flexible wire and push complete. The lamp is fixed inside the glass and is thoroughly protected. The dry battery is specially constructed for the purpose, is claimed to be very lasting, and can be readily and cheaply renewed. Messrs. Smith & Son invite inquiries for particulars.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Sept. 24 to 30, with the ports of destination:—

Africa—Alexandria, £723; Beira, £109 (telegraph material); Cape Town, £847; Chinde, £15; Durban, £523; East London, £655. *Argentina*—Buenos Ayres, £403 (including £329 telegraph material). *Australasia*—Adelaide, £552; Auckland, £34; Fremantle, £176; Perth, £894; Sydney, £603; Wellington, £67. *Canada*—Halifax, £13,626 (telegraph material). *China*—Foochow, £451; Shanghai, £176. *Denmark*—Copenhagen, £360 (including £192 telegraph wire). *Germany*—Hamburgh, £300 (telegraph material). *Gibraltar*, £11. *Greece*—Syra, £50 (telegraph instruments). *Holland*—Amsterdam, £22. *Hong Kong*, £222. *India*—Bombay, £291; Calcutta, £57. *Portugal*—Lisbon, £35. *Russia*—Odessa, £243; St. Petersburg, £874 (telegraph material). *Siam*—Bangkok, £26. *Straits Settlements*—Penang, £242 (telegraph cable); Singapore, £64. *Sweden*—Stockholm, £144 (telegraph wire). *United States*—San Francisco, £300,000 (telegraph cable). Total £322,795 against £17,815 in the corresponding week last year (Sept. 25 to Oct. 1).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

August 15, 1902.

17,698. L. G. NILSON. Electro-gasoline vehicles. (Date applied for May 15, 1902, date of application in U.S.)*

18,009. E. H. PRYCE. Electric ignition of flammable gases.

August 16, 1902.

18,021. F. D. EMERY and A. J. HALLAM. Manchester. Adjustable switches or circuit-breakers.

18,040. H. W. VAN RADEN. Coventry. Breaking devices for induction coils

18,048. J. C. FULLER, G. FULLER and L. FULLER. Storage batteries.

18,055. B. BRANDER. Continuous action electric bell.

18,076. BRITISH THOMSON-HOUSTON Co. Systems of electrical distribution. (M. O. Troy, U.S.)

18,077. BRITISH THOMSON-HOUSTON Co. Current collectors. (E. D. Priest, U.S.)

18,078. BRITISH THOMSON-HOUSTON Co. Current-limiting switches for electric lights. (H. W. Brown, U.S.)

18,079. BRITISH THOMSON-HOUSTON Co. Protective devices for electric circuits. (C. P. Steinmetz, U.S.)

18,080. BRITISH THOMSON-HOUSTON Co. Electric current regulators. (J. J. Wood, U.S.)

18,082. BRITISH THOMSON-HOUSTON Co. Charging devices for storage batteries. (H. Lemp, U.S.)

18,084. BRITISH THOMSON-HOUSTON Co. Switches. (H. R. Sargent, U.S.)

18,086. BRITISH THOMSON-HOUSTON Co. Charging devices for electromobiles. (F. P. Cox, U.S.)

18,087. BRITISH THOMSON-HOUSTON Co. Alternating electric current generators. (H. G. Reist, U.S.)

18,088. BRITISH THOMSON-HOUSTON Co. Transformers. (A. R. Everest, U.S.)

18,089. BRITISH THOMSON-HOUSTON Co. Magnetic separators. (C. M. Green, U.S.)

18,090. BRITISH THOMSON-HOUSTON Co. Electricity meters. (E. J. King, U.S.)

August 18, 1902.

18,113. J. W. L. NUTTALL. Oldham. Automatic guard for trolley cars.

18,148. J. P. ROBERTSON. Electrical fire alarm apparatus.*

18,169. C. H. MERZ. Electric propulsion of vehicles.

18,172. T. W. SCHMIDT-ALTWEGG. Birmingham. Electrodes.

18,173. A. G. WHITNEY. United States. Electric ladder.

August 19, 1902.

18,174. A. J. BEAUMONT. York. Earthing device and cutout.

18,188. H. S. NOWELL. Birmingham. Starters and controllers.

18,228. H. H. LAKE. Switches. (G. E. Co., U.S.)

18,229. H. H. LAKE. Field coils. (G. E. Co., U.S.)

18,230. H. H. LAKE. Make-and-break devices. (G. E. Co., U.S.)

18,246. D. R. BROADBENT. Switches and the like.

18,254. P. HARDGEN. Liverpool. Weatherproof conducing casing and cover for telephone transmitters and receivers.*

August 20, 1902.

18,279. J. A. DE MACEDO. Leeds. Electric tramcars.

18,316. BRITISH THOMSON-HOUSTON Co. Circuit breakers. (J. J. Wood, U.S.)

18,317. BRITISH THOMSON-HOUSTON Co. Arc lamps. (J. J. Wood, U.S.)

18,318. BRITISH THOMSON-HOUSTON Co. Varying voltage of delta connected polyphase circuits. (A. H. Armstrong and J. E. Woodridge, U.S.)

18,319. BRITISH THOMSON-HOUSTON Co. Arc lamps. (R. Fleming, U.S.)

18,320. BRITISH THOMSON-HOUSTON Co. Controllers for electric motors. (E. F. Dutton, U.S.)

18,321. BRITISH THOMSON-HOUSTON Co. Systems of electrical distribution. (C. W. Stone, U.S.)

18,322. BRITISH THOMSON-HOUSTON Co. Fuseless rosettes for electric circuits. (H. C. Wirt, U.S.)

18,323. BRITISH THOMSON-HOUSTON Co. Lightning arresters. (T. J. Johnston, U.S.)

18,324. BRITISH THOMSON-HOUSTON Co. Systems of dynamo-electric machines. (F. H. Jeannin, U.S.)

18,325. BRITISH THOMSON-HOUSTON Co. Method of winding coils. (J. W. Lundskog, U.S.)

18,326. BRITISH THOMSON-HOUSTON Co. Preventing creeping of electricity meters. (A. D. Lunt, U.S.)

18,327. BRITISH THOMSON-HOUSTON Co. Starting devices. (R. H. Read, U.S.)

18,328. BRITISH THOMSON-HOUSTON Co. Systems of motor control. (F. E. Case, U.S.)

18,329. BRITISH THOMSON-HOUSTON Co. Operating dynamo-electric machines. (F. E. Jeannin, U.S.)

18,330. BRITISH THOMSON-HOUSTON Co. Armatures for dynamo electric machines. (H. G. Reist, U.S.)

18,331. BRITISH THOMSON-HOUSTON Co. Regulating dynamo-electric machines. (C. R. McKay, U.S.)

18,334. G. W. PARTRIDGE. Switches.

18,341. SIEMENS BROS. & Co. Telephone installations having a central microphone battery. (Siemens and Halske A.G., Germany.)

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each

1902.

11,340. HEYS. (Hutchinson Acoustic Co.) Dry or semi-dry cells.
11,342. HEYS (Hutchinson Acoustic Co.). Charging switches for secondary electric batteries.
11,374. CRUVELLIER. Surface contact railways.
11,427. BAXTER, CLARK and HILLMANN. Endless electric conveyor.
11,487. HARRISON (Kabelfabrik A.G.). Cables.
11,889. NORRIS. Electric devices for igniting mines.
11,940. PALATINE ENGINEERING Co. and BLAKISTON. Frog for overhead conductors.
11,950. MITCHELL. Brush-holder.
11,994. GRÄETZER. Circuit closing devices for line selectors of telephones.
12,099. EGNÉR and CELION. Staying telegraph and telephone poles.
12,110. YOUNG. Telephonic intercommunication.
12,121. DAMASKINOS. Telegraphic apparatus.
12,309. DE MARE. Electric heating device.
12,536. BLACK and HOGG. Electric tramcars.
12,547. VON LIEBERMANN. Making electrolytic baths.
12,554. SIEMENS BROS. & Co. (Siemens and Halske A.G.). Telephonic communication.
12,578. JUSTICE (Theiler & Co. and Eibig). Current reversing mechanism for oscillating electricity meters.
12,582. WISE. (Moore Electrical Co.) System of electric lighting.
12,706. EHRET. Wireless telegraph systems.
12,755. KOLBEN. Reducing or suppressing synchronising currents of single or multiphase alternators working in parallel.
12,870. SOC. LESPAGNOL and MÉRIGNET. Charging accumulators. (Date applied for, Nov. 14, 1901.)
12,956. JUSTICE (Rowland Telegraphic Co.). Transmitting apparatus for telegraphs.
13,170 and 13,171. HILL and HILL, Junr. Trolley wire support.
13,175. SIEMENS BROS. & Co. (Siemens and Halske A.G.). Equalising appliances for interconnected polyphase current systems.
14,136. GORMAN and GRAHAM. Telephones for diving.
14,329. MARKS. (Smith Storage Battery Co.) Storage batteries.
14,573. EDISON AND SWAN UNITED ELECTRIC LIGHT Co., SHEPHERD and GOVER. Switches for glow lamps.
14,788. SCHNEIDER. Automatic switches for telephones.
14,855. SIEMENS BROS. & Co., (Siemens and Halske A.G.) Transformers for mono and polyphase currents.
15,435. LAKE (Consolidated Storage Batteries Co.). Secondary or storage batteries.

COMPANIES' MEETINGS AND REPORTS.

Willans and Robinson (Ltd.)

The ordinary general meeting of this company took place on Wednesday at Rugby, under the presidency of Mr. MARK ROBINSON, M.Inst.C.E.

The SECRETARY (Mr. C. S. Essex) read the notice convening the meeting, and

The CHAIRMAN said: Gentlemen, in rising to move the adoption of the report and accounts I have a less easy task than usually falls to me, because it is evident that the results are not up to our usual standard. It is true that a business which allows of a 10 per cent. dividend cannot be called unsatisfactory, but we undoubtedly pay it with less margin than usual; in fact, to pay it at all we have to draw a little upon the accumulated savings of the past. To our reserve fund, which happily stands at the fine figure of nearly £113,000, we have, indeed, carried a further sum, but it is only £475, in addition to a further sum which has been added during the half-year, and we reduce the balance carried forward about £1,600—a net reduction of £1,100. The truth is, the half-year's figures are good enough if taken by themselves, but they are not so good as we are accustomed to. The net profit shown for the half-year's working is substantially the same as for the corresponding half of last year, but we have a larger capital to pay interest on. The works at Queensferry, with their plant, stood at over £156,000 on June 30, and if we add the as yet unproductive, or only partially productive, capital in the extensions here, we may perhaps bring the total figure to £200,000. If we had not to pay interest on that large sum, I need not say that we should have plenty of surplus profit to carry to reserve, or even to increase the dividend with, so we must not mislead ourselves into the belief that things are very bad. As you see, I have gone straight to the real point—the large lock-up of capital, and its present unproductiveness. That that capital is any too large for the proper conduct of the business we hope and believe we shall carry on at Queensferry I do not allow for a minute. Our belief in the Niclausse boiler is as strong as ever it was, and it is, of course, strengthened by the gratifying figures, briefly given in the report, of the recent Admiralty orders. They may fairly be taken to imply that in the opinion of the Admiralty the Niclausse boiler has passed out of the trial or experimental stage, and has become one of the approved standard types for the Navy. We are as convinced as we were, in days when it held no such position, that it will in the end be recognised as the best standard type, to be the most largely used in the Navy, and we anticipate for it a proportionate success on land. We have, therefore, no regrets to express for having locked up so large a sum—that is, for having made, as we hope, fully adequate preparations—in readiness for the business which we believe lies before us. Our admiration for the Niclausse boiler from the first was largely due to its unlikeness to other boilers, and to its lending itself to methods of manufacture which are not those of other makers, and the result is that the plant is new throughout, and, broadly speaking, has almost all been designed for its particular use. Rightly or wrongly, we decided that we would not only put together our boilers, but that we would make the tubes for them ourselves, and then, that we would make the steel for the tubes. This introduced two industries which were new to us, and for which we had to make all preparations from the first. It may be said that this was bold, or even rash, but we ask you to defer your judgment on this point until we have been for a year or two at work. After the year or two, we think you will share it. We had hoped to begin our tube-drawing, on a very small scale, in July, but one hindrance after another has arisen, chiefly in getting plant from the makers, and we are still without a specimen tube to show you. We are assured that, at worst, it is only a question of weeks now. If you could realise, as we do, the devotion and zeal of the staff, who are trying to bring these works into fruitful use, you would be inclined to believe, with us, that they have done as much as men could do to overcome unavoidable difficulties. Their personal interests are strongly on the side of the earliest possible prosecution of the work, and you may infer from certain figures in the report that the directors are also under very strong inducements to lose as little time as may be. A letter I have received from a shareholder this morning suggests the impression on the part of at least one of our shareholders, that we have in some way failed in work carried out or attempted at Queensferry. Let me assure you that this is a complete mistake. We have done no boiler work and we have not attempted to draw tubes for the simple reason that the plant for both operations is still unready, although now upon the point of completion. As regards steel making, we have carried out a certain amount on an experimental scale only. At present that work is suspended, having served its purpose and shown us what amendments are required in certain parts of our plant. Those amendments are insignificant in regard to cost, and they will not delay us long. We have accumulated a sufficient amount of material to give us a good start in tube-drawing, and, naturally, a certain quantity of material, which, though not good enough for this, can be used for other purposes. It never was any part of our expectation that we should produce successful steel billets for tube-drawing without a considerable amount of preparation and experiment; that experiment we consider is now ended, or practically ended. Turning to the accounts, it may be noticed that the depreciation is smaller than usual. I hope no shareholder is so uncharitable as to read a connection between this fact and a less prosperous half-year. If there is such let me assure him that the depreciation was settled long before we had any knowledge how the half-year would turn out, and that it was settled upon our usual plan of dealing with every article of plant upon its merits as they appeared at that particular time. The Queensferry plant, not having been brought into use, does not come into the account. When it does I fear there will be no ground for complaint that our depreciation is small. But when that time comes we hope there will be boiler profits to correspond. The paragraph in the report dealing with Admiralty orders has been already referred to, but I may point out here that the boiler business is not quite without revenue already. The ships now being fitted with Niclausse boilers, though not by us, represent a substantial sum in royalties payable to our company, which will appear in future accounts, and though we hope in future to make many boilers for the Admiralty ourselves, we also hope that a still larger number will continue to be built by other firms under royalty. The completion of the new fire insurance fund is perhaps sufficiently referred to in the report, but I may add that under the trust deed referring to the late issue of debentures we were not bound to create it at once, but only by yearly contributions of a certain amount. As, however, we had in hand the old debenture redemption fund, and a fire insurance fund, both set free by the new arrangements, we thought we could not do better than apply so much of them as was needed to raising to its full amount the fire insurance fund called for by the new trust deed, rather than transfer the whole of the funds in question to the reserve fund, which might have been done. No further contribution is now required, which will be to our advantage in future years, but the fire fund will continue to grow by accretion of interest until it reaches £50,000. We think shareholders may rest satisfied that the fund, as it now stands, is ample to safeguard them against anything like a serious disaster from fire. I now move the adoption of the report and accounts.

The resolution was carried unanimously, as were resolutions approving the dividends and according a vote of thanks to the chairman and directors.

NEW ST. HELENS AND DISTRICT TRAMWAYS CO.—At the meeting on Friday the chairman (Mr. J. B. Atherton) said the report for the year ended June showed that traffic receipts had increased by £4,130 over the previous year, whilst expenditure had increased by £3,608, chiefly due to augmented amounts payable to the Corporation for rent, interest and electric current. The amount paid to the Corporation was £17,976, an increase of £2,618 over 1901. The opening of the Knotty Ash section of the Lancashire Light Railways Co. had considerably improved the earnings of their own company. It had established access to Liverpool, and further excellent results might be anticipated from the opening up of the larger section of the South Lancashire Company's lines on the east of St. Helens to Leigh, Atherton, Tyldesley, Bolton, &c. The question of the establishment of a parcels service in connection with their own and the South Lancashire lines was also engaging attention, and following this would come the important matter of arranging for a heavy goods traffic, both of which would benefit their company.

ERNEST SCOTT AND MOUNTAIN (LTD.)—At the meeting on Wednesday the directors' report stated that there was a divisible profit of £7,482. 16s. 6d., after deducting £3,103 for depreciation and debenture interest, &c. A dividend at the rate of 6 per cent. per annum was recommended on all shares, absorbing £5,541. 2s. 9d., and £2,000 was put to reserve, and £2,232. 9s. 6d. carried forward. The chairman (Mr. W. C. Mountain) said

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the works were well supplied with orders, and that the prospects for the year were favourable. Their chief difficulty was that the present shops were too small, and consequently too overcrowded with machinery to produce the work in the most economical manner. He thought the shareholders should consider the advisability of moving to more commodious premises. There was great necessity for much larger machines than had up to the present been made, although they had produced larger machines than had been elsewhere manufactured on the North-East Coast. They had been approached by some firms with a view to amalgamation, but the proposals were not such as they considered advisable to put before the shareholders.

NEW COMPANIES, COMPANIES' RETURNS, LIENS, &c., REGISTERED.

ATMOSPHERIC ELECTRICAL PURIFICATION CO. (LTD.)—Reg. Sept. 23, capital £16,000 in £1 shares (12,500 ordinary and 3,500 deferred), to acquire a licence to manufacture, sell and use, exclusively in Lancashire, all apparatus necessary to carry into effect patent No. 17,805 (1901) for improvements in the purification of air, and to carry on the business of an electric company and of purifiers of air. The subscribers are H. Hutchinson, engineer, M. T. Barber, J. Boydell, J. S. Pixton, A. D. Pixton, J. E. Ramsdale and W. H. Hastings. The first directors are Col. J. Harris and others to be appointed by the subscribers. Reg. office: 21, Spring Gardens, Manchester.

BRAY, MARKHAM AND REISS (LTD.)—Reg. Sept. 15, capital £5,000 in £1 shares, to carry on the business of electrical engineers, contractors, manufacturers, &c. The subscribers are:—E. N. Bray, electrical engineer, F. R. Markham, electrical engineer, F. E. Reiss, electrical engineer, S. E. A. Reiss, F. Markham, R. M. Bray, K.C., and C. F. Lloyd. The directors are E. N. Bray, F. R. Markham and F. E. Reiss.

McGREGOR BROTHERS (LTD.)—Reg. Sept. 25, capital £5,000 in £1 shares, to acquire and carry on the business of McGregor Brothers and to carry on the business, at Leigh, Lancs., of electrical, mechanical and sanitary engineers, electricians, tool and boiler makers, &c.

MOSS WIRE MILLS (LTD.)—Reg. Sept. 23, capital £4,000 in £1 shares, to acquire the business carried on as the Surrey Wire Mills, Blackheath Hill, Greenwich, and to carry on the business of working, drawing, tinning, coppering, galvanising, coating and covering wire, metals, &c., and of dealing in steel, copper, iron, tin, silk, cotton, &c. T. F. Moss and S. H. Dunn are first managing directors.

WOODHOUSE AND MITCHELL (LTD.)—Reg. Sept. 26, capital £30,000 in £1 shares, to take over the business of Woodhouse and Mitchell, and to carry on the business of mechanical, electrical and general engineers, tool makers and manufacturers of electrical, hydraulic, &c., machinery. First directors: R. Woodhouse (permanent governing director) and J. Mitchell. Reg. office: Clifton Bridge Works, Brighouse.

COLUMN PRINTING TELEGRAPH SYNDICATE (LTD.)—The return to Aug. 13 gives the capital as £25,000 in £50 shares, of which 289 have been taken up. £50 per share has been called up on 189, and £9,006. 5s. has been received, leaving £443. 15s. in arrears. £5,000 is considered as paid on 100 shares. Mortgages and charges nil.

CROMPTON & CO. (LTD.)—In the return to Aug. 13 the capital is given as £300,000 in 100,000 shares of £3 each, 85,000 of which have been taken up. £3 per share has been called up on 83,000 shares, and £249,000 has been received. £6,000 is considered as paid on 2,000 shares. Mortgages and charges £100,000.

EDMUNDSON'S ELECTRICITY CORPORATION (LTD.)—The return to July 17 gives the capital as £400,000 in 50,000 ordinary and 30,000 preference shares of £5 each, all of which have been taken up. £5 per share has been called up on 30,000 preference and 36,800 ordinary shares, and £334,000 has been received. £66,000 is considered as paid on 13,200 ordinary shares. Mortgages and charges £180,000.

EXCHANGE TELEGRAPH CO. (LTD.)—According to return to Aug. 12 the capital is £246,250 in 8,125 "A" and 16,500 "B" shares of £10 each, of which 8,023 "A" and 16,200 "B" have been taken up. £9 per share has been called up on 6,000 "A" and £1 per share on 2,023 "A" shares, and £56,023 has been received. £179,000 is considered as paid, being £10 per share on 16,200 "B" and £8 per share on 2,125 "A." Mortgages and charges nil.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MANUFACTURING CO. (LTD.)—Lien registered Sept. 18 for £9,500; charged on the undertaking and all the assets, including the uncalled capital.

Discharge registered Sept. 18, of lien registered Nov. 29, 1901, for £5,000.

GORSEINON ELECTRIC LIGHT CO. (LTD.)—There was an issue on Sept. 11 of £800 debentures (three for £200 each, one for £100, one for £80 and one for £20), part of a series created July 1, 1902, to secure a total sum of £1,000. Property charged: the company's undertaking and property, present and future. Holders: D. Lewis, Gorseinon; T. Lewis, Gorseinon; Mrs. C. Mitchell, Gorseinon; D. Jones, Crown Stores, Gorseinon; T. Jones, Supply Stores, Gorseinon, and P. Williams, High-street, Gorseinon. No previous issue of same series.

SOUTH AFRICAN LIGHTING ASSOCIATION (LTD.)—Issue on Sept. 3 of £2,150 debentures (six, of £100, £500, £400, £1,000, £100 and £50 respectively), charged on the company's undertaking and property, part of a series created Aug. 12, 1890, to secure £20,000. No trustees. Total amount previously issued of same series, £17,850.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (Oct. 2, 1902). Price of silver 23 1/16d. per oz. (Oct. 2). Consols (2¾ per cent.) 93—93⅛ for money, 93 1/16—93 1/16 for account; 2½ per cent. 93—93⅛ (Oct. 2). Consols Pay day, Nov. 5; Stocks and Shares Continuation Days, Oct. 13 and 28; Ticket Days, Oct. 14 and 29; Pay Days, Oct. 15 and 30; Mining Share Carry-over Days, Oct. 10 and 27.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—After placing £6,000 to renewal fund, an interim dividend for the quarter ending Sept. 30 of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock (less tax) has been declared, payable Nov. 1.

STOCK EXCHANGE NOTICES.—Oct. 8 has been appointed a special settling day in £120,000 5 per cent. first mortgage debenture stock of the *Colombo Electric Tramways and Lighting Co. (Ltd.)* The committee have been asked to allow £100,000 4½ per cent. first debenture stock (in lieu of provisional certificates) of the *Blackheath and Greenwich District Electric Light Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Sept 20	1,003	+ 250	16	18,464	+ 4,539
Ayr Corporation	,, 27	267	...	19	7,526	...
*Birmingham Tramways.	,, 27	5,402	+ 97	12	60,203	+ 1,820
*Blackburn Corporation..	,, 26	831	+ 50	27	22,665	+ 3,797
Blackpool Corporation...	,, 25	1,616	+ 73	26	32,405	- 194
Blackpool and Fleetwood	,, 27	1,013	+ 90	13	17,431	- 446
Bolton Corporation	,, 28	1,707	+ 138	26	42,863	+ 2,724
BournemouthCorporat'n	,, 24	275	...	..	...	...
Bradford Corporation ...	,, 28	3,586	+2,227	25	88,773	+59,656
Brighton Corporation ...	,, 28	1,033	...	44	33,327	...
Brisbane Tramways.....	Aug. 13	2,782	+ 850	7	16,501	+ 3,570
*Bristol Trams & Carriage	Sept.26	4,934	+ 811	18	61,656	+11,945
*Buenos Ayres & Belgrano	Aug. 31	2,812	+ 103	9	25,419	+ 1,738
Burnley Corporation ...	Sept.27	711	+ 528	‡26	17,641	+ 7,766
Calcutta Tramways Co...	,, 27	R28.465	+R7,451	13	R335,214	+R63,220
Cardiff Corporation	,, 27	1,611	...	26	36,805	...
Carlisle Tramways Co....	,, 27	202	+ 10	†39	6,979	+ 460
Central London Railway	,, 27	6,599	+ 697	13	81,936	+ 6,843
Chatham & Dist. Lt. Rys	,, 25	595	...	14	7,808	...
City & South London Ry.	,, 28	3,028	+1,090	13	36,244	+12,035
Cork Elec. Tramways Co.	,, 25	802	+ 313	§38	22,652	+ 4,313
Devonport & Dist. Trams	,, 19	480	+ 17	37½	16,408	+ 615
Doncaster Corporation..	..	...	...	...	...	...
Dover Corporation	,, 27	252	- 16	26	6,515	- 155
Dublin & Lucan Railway	,, 28	112	+ 11	13	1,790	+ 1
Dublin Southern Dist....	,, 26	933	+ 129	13	15,342	+ 793
Dublin United	,, 26	3,973	+ 444	†13	51,552	
Dudley—Stourbridge ...	,, 19	807	+ 56	37½	28,362	+ 3,639
*Dundee Corporation ...	,, 24	803	+ 109	§18	14,613	+ 1,475
East Ham Council	,, 27	588	+ 131	13	6,985	+ 1,120
Gateshead & Dist. Trams	,, 19	870	+ 249	37½	27,764	+ 4,843
Glasgow Corporation ...	,, 27	13,082	- 1,196	17	205,535	- 7,681
Gravesend—Northfleet	,, 19	205	...	7	1,558	...
Greenock & Port Glasgow	,, 19	556	+ 305	37½	19,030	+11,542
Hartlepool Tramways ..	,, 19	282	- 2	37½	9,788	+ 1,180
Hull Corporation	,, 27	1,718	+ 16	26	45,859	+ 1,924
Isle of Thanet Co.	,, 27	971	+ 123	13	19,237	+18,622
Kidderminster & Dist....	,, 19	136	...	37½	4,769	+ 11
Leeds Corporation	,, 27	5,267	+ 732	26	141,925	+23,481
*Liverpool Corporation...	,, 20	10,260	+ 684	38	369,574	+29,674
Liverpool Overhead Rly.	,, 28	1,473	- 117	‡13	20,804	- 1,316
Manchester Corporation	,, 27	5,776	+3,485	67	202,125	...
Merthyr.....	,, 19	198	- 37	37	7,650	- 1,416
Middleton	,, 19	268	...	25½	8,061	...
Newcastle-on-Tyne Corp	,, 27	3,008	...	...	...	...
Oldham, Ashton & Hyde.	,, 19	525	+ 3	37½	20,026	+ 964
Perth (W.A.) Elec. Trams	,, 26	988	+ 188	¶38	40,445	+ 6,915
Peterborough	...	...	...	...	...	...
Poole & Dist.....	,, 19	331	+ 21	37½	9,905	- 107
*Portsmouth Corporation	...	...	...	...	...	...
Potteries	,, 19	1,679	+ 64	37½	55,151	+ 2,163
Rothesay	,, 19	163	+ 51	4½	1,170	+ 350
Salford Corporation ...	,, 29	3,104	+1,174	26	68,859	...
*Sheffield Corporation ..	,, 28	4,233	+ 371	13	55,900	+11,504
Southampton Corp.	,, 25	1,107	+ 137	...	...	...
Southend Corporation...	,, 24	371	+ 68	25	8,257	...
Southport Tramways ...	,, 19	296	+ 109	37½	9,873	+ 3,505
*S. Staffordshire Trams...	,, 19	691	- 165	37½	28,786	- 426
Sunderland Corporation.	,, 28	1,180	+ 3	...	...	...
Swansea Trams.....	,, 19	531	+ 54	37½	17,970	+ 1,172
Taunton Trams.....	,, 19	68	- 34	37½	2,538	- 193
Tynemouth & Dist.	,, 19	379	+ 101	37½	11,434	+ 1,339
Weston-super-Mare	,, 17	199	...	19½	4,817	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 19	316	+ 192	37½	7,287	+ 4,795

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 24.		Price Wednesday, Oct. 1.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Oct. 1. Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Bl'ckb'n & Gr'nw'ch D'st'ct Misc. Ld. Ord. (fully pd.)						...	...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) xd	108	106	105	106	4 4 11	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	5 7 8	...	12½	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10½	4 5 9	...	...	...
£75,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	102	105	102	105	4 5 10	...	...	...
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord.	10½	10⅝	10½	10⅝	3 14 5	...	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	10½	10⅝	10½	10⅝	3 5 1	March and September	...	...
37,000	5	3/6	Calcutta Elec. Supply Ord. (1 to 30,000)	7⅛	8⅛	7⅛	8⅛	3 10 7	...	...	...
10,000	5	...	Do. (30,001 to 40,000)	7	8	7⅛	8⅛	...	...	...	...
£350,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	108	105	108	3 14 8	...	...	...
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	9½	9	9½	5 5 3	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	8½	...
70,000	5	2/8	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	,, ,,	5⅞	...
40,000	5	...	Do. City Undertaking 4½% Cum. Pref.	4½	5½	4½	5½	...	...	...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	...	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	6½	6½	6½	6⅞	2 12 2	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	9	10	9	10	5 0 0	February and August	9⅞	9 1/16
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12½	13½	12½	13½	4 8 11	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	153	158	123	128	3 18 4	June and December	128½	...
£300,000	Stock	4½%	Do, 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 5 0	...	105⅝	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½	9½	8½	9½	4 4 3	...	9	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12½	11½	12½	4 16 0	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	111	114	111	114	3 19 8	...	...	...
19,000	5	2/0	Folkestone Electricity Supply Co. Ordinary xd	5⅝	6½	5⅝	6½	5 4 0	...	6	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	7⅛	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10½	11⅛	10½	11½	4 6 11	...	10⅞	...
19,000	5	6%	Do. 6 per Cent. 1st Pref.	6⅛	6⅝	6⅛	6⅝	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knghtbg. Co. & Notting Hill Co. (J't. St'k.) 4%	105	108	xd 104	107	3 14 9	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1⅞	2⅛	1⅞	2⅛	...	...	...	...
49,840	5	2/6	Do. 6 per Cent. Preference	4⅝	5	4⅝	5	6 0 0	...	...	...
£350,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	96	99	96	99	4 1 2	Mar., June, Sept., Dec.	97⅛	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15⅛	16⅛	14⅛	16⅛	4 4 10	April and October	16	15 11/16
£230,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	110	113	110	115	3 18 11	June and December	...	...
£300,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99	102	99	102	3 9 2	...	...	...
10,853	10	6/-	Notting Hill Electric Ordinary	13½	14½	13½	14½	4 2 9	March	...	...
13,194	5	2/6	Oxford Electric Ordinary	5	6	5	6	4 3 4	,,	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	98	101	98	101	3 19 7	...	...	...
300,000	1	...	Rand Electric	⅞	⅞	⅞	⅞	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs. xd	103	105	101	103	4 7 5	April and October	...	...
40,000	5	5 0	St. James's and Pall Mall Electric Ordinary	15	16	15	16	4 10 8	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98	101	98	101	3 9 7	...	...	...
13,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2⅛	3	2⅛	3	...	...	2⅛	...
30,000	5	1/3	Urban Electric Supply Ord. (£4 paid) xd	2⅞	3⅛	3⅛	4⅛	...	...	2⅛	...
30,000	5	1/3	Do. 5% Cum. Pref. (£4 paid) xd	3⅛	3⅝	3⅛	4⅛	...	...	...	...
110,000	5	5 6	Westminster Electric Supply Ordinary	11	12	11	12	4 11 8	March and September	11⅞	...
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	6	6⅛	6	6⅛	3 16 11	...	6⅛	...
			TELEGRAPHS.								
£67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98	102	98	102	3 18 5	January and July	...	...
20,000	10	...	Amazon Telegraph	3⅜	4⅛	3⅜	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£78,840	Stock	15/0	Anglo-American	47	50	47	50	5 17 0	Feb., May, Aug., Nov.	48⅛	47½
£2,105,580	Stock	20/0	Do. Preferred	91	93	91	93	6 3 2	,, ,,	92⅛	92½
£2,105,580	Stock	2/0	Do. Deferred	7⅛	7⅝	7⅛	7⅝	1 5 9	,, ,,	7⅝	7 1/16
$12,333,300	$100	$12	Commercial Cable Capital Stock xd	160	170	163	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,200	Stock	4%	* Do. 4 per Cent. Debenture Stock xd	95	97	98	16	4 3 4	,, ,,	96	95⅝
16,000	10	4/0	Cuba Submarine Ordinary	5½	6⅛	5½	6⅛	6 13 4	February and August	...	5⅛
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 6	,, ,,	...	...
12,000	5	2/0	Direct Spanish Ordinary xd	2⅛	3⅛	2⅛	3⅛	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference xd	7	8	7	8	6 5 10	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞	103⅞	99⅞	103⅞	4 7 8	January and July	...	...
60,710	20	4/0	Direct United States Cable	10⅛	11	10⅛	11	5 18 2	Jan., Apr., July, Oct.	1⅛	...
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	100	103	100	103	4 7 11	June and December	...	...
£4,000,000	Stock	65/0	Eastern Ordinary [to 1,200) (red.)	124	129	124	129	5 8 6	Jan., Apr., July, Oct.	128	125½
£1,155,565	Stock	17/6	Do. 3½ per Cent. Preference Stock	90	93	90	93	3 15 8	,, ,,	93	91
£1,584,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	108	111	107	1 0	3 13 11	May and November	109½	108
200,000	10	2/6	Eastern Extension	12⅜	12⅝	12	12⅛	5 1 0	Jan., Apr., July, Oct.	12⅛	12⅛
£230,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 0	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 18 7	February and August	...	...
£300,000	20	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞	104⅞	101⅞	104⅞	3 17 6	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen	26	27	26	27	5 11 1	January and July	...	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos	100	103	100	103	4 7 5	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	38	42	38	42	5 19 1	May and November	38	...
£100,000	100	6%	London Platino-Brasilian 6 per Cent. Debs., 1904	101	105	101	105	5 14 3	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 5	June and December	...	...
15,000	10	...	*West African Telegraph Shares	3½	4½	3½	4½	...	...	...	...
30,008	2½	...	West Coast of America	⅜	⅜	⅜	⅜	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	98	101	98	101	3 19 7	January and July	...	...
88,321	10	...	West India and Panama	⅜	⅜	⅜	⅜	...	May and November	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Pref.	4⅝	5⅛	4⅝	5	12 0 0	,, ,,	4⅝	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3	4	3	4	...	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	January and July	...	...
207,980	10	3/0	Western Telegraph (late Br gill'n Submarine)	11⅜	12⅛	11⅜	12⅛	5 14 3	Mar., June, Oct., Dec.	12	11⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 10	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	98	101	99	102	3 19 8	...	...	...
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3¾	4	3⅞	4	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/0	2/0	1/0	2/0	15 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅜	⅜	⅜	⅜	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	,,	...	...
£1,963,333	Stock	6%	National Co. Preferred Stock	93	95	93	95	6 5 10	...	93	...
£1,966,667	Stock	4½%	Do. Deferred Stock	55	57	55	57	7 17 10	...	56⅛	55
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	13	12	13	4 12 4	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11	12	11⅛	12⅛	4 11 0	,, ,,	11⅝	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅛	4⅞	5⅛	5 0 1	,, ,,	4⅞	4⅞
£3,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	96	99	96	99	3 10 10	June and December	97⅛	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6	...	103	...
171,504	1	0/6½	Oriental	¾	1	¾	1	6 0 0	April and October	...	...
58,000	5	4/6	United River Plate	4⅞	5⅛	4⅞	5⅛	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅝	5	4⅝	5	4 15 8	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	104	101	104	4 16 2	June and December	...	...
			FINANCIAL, INVESTMENT, &c.								
19,980	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	6	5⅛	6⅛	4 16 0	...	5⅛	...
180,227	10	4/0	Globe Telegraph and Trust	9½	10	9½	10	5 5 0	Jan., Apr., July, Oct.	9⅝	9⅜
180,943	10	3/0	Do. 6 per Cent. Preference	13⅜	13⅝	13⅜	13⅝	4 7 3	,, ,,	13⅛	13⅜
11,280	8	4/0	Reuter's	6⅝	7	6⅝	7	5 14 3	April and October	...	...
3,208	£100 Cert	6%	Submarine Cables Trust	110	120	110	120	5 0 0	,, ,,	117½	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Sept. 24.		Price Wednesday, Oct. 1.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 1.	
								£ s. d.		Highest	Lowest
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
200,007	5	2/0	Anglo-Argentine Shares (1 to 200,007) ..... xd	4½	4¾	4¾	4¾	4 11 5	April and October.....	4¾	4½
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9	11	9	11	2 14 7	...	10⅛	...
10,000	10	5/0	Do. 5% Cumulative Preference	9	10	9	10	5 0 0	...	...	...
£142,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 2	...	...	...
15,000	10	4/0	Blackpool and Fleetwood Tramways.....	13	14	13	14	4 12 10	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3½	4	3¾	4	...	...	...	...
75,000	5	2/6	Do. 5% Cum. Pref.	4½	5	4½	5	5 0 0	...	4⅝	4½
£400,000	Stock	4½%	Do. 4½% Deb. Prov. Certs.	103	106	103	106	4 5 0	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	20½	21½	20½	21½	3 14 2	February and August	...	...
25,000	10	6%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106	108	106	108	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary.....	7	7¼	7	7¼	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9	9½	9	9½	5 5 3	May and November ...	...	...
£250,000	40	4½	Do. 4½% 1st Mort. Debs.....	103⅞	105⅞	106⅝	106⅞	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary.....	12½	13½	12½	12¾	6 12 4	...	13½	12⅝
100,000	10	6/0	Do. 6% Cum. Pref.	12½	13	12½	13	4 12 4	February and August	12⅝	12⅛
£800,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures ..... xd	125	128	124	127	3 18 9	...	125½	124½
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅝	1¾	1⅝	1¾	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref.	5	5½	4⅞	5⅛	5 14 3	...	...	...
27,500	5	3/0	Do. "B"	5	5½	5	5⅛	5 9 1	...	5⅛	...
£230,000	Stock	5%	Do. 5 per Cent. Debentures	104	107	104	107	4 14 3	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)...	98	101	98	101	5 0 2	...	...	...
70,000	10	6/0	Calcutta Tramways	7⅛	7⅜	7⅛	7⅜	3 17 5	...	7⅜	7⅛
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	109	107	102	4 8 1	...	...	...
480,000	1	1/2½	Cape Electric Tramways Shares	2½	2⅝	2½	2⅝	6 14 9	...	...	...
£1,840,014	Stock	4%	Central London Ordinary Stock	103	106	103	106	3 15 6	June and December...	105½	104
£494,093	Stock	4%	Do. 4% Preferred Stock	106	108	106	109	3 13 9	...	107⅛	...
£494,993	Stock	4%	Do. Deferred Stock	103	106	103	106	3 15 6	...	106⅝	106
£668,201	100	4%	Do. 4% Deb.	115	118	115	118	3 7 8	...	118	...
40,000	5	2/6	City of Birmingham Trams, Co. 5% Cum. Pref.....	4⅝	5½	4⅝	5½	4 15 8	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	5%	City and South London Railway Con. Ordinary	72	74	71	73	3 12 8	February and August	73	71⅛
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	" "	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	...		...		...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)..	138	141	138	131	3 16 6	" "	...	...
£200,000	Stock	5%	Do. (1896)	126	129	126	129	3 17 6	...	...	...
£150,000	Stock	5%	Do. (1901)	123	125	123	126	3 19 7	...	128½	123½
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November ...	...	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary.....	11½	12½	11½	12½	4 8 0	...	...	...
53,987	10	6/0	Do. 6 per Cent. Preference.....	14½	15½	14½	15½	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)..... xd	96	99	95	98	3 11 5	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½	4¾	4½	4¾	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.) ..	99	102	99	104	4 18 0	...	...	...
78,000	10	8/0	Great Northern and City Railwy Pref. Ord. (4%) ..	8	9	8	9	3 6 8	...	8½	8
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference.....	13½	13⅝	13½	13⅝	4 7 3½	" "	...	...
£800,000	Stock	4½%	† Do. 4½ per Cent. Debenture	109	111	110	1.2	4 0 5	January and July	...	...
£30,000	5	2/6	Isle of Thanet Elec. Trams and Light'g 5% Pref. ...	4½	4¾	4½	4¾	5 5 3	...	...	...
47,500	10	1%	Liverpool Overhead Railway Ordinary	4⅝	4¾	4⅛	4⅛	2 1 7	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	9¾	10¼	9¾	10¼	4 17 7	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	99	1 1	99	101	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid) .	11½	12	11½	12	4 3 4	...	11⅞	11⅛
30,999	10	2/8	Do. (£7. 10s. paid)	8¾	9⅛	8¾	9⅛	4 1 0	...	...	...
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	105	110	108	110	3 12 9	...	108½	108½
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	81	84	82	84	...	...	...	...
$1,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds.	112	117	116	117	4 5 7	...	...	...
£80,000	100	5%	Montreal Str't R'l'w'y & St'r'l'g 5% Mort. Debs. (1908) ..	104	106	104	106	4 14 3	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1923)	108	110	108	110	4 2 2	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3	4	7 10 0	May	...	...
£181,800	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.).....	98	98	98	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk ..	101	105	104	105	4 16 5	...	...	...
13,334	10	8/0	Potteries Electric Traction Ordinary	8½	9½	8¾	9¼	4 4 3	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9	10	10	11	4 10 11	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108	111	108	111	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord..	...		...		...	...	...	...
51,182	1	...	Do. 6% Preference (14/0 paid)	...		...		...	April and October.....	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...		...		...	" "	...	...
600,000	Stock	...	Do. 4½% Debenture Stock (70% paid)	-		-		-	January and July	...	...
£540,800	Stock	8%	Waterloo and City Ordinary	90	93	90	93	3 4 6	June and December ..	97½	91
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	¾	⅞	¾	⅞	6 18 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	1/16	1/32	1/16	1/32	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	⅞	1	⅞	1	12 0 0	March and September	...	...
100,000	5	4/0	British Insulated Wire Ordinary	7½	7¾	8	8¼	5 5 11	July and February ...	...	...
100,000	5	3/0	Do. 6 per Cent. Preference	5¾	6	6¼	6½	4 16 0	January and July	5½	...
£260,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	102	105	103	105	4 5 6	...	104½	103½
200,000	5	4/0	British Westinghouse 6% Preference.	6	6½	6	6½	4 13 0	...	6⅜	6¼
£500,000	Stock	14/0	Do. 4 per cent. Mortgage Deb. Stock	103	105	103	105	...	...	104	103½
108,781	2	...	Brush Electrical Engineering	¾	1⅛	¾	1⅛	...	March	...	...
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1	1⅛	1	1⅛	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	100	103	100	103	4 7 7	March and September	101	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	98	98	94	99	4 10 11	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15½	16½	15½	16½	4 10 11	" "	...	...
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference..	6⅜	6½	6⅜	6½	4 0 0	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb.(red.).....	109	113	109	113	3 19 8	November and May ...	111	...
£150,000	1	0/0½	Castner-Kellner Alkali Co. (fully paid).....	¾	1⅛	¾	1	6 0 0	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	94	99	95	98	4 11 8	...	...	...
60,000	1	1 0	Chadburn's Ship Telegraph Ordinary ..... xd	¾	1	¾	1	9 2 0	March	...	...
35,000	2	1/0½	Crompton and Co. (Nos. 1 to 54,000)	5⅛	5	2⅛	3	6 0 0	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb.(red.) ...	104⅞	106⅞	104⅝	106⅝	4 14 4	" "	...	...
99,361	5	...	Edison & Swan United ("A" Shares) (£3 paid) ...	⅜	⅝	⅜	⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid).....	1⅛	2⅛	1⅛	2⅛	...	" "	...	...
£344,028	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	74	78	74	78	5 3 0	June and December...	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock . xd	78	83	77	82	6 1 11	...	...	...
50,000	5	4/0	Edmundson's Electricity Corporation Ord.....	6½	6¾	6½	6¾	5 3 3	Half-yearly	6⅝	6½
80,000	5	3/0	Do. 6% Cumulative Preference	6	6⅛	6	6⅛	4 12 4	...	6⅞	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	107	110	4 2 1	...	103⅛	103½
113,100	2	1/3½	Electric Construction Co.	1½	2	1½	2	6 0 0	January and July	1½	...
31,290	2	2/0½	Do. 7 per Cent. Cumulative Preference	2½	3	2½	3	4 18 4	July	2⅜	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 19 1	January and July	101	100
122,985	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50,000	1	...	Do. 7 per Cent. Cumulative Preference	¾	1⅛	¾	1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd. 5% Cum. Pref.	10	10½	10	10½	4 15 8	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures ..... xd	103	103	99	102	3 18 11	...	...	...
35,000	5	5/0	Henley's Telegraph Works Ordinary	16	17	16	17	4 14 2	February and August	16⅛	16½
35,000	5	3/3	Do. 4½ per Cent. Preference	5½	5⅝	5½	5⅝	3 18 3	" "	...	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) ...	109	113	109	113	3 19 3	" "	109	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½	21½	20½	21½	4 13 0	" "	21½	...
£200,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) .. xd	100	103	99	102	3 18 2	March and September	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½	15½	14½	15½	6 9 0	July	...	...
37,350	12	12/0	Telegraph Construction and Maintnce.	38	41	38	41	5 17 0	March and July	38	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	105	102	105	3 16 2	January and July	103	...
60,000	5	5/0	Williams and Robinson Ordinary	...		...		...	April and October	...	...
60,000	5	3/0	Do. 6 per Cent. Cumulative Pref.....	...		...		...	" "	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

On the occasion of Prof. Becquerel's lecture at the Royal Institution, we expressed a hope that British physicists would take up research into the properties and possibilities of radio-active bodies. The incitement of Prof. Becquerel's lecture has apparently not borne fruit, for no new work in this direction has been done in this country, while on the other hand the pioneer work by Becquerel and M. and Mdme. Curie has been speedily followed up by German and even Italian investigators. Our "Contemporary Electrical Science" Notes this week contain important contributions from Elster and Geitel, Giesel, Sella and Behrendsen, the last-mentioned adducing further proof as to the existence of polonium as an independent element. Perhaps Prof. J. J. Thomson's recent lecture will help to impress English, Scotch and Irish physicists as to the importance of the subject. They do not forget, as their foreign colleagues are sometimes apt to do, that even delicate physical investigations may have practical and utilitarian applications, and perhaps we may soon have the means at our disposal to weigh the chances of radio-active bodies as a possible means of direct illumination.

Prof. A. M. Worthington contributes a brief article on "Mr. Marconi's Recent Invention" to the current number of the *Monthly Review*. The article is so brief, indeed, as to be little more than a note or memorandum. Its chief purpose seems to be to laud the magnetic detector in contrast with the coherer without giving the lay reader any very intelligible account of either. The magnetic detector, Prof. Worthington thinks, exalts Mr. Marconi to "the foremost rank of scientific inventors," and removes from wireless telegraphy the stumbling-block in the way of fast speed. In the older method, he says, "all depends on the coherer," which is true enough to the extent that if the coherer sulks all must go wrong. But it is far from correct to suggest that the coherer was the only obstacle to high speed, and that that obstacle is now removed by the use of the magnetic detector. Anyone who has any experience of wireless telegraphy must know that the impediment is not exclusively at the receiving end, but that in the matter of "sending" there are also serious limitations of speed.

Considerations of high imperial policy, no doubt, must always predominate in the attitude of His Majesty's Government towards an empire like India; but it is difficult to discover in what manner imperial interests are served by the recently-issued regulations for scientific research in the Indian Empire. The researches conducted by the Government scientific officers are to be brought under State control; and, instead of each being allowed, as heretofore, to follow his own particular bent, he is to be directed, according to a State programme, as to what lines of research he is to pursue. Moreover, the "natural tendency" to give the claims of abstract science precedence over the demands of economic or applied science is to be checked. A board of scientific advisers is to frame annually a programme of research to be carried out during the year. The development of practical research is, of course, to be commended; but it is a pity that the Government of India thinks this inconsistent with abstract research.

The outlook for electricity supply works in this country during the coming winter is anything but pleasing, as regards fuel supply and working expenses, if the present serious coal strike in the United States continues. With coal at £5 to £6 per ton in America, and scarce at that, and with heavy shipments of British coal to the United States taking place daily, it is not surprising that prophets of evil predict that we shall soon have to pay 40s. or more per ton here. It is a trite saying that economic crises like this affect gas works equally with electricity works; there is not much consolation in the fact. What would be more comforting would be the discovery of an economic antidote sufficiently powerful and prompt in its action to prevent the mischief altogether.

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THE present crisis has the disadvantage that its centre is located where our own Government departments have neither jurisdiction nor *locus standi*. When it is a South Wales coal strike there is always hope that the Home Secretary or the Board of Trade may restore harmony and avert disaster. But in the present instance the exciting cause is in a foreign land, and the danger is all the more formidable in consequence. This, however, furnishes no excuse to HIS MAJESTY'S Government to stand idly aside and let things drift. What, indeed, is the national outlook if they do? This: the huge shipments of British coal to America will produce such scarcity at home as must inevitably precipitate an industrial crisis here; besides causing distress in the homes of the poor, and general inconvenience everywhere, through high prices. And even after the immediate crisis is over, it will be Great Britain far more than the United States that will continue to suffer. Our limited stock of national coal will have been depleted, although without appreciable national gain, when it would have been far wiser to have let the coal remain in the bosom of the earth until we might need it ourselves. And we, ourselves, will have to pay back, in higher prices for American manufactures, the extra price paid by them for our own coal.

WE have more than once directed attention to the national necessity for a permanent export duty on British coal—not a mere revenue-producing duty, but a tariff sufficient to act practically as a prohibitive tax. It is not true that such a tariff would be opposed to our national practice of free trade. It has neither to do with free trade nor with the ordinary rules of protection. Our coal differs from our other exports, in that we possess only a limited amount of it, coupled with the fact that our possession of it is of vital importance to our industrial life as a nation. Coal is our birthright, which we dare not traffic with to aliens for any quantity of pottage.

"OILING the wheels" generally has reference to the application of oleaginous lubrication to the hub; but in the case of a curious experiment which has been tried recently on a portion of the Southampton road, near Farnborough, the oil was applied to the tyres of the wheels. The mode of applying it was by sprinkling a mile or so of road with petroleum, by means of a "water"-cart and men with "water"-cans. Some years ago the Pennsylvania Railroad Co. of America tried petroleum for the purpose of laying the dust on their tracks, and the same reason has prompted the persons interested in the above-described experiment in Surrey. Doubtless for preventing the thick clouds of dust in the wake of an on-rushing motor car, this method may prove effective; but it promises to be injurious to rubber tyres, and it does not appeal to pedestrians as likely to be pleasing to their olfactory nerves.

MESSRS. CROMPTON & Co. are to be commended for their admirable scheme of evening lectures for their pupils. Four series of lectures are arranged for the coming winter—viz., "Steam Engineering," by Mr. W. H. BOOTH; "Practical Details of Dynamo Design," by Mr. A. HUTCHINGS; "Arc Lamp and Alternating Currents," by Mr. E. A. N. POCHIN; and "The Theory of Direct Currents of Electricity," by Mr. H. C. WRIGHT. A praiseworthy feature of the arrangements is the prizes which are offered "for the best note books"; and, as will be seen from the following excerpt from the prospectus, really practical and useful note making is the thing to be encouraged:—

> In making these awards Lieut.-Col. CROMPTON will give preference to those note books which contain clear and exact but brief notes with explanatory sketches, and which not only show that their owners are cultivating the power of rapidly, accurately and completely observing and recording every new fact or phenomenon of importance coming to their notice during the lectures, and during their daily work, but that they are also considering what they have learnt, noting its application to their daily work, and originating new applications and ideas. He does not require long descriptions or highly-finished sketches.

THOSE who are in doubt as to the wisdom of following the advanced reformers of technical education, from whose lips so much assertive dogma has fallen of late, may, perhaps, find occasion for pause in the utterances of Prof. JOHN PERRY at the prize distribution at the Royal College of Science last week. We have heard already Prof. PERRY'S condemnation of Latin and Greek, of Euclid and of ancient history. He now declares that "no kind of physicist or engineer needs French, German or any foreign language so much as to make it necessary for him to study it." We entirely disagree, and our pity is increasing for the luckless youths whose education from start to finish is to be carried out on such narrow and stunted lines. And why does Prof. PERRY think this? Because, forsooth, physicists and engineers can contentedly read translations. But where are the translations to come from, or who is to advise publishers as to the works worthy of translation, if ignorance of foreign tongues is to prevail among engineers and scientists? Besides, the reading of foreign literature is not the be-all and end-all in the knowledge of foreign languages, especially in a nation like the British, whose sons are to go forth to the ends of the earth. We want no little-Englander notions in our educational programme, please.

The Murray Type-Printing Telegraph.—The experiments made by the British Post Office with this instrument, which were commenced about a year ago, are still proceeding, and one of the telegraph lines between London and Edinburgh is tentatively working on this system. The Murray type-printing telegraph was described in *The Electrician*, Vol. XLVIII., p. 86.

Telephones on Mont Pelée.—According to the *Electrical World* of New York, Prof. Le Croix, who is now on his way to Martinique, will establish posts of observation near Mont Pelée. These posts will be connected by telephone with Fort de France, in order to give timely warning of threatening signs on the mountain and enable the authorities to take proper precautions.

Municipal Expenditure in Glasgow.—A list was published in *The Times* on Tuesday of some items of municipal expenditure in Glasgow. The reception given to members of the Engineering Conference last year cost £380. 9s. 7d.; the reception to the British Association in the same year cost £384. We note that one item, "Dinner to Sir H. RAWSON, £156" is followed by the item "Dinner to Poor Folk, £8. 8s." Poor folk!

Westinghouse Integrating Wattmeter.—The Board of Trade has recently approved of the Westinghouse integrating wattmeter for the measurement of electrical energy supplied on the constant-potential alternating-current system. They also have further approved of the means provided for fixing this

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meter and for connecting it with the supply mains. This type of meter is well known, and has come largely into use both for single and polyphase working during the past few years.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
St. Lucia—Grenada	May 9, 1902 ...	—
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Santa Cruz—Teneriffe	July 7, 1902 ...	—
Puerto Plata—Martinique	July 10, 1902 ...	—
Anjer—Kalianda	Aug. 2, 1902 ...	—
Guantanamo—Mole St. Nicholas	Aug. 5, 1902 ...	—
Cayenne—Pinheiros	Aug. 13, 1902 ...	—
St. Lucia—St. Vincent	Sept. 19, 1902 ...	—
Gibraltar—Tangiers	Sept. 19, 1902 ...	Oct. 4, 1902
Maranham—Para	Sept. 19, 1902 ...	—
Maranham—Ceara	Sept. 19, 1902 ...	—

Wireless Telegraphy.—The report that a message has been received at Cape Breton, Nova Scotia, from the Marconi Company's station in Cornwall has been officially denied. As the receiving apparatus on the other side is not yet complete, no wireless message could have been received.

Last Monday afternoon the ss. "Minnehaha," from New York, should have docked at Tilbury, but was lost sight of after passing the North Foreland. The owners communicated with the Marconi Company, who immediately instructed their Chelmsford station to signal the vessel, and on this being done she replied to the effect that she was detained by fog in the Thames above Southend.

An article in the October number of *Page's Magazine*, by Mr. H. C. Marillier, on the developments of wireless telegraphy, deals with the Marconi system.

New Cable Laying and Repairing Steamers.—We referred briefly in our last issue to the launching of the Eastern Extension, Australasia and China Telegraph Co.'s new c.s. "Patrol." This vessel was successfully launched on Saturday from the yard of Messrs. Wigham-Richardson & Co., the christening being performed by Mrs. Pattison, wife of Capt. G. Pattison, the popular commodore of the Eastern and Associated Companies cable fleet, Capt. Pattison representing the owners on the occasion. Both the "Patrol" and the "Restorer" (recently launched) have returned to the shipyards, where the machinery is now being put on board. When this work is completed the vessels will come south for their electrical equipment. The "Restorer" will ultimately be stationed in Australian waters, and the "Patrol" will be employed in the Straits and China.

The Discovery of Aluminium.—A correspondent writing to the *Chemical News* quotes the following which appeared in the September issue of *Knowledge*:—

> The first discoverer of aluminium had the reward of genius. Pliny tells us that in the reign of Tiberius (41 B.C. to 37 A.D.) a worker in metals presented a beautiful metal cup resembling silver, but lighter, to the Emperor, who questioned him, and learned that he had extracted the new metal from clay. The secret, he said, was known but to himself and the gods. The sage Tiberius, reflecting that if this metal could be made from earth it would lower the price of silver and gold, decapitated the artificer in order that his secret might remain with the gods, and so deprived the world of a most useful metal for 18 centuries.

The correspondent wishes to know, in view of the metal being aluminium, how it was produced. He says that as neither sodium nor potassium had been isolated at that period, and no electrical method was known, they must have possessed some means of producing it of which scientists are at present in ignorance.

The Duration of a Generation of Electricity.—According to *Cassier's Magazine*, the contractor for the building of the New York rapid transit subway recently made the somewhat startling statement that, owing to the great developments now taking place in the electrical industry, a generation of electricity was not now over three years, whereas when he had originally started on the work it was considered to be at least seven years. The great advance in the design and construction of electrical equipment has raised prices to a large extent, so that his estimates of a few years ago will be exceeded in actual cost by several million dollars. It is hardly necessary to point out the remarkably rapid changes that have occurred in the design of lighting machinery, in addition to that in use for traction purposes. Telephone apparatus does not escape, and it is pointed out that in one case alone, in New York, this form of plant to the value of $400,000 was scrapped to make way for more economical apparatus.

Canadian-Australasian Cable.—The c.s. "Colonia," belonging to the Telegraph Construction and Maintenance Co., having laid this cable to Fanning Island (the longest section, =3,455 nauts), has left that place for Honolulu, where she will meet the same company's c.s. "Anglia," and will transfer cable, staff and engineers to the latter vessel. The "Colonia" will then return to Fanning Island to complete the shore end of the cable there, and thence proceed to lay the Fanning Island-Fiji section, so, it is calculated, completing the cable contracted for by the company with the British Government well within contract time. A large proportion of the 8,300 nauts of this cable is of a heavy type of core. The "Colonia," before returning home will, we understand, take soundings in the neighbourhood of Midway Island and Guam in connection with the Commercial Cable Company's Pacific cable. The "Anglia" returns home direct on the completion of her work in connection with the Canadian-Australasian cable.

Lead v. Nickel Storage Batteries.—At the Niagara meeting of the American Electro-chemical Society, Mr. Hugh Rodman read a Paper entitled "Storage Battery Invention," which, according to the *Electrical World* of New York, contrasted at length the relative merits of the lead and nickel types of storage batteries. The author argues that the alkali battery possesses the advantage of being composed of plates of a stiff, easily-worked metal. The stiffness ensures absence of buckling (a trouble which must be considered and compensated for with lead plates), while the stiffness and ease of working together admit of a high mechanical perfection. The inferiority of the lead plate lies in its mechanical weakness, and in the difficulty of making fine castings. After discussing the various advantages and disadvantages of both types, the author concludes that as far as central station work, which at present takes about 75 per cent. of the battery output, is concerned, the position of the lead cell seems secure. Its low first cost, low internal resistance, high voltage and general efficiency more than overbalance the deterioration.

Electrolysis of Water.—Mr. Carl Hering, of America, describes, in a recent Paper, which is abstracted in the *Electrical World* of New York, some curious experiments performed by himself and Mr. Reed, relating to the electrolysis of water. They electrolysed some acidulated water contained by a strong N-shaped glass tube, sealed at both ends and provided with a bend containing mercury, which enabled the mechanical pressures to be read off. The pressure reached about 23 atmospheres when the tube exploded. The voltage at the terminals, with a constant current passing, diminished rapidly and very decidedly to about 0·3 volt, at about 16 atmospheres, and then remained practically constant. Allowing for the loss due to resistance, the actual voltage of decomposition was even much lower—nearly zero. Gassing was visible during the whole of the test, and the pressures increased, thus proving that water was really being decomposed. A possible explanation was suggested, based on the assumption that some of the gases probably passed mechanically to the opposite electrode, which they could easily do in suspension, as the electrodes were very close together. These were consumed as depolarisers, so that only a fraction of the theoretical amount of gas was really liberated. This depolarisation lowered the voltage. A calculation based on the reduced amount of gas which was actually liberated, on the actual current which passed, and on the energy which must be accounted for to conform with theory, would also show that the required voltage may be very low; and the lower the greater the amount of depolarisation. The Paper concluded with a suggestion of an experiment, in which water is electrolysed in a strong, sealed vessel, which is completely filled so as to leave no room for the gases. Some curious results may then be expected.

Transposition of Alternating-Current Overhead Conductors.—At a recent convention of the American National Electric Light Association, a question was asked relative to the best

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practice regarding the above subject. Dr. Perrine, in reply, stated that in a case brought to his knowledge, where many lines carrying large currents were run out of the station for distribution to a city, being in parallel in some cases for not over 1,000ft., the interference between the different power lines was so serious that pressure wires run back to the station gave no indication of the pressure at the terminals, since both the power lines themselves and the pressure wires were seriously affected by neighbouring currents. Single-phase lines are transposed simply as telephone lines by crossing them, since any two sections of equal length between which there is a cross have equal fields of force acting in opposite directions, and consequently neutralise each other. A "barreling" of a three-phase line rotates the field of force one-third of a revolution, and, in consequence, it is necessary to rotate the line twice before the individual equal sections neutralise each other, and in this case no two of the three equal sections between which there are transpositions neutralise, though the three are neutral when taken together in reference to any parallel line. The four-wire two-phase line is only neutralised when there are three barrelings, and four sections of equal length, and the three barrels divide the line into four sections of equal magnetic strength. These four sections neutralise each other in pairs, but no two neighbouring sections neutralise. The first and third neutralise each other, and the second and fourth neutralise each other, but the first has no influence on the second or fourth, the second has no influence on the first or third, and so on. It is stated that the barreling of a line is necessary for neutralising the effect of the earth upon that line itself, but Dr. Perrine found no such effect, two and three-phase lines without any transpositions working as well as those which had been transposed or barreled, provided the three-phase wires were located at the corners of an equilateral triangle and the wires of each phase of a two-phase line at the diagonally opposite corners of a square. In transposing any line in reference to any other line, Dr. Perrine continued, the transpositions should be introduced in sections where the current, and consequently the magnetic field, is constant. If this question of the constancy of the magnetic field and the effect of its direction already described be taken into account, all interference to or from neighbouring lines is readily overcome.

Ferro-concrete.—At a meeting of the Society of Engineers held at the Royal United Service Institution, Whitehall, on Monday evening last, Mr. Percy Griffith, president, in the chair, a Paper was read on "The Hennebique System of Ferro-concrete Construction," by Mr. Augustus de Rohan Galbraith. The author sketched the early history of the system, pointing out that the first authenticated adoption of the principle was by Napoleon the Great in the erection of fortifications near Strasburg in Alsace-Lorraine, towards the close of the eighteenth century, and in which works hoop-iron bonding in concrete was employed. He then referred to the various systems of ferro-concrete construction, stating that the originator of the principle was M. Joseph Monier, a Frenchman, and that it was first applied to the manufacture of slabs and pipes in ferro-cement. He then described the ferro-concrete system invented by M. Hennebique, a French engineer, which is being adopted in this country in various engineering works, notably in connection with the Old Quay widening, and new dock works of the London and South-Western Railway Co. at Southampton. The Hennebique principle consists in embedding in concrete straight and cranked iron or steel tension bars and stirrups, to take the shearing stresses, together with distance pieces, the system being applicable to, and employed in, entire buildings from foundation to roof inclusive. The piles used at Southampton are built up in vertical moulds, in which are placed long steel rods, which give the required strength. These are laced together with wire stirrups, and Portland cement concrete of the best quality is filled into the moulds and rammed round the steel. After a month the pile is taken out of its mould and driven in position, much in the same way as timber piles are. The author then pointed out the care required in the selection and preparation of the materials, explaining that the usual proportions of the concrete were five to one, and giving the preference of Siemens-Martin steel to Bessemer steel owing to the purer and more uniformly good quality of the former. He then dealt with the application of the system in general construction, giving the results of some tests on Hennebique beams with and without stirrups, which proved the superior strength of the former. He stated that the results of experiments by Profs. Baushinger and Ritter showed that the adherence of iron to concrete was about 570lb. per square inch. The coefficient of expansion and contraction of steel and concrete was found by M. Durand Claye to be identical up to the fifth decimal, giving the breaking strain of concrete as between 3,000lb. and 4,000lb. per square inch. The author then gave the following examples of the cost of the Hennebique system as carried out in different structures:—A grain warehouse at Plymouth 4½d. per cubic foot of space; a flour mill at Swansea 6¼d. per cubic foot; grain silos at Swansea 6¼d. per cubic foot, and some coal hoppers at Portsmouth 7¼d. per cubic foot.

Electrolytic Action on Iron Pipes.—Herr Absalón Larsen publishes in the *Elektrotechnische Zeitschrift* of September 18th the results of some interesting experiments made in order to cast further light on the action of stray tramway currents on iron pipes. He placed nine pieces of 2in. pipe in separate iron cylinders, and surrounded them with an ordinary clayey earth containing 66⅔ per cent. of sand and 0·187 per cent. of soluble material (of which 0·019 were chlorine compounds, and 0·087 sulphuric acid compounds), but no free acid. The "cells" were connected in series, and about $\frac{1}{10}$ ampere was passed through them all, the 2in. pipes being the anode in each case. Five of the pipes were of cast iron, but of different height, so that the surfaces exposed to the electrolytic action varied from 100 to 1,600 sq. cm., and the pressure at their terminals from 18·9 to 3·06 volts. The sixth pipe was of wrought iron, the seventh, eighth and ninth were of cast iron; but various quantities of chloride of sodium were added to the earth which surrounded them. The ninth pipe received the same current as the others, but intermittently, the circuit being made for 5 seconds and then broken for 20 seconds. Although the E.M.F. of polarisation, observed immediately after switching off the current, was different in each case, the actual loss in weight in the iron pipe per ampere-hour was found to be the same for each of the nine pipes within the limits of experimental error. This amounted to 1·11 grammes per ampere-hour. It is to be noticed that this weight is independent of the pressure between pipe and earth, which is contrary to the results of M. Georges Claude's recent experiments. The E.M.F. of polarisation was found to be approximately proportional to the primary voltage, from which it follows that the stray current is proportional to the working current in the trolley line. This confirms tests on the Copenhagen tramway made by the author recently.——In an article by the same author published in the *Elektrotechnische Zeitschrift* of September 25th, some experiments are described on the effect of a periodical reversal of the current on iron pipes. The pipes were cut in half, and each half was placed in a separate box of earth in which also was an earth plate. These two boxes were connected in series, but a reversing switch was connected in circuit with one of them, so that, while the current flowed continuously from pipe to earth plate in one box, in the other it was reversed periodically. After exposure to air for a short time it was found that there was a certain scaling off from some of the specimens, and this loss is included in the following totals for loss in weight:—

Box No.	Diameter of pipe. (Mm.)	Mean current. (Ampere.)	Pipe.	Ampere-hours.	Reversal of current.	Loss in weight. (Grammes.)
1	150	0·301	a	608	0	855
			b	+304 −304	Hourly.	27
2	100	0·121	a	244	0	321
			b	+122 −122	Hourly.	10
3	150	0·341	a	570	0	702
			b	+285 −285	Daily.	164
4	100	0·124	a	208	0	274
			b	+104 −104	Daily.	70

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

Induced Radio-activity.—A. Sella has found that a temporary radio-activity can be imparted to a spiral spring by means of a charged rod placed in its axis and provided with needle points. The most remarkable circumstance observed was that the spring, and indeed any metallic body exposed to the "effluvium" from an influence machine, may thus be made radio-active even if positively charged. The amount of radio-activity acquired depends largely upon the state of the atmosphere, and is largest in a room closed for some time, but is independent of the nature of the metal. It is not obtained in an atmosphere of oxygen or coal gas, nor in a small confined space, unless some thorium oxide or other radio-active body is introduced into it. In that case the radio-activity acquired is great, but is the same whether the body is charged positively or negatively. On renewing the air, however, the negative radio-activity is much the greater. The author also describes some figures resembling Kundt's dust figures obtained by the effluvia from three points close together. He mentions that he has succeeded in making metallic electrodes strongly radio-active by using them to electrolyse a solution of thorium nitrate. "Auer's solution" with some nitric acid is very suitable. This radio-activity is also temporary.

[A. Sella, *Nuovo Cimento*, August, 1902.]

Radio-activity of Cave Air.—Elster and Geitel have shown that any conductor becomes radio-active when charged and exposed to air, especially when the air is contained in a closed subterranean space. To shed some light on the origin of this radio-activity, the same authors have made experiments on air enclosed for three weeks in a boiler and on air sucked up out of the ground. If the activity is due to a process within the air itself, it will be evolved in the boiler, and if it is due to contact with the earth, it will be shown in the air sucked up. The authors pushed an iron tube into loose garden soil, and inserted a glass tube into it, through which the air was sucked into an electroscope. The results were altogether in favour of the view that the activity of the air in a cave or cellar is due to contact with the earth and to exhalation of ground air. For the electroscope was discharged in a few minutes by the air sucked up, whereas the air in the boiler did not show any extraordinary radio-activity. The authors, therefore, claim to have traced two distinct sources of radio-activity, one of them being the action of the sun upon the higher strata of the atmosphere, and the other being the exhalation from the soil of air which has been in intimate contact with it, and which diffuses up through capillary passages in the ground.

[Elster and Geitel, *Physikal. Zeitschr.*, September 15, 1902.]

Becquerel Ray Photographs.—J. Elster shows how to obtain Becquerel radiographs with the simplest means. The radio-active substance is obtained by exposing negatively charged copper wires to the air, and rubbing off the surface layer after exposure. If cotton wool is used for rubbing it off, it should be moistened with a little hydrochloric acid. This is afterwards neutralised with ammonia and eliminated by igniting the cotton wool. The activity of the ashes is the same as that of the cotton wool. The radio-activity lasts for about five hours. As its loss is greatest at first, the exposures must be made as soon as possible. To save time it is advisable to substitute a piece of leather, moistened with ammonia, for the cotton wool, since it can be quickly dried in a spirit flame. The exposure is then made for about four hours, and the leather is renewed. After about five such renewals good radio-graphs of lead stencils are obtained through aluminium foil 0·1mm. thick. The radio-activity of the exposed wires depends, of course, to a great extent upon the weather. Air free from mist and dust is specially favourable. But the best of all is a cellar free from dust, and the author has found that the leather rubber over charged wires suspended in a cellar exerted some visible action upon a fluorescent screen. He points out that the whole surface of the earth is practically a cathode.

[J. Elster, *Jahrbuch für Photographie*, 1902.]

Polonium.—If pitchblende is powdered and ignited in a porcelain crucible, and the lid is kept cool, the latter is covered with a reddish-grey deposit which shows a strong radio-activity. This substance, referred to as "volatile" by Giesel, cannot have a merely "induced" radio-activity, since its activity is about six times that of the pitchblende, whereas radium never induces an activity equal to its own in a body it influences. O. Behrendsen proves that the deposit consists largely of polonium. On covering the deposit in question and a radium preparation with imitation gold film of the same thickness, he found that the former lost 85 per cent. and the latter only 20 per cent. of its original radio-activity. This great absorption of the rays from the deposit is only found in polonium rays. Another point of resemblance is the volatility of the substance and the comparatively short duration of its radio-activity. Like polonium, the volatile deposit has a preference for bismuth. If pieces of various metals are covered with it and ignited, bismuth shows as a result an activity 10 times greater than any other metal. This preference for bismuth has been utilised by Marckwald for the electrolytic preparation of polonium. The author considers it definitely established that polonium is an independent element.

[O. Behrendsen, *Physikal. Zeitschr.*, September 15, 1902.]

Radium Bromide.—F. Giesel gives some interesting particulars concerning the properties of radium bromide, which he has obtained in a pure state by fractional crystallisation of the barium and radium bromides, and which is manufactured at the Braunschweig quinine works. Experimenting with 0·5 gramme, the author found that the salt showed a rich bluish phosphorescence, especially in the dry state. The spectrum of the phosphorescence is continuous. The effect upon the fluorescent screen and the photographic plate may be compared with that of a small Röntgen tube. As the purification of the bromide proceeds, the green barium spectrum in the Bunsen flame vanishes, and the flame becomes crimson. The flame spectrum of radium consists of two bright bands in the red, an intense line in the blue and two indistinct lines in the violet. Of the two bands, the one nearest the yellow is the brighter, and is sharp and homogeneous, whereas the other consists of a dark separation line, a bright line, and several series. The bright blue line is probably the same as that found by Demarçay at λ 4,826·3 in the spark spectrum. Radium belongs to the elements which are easily detected by the spectroscope. A fair quantity of barium is quite obscured by a small quantity of radium, especially in the red. That Demarçay did not notice the red bands is probably due to a difference in the two spectra.

[F. Giesel, *Physikal. Zeitschr.*, September 15, 1902.]

Luminescence of Wires in a Vacuum.—J. Borgmann has extended his researches on luminous lenses round wires in a vacuum to the case of two wires, mounted parallel to the axis of a tube 75cm. long and connected with an induction coil. A narrow strip of tinfoil was stuck along the tube outside. The author describes the various phenomena produced by connecting one or both of the wires with the induction coil and exhausting to various degrees of vacuum. When the pressure is 4mm. to 6mm., and both wires are joined to the positive pole, with a spark-gap in parallel with the pole of the coil, and the strip of tinfoil not earthed, both wires show portions of luminous lenses at right angles to the axis of the tube. These lenses are motionless as long as the interrupter works uniformly, and occur at nearly equal intervals along the wires, but displaced in one wire with respect to the other. The space between the wires remains dark. When both wires are connected to the negative pole, and the tinfoil is earthed, two luminous surfaces appear between the tinfoil and each wire. When the pressure is a fraction of a millimetre, then the lenses observed in the first case are changed into cylindrical sheaths of violet light surrounding the wires, and in the second case there are longitudinal sheafs of light interrupted by dark rings. There is also the shadow of each wire thrown by light from the other.

[J. Borgmann, *Physikal. Zeitschr.*, September 15, 1902.]

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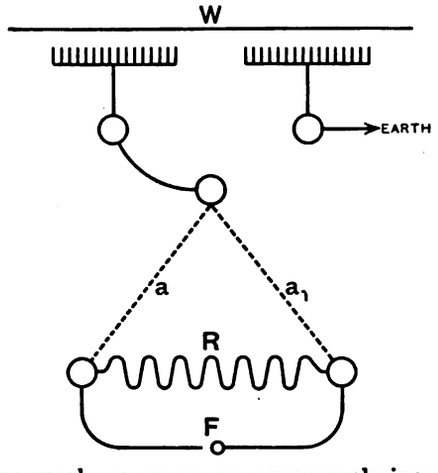
Electromotive Force of Ozone.—The decomposition of ozone produces heat, which, according to Berthelot, amounts to 29,600 gramme-calories per 48 grammes of ozone. A. Brand raises the question as to whether this considerable energy can be utilised wholly or in part for the production of electrical energy. As a matter of fact, a Grove gas battery can be constructed with oxygen and ozone as elements, the current passing from the oxygen electrode through the electrolyte to the ozone electrode. To determine how much of the energy is thus transformed it was necessary to find the E.M.F. of the cell. But since the E.M.F. of an oxygen electrode is not constant, the E.M.F. of an oxygen electrode and of an ozone electrode were separately determined by comparison with a standard mercury electrode consisting of mercury covered with mercurous sulphate and immersed in normal sulphuric acid. This determination was rendered difficult by the presence of H_2O or $H_2S_2O_8$ or both. Eventually the author found an amount of energy of 0·5 joule per coulomb. The total work of ozonisation amounts to 0·642 joule per coulomb, so that there is a pretty high electrical efficiency. Gräfenberg, in a similar investigation, has found 0·56 for the E.M.F. of the ozone cell.

[A. Brand, *Ann. der Physik*, No. 10, 1902.]

Electrified Spark-gaps.—E. Lecher describes a new set of experiments which seem to be of considerable importance to the theory of electrical discharge. He electrifies the whole secondary of an induction coil by an independent source of electricity and then works it as usual. He finds that the brushes usually seen on the positive electrode of an induction



coil when no spark can pass, are enormously increased when the whole is positively electrified, whereas they disappear when the electrification is negative. The apparatus is shown in the diagram, where R represents the secondary of the coil, *aa'* wet threads joined to the influence machine W, and F the spark-gap. The author describes a number of experiments made with this arrangement, and suggests that the results observed are probably due to the fact that the influence machine charge eliminates from the air of the spark-gap one or the other kind of electrons.

[E. Lecher, *Ann. der Physik.*, No. 10, 1902.]

Electric Potential and Surface Tension.—N. A. Hesehus points out a relation between electric potential and surface tension which is supported not only by experiment but also by the dimensions of the physical quantities involved. If, after Williams and Joubin, k and μ are given dimensions such that the electromagnetic quantities acquire formulæ involving integral powers of length, mass and time, and if, further, μ is taken to be a density and k the reciprocal of an elasticity, the quantity of electricity acquires the dimensions of a surface, and the E.M.F. acquires the dimensions of a surface tension. The author points out that this is open to a direct physical interpretation, and refers to his own experiments on frictional electricity. A surface tension is an energy per unit of surface. Two different bodies, such as ground glass and smooth glass, have different energies per unit surface, and when these energies are given an opportunity of equalising, as by rubbing the surfaces together, the difference of energy will appear as a difference of potential. On the same dimensional system the intensity of the electric field appears as a pressure or energy per unit volume, and the magnetic field as a linear velocity. The electric quantities, generally speaking, involve T^{-2}, or an acceleration, and the magnetic quantities involve T^{-1}, or a velocity.

[N. A. Hesehus, *Physikal Zeitschr.*, September 15, 1902.]

Physiological Effects of Röntgen Rays.—The skin disease called radio-dermatitis is the consequence of excessive exposure of the skin to Röntgen or Becquerel rays. Its pathology and treatment are fully described by Dr. Oudin. It is a painful and troublesome malady which may last for eighteen months, and is difficult to cure, though it does not appear to give rise to infectious or dangerous complications. The minor and general effects include vomiting (which often sets in the next day in consequence of abdominal radiography), palpitation of the heart, trembling of the fingers, and local loss of sensibility. The first symptom of acute and deep-seated radio-dermatitis is a reddening of the skin, which appears 24 to 36 hours after exposure. From 10 to 25 days after this the skin becomes covered with small vesicles, and itches violently. At the end of this period the skin begins to peel off, and is painful to touch. This phase lasts 10 to 15 days, at the end of which time healing often sets in. In more serious cases, however, ulceration sets in, which may last for many months. It is accompanied by epilation and a darkening of the skin over wide areas. As regards treatment, nothing has yet been found capable of stopping the development of the disease, though applications of cocaine or orthoform dressings give some relief. The electric effluvium and red light appear to accelerate the course of healing, and it is supposed that red light would, to a certain extent, counteract the effects of Röntgen rays, as they somewhat resemble the effects of ultra-violet light. Besides this acute radio-dermatitis, which is practically confined to over-exposed patients, there is a "chronic radio-dermitis" which attacks the operators. It affects more especially the fingers. The skin becomes red and swollen, and it is often impossible to close the hand. The nails usually become thin, brittle and creased—sometimes they fall off entirely. There is no treatment for this malady except the suppression of the cause. The author uses fencing gloves containing a padding of very fine brass wire to protect his hands. To protect his patients he uses fairly strong rays and short exposures, gradually increasing in duration. He never lets the anti-cathode become brighter than cherry-red, but brings the tube within 5cm. of the skin. For difficult radiographs he gives an exposure of 30 seconds at the first sitting, one minute two days afterwards, and so on until the exposure is increased to three minutes. Then the sitting is interrupted for eight days, and if, after that, no redness shows itself, the exposure can be gradually raised to five minutes, which must not, however, be surpassed. As regards the precise action of the rays in producing the disease, we are as yet in the dark.

[Oudin, *Archives d'Électricité Médicale*, September, 1902.]

Sparking Distances in Oil.—E. Jona has examined a large number of various oils with respect to their "dielectric strength." The charges were derived from an alternate-current transformer yielding voltages as high as 160,000. The oils differ greatly in their insulating powers, but the curves indicating the relation between voltage and maximum sparking distance all tend to become straight lines at voltages higher than 80,000. Natural olive oil shows the lowest insulating power. Benzol and fused paraffin are at the other extreme, and of these, benzol only shows a very slight increase of sparking distance for the higher voltages. It begins at 44cm., and only rises to 47cm. at a voltage of 160,000. The sparking distances in air show a very much greater increase with voltage than those in any liquid, but they also tend to a straight curve at the higher voltages. All dessiccated oils show a smaller change of sparking distances with voltage than the corresponding oils do in their ordinary state. Toluol, xylol, and solution of colophony in xylol have nearly the same insulating power as benzol, but the modern vaseline oils used for transformers closely approach them. Benzol is, in any case, too dangerous on account of its inflammability.

[E. Jona, *Atti. Assoc. Elettrot. Ital.*, No. 4, 1902.]

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RECENT PROGRESS IN LARGE GAS ENGINES.*

BY HERBERT A. HUMPHREY, M.I.MECH.E., A.M.I.C.E., M.I.E.E.

The development of large gas engines which has taken place during the last few years has but few parallels in the history of engineering enterprise. Gas engines of 1,200 H.P. and 1,500 H.P. are already working, and others of 2,000 H.P. to 4,000 H.P. are being constructed. In the Paris Exhibition of 1900 the 600 H.P. Cockerill gas engine created much surprise, but now the makers have in hand an engine of 2,500 H.P., and are quite prepared to build a 5,000 H.P. gas engine. In England the first gas engines above 400 H.P. were only started in the year 1900, and they worked with Mond gas. One was a 450 H.P. Crossley engine and the other a 650 H.P. Premier engine; both engines had two cylinders, and were direct-coupled to large dynamos supplying current for an electrolytic plant at Messrs. Brunner, Mond & Co.'s works at Winnington. Additional gas-engine plant is now being added, and all the dynamos work in parallel. At the present time (August, 1902) the two leading English manfacturers have delivered or have under construction 51 gas engines, varying in size between 200 H.P. and 1,000 H.P. Of these, Messrs. Crossley Bros. of Manchester supply 28 engines, having an aggregate of 8,300 H.P., or an average of 296 H.P. per engine, and the Premier Gas Engine Co. of Sandiacre, Nottingham, supply 23 engines, with a total of 9,300 H.P., giving an average of 404 H.P. per engine. These two makers collectively supply 17,600 H.P., and of this power 12,500 H.P. is for driving dynamos. This is a striking proof of rapid progress, but we have to look abroad for the great achievements in this direction. Neglecting throughout this Paper all engines below 200 H.P., we find that Messrs. Körting Bros. and their licencees have made, or have under construction, 32 gas engines, with a total of 44,500 H.P.. averaging 1,390 H.P. per engine. The Société Anonyme John Cockerill, of Seraing, and their licencees come next with 59 engines, having an aggregate of 32,950 H.P., so that the average size of the engines built by this firm is 558 H.P. The Gazmotoren Fabrik Deutz takes the third place with 51 engines, developing collectively 20,655 H.P., and are followed by the Deutsche Kraftgas Gesellschaft and licencees, working under the Oechelhauser patents, with engines numbering 28 and giving 16,900 H.P. Table I. gives a classified list of these and other large gas engines, and shows the

* Abstract of a Paper read before the British Association (Section G) at Belfast, September 11th.

Table I.—*List of Gas Engines over 200 H.P., Delivered or in Hand.*

Style of engines and name of makers.	Engines for driving dynamos.				Engines for other purposes.				Total for all purposes.		
	No. of engines.	H.P. of each.	Total No. of engines.	Total H.P. of engines.	No. of engines.	H.P. of each.	Total No. of engines.	Total H.P. of engines.	Total No. of engines.	Total H.P.	Aver. H.P. per engine.
Simplex engine (Société Anonyme John Cockerill, of Seraing, and licencees)	3	1,200	25	11,950	2	1,200	34	21,000	59	32,950	558
	8	200			3	800					
	3	250			26	600					
	9	600			3	200					
	2	300									
Körting engine (Gebr. Körting, Maschinenbau A.G., formerly Gebr. Klein, in Dahlbruch, and licencees)	7	1,000	11	9,200	16	2,000	21	35,300	32	44,500	1,390
	1	700			1	1,000					
	3	500			1	700					
					1	600					
					2	500					
Gasmotoren Fabrik Deutz (Deutz, Köln)	11	200	50	20,455	1	200	1	200	51	20,655	405
	12	300									
	2	350									
	1	400									
	7	500									
	6	600									
	5	1,000									
	1	280									
	2	250									
	3	225									
Oechelhäuser (Deutsche Kraftgas Gesellschaft and licencees)	6	1,000	22	13,000	1	1,200	6	3,900	28	16,900	603
	3	600			1	700					
	3	500			4	500					
	7	400									
	3	300									
Westinghouse Machine and Mfg. Co., East Pittsburg, U.S.A.	35	300	45	17,600	Returns not complete.				45	17,600	391
	4	500									
	4	650									
	1	1,000									
	1	1,500									
British Westinghouse Electric and Mfg. Co. ...	23	250	24	6,350	1	250	1	250	25	6,600	264
	1	600									
Snow Steam Pump Works of Buffalo, New York, U.S.A.	...	...	...	...	2	4,000	9	14,500	9	14,500	1,611
					6	1,000					
					1	500					
Premier engine (Premier Gas Engine Co., Sandiacre, Nottingham)	1	700	19	7,250	1	1,000	4	2,050	23	9,300	404
	4	600			1	600					
	1	500			1	250					
	3	400			1	200					
	9	250									
	1	200									
Crossley Bros, Openshaw, Manchester.....	5	500	17	5,250	2	500	11	3,050	28	8,300	296
	1	400			1	400					
	3	250			1	250					
	8	200			7	200					
Struthers, Wells & Co., Warren, Pa.	2	500	2	1,000	...	...	...	...	2	1,000	500
Letombe engine (Cie. de Fives Lille, France) ...	5	400	16	4,400	...	...	...	...	16	4,400	275
	4	250									
	7	200									
Stockport engine (Andrew & Co., Reddish, near Stockport)	3	300	5	1,400	...	...	...	...	5	1,400	280
	2	250									
Nürnberg engine (Vereingte Maschinenfabrik Augsburg und Maschinenbau Gesellschaft, Nürnberg)	1	700	2	1,100	2	1,200	2	2,400	4	3,500	...
	1	400									
Totals	...	...	238	98,955	...	...	89	82,650	327	181,605	555

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remarkable total of 827 gas engines, capable of supplying 181,605 H.P.

Although America has lagged somewhat behind the Continent in adopting large gas engines, there is evidence that this state of affairs will not long remain. The De la Vergne Refrigerating Machine Co., New York, have taken out a licence to manufacture the Körting engine, and have on order 16 2,000 B.H.P. engines (total 32,000 H.P.) of the Körting type; and the Lakawanna Steel Works, Buffalo, U.S., have ordered five 1,000 B.H.P. engines for coupling to dynamos. It is only a question of time before America will be one of the largest producers of gas engines, and one enterprising American firm, the Snow Steam Pump Works of Buffalo, New York, have already put to successful work six 1,000 H.P. gas engines, and have now nearly completed the construction of two enormous gas engine gas compressors of 4,000 H.P. each, the first to be running by next November and the second by January, 1903. The Westinghouse Machine and Mfg. Co. of East Pittsburg have made gas engines of 1,500 H.P., and are prepared to build sizes up to 3,000 H.P.

The standard 500 H.P. Crossley gas engine is a two-cylinder "vis-à-vis" engine, with both connecting rods coupled to the same crank. The Otto cycle is employed, and the explosions follow at unequal intervals, two explosions taking place in one revolution and none in the next. The diameter of the cylinders is 28in., length of stroke 36in., and speed 150 revolutions. Of the seven engines of this size, four are working with Mond gas, two with Dowson gas, and one with blast furnace gas. A smaller engine (150 H.P.) of the same type ran for 138 days and nights at nearly full load without a single stop, and holds the world's record in this respect. Fig. 4 is from a print of the 500 H.P. Crossley engine, and shows the oil guard over the crank chamber. Fig. 5 shows the latest design of gas engine introduced by Messrs. Crossley Bros., being of the vertical type with two inclined inverted cylinders. It is specially suited for dynamo driving, and the photograph shows the engine coupled through a Raffard flexible coupling to a 215 volt by 200 ampere direct-current dynamo, running at 275 revs. per min. Fig. 6 is a view of the 650 H.P. Premier gas engine of the tandem positive scavenger type. The motor cylinders are placed in tandem, and the front cylinder has an enlargement, in which an additional piston compresses the air required both for scavenging and combustion. The large air piston acts as a guide for taking the oblique thrust of the connecting rod, and also assists in bringing the reciprocating parts to rest by cushioning the air on the return stroke, thus facilitating smooth running and helping to keep the connecting rod always in compression. The motor cylinders are

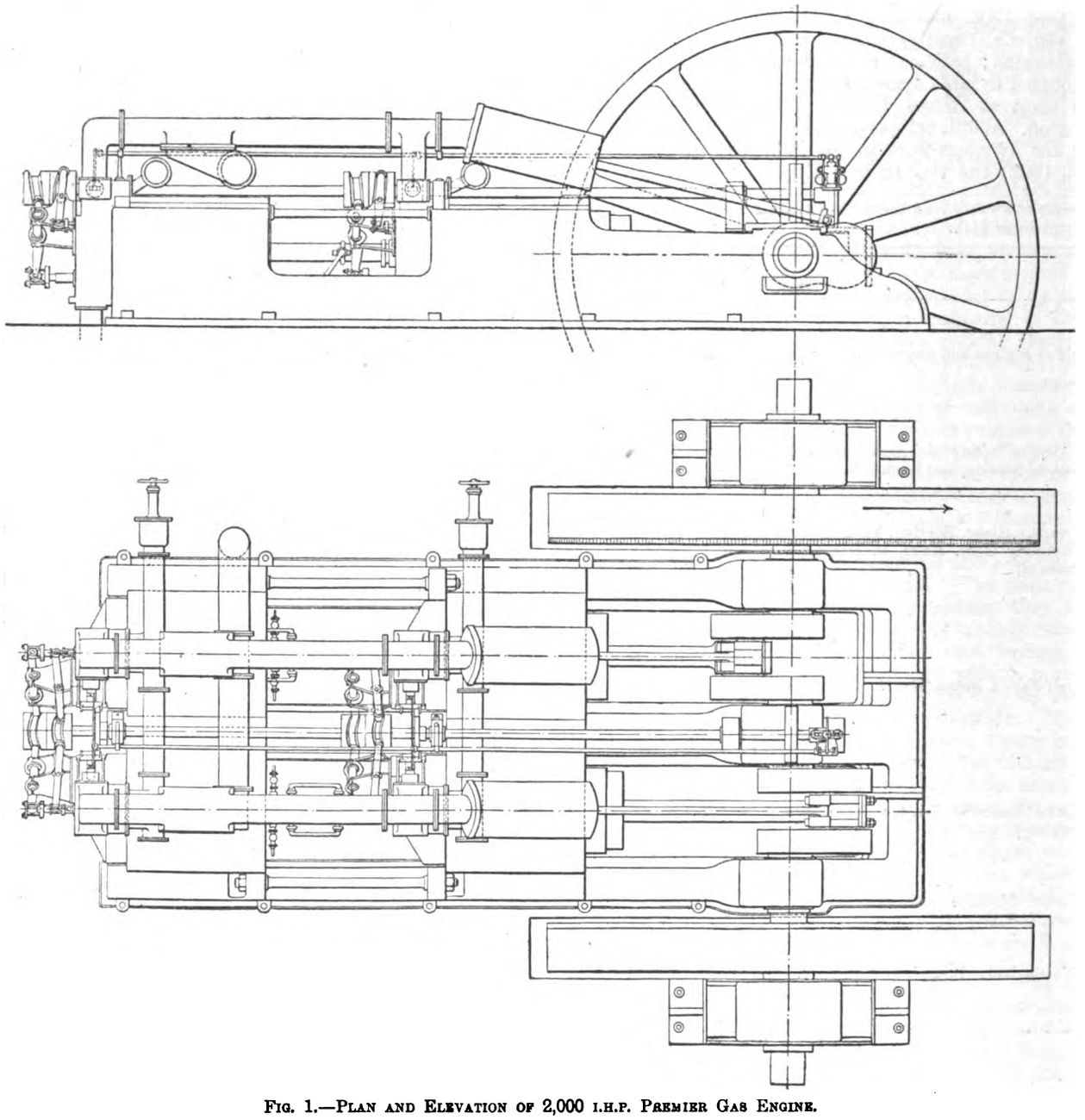

FIG. 1.—PLAN AND ELEVATION OF 2,000 I.H.P. PREMIER GAS ENGINE.

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28⅛in. in diameter, the scavenger cylinder 43½in. in diameter, and the common stroke 30in. The engine runs well at 125 revs. per min.

In the new type 500 H.P. Premier engine, in which the scavenging is performed by a separate cylinder placed at an incline, and driven from an attachment to the main connecting rod, the motor cylinders are 27in. diameter, the stroke 27in. stroke, and the speed 150 revs. per min. In this engine the side rods shown in Fig. 6 are dispensed with, and the two pistons are joined by a tail rod passing through a gland in the front cylinder. All the valves are positively driven from the elevated side-shaft shown, and are both opened and closed mechanically. The levers for this purpose carry conical rollers, engaging in grooved cams, and when two engines are placed side by side to give a 1,000 H.P. combination, the same side-shaft and cams serve for both, thus making a very simple and compact arrangement. The author carried out a very successful 24-hour trial of this 500 H.P. engine a few months ago, the engine using Mond gas.

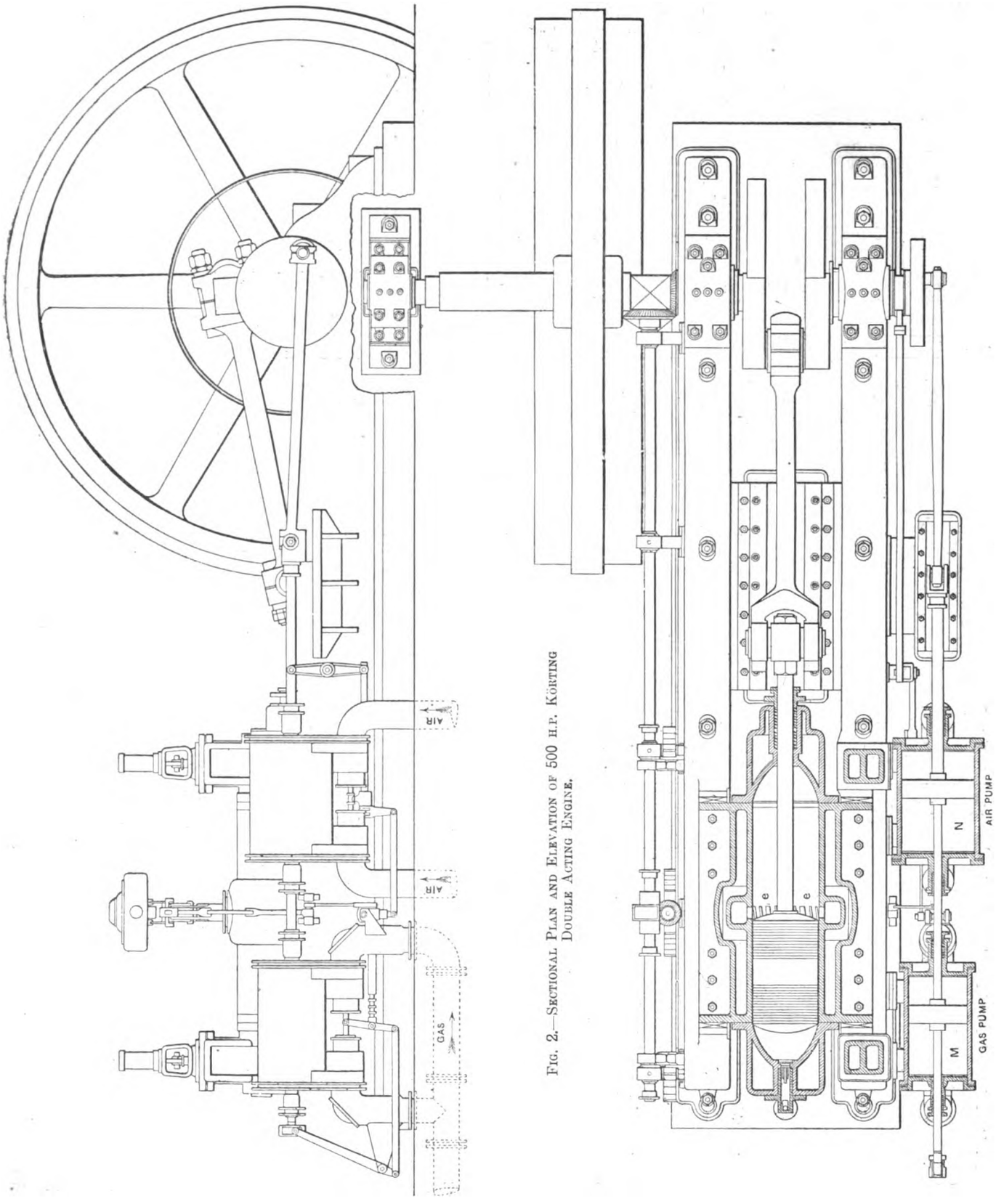

FIG. 2.—SECTIONAL PLAN AND ELEVATION OF 500 H.P. KÖRTING DOUBLE ACTING ENGINE.

Fig. 1 is a drawing of the new type 2,000 H.P. Premier four-cylinder double-tandem engine. A 1,000 H.P. Premier engine ordered by Messrs. Alfred Hickman & Co. for blast-

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furnace work is required to give 900 I.H.P. with blast-furnace gas, but would easily develop 1,200 I.H.P. using Mond gas. The blowing and motor cylinders are all arranged in one line, and the latter are 38in. diameter by 4ft. stroke, the speed being 85 rèvs. per min. A higher speed is not advisable where the reciprocating masses are necessarily so heavy; nor will the valves on the blowing cylinder work so well at increased speeds. The firm mentioned have also ordered from the Premier Company three gas engines of 400 H.P. each.

We now come to engines of the Simplex type, the original designs for which were prepared by M. Delamare Debouteville, who did perhaps more than any other man to hasten the advent of large gas engines, and whose early death deprived the engineering profession of one of its most skilful and courageous workers. The Simplex engine was the first to give 300 H.P. in a single cylinder; but after passing into the hands of the Société Anonyme John Cockerill the development of this type has been marked by rapid progress, and as much as 1,250 H.P. can now be obtained from one cylinder.

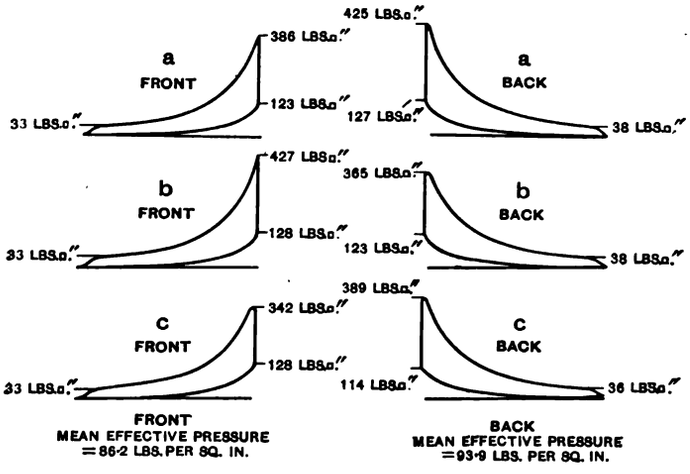

FIG. 3.—INDICATOR DIAGRAMS FROM 700 I.H.P. KÖRTING GAS ENGINE USING PRODUCER GAS.

Diam. of Piston = 750mm. = 29½ins. Stroke = 1,300mm. = 51$^{3}_{16}$ins.

Particulars of the dimensions of all sizes of Simplex engines are to be found in Table II. The Cockerill Company are now building an engine for 2,500 H.P., or 1,250 H.P. per cylinder. By duplicating the arrangement, we arrive at a four-cylinder double-tandem engine of 5,000 H.P.

Table II.—*Cockerill Simplex Gas Engines Working with Blast-Furnace Gas.*

Ref. No.	H.P.	System.	Rev. per min.	Diameter of cylinder.	Length of stroke.	Regularity. Absolute.	Regularity. Cyclical.
				mm. in.	mm. in.		
1*a*	100	Single-cylinder	150	600 (23·62)	800 (31·5)	35	60
b	225	Tandem	150	,,	,,	41	80
c	450	Double-tandem	150	,,	,,	52	210
2*a*	200	Single-cylinder	150	750 (29·5)	900 (35·5)	42	78
b	425	Tandem	150	,,	,,	50	96
c	850	Double-tandem	150	,,	,,	65	260
3*a*	300	Single-cylinder	130	900 (35·5)	1m. (39·375)	63	110
b	650	Tandem	130	,,	,,	77	150
c	1,300	Double-tandem	130	,,	,,	100	400
4*a*	475	Single-cylinder	100	1·100m. (43·3)	1·200m. (47·24)	62	105
b	1,000	Tandem	100	,,	,,	74	140
c	2,000	Double-tandem	100	,,	,,	95	380
5*a*	600	Single-cylinder	90	1·300m. (51·18)	1·400m. (55·11)	19	30
b	1,250	Tandem	90	,,	,,	22	43
c	2,500	Double-tandem	90	,,	,,	29	120
	200	Single-cylinder, bayonet constructed.	105	850 (33·5)	1m. (39·375)	32	55

NOTE.—The cyclic speed variation is equal to the maximum angular velocity minus the minimum angular velocity divided by the mean angular velocity. The reciprocal of this is the *regularity* given in the last column. When the governor cuts out one admission of gas the regularity is diminished, and is then called the "absolute regularity," as shown in the last column but one.

Nine Cockerill gas engines have been erected for the Société des Hauts-Fourneaux de Differdange, each of 600 H.P., three being direct-coupled to dynamos and six to blowing cylinders for producing the blast required by the furnaces. These engines work with blast-furnace gas, purified by passing it through centrifugal fans with water injection. Messrs.

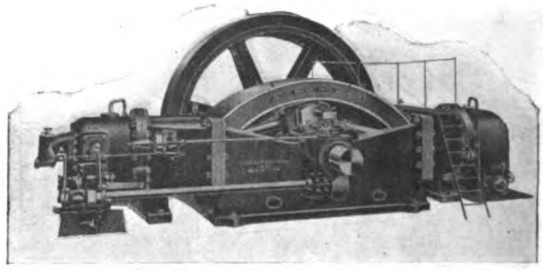

FIG. 4.—500 H.P. CROSSLEY GAS ENGINE.

Richardson, Westgarth & Co., of Middlesbrough have taken up the manufacture of Cockerill engines in this country, and are now engaged in building two engines of this type for the Cargo Fleet Iron Co. of Middlesbrough. Messrs. Cochrane & Co. have had a 600 H.P. Cockerill blowing engine at work

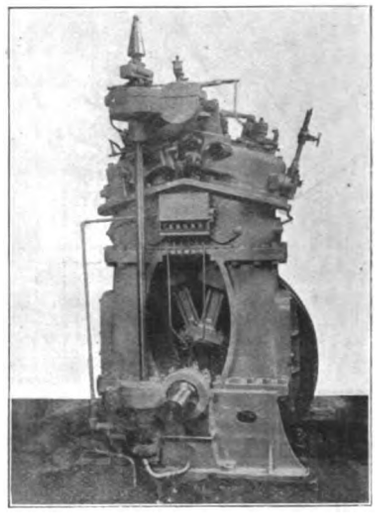

FIG. 5.—TWO-CYLINDER VERTICAL CROSSLEY GAS ENGINE WITH DYNAMO.

at their Ormsby ironworks since November, 1901. The aggregate power of the engines for the Société des Hauts-Fourneaux de Differdange is 5,400 H.P., and the Cockerill Company are supplying an even larger horse-power to Messrs. Wendel & Co., where nine engines have a total of 6,700 H.P., and include three dynamo engines of 1,200 H.P. each.

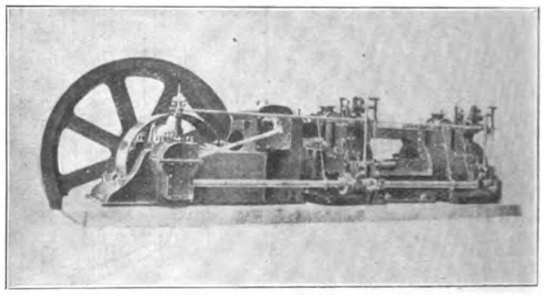

FIG. 6.—650 H.P. PREMIER TANDEM POSITIVE SCAVENGER ENGINE.

We come now to the Körting engine, made by the Gebr. Körting, the Maschinenbau Actien-Gesellschaft of Dahlbruch, and others; and as the construction of this double-acting engine is of particular interest, and is, perhaps, not so well known in this country, a very brief description will be given.

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Fig. 2 shows a horizontal section through the motor cylinder and the two pump cylinders, one of which supplies air and the other gas. The length of the piston is practically half the length of the motor cylinder, and the exhaust port is at the centre of the latter, and is uncovered when the piston is at either end of its stroke. Following the exhaust comes a scavenging charge of air from the air-pump, which sweeps out the burnt products, and finally there enters a mixture of gas and air together. The mixture passes a diaphragm which gives it a whirling motion and makes it act like a plug, it being maintained that the mixture remains at the back end of the cylinder, with the pure air in front next the piston. On the return stroke the piston closes the exhaust port and compression takes place; then the mixture is fired and the working stroke results. Both sides of the piston are utilised, and thus two impulses per revolution are obtained, and the crank effort approaches in evenness the turning moment of a double-acting steam engine. Indeed, in some ways it resembles a steam engine using gas, and the speed can be regulated by simply opening or closing the gas valve. In practice the mixture is regulated by the governor acting on a bye-pass in the gas suction, in such manner that more or less gas is returned to the gas pipe and only a portion of the pump-volume delivered into the motor cylinder, according to the work to be done. The piston is water-cooled, as well as the jacket and valves. Messrs. Mather and Platt of Manchester have secured the English licence to manufacture Körting engines for dynamo driving and general purposes; and Messrs. Fraser and Chalmers of Erith, Kent, have purchased the right to make these engines for blowing and compressing, and for rolling mills.

Fig. 3 shows some indicator diagrams taken from the single-cylinder double-acting 700 H.P. Körting gas engine at the Düsseldorf Exhibition, using producer gas. One 700 H.P. and one 500 H.P. engine are on order for this country, and will be worked with Mond gas. Both engines are for dynamo driving.

Table III. is a table of comparison of different types of engines, showing the advantage obtained by using a double-acting engine of the Körting type as compared with Otto cycle engines. Three engines of approximately the same power are compared as to size of cylinders, stroke, weight and cyclic speed variation.

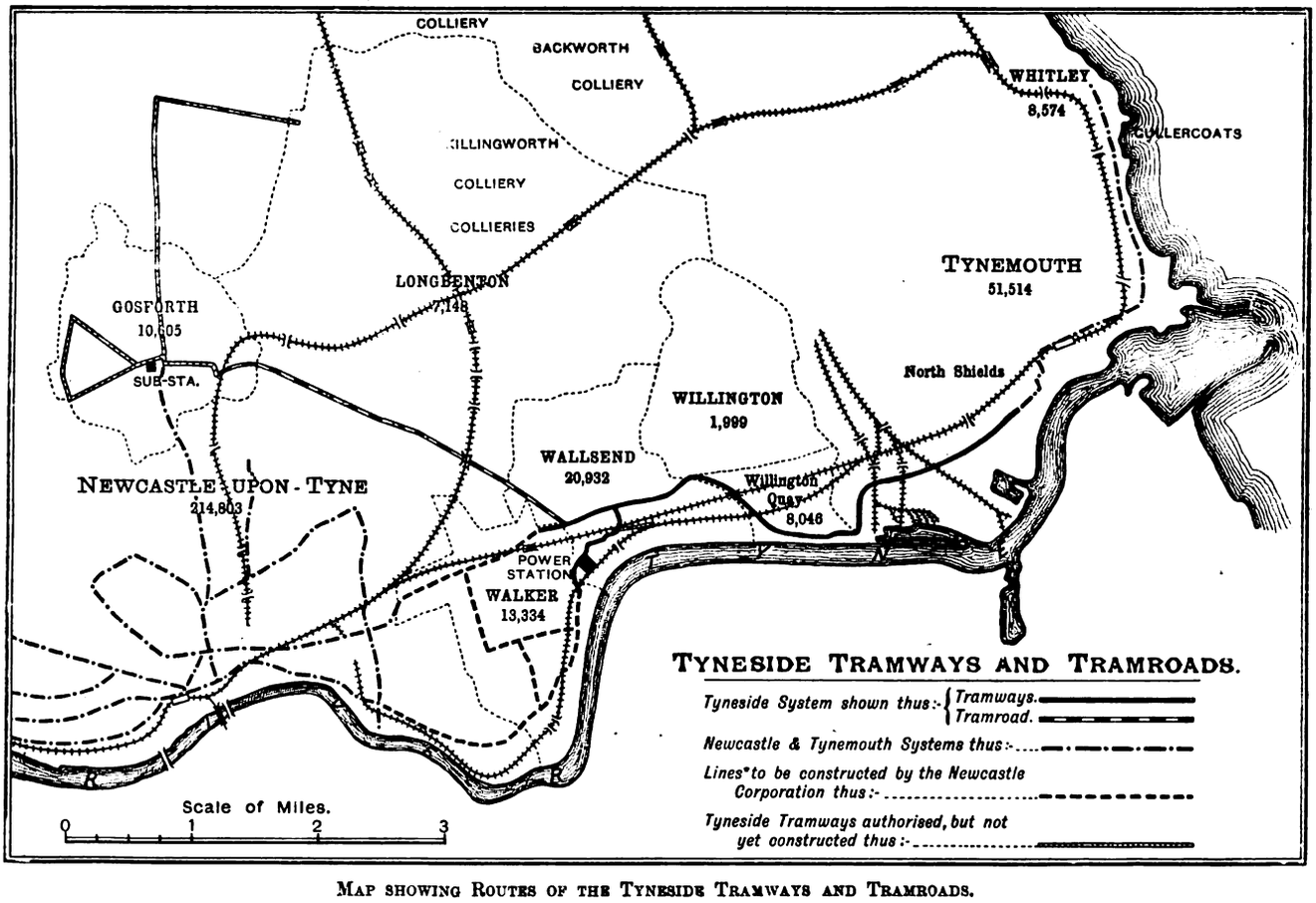
Table III.—*Comparison of Various Types of Gas Engines.*

Type of engine.	No. of cylinders.	Dia. of cylinders.	Stroke	Max H.P.	Weight without flywheel.	Weight with flywheel.	Revs per min.	Cyclical variations.
		mm.	mm.		kilog.	kilog.		
Cockerill engine single-cylinder Otto cycle ...	1	1,300	400	600	94,000	127,000	90	1 : 30
Deutz engine, four-cylinders Otto cycle ...	4	660	850	600	88,000	100,000	150	1 : 130
Körting engine, single-cylinder double-acting	1	635	1,100	550	58,000	70,000	100	1 : 80

(*To be continued.*)

TYNESIDE ELECTRIC TRAMWAYS AND TRAMROADS.

The advantages accruing from the existence of a supply of cheap electric power in any district are again exemplified on the populous and busy north bank of the Tyne, between Newcastle and the sea. Here, extending over a wide area, the Neptune Bank electricity supply station—a fully illustrated description of which appeared in *The Electrician*, Vol. XLVII., pp. 319, 359 and 397—furnishes a source of cheap and abundant power to shipyards, engine works, factories, &c., as well as for general purposes. With this convenient supply ready to hand, it was natural, indeed, almost inevitable, that a company should be formed for utilising some of the power for providing the Tyneside districts with a service of electric



MAP SHOWING ROUTES OF THE TYNESIDE TRAMWAYS AND TRAMROADS.

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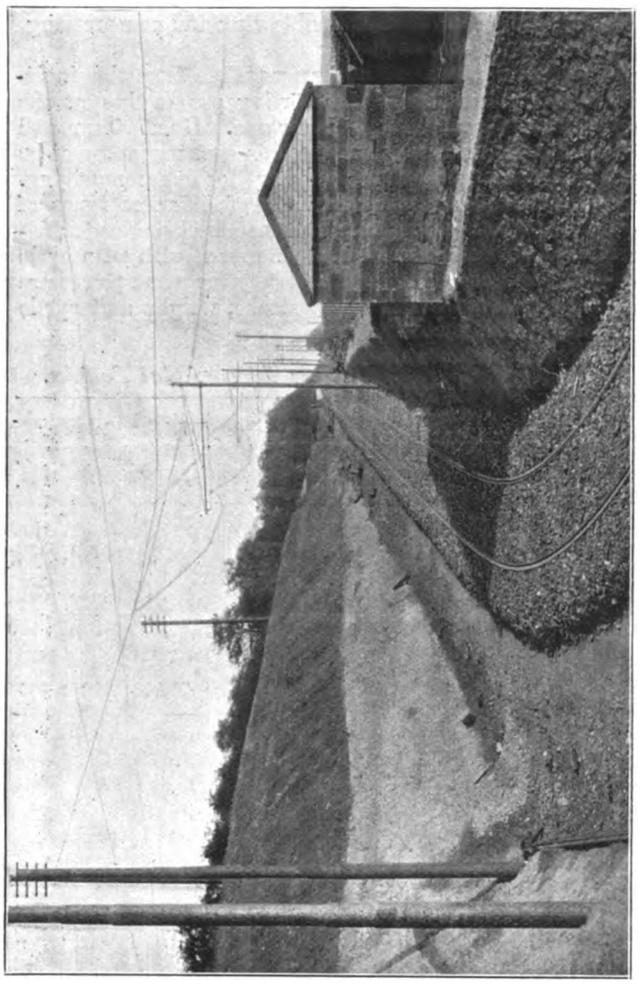
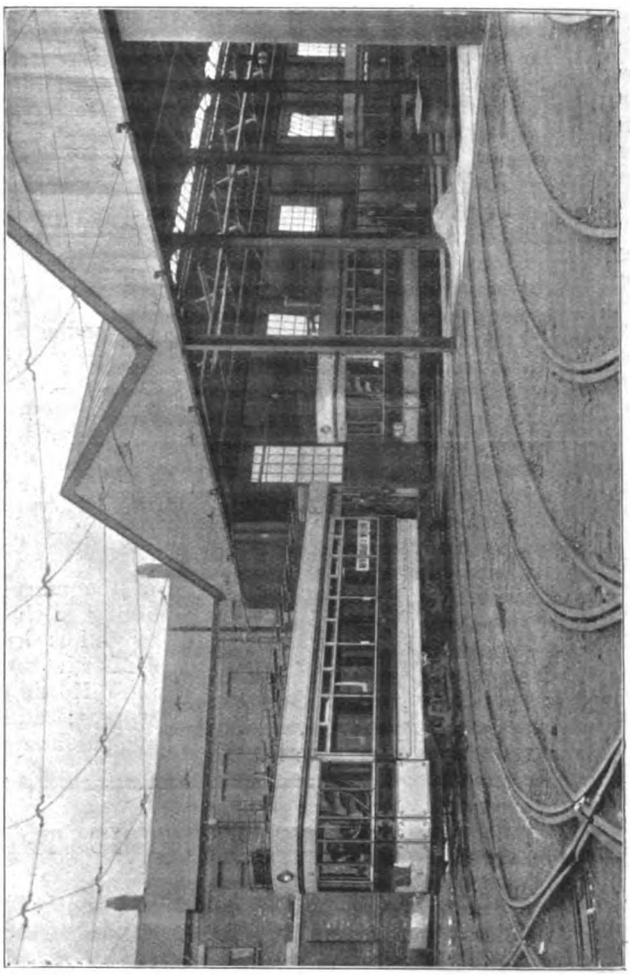
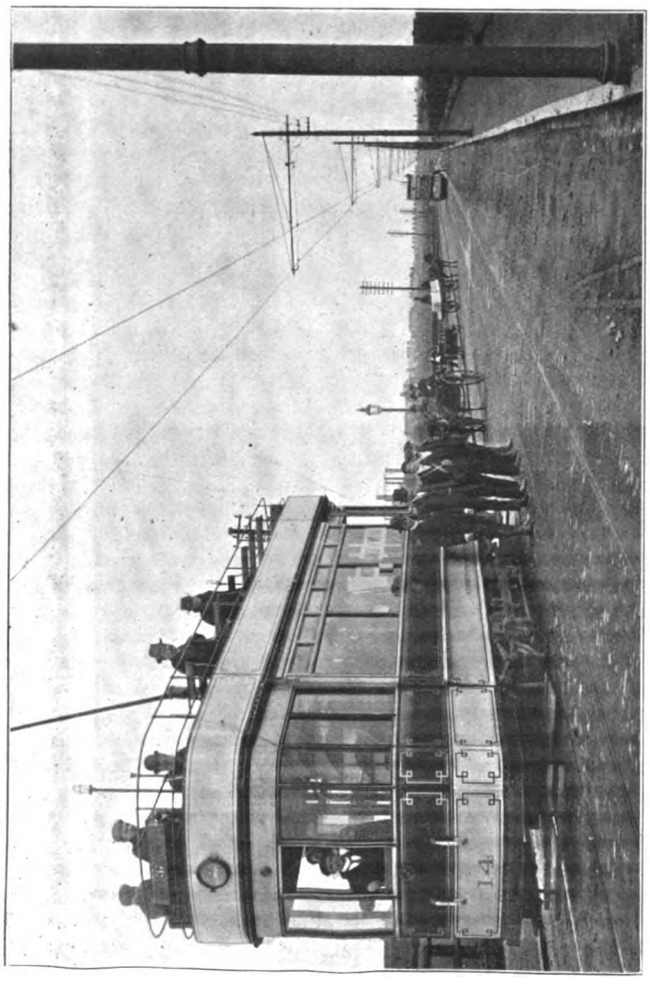


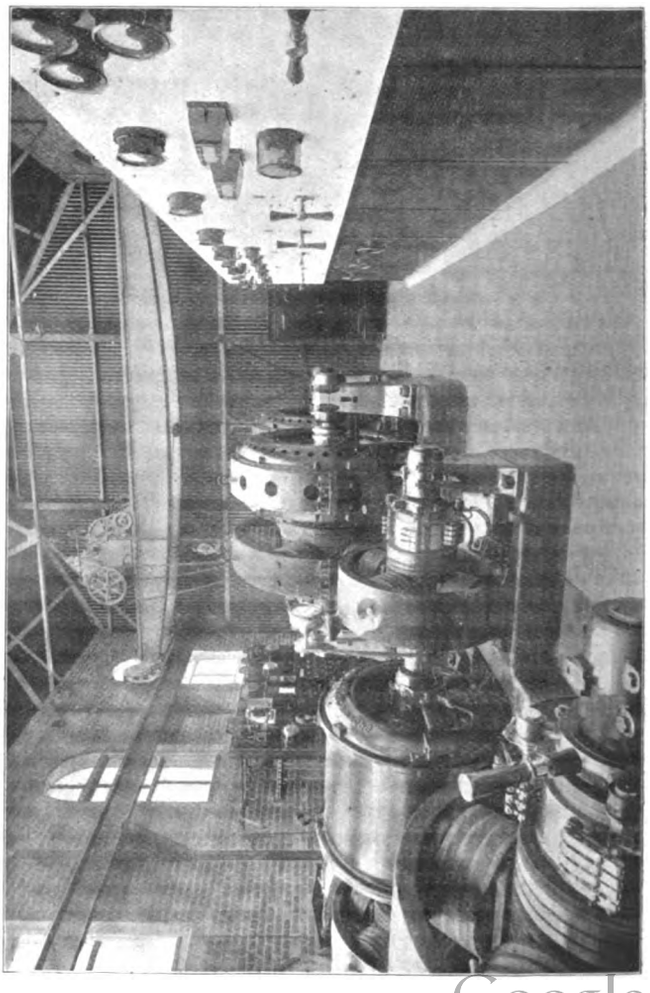
TRAMROAD CUTTING AT GOSFORTH, SHOWING BALLASTING.



CAR-SHED ENTRANCE AND BOGIE CARS.



CARS ON HOWDEN ROAD, NORTH SHIELDS.



GOSFORTH SUB-STATION.

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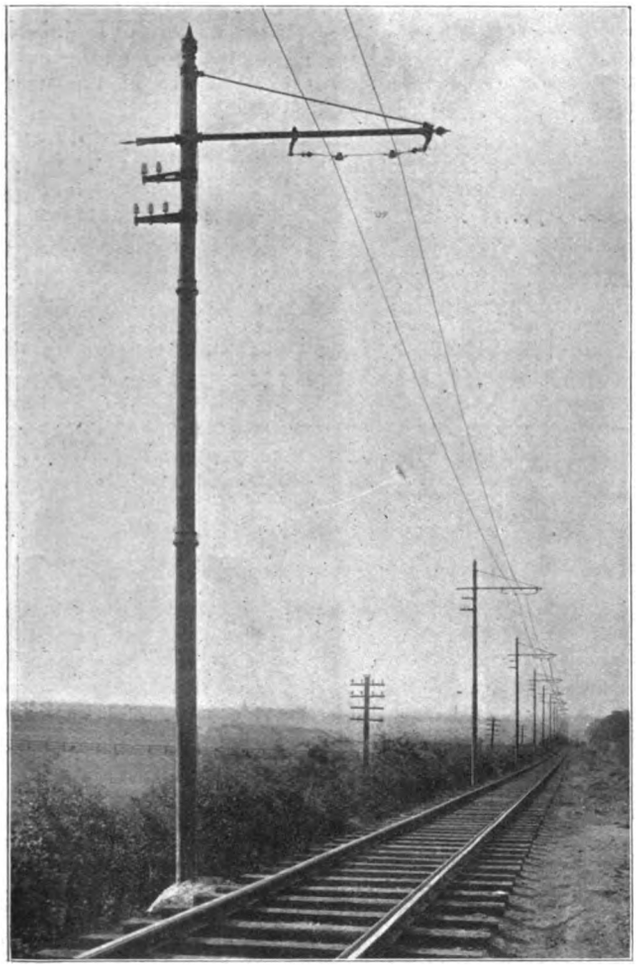
cars. Hence the formation of the Tyneside Tramways and Tramroads Company, the first portion of whose electric lines was formally opened for traffic on September 29th. The district through which the lines run is of great industrial inportance, as some of the principal shipbuilding yards and engine works in the country are situated along the route, there being besides a large resident population. The accompanying map shows the nature of the district and the relative positions of the various manufactories and the residential quarters; also the lines which are now completed through Gosforth, Wallsend and Willington Quay to North Shields. The map further shows that when the Newcastle Corporation have completed the extension in Walker which they have in hand, direct tramway communication will be afforded along the whole length of the north bank of the river Tyne from Newcastle to North Shields.

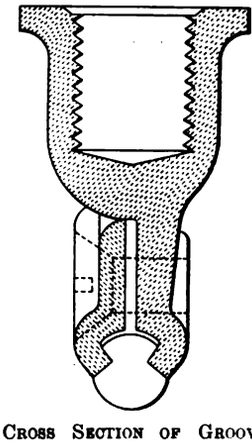


TRAMWAY ROAD TRACK BEFORE BALLASTING.

It would perhaps be convenient at the outset to draw attention to the distinction between tramways and tramroads, a tramroad being the name applied to a tramway when laid on any ground other than public roads. In the Tyneside system the tramroad, which runs from the residential quarter of Gosforth to Wallsend, is constructed on land owned by the company, and as there is no other traffic higher speeds are attainable than prevail in ordinary tramway practice. It is also found that, even allowing for the cost of the land, the capital expenditure is often lower than in the case of a tramway, since it is possible to dispense with a concrete foundation and stone paving. A point of local interest in connection with this tramroad is that it follows the route of an old colliery waggon-way, formerly used for conveying coal from Coxlodge pit to the river. On this part of the line a special form of grooved rail with a high check has been adopted. These rails are laid on wooden sleepers and the track is ballasted up to the tread in order to meet the Board of Trade requirements. The tramroad consists of a single track with passing places, which are located where the line crosses a public road, and at points where the speed would in any case have to be reduced. The tramway between Wallsend and North Shields, a considerable portion of which is double track, is of the usual construction. The gauge is 4ft. 8½in. and the distance between the centres of the track 8ft. 4in.

The overhead trolley wire, of 00 S.W.G., is of special form, as shown in one of our illustrations, which also shows the type of mechanical ear employed on the whole of the route except at curves where ordinary soldered ears are used. The perfect continuity of the lower surface of the wire obtained by this system of suspension enables the trolley to run much more smoothly than with soldered ears. The entire track and overhead equipment has been constructed by Messrs. Dick, Kerr & Co. The special work is of Messrs. Hadfield's manufacture, their manganese steel being used throughout.

The rolling stock at present consists of four bogie cars, each carrying 112 passengers, and 14 single-truck cars each having a capacity for 80 passengers. They are all of the double-deck type with completely enclosed vestibule at each end. The bogie cars are provided inside with combined longitudinal and transverse sets, the four-wheel cars having longitudinal seats only. All the cars are fitted with Tidswell's life-guards and both hand and electric brakes, the latter being of the Newall magnetic type, the resistance in connection with which is used in winter as a car heater. The great power of these brakes is demonstrated in the ease with which the heavy cars can be pulled up on the gradient of 1 in 11 at Church Bank, near Wallsend.



CROSS SECTION OF GROOVED TROLLEY WIRE, SHOWING MECHANICAL EAR. (Full Size.)

The bogie cars are provided with a four-motor equipment, each motor rated at 30 H.P. when running with a line pressure of 500 volts. The wheel base of the bogies is 4ft., with 12ft. 6in. between bogie centres, and the single-truck cars have a wheel-base of 6ft. 6in. Steel-tyred wheels are used throughout. The car contract has been carried out by the British Westinghouse Company, the bodies having been supplied by Messrs. Geo. F. Milnes.

Electricity at a pressure of 5,500 volts three-phase and a periodicity of 40 cycles per second is transmitted by means of three-core paper-insulated cables to the various sub-stations, from which it is distributed for tramway purposes at a pressure of 500 volts, continuous current. The Gosforth sub-station supplies current for the tramways, and also lights the district of Gosforth. The two small machines in the foreground are each of 75kw. capacity and are double-ended, supplying a 480-volt three-wire continuous network. The two larger machines are at present used for traction purposes only, although when the lighting load increases, they will be used for this also, and further sets will be installed to supply the tramways. The capacity of each of these traction motor-generators is 500kw. The synchronous motor is supplied direct with three-phase current at 5,500 volts and runs at 300 revolutions. The continuous-current generator is compound wound for 500 volts at no load to 550 volts at full load. In these sub-stations the motor-generators and high-tension switch gear have been supplied by Messrs. Richardsons, Westgarth & Co. and the low-tension switch gear by Messrs. A. Reyrolle & Co. Mr. W. L. Phillips has acted on the company's behalf as clerk of works for the construction of the line, Mr. F. C. Kidman being resident engineer and traffic manager, while Mr. W. McLellan, on behalf of the firm of Chas. H. Merz, acted as consulting engineer.

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THE "MIDLAND" ELECTRIC POWER DISTRIBUTION.

(*Concluded from page 942.*)

The area to be covered by the Midland scheme and the position of the existing mains and sub-stations were indicated in the map in the first part of this article. Cables of the type shown in section in Fig. 11 are employed, Fig. 11 representing the largest size. Its two inner conductors are each 0 14 sq. in. in section, and the common return, which is composed of flat

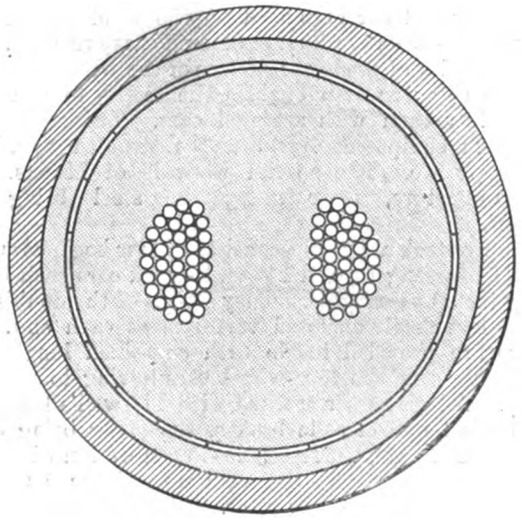

FIG. 11.—SECTION OF 0·14, 0·14, 0·2SQ. IN. CABLE. Full size.

strip, has a sectional area of 0 2 sq. in. The capacities are as follows:—Between the two inner conductors 0·14 microfarad per mile; between the two inner conductors when one is connected to the outer conductor, 0·25 microfarad per mile; between the two inner conductors connected together and the outer, 0·38 microfarad per mile; and finally, between the outer

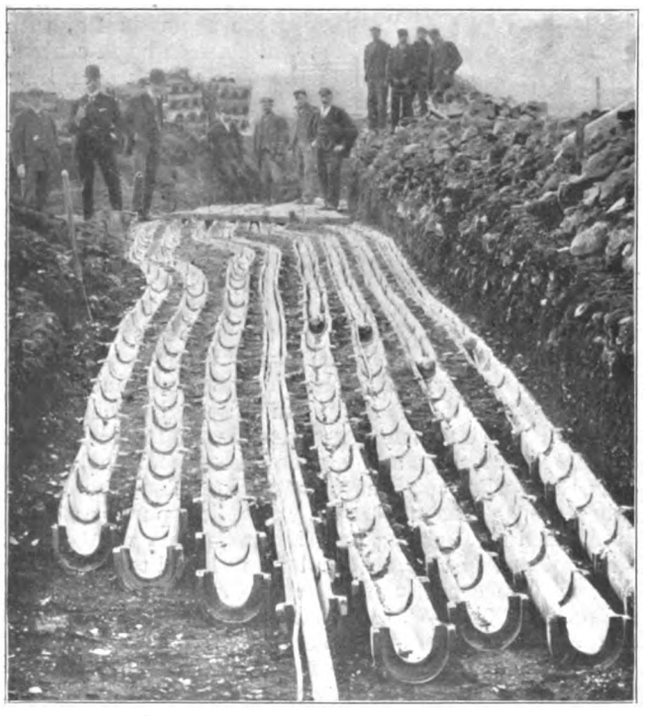

FIG. 12.—VIEW OF CABLE TRENCH DURING LAYING.

conductor and lead sheathing, 3·8 microfarads per mile. The cable is of the British Insulated Wire Co.'s manufacture. It is insulated with paper, and is not armoured, but outside the lead covering there is a serving of jute impregnated with preservative compound. It is laid at a depth of about 8ft. in earthenware troughs filled "solid" with pitch and covered with bricks. The troughs are of U section, with spigot and socket joints, and the cable rests on separate bridge pieces. Fig. 12 is from a photograph taking during laying.

Subsidences due to the mining operations in the district are things to be guarded against, and in places where trouble from this cause might have been expected, a different mode of main laying has been adopted. Lengths of cast iron piping are used whose ends are merely butted together, and these are held in place by 2ft. sleeves passed over the ends of the pipe and packed with yarn. In addition to this increase in flexibility, "loop pits" are provided every 200yds. in which about 6ft. of slack cable is left, this being passed over rollers so that it is taken up automatically without undue strain in case of a subsidence occurring. One of these "loop pits" is shown in Fig. 13.

The high-pressure and low-pressure cable is B.I.W. lead-covered concentric, and is laid in the same way as the extra high-pressure cable. Double service boxes of the usual pattern with compound glands are employed.

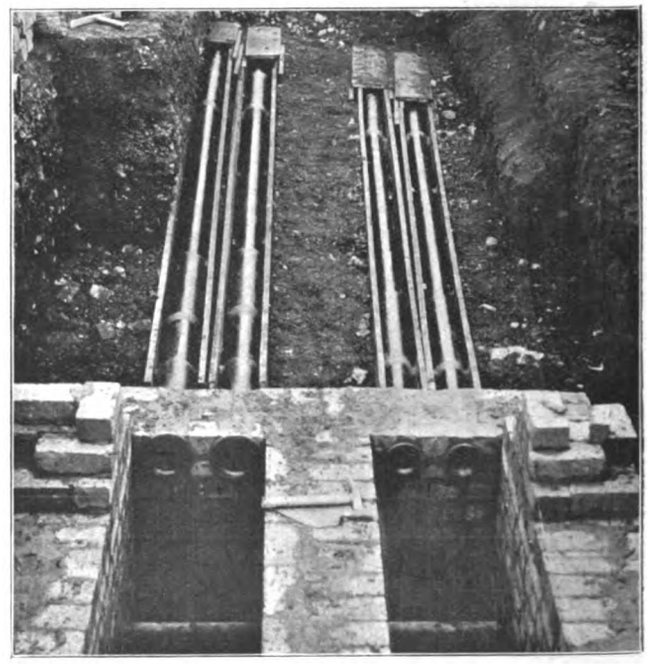

FIG. 13.—LOOP PIT.

Distribution takes place in three ways: Directly from the sub-stations at 200 volts two-phase; from street transformers fed at 2,700 volts from the sub-stations, and delivering at 200 volts two-phase to the consumers' networks; and (from the Bilston sub-station only) at 500 volts continuous current for tramways, through rotary converters. As the Bilston sub-station is the only one in operation at present we will describe this one; the others are of similar design except that the rotary converter plant is omitted for the present.

The general arrangement of the sub-station is apparent from Figs. 14 and 15. It is seen that the floor is occupied by the stationary transformers and the rotary converters, a rail dividing these two portions, and that the various switchboards (with the exception of the tramway switchboard, which is, so to speak, a lodger) are placed on two low galleries only just above the floor level, and running about half the length of the room by the transformers. Two extra high-pressure cables (both of 0·105 sq. in. section inner conductors) come in to the sub-station, and two (0·105 sq. in. and 0·07 sq. in.) go out again, the extra high-pressure cables being arranged more or less in a ring to feed the sub-stations. All four cables are led to an extra high-pressure switchboard divided into two parts, and connecting the extra high-pressure mains to the

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7,000 : 2,000 and 7,000 : 200 transformers, for the high-pressure and low-pressure distribution respectively. The apparatus on these boards is of the new Ferranti pattern, similar to that employed at the sub-station. A panel is seen to the extreme left of Fig. 17. The transformers which transform down for the rotary converters are not connected to this board directly, there being merely switches to connect the extra high-tension mains to the top of the rotary converter board (Fig. 17) to which these transformers are connected, and which will be referred to presently. Rubber cables on insulators, seen in Fig. 17, connect these switches with the rotary converter board.

It may be well here to enumerate briefly the switchboards at the sub-station, and to indicate their positions, before proceeding with the more detailed description of them. Standing in the room at the end further from the door, the first boards are the two extra high-tension boards already alluded to, which are at the end on the left. These are not seen in Fig. 14, but the last panel of one of them is seen in Fig. 17. Besides this, the only other board on the left gallery is the rotary converter

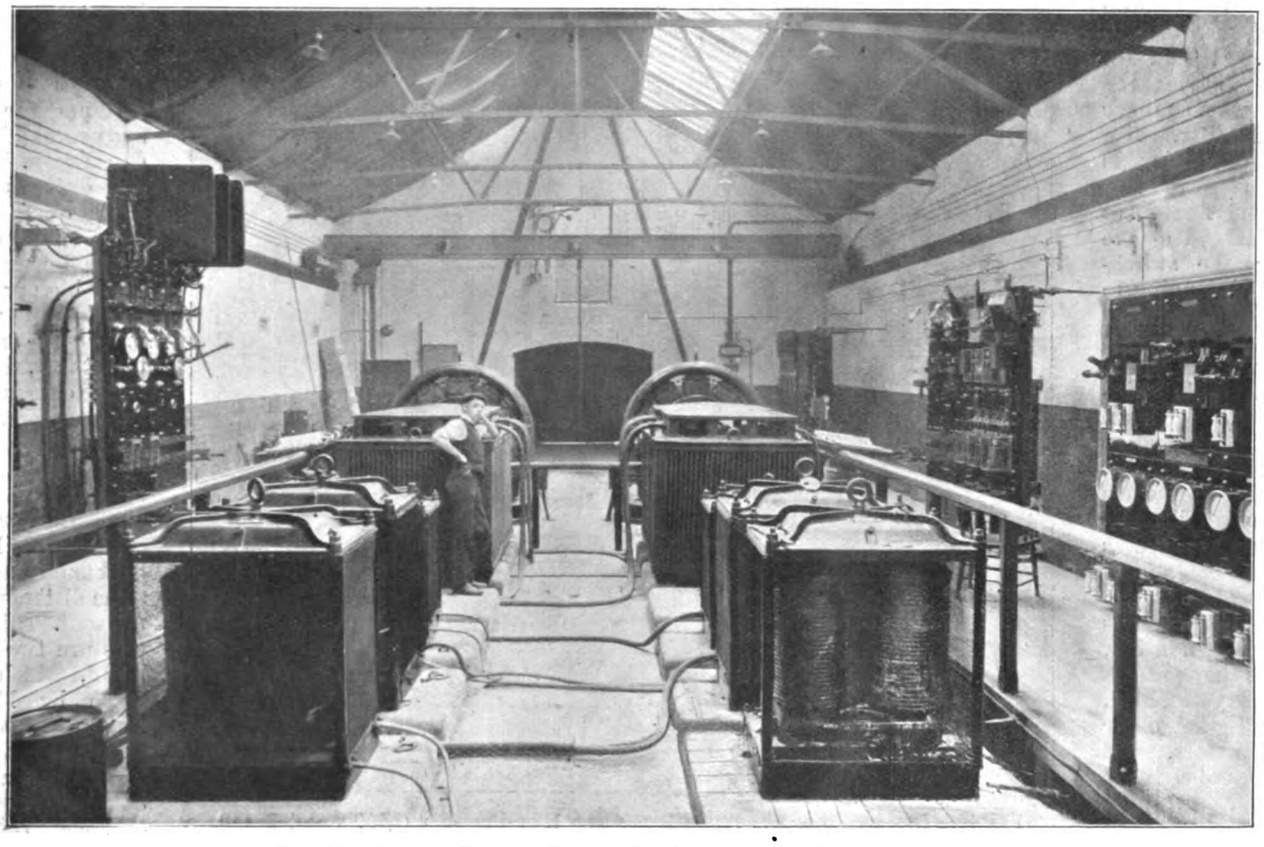

FIG. 14.—GENERAL VIEW OF BILSTON SUB-STATION FROM TRANSFORMER END.

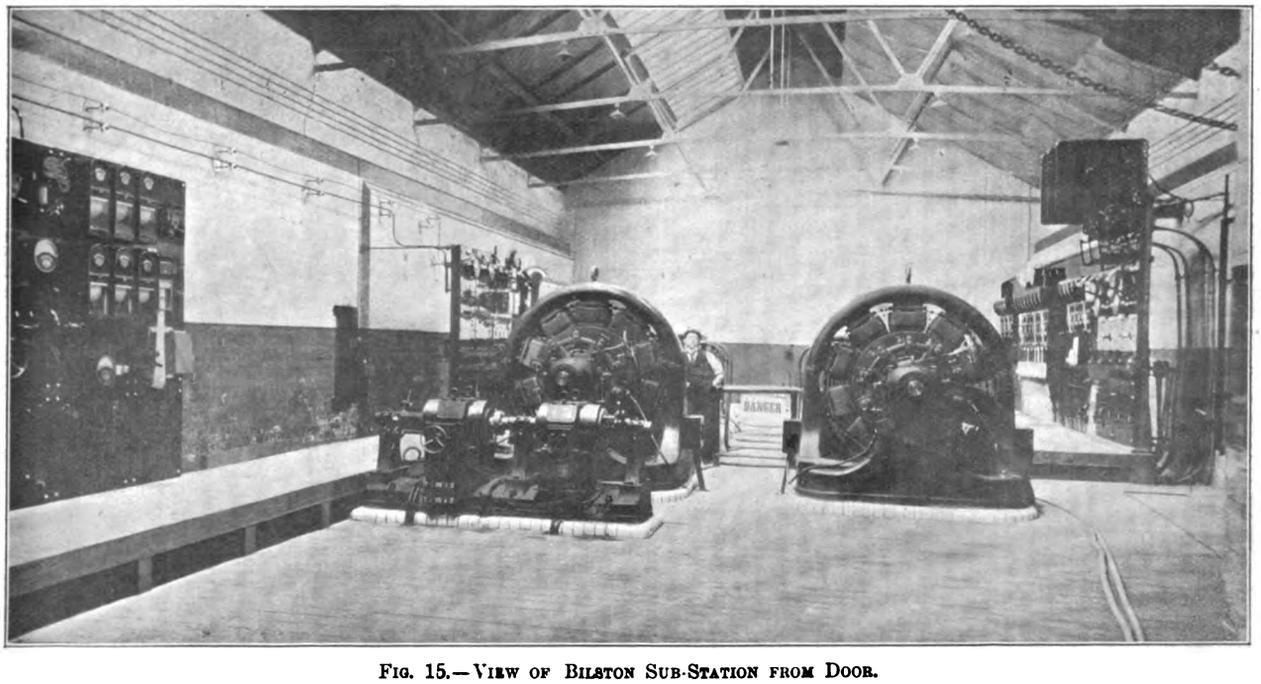

FIG. 15.—VIEW OF BILSTON SUB-STATION FROM DOOR.

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board seen in Fig. 14 and on a larger scale in Fig. 17. On the right-hand side there is, first, the high-pressure (2,000-volt) board against the wall, seen on the right of Fig. 16, but not embraced in Fig. 14, next, the low-pressure two-phase board, seen both in Figs. 14 and 16. Next to this the tramway meter board (Fig. 18), whose position is also seen in Fig. 14, and finally, at the far end of the room, the switchboard belonging to the Wolverhampton and District Tramways, whose position is just visible in the distance in Fig. 14 and to the left of Fig. 15. There are thus seven switchboards for various purposes in the sub-station.

The 7,000 : 2,000-volt transformers are not seen in Fig. 14, as they are not in place yet. These, as all the other transformers, will be pairs of separate transformers, one transformer on each phase. From the secondaries of these, mains are led to the high-pressure board seen to the left of Fig. 16, whence feeders will run to Ferranti tank transformers, which will be used in the Willenhall district, the first portion of the company's area to be supplied at this pressure. This board is of the standard Ferranti high-pressure type, and needs no further description. In Fig. 16, owing to the effect of the perspective, it looks as if the low-pressure and high-pressure boards were touching; but, as a matter of fact, there is some distance between them, and, moreover, the high-pressure board is against the wall, while the low-pressure board has a back and stands out some distance from the wall. This low-pressure two-phase board, which was made by Messrs. Kelvin and White, receives current from two pairs of 50kw. and one pair of 25kw. transformers. One set of

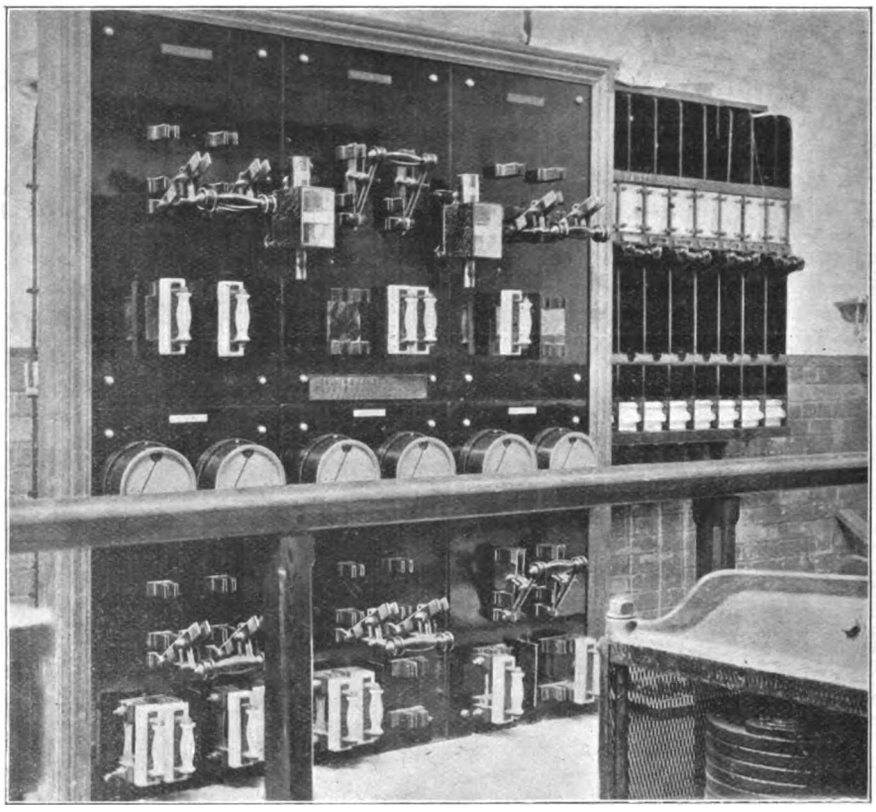

FIG. 16.—LOW-PRESSURE TWO-PHASE BOARD AND HIGH-PRESSURE (2,000 VOLTS) BOARD.

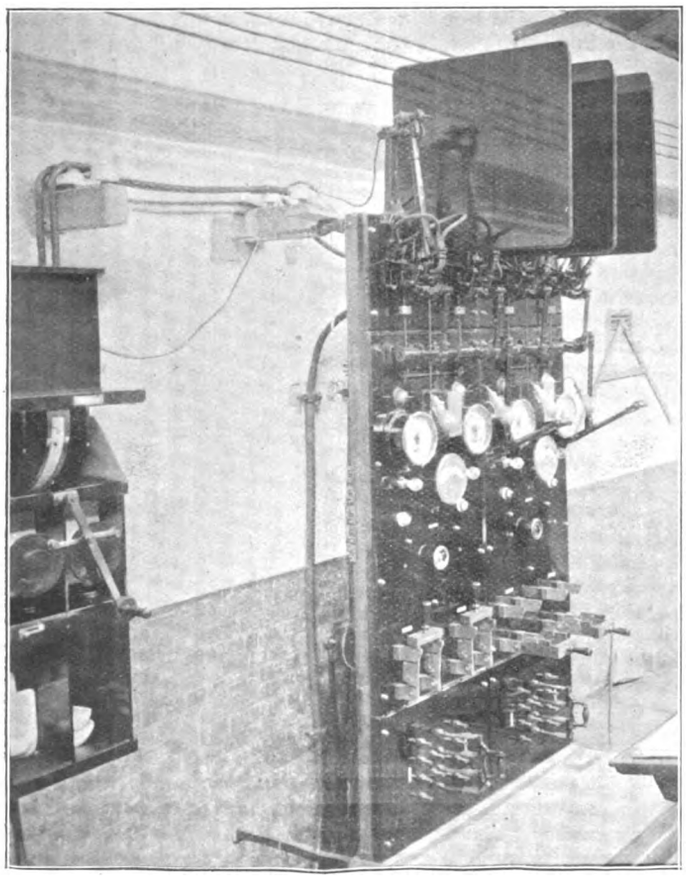

FIG. 17.—ROTARY CONVERTER BOARD.

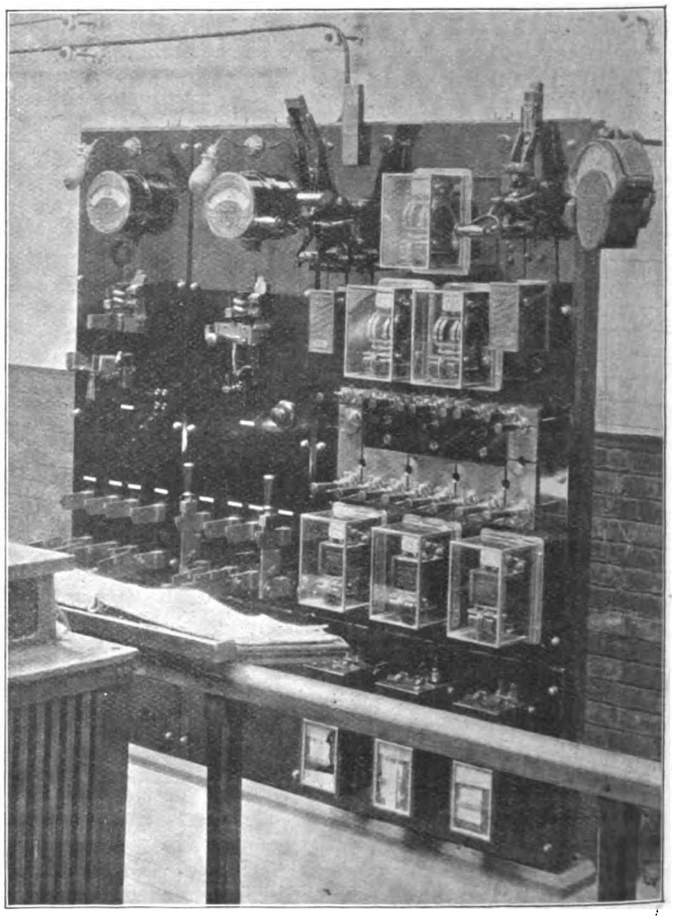

FIG. 18.—TRAMWAY METER BOARD.

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switches and fuses connect the transformers to the 'bus bars, and the other set are between the feeders and the 'bus bars; and in each case the switches of the two-phases are coupled together. Although the mains are two independent concentric cables for the two-phases and the transformers are also separate, both the outers are connected to a common 'bus bar, and there are no fuses on these outers except on the consumers' premises. The two multi-cellular voltmeters seen in Fig. 16 are connected one in each phase.

At the top of the converter board (Fig. 17) are four "time element" cutouts, which are also used as switches, for connecting the two pairs of step-down transformers which feed the rotary converters to the 7,000-volt 'bus bars of the adjacent extra high-tension switchboard. These time element cutouts have been described in *The Electrician*, Vol. XLVI., p. 232. They are fitted with a time-element relay which it is in its middle or no-contact position. Above the secondary switches are hand-wheels for adjusting the field excitation of the rotaries, and above these again are three ammeters for each rotary. Two of these in each case are connected to the secondaries of small transformers, whose primaries are in series with the slip rings; they therefore show the current flowing from each phase to the rotaries. The third ammeter is in the field circuit. These connections are seen in the upper part of Fig. 19, the lower part of which corresponds to the board at which current is metered to the tramway circuits.

On the meter board there is a voltmeter and two ammeters to indicate the continuous current passing from each converter and its voltage. A time element cutout is placed on each of the positives from the converters, and an instantaneous cut-out on the negatives. The four switches in connection with each converter (as arranged in Fig. 19) enable it to be utilised

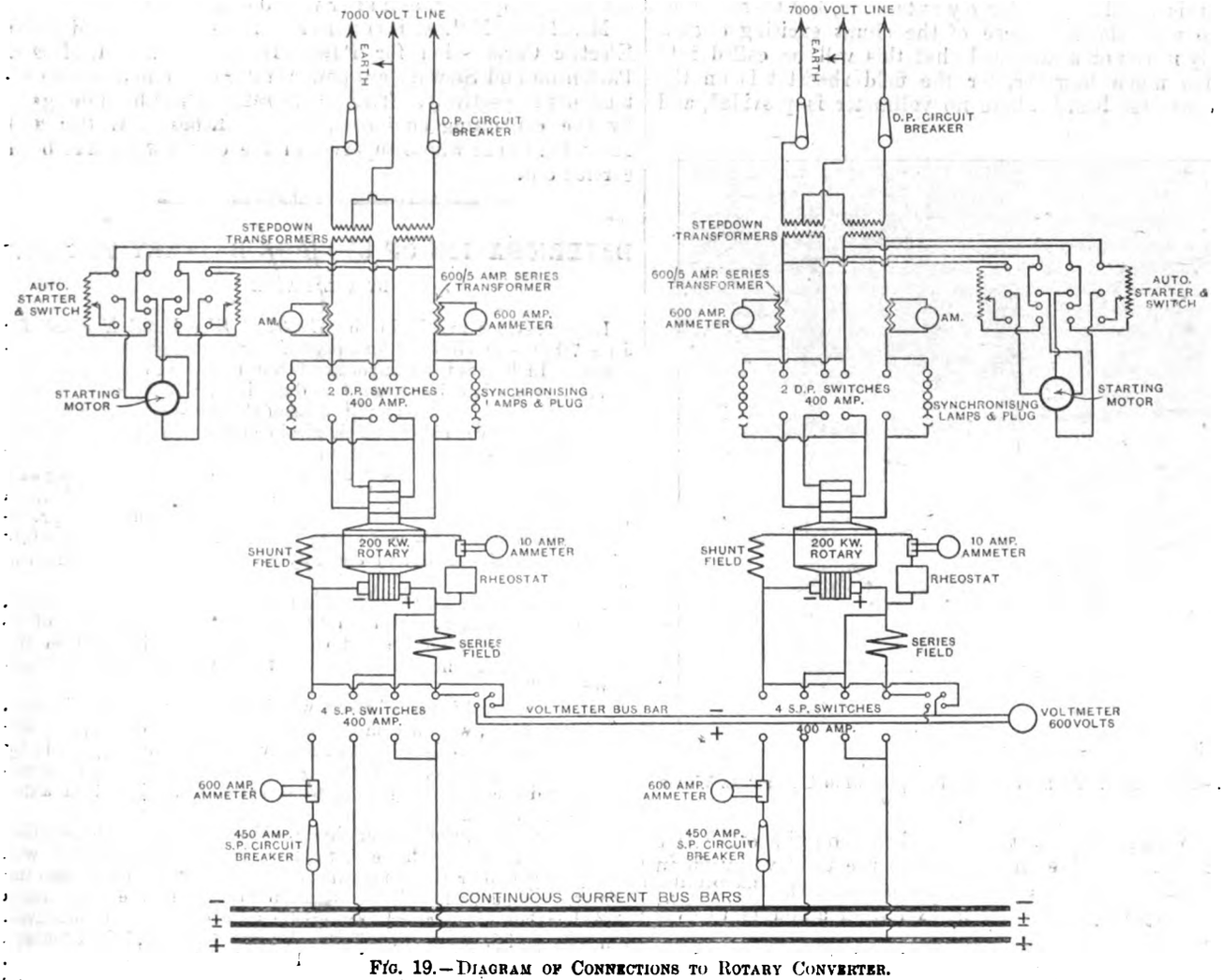

FIG. 19.—DIAGRAM OF CONNECTIONS TO ROTARY CONVERTER.

possible to adjust so that there is an interval of any time up to 10 seconds between the short circuit and the cut-off. If the short circuit or excess current is of shorter duration, the cutout does not fall. Two pairs of 100kw. Westinghouse transformers are connected to these cutouts, the connections being single-pole, as are all the extra high-pressure switching arrangements. The secondaries of these transformers are brought back to the board to the two pairs of switches in the bottom row but one, which connect them to the slip rings of the rotary transformers. At the bottom of the board are two throw-over switches to switch on induction motors placed on the shafts of the rotaries for starting them. When the switch is thrown over to one side, the induction motor is started through a resistance. The switch is then thrown right over to the other side, and the synchroniser switch is closed, and finally, when synchronism is reached, the transformer secondary switches are closed and the starting switch placed as a shunt machine, or as a compound wound machine with an equalising switch for paralleling. As agreed with the Wolverhampton and District Tramways Co., the current delivered to them is passed through three meters in series. A single meter might be liable to error; if there were two meters and they differed, it would be difficult to know which was the correct one; so three meters are used on the "odd man out" principle. Although not more than three meters are in circuit at a time, six are provided; one set of three reads from 0 to 400 amperes and the other three from 0 up to 1,200 amperes. There are also two recording ammeters reading up to 400 and 1,200 amperes to correspond with these, a recording voltmeter, and a set of plugs for short circuiting the meters and recorders which are not in use.

The rotary converters are rated at 250kw. each, and they run at 600 revolutions, the frequency being 50~, as already stated. They are of the Westinghouse standard type, with a

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damping coil on each pole-piece, and are compound wound. Their continuous-current output is 400 amperes at from 500 to 550 volts. As will have been gathered from the description of the switchboards and the diagram of connections, the regulation of the continuous-current voltage does not take place with the assistance of induction regulators or regulating turns on the secondaries of the transformers, but by a variation of the excitation. Altering the excitation varies the lag between the alternate-current voltage, and practically varies the transformation ratio of the step-down transformers, which are specially built to have a high inductance at light loads. A decrease in the strength of the field increases the lag of the alternate current behind the pressure, and the pressure is lowered owing to the increase in self-induction. Conversely an increase in the field increases the pressure, and in both cases the continuous current voltage of course changes with the alternating voltage. As the converter fields are compound wound, this regulation is largely automatic, but there is provision to vary the resistance of the shunt exciting circuit. Evidently it is not anticipated that this will be called into requisition much, however, for the field rheostat is on the rotary converter board, where no voltmeter is provided, and

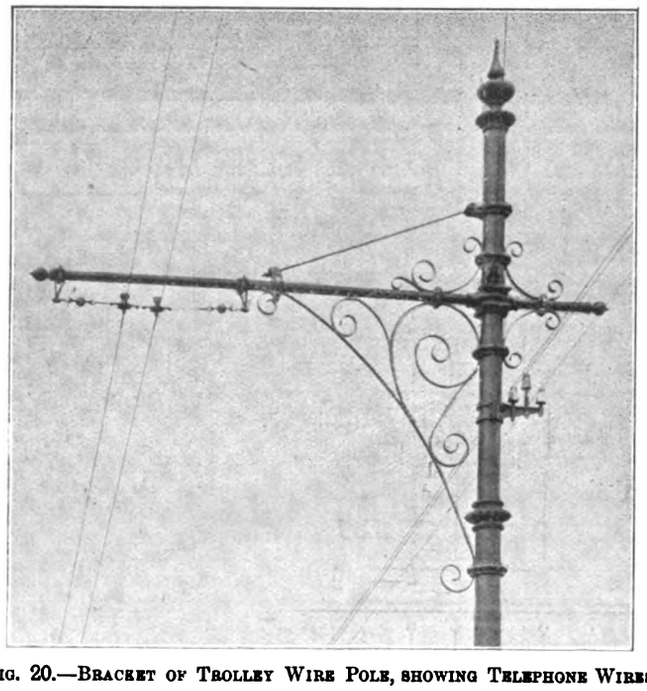

FIG. 20.—BRACKET OF TROLLEY WIRE POLE, SHOWING TELEPHONE WIRES.

the only voltmeter is on the meter board on the other side of the room. We are informed that the total variation in pressure which can be effected with the rotaries at the Bilston sub-station by varying the shunt excitation amounts to over 15 per cent.

From the meter board the current is led to the board of the Wolverhampton and District Tramways, partly seen on the left of Fig. 15. This board presents no features of special interest. It has four feeder panels, with cutouts, ammeters and single-pole switches, the usual negative booster connections, and the Board of Trade panel. The booster, seen in the foreground in Fig. 15, runs at 850 revs. per min., and can deal with 260 amperes and produce a pressure of 49 volts as a maximum. There is space in the first-floor of the sub station for a battery, but none has been put in yet.

The Wolverhampton and District Tramways is one of the offspring of the British Electric Traction Co. Its route, which was indicated in Fig. 1, published in our last issue, is in all 10 miles in length, and is part single and part double track. The current is all taken from the Bilston sub-station, and is supplied to the line through the usual feeder pillars placed at about ½ mile intervals. The line construction is chiefly with span wire suspension from side poles, but there is a certain amount of single bracket pole construction as well. In this connection it is interesting to remark that the Board of Trade has recently limited the length of bracket arms to 16ft., so that span wires will now be used on new work instead of those top-heavy-looking poles with extraordinarily long brackets which are an eye-sore in some towns. On the Wolverhampton and District lines the telephone wires are in some parts overhead, being placed on the poles as shown in Fig. 20. The three insulators on the right carry the telephone wires, which are supported by a clip fixed to the pole.

In concluding this article we may mention the tariff which has been fixed by the Midland Corporation. All the supply, except to the tramway company, is by two-phase alternating current at 200 volts pressure. For lighting, the consumer can choose between a flat rate of 4½d. per unit, or 6d. per unit for the first 100 hours of maximum demand per quarter plus 8d. for additional units. For power, the flat rate is 1½d. per unit with discounts to large consumers; and the "Wright" system tariff is 3d. per unit up to 78 hours of maximum demand per quarter, and after that 0·825d. per unit.

Mr. Hardie McLean is engineer and manager to the Midland Electric Corporation for Power Distribution, and Messrs. Parkinson and Stewart are power station and mains superintendents respectively. The whole scheme has been designed by the consulting engineers, Messrs. Kincaid, Waller and Manville, under whose supervision the entire work has been carried out.

DETERIORATION OF STORAGE BATTERY PLATES.*

BY A. L. MARSH.

In a previous article in the *Electrical World and Engineer* for June 7th, the possibilities for a light-weight storage battery were discussed. Lightness is an important factor in traction work, but not of such immediate importance as durability. The greater part of the patents taken out on storage cells of the lead-lead type are based on minor improvements in mechanical construction. These improvements are generally intended to increase the life of the battery rather than to reduce its weight, although some are obviously designed to secure lightness at the expense of life. There is room for improvement in both directions in the lead cell, but the improvements will undoubtedly come from the chemical and physical study of the active materials and electrolyte rather than in a mechanical way.

From the properties of lead with respect to its equivalent weight, lack of rigidity, &c., and from the nature of the reactions of its compounds during charge and discharge, we are justified in the conclusion that attempts at reduction of the weight of lead cells are impractical.

What is wanted is not a battery which will show good results on a laboratory table, with a competent battery man in charge, but one which can successfully withstand the average treatment given it by inexperienced persons, and the necessarily great variations of current output and the constant jarring to which it is subjected in automobile or street-car propulsion.

Taking up, first, the lead-sulphuric acid-lead peroxide type, we find that in actual practice the negative plates, in a well-designed cell, will last during two or three renewals of the positives. To be sure the negatives gradually lose their capacity, but ordinarily the depreciation is so slow that it is practical to use them with several sets of positives. Since the positive electrode is the weak point of the cell, I shall concern myself more particularly with it. In discharging a lead storage cell, lead sulphate is formed on either plate. This sulphate being insoluble remains in its position and there is thus formed a mixture of lead peroxide and lead sulphate on the positive electrode, and spongy lead and lead sulphate on the negative. As the proportion of sulphate increases, the conductivity of the mixture decreases. In practice the proportion of the sulphate is not allowed to increase to more than 50 per cent., as at this point the E.M.F. of the cell falls (and even before this point is reached), and further sulphation takes place rapidly if the cell is not at once recharged. It is held by some that this mixture is in reality a complex compound; that the lead peroxide of a charged cell is not as represented by the simple formula PbO_2, but is an allotropic form in which many simple molecules are combined into the complex one $(PbO_2)x$, where x is an unknown number but assumed to be 50 for mere convenience. Then the discharge of the positive electrode will be represented by a series of changes in the molecules, as follows:—$(PbO_2)_{50}$, $(PbO_2)_{49}$, $PbSO_4$, $(PbO_2)_{48}$, $(PbSO_4)_2$ . . . to approximately $(PbO_2)_{25}$, $(PbSO_4)_{25}$, when the electrode has practically reached its discharge limit. Each molecule contains some lead peroxide throughout the discharge and keeps the mass conductive. The molecule becomes less stable as the

* From the *Electrical World* of New York, September 13th.

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percentage of peroxide decreases, and when the point represented by $(PbO_2)_{25}(PbSO_4)_{25}$ is approximately reached, it readily breaks up with the formation of ordinary lead sulphate and simple molecules of lead peroxide, thus accounting for the rapid sulphation which is apt to take place if a cell is allowed to remain long uncharged. This structure of the molecule also accounts for the ease with which the discharged plate is reconverted to the peroxide condition, it being generally held that pure sulphate of lead is very slowly converted to the peroxide electrolytically, and only with a relatively large expenditure of energy.

This theory of the complex nature of the lead peroxide molecule was brought forward by Wade in a Paper read before the British Institution of Electrical Engineers. Sulphate of lead does form rapidly if the cell is allowed to stand uncharged, and also forms under other conditions which are not well understood. Although sulphation can be controlled to a certain extent by exercising great care, it is still a serious drawback to the use of lead in batteries, and is in a large measure responsible for the rapid deterioration of the plates. Another cause for deterioration is the lack of porosity in the active mass. The plate cannot absorb sufficient acid for its discharge, and so must depend upon diffusion. A heavy discharge will exhaust the acid in the interior of the active mass, and, as was shown by Gladstone and Tribe, the normal reactions do not take place in very dilute acid. A rapid charge may loosen particles of the active material by the too rapid evolution of gas. This is known as scaling. In pasted plates the peroxide mass softens when subjected to severe service in an automobile, and tends to wash away from the grid. This result takes place in a very short time if sediment, consisting of lead sulphate, is allowed to accumulate in the bottom of the cell until it touches the lower edges of the plates and thus causes a short-circuit. In order to prevent the falling away of active material, due to the softening of the mass and to dislodgment by escaping gas, and to prevent sediment from falling to the bottom of the cell, some battery makers wrap the plates with some porous substance, as specially treated cellulose, glass, wool, &c. In my opinion this cannot stop the formation of sediment, which I believe is due to the following causes:—Lead sulphate is soluble in concentrated sulphuric acid, is practically insoluble in dilute acid, and is again slightly soluble in pure water. In charging a cell at a fairly rapid rate, sulphuric acid is liberated in the pores of the active masses faster than it can diffuse out. Therefore the interior of the plates must contain fairly concentrated acid, in which lead sulphate is slightly soluble. The strong acid, carrying lead sulphate, slowly diffuses out of the plates and is there diluted by the weaker acid. The sulphate being less soluble in the weaker acid is precipitated and settles to the bottom of the cell. This action would take place through the porous envelope and so form a sediment the same as without it. The way to prevent this action would seem from the foregoing to be by preparing the plates with greater porosity, so that the acid could diffuse more rapidly, and so avoid great changes in density of the electrolyte, or by preventing the formation of the white sulphate, assuming Wade's theory to be correct; preferably by both methods together. Mr. G. H. Robertson thinks that the formation of sulphate might be checked by adding some substance to the electrolyte that will prevent the formation of oxidised bodies in it, and which at the same time will not injure the plates.

Zinc-copper Oxide Cell.—This cell, which uses an alkaline hydroxide electrolyte, possesses certain advantages over the lead cell, but also introduces new difficulties, which have rendered it less useful than the lead type. In the alkaline cell there is no such thing as sulphating and buckling, and no harm is done to the plates even if charge does not immediately follow the discharge. The zinc negative, however, is liable to local action, and great difficulty is experienced in plating the zinc in compact form available for the discharge. To charge the cell, the temperature should be about 54°C., and the charge rate low and intermittent to produce the best results. These conditions cannot always be realised in practice, and since the life of the cell is rather short and its application somewhat limited, owing to the comparatively short time that it will retain its charge, this type has not been able to fulfil the expectations of its promoters.

Nickel-iron Cell.—The nickel-iron cell, invented by Mr. Edison, I think will be found subject to certain bad tendencies similar to those of the lead cell, but they may be found less difficult to control. The material of the positive electrode is peroxide of nickel, probably having the formula NiO_2. In the discharge of the cell, the peroxide is reduced, according to one theory, to nickelous oxide (NiO). This compound (NiO) is difficult to oxidise electrolytically, while a reduced peroxide plate is not. It seems likely that the reaction of discharge is in many respects analagous to that of lead peroxide, and that the capacity is only about half of the theoretical. In normal discharge, I believe that the lowest oxide formed is the sesquioxide Ni_2O_3 (sometimes called peroxide), but under certain conditions the nickelous oxide (NiO) might be formed, and would present difficulties similar to those due to the formation of lead sulphate in the lead cell were it not for the fact that the oxide is insoluble, so that it remains in place and is slowly brought back to the proper condition. Overcharging does not harm the plates, because nickel is not readily attacked by the nascent oxygen if the electrolyte is a solution of pure potassium hydroxide. Chlorides, nitrates and tartrates should not be present, as nickel is more readily attacked in such solutions.

Silver Cell.—Of all the storage cells having insoluble electrodes, those using silver oxide for the positive seem to be best adapted to maintain normal reactions under the severe conditions of service. Jungner uses this material in his work with storage cells. The negative plate of a lead cell is very durable when compared with the peroxide plate, and the difference must be due to the metallic nature of the negative. In the discharge, only about half of the spongy lead is converted to the sulphate, so there is always some metal present and this is in the nature of sponge which holds the mass together. By obtaining a similar physical condition on the positive there should be realised an increase in the life of the battery, corresponding approximately to that of the negative electrode. To obtain this condition, a depolariser which reduces to the metallic state must be chosen and, moreover, this metal must have the property of holding together when in a spongy state. Silver oxide is such a material.

Taking a silver-cadium cell for illustration, we have spongy cadmium and silver oxide when the cell is in the charged state, and cadmium oxide and spongy silver when in the discharged state. In both these plates we have a condition very similar to that of a spongy lead electrode. There is this difference: the silver passes from an oxidised state to approximately half oxide and half metallic and half negative plates pass from the metallic state to half metallic, and half oxide or sulphate, as the case may be. The positive is never entirely reduced, and the negative never entirely oxidised under normal conditions, but they are near enough alike so that we should expect them to be of approximately the same durability.

Silver presents the difficulty that its oxides are slightly soluble in the alkaline electrolyte in which they are used. It has a great advantage, however, in the nature of its reactions. A cell may be left in any state of charge, or completely discharged, without danger of harming the plates. There is no tendency to form compounds which cannot be brought back to the original charged state with ease. Spongy silver can be readily oxidised to the oxide (Ag_2O), or to the peroxide (AgO), and the oxide (Ag_2O) may be easily further oxidised or reduced. No other compounds are formed. Silver oxide may be made by chemical methods and applied to the electrode, which can then be used immediately without any forming process. This is a good indication that the chemical reactions will not get out of order as long as they are confined to the electrode. The slight solubility of silver oxide is the weak point in this cell, but this drawback can perhaps be largely overcome either by a method employed by Mr. Edison in the preparation of copper electrodes or by slight alterations in the electrolyte.

Conclusion.—The lead cell has not received enough attention from its chemical and physical side, most manufacturers having paid more attention to mechanical details, and this has given the battery a rather unbalanced development. However, the manufacturers are now giving more attention to the chemistry of batteries, and we may expect to see in the near future a considerable improvement in lead cells in the way of longer life and greater reliability. I think the investigations should be directed to methods for securing greater porosity and firmness in the active material of the positive electrode and to improving the electrolyte so as to prevent the formation of lead sulphate, or at least to render it insoluble in all densities of the acid solution, so that it remains in place and can be restored to the proper condition.

Other metals will undoubtedly come into competition with, and may displace, lead in batteries for traction work, but as an auxiliary in electric light and power-stations lead cells will probably hold their own for some time. Nickel is a strong metal compared with lead. Its peroxide belongs to that class of depolarisers which adds electromotive force to the cell, and in this respect it is the best, so far, that it is practical to use in alkaline electrolytes. The electrolyte permits the use of steel for the grids and the containing vessel, and this gives a construction both light and strong. There seems to be no reason to believe that this cell will not do what Mr. Edison claims for it. Silver would be a good metal to use in traction batteries if its cost were not so great. To be sure, the silver in a worn-out battery would go a long way toward paying for a new set, but the first cost would be rather great. Silver is a rather abundant metal, and ought to be produced for much less than it brings at present, if the demand for it should sufficiently increase. In the lead cell the active material of the positive is only about half of the weight of the entire plate, so the weight of silver oxide required in the silver cell would correspond to the weight of lead peroxide, and not to the whole electrode. The other materials used would be inexpensive; nickel or steel for the positive grid, and probably iron for both negative grid and active material. Experiments indicate that a silver battery, giving the same power as a lead automobile battery weighing about 550lb., would require only about 70lb. of silver oxide, and perhaps less. It would not take a very extraordinary reduction in the price of silver nitrate to make the cell practical from a financial standpoint, and for the reasons given above such a cell could be made to have a comparatively long life and high efficiency, and would require but little attention to keep it in working order.

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LOANS FOR COMBINED LIGHTING AND TRACTION STATIONS.

An interesting event in municipal electric matters has been the recent refusal of the Local Government Board to grant a loan of £107,611 for electric lighting extensions at Cardiff. The Board has sanctioned £20,910 of this sum for extensions at the old electric lighting works, but permission to borrow the remaining £86,701 has been refused on the ground that it is for erecting electric lighting plant in a tramway power house which the Corporation had no statutory powers to build. The circumstances of the case are peculiar. The Cardiff Corporation have an electric lighting works which has now been running about seven years. This electric lighting undertaking is run under an ordinary Provisional Order, obtained under the Electric Lighting Acts of 1882 and 1888, by which, of course, the Corporation are empowered to build generating stations for electric light on any land of their own and to acquire land for the purpose. In 1898, the Corporation having resolved to lay down electric tramways, obtained an Act authorising them to acquire certain existing lines and equip them electrically and also to build new electric tramways. This Act specifically stated that no land, except three particular pieces set forth in a schedule to the Act, was to be employed for generating stations; the land scheduled in the Act might be acquired compulsorily, but no generating station for the tramways was to be erected on other land owned by the Corporation at the time or subsequently acquired. Two out of the three pieces of land were bought—one was employed as a car depôt, and the second (which is about 1 acre in extent) has been bought, but not yet made use of. It was the third piece of property, consisting of about 1½ acres, which the Corporation destined for their power station, and notice to purchase was duly served upon Lord TREDEGAR, the owner; but his lordship refused to sell unless he were compelled to, and clearly indicated to the Corporation that if compulsion were employed they might anticipate a discontinuance of certain favours, in the form of gifts of land for improvements, street widenings and public parks which it had been his habit to bestow when occasion arose. Wishing to remain friends with Lord TREDEGAR, the Corporation decided to build their tramway power station elsewhere, and, apparently forgetting the clauses in their Tramway Act referred to above, they bought about 7 acres of land for the purpose partly from Lord TREDEGAR and partly from Col. LOCKWOOD for £11,380. The tramway power house was built there, and the tramways were finally completed and opened to the public in May last.

The Corporation desiring to proceed with the combined lighting and traction scheme which had been decided upon when Mr. ARTHUR ELLIS succeeded Mr. APPELBEE as Borough

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Electrical Engineer in Cardiff, had in the meantime applied to the Local Government Board to sanction the loan of the £107,611 above referred to for electric lighting extensions, about £86,000 of which was for electric lighting plant to be put down in the new tramway power house, and it is this latter portion of the loan which the Board refuses to authorise. Put briefly, the situation is this: The tramway power house has been built on an unauthorised site, and the Board refuses to sanction a loan for the erection of electric lighting plant on that site.

The matter is complicated however, by the fact, that £48,754 of the unauthorised £86,701 has already been spent up to October 1st. Already, the Local Government Board has been appealed to a second time—an appeal almost *ad misericordiam*—and has again refused its sanction to the loan, and the Corporation remain in a difficult position. If they cannot obtain authorisation for placing electric lighting plant in their new power house, not only will they have to abandon their combined lighting and traction scheme for the present, but they might conceivably have to build a third generating station, to which the plant already obtained would have to be transferred. The question also arises as to how the cost of this transfer would be paid for, and whether the electric lighting and traction plant can be physically divided in this manner. It is one thing to apportion the cost of the plant to the two accounts and another to split up the plant itself. Moreover, there will be the difficulty of the coming increased winter load, with which possibly it was proposed to deal in part from the new plant in the tramway station.

Although the circumstances are peculiar to the particular case in point, and arise out of conditions which would not be repeated precisely in the same way elsewhere, other municipal corporations may profit by the experience obtained by Cardiff. Apparently, there is nothing which could be deemed objectionable in the scheme for the re-organisation of the electric lighting system at Cardiff and its combination with the new electric tramway undertaking if the proper procedure from a legal point of view had been followed. On the contrary, when Mr. ELLIS arrived at Cardiff, the electric lighting plant was both imperfect and obsolete, and his experience in precisely similar circumstances at Bolton was sufficient to show that considerable improvement and economy could be effected by a conversion of the greater part of the system from alternating into continuous current, and a combination of the lighting and traction plant under one roof. Of course, the Cardiff Corporation were wrong to obtain compulsory powers to acquire a particular site for its station before first considering whether they intended to exercise them, especially as it appears that it was necessary to limit their powers as to the acquisition of land and the erection of their generating station on their own property. Moreover, the Corporation were either badly advised by their legal adviser before they built their tramway power house on land acquired contrary to the provisions of their Act, or, if they acted in opposition to their legal adviser, they were more than indiscreet. We believe that the idea of combining the electric lighting and traction undertakings in Cardiff was more or less an after-thought, and was not definitely contemplated in 1898 when the Corporation obtained their Tramway Act; but even then the method of procedure was unwise. A local authority holding a Provisional Order has power to supply electricity for any public or private purpose within its area, and to construct works for this purpose on any site acquired in the ordinary way. Consequently, money for the combined lighting and tramway works which has been erected at Cardiff could have been borrowed under the Cardiff Electric Lighting Provisional Order, and current could then have been supplied to tramways from this station without any objection being raised. This, then, is the course that other municipalities desiring to combine their two electricity undertakings should adopt as a general rule. If, on the other hand, difficulty is anticipated in acquiring a site for new works without powers for compulsory purchase, they should make sure of their policy and requirements in this respect beforehand, and when they draft their special Act take warning by the mistake made at Cardiff. And, above all, let them remember that the Local Government Board occasionally moves slowly in granting sanction for loans; it is better that they should anticipate an increase in their loan before it has actually occurred, and obtain sanction in advance to borrow money for more plant, than that they should anticipate the loan, put down their plant in advance, and afterwards endeavour to obtain sanction for the plant.

OBITUARY.

JOHN HALL GLADSTONE.

It is with profound regret that we announce the sudden death of Dr. J. H. Gladstone, D.Sc., Ph.D., F.R.S., which took place on Monday at his house in London, at the age of 75 years. Only a few days ago Dr. Gladstone was a familiar figure to us and to many of his friends, as he took an active part, with his customary geniality and wonderful virility, at the British Association meetings at Belfast. He seemed then as vigorous as in many years past, when he has paid his usual visit to the annual meetings. His step was as elastic, his interest as keen, his sympathies as kind as ever. Many leaders of science have lost a rare comrade; many of the young men in the ranks of science have lost a helpful and sympathetic friend.

John Hall Gladstone was born in 1826, and early showed a fondness for scientific pursuits. So thoroughly, indeed, did he take up scientific research, and with such originality and keen intellectual perception did he pursue his various lines of investigation, that at the remarkably early age of 26 years he was elected a Fellow of the Royal Society. Although Dr. Gladstone was under no necessity to adopt a scientific career as a means of livelihood, he followed it with professional zeal throughout his long and busy life, and he certainly is entitled to rank with the leading physicists and chemists of the last generation in this country. The chief point of contact between his researches and electrical industry was the lucid theory of the secondary battery which, in conjunction with Dr. Tribe, he published some 15 years ago, in which the importance of the part played by lead sulphate in the action of the lead accumulator was systematically examined and clearly insisted upon. Dr. Gladstone was, in 1847, elected first president of the Physical Society of London, and three years later he was elected president of the Chemical Society. For a short time he occupied the Fullerian chair of chemistry at the Royal Institution. He was the recipient a few years ago of the Davy medal awarded by the Royal Society.

It is announced that Dr. Gladstone's funeral will take place to-day at St. Peter's, Kensington Park-road, at 2 p.m.

Manufacture of Water Gas by Electric Heating.—The *Practical Engineer* states that Schmidt, in comparing the economical value of coal and electricity as sources of energy, arrives at the conclusion that on the average only 30 per cent. of energy is utilised in the former case, whereas in the latter case it is 90 per cent. For this reason he recommends that electrical heating be used in the manufacture of water gas, instead of the usual process of supplying the necessary heat by direct combustion under air blast. He bases his calculations on the economical conditions existing in Switzerland, and expresses the opinion that it would be easy to adapt carbide furnaces to the manufacture of water gas.

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	CHELMSFORD.		LIVERPOOL.		LYMINGTON.
Undertaking Worked by	Chelmsford Electric Lighting Co.		Liverpool District Electric Lighting Co. (Ltd.).		{Lymington Light and Electric Power Co.
Date of Commencement of Supply	April 14, 1890.		September, 1897.		1900.
System of Supply	Alt.-curr. transformer sub-stations; 2 and 3-w.		Low-pressure continuous current.		Con.-curr. 3-wire.
Chief Engineer	Arthur H. French.		W. Miles Horsfall.		E. Hesketh.
YEAR ENDED	DEC. 31, **1900.**	DEC 31, **1901.**	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1901.**
QUANTITIES—					
Units generated	568,921	568,946	—	—	76,699
„ **SOLD (TOTAL)**	**482,906**	**484,762**	**102,925**	**126,689**	**48,591**
„ sold to consumers	304,854	304,651	91,191	110,456	31,437
„ sold for public lighting, &c.	164,187	166,724	11,734	16,233	17,154
„ sold for traction	nil	nil	—	—	nil
„ used on works	13,865	13,387	—	—	9,028
UNITS SOLD per MEAN 8 c.p. CAPACITY	**25·5**	**25·6**	**14·4**	**13·3**	**25·1**
Actual maximum supply demanded	274 kilowatts	349 kilowatts	—	223 kilowatts	55 kilowatts
Load factor	20·1%	15·9%	—	6·49%	10·1%
Number of public lamps	20 arc, 263 glow	20 arc, 267 glow	16 (10 amp.) arc	12(10 amp.)arc, 18(8 c.p.)	2(5 amp. encl.)arc, 107
Number of consumers	393	442	—	— [glow	— [(25 c.p.)glow
Connections to mains in 8 c.p. at end year	14,279	15,417	12,578	17,612	4,557
CAPACITY of PLANT in KW. at END YEAR	**605**	**605**	**261**	**348**	**62**
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kw. capacity.**
AUTHORISED (TOTAL)	**£70,000** / **£116**	**£70,000** / **£116**	— / —	— / —	— / —
Share	50,000 / 82·6	50,000 / 82·6	— / —	£50,000 / £144	— / —
Loan (including Debenture charges)	20,000 / 33·0	20,000 / 33·0	— / —	— / —	— / —
RECEIVED (TOTAL)	**22,678** / **37·5**	**39,993** / **66·1**	**£49,880** / **£191**	**50,000** / **144**	**£3,275** / **£52·8**
Share	9,871 / 16·3	34,993 / 57·8	49,880 / 191	50,000 / 144	3,275 / 52·8
Loan (including Debenture charges)	12,807 / 21·2	5,000 / 8·26	— / —	— / —	nil / —
AUTHORISED, NOT RECEIVED (TOTAL)	**47,322** / **78·2**	**30,007** / **49·6**	— / —	— / —	— / —
Share (unissued)	40,122 / 66·3	15,000 / 24·8	— / —	— / —	— / —
Share (uncalled)	7 / 0·012	7 / 0·012	— / —	— / —	— / —
Loan (including Debentures)	7,193 / 11·9	15,000 / 24·8	— / —	nil / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	nil / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	— / —	— / —
DEPRECIATION FUND	— / —	**800** / **1·32**	**713** / **2·73**	**1,240**[n] / **3·56**	— / —
EXPENDED (TOTAL)	**45,743** / **75·6**	**49,377** / **81·6**	**32,972** / **126**	**37,909** / **109**	**22,619** / **365**
Lands and buildings	6,560 / 10·8	7,595 / 12·6	5,401[a] / 20·7	5,401[a] / 15·5	2,184[c] / 35·2
Plant	17,933[a] / 29·6	20,297[i] / 33·5	10,378[b] / 39·7	11,130[g] / 32·0	11,599[d] / 187
Mains	17,445 / 28·8	17,679 / 29·2	16,766 / 64·2	20,950 / 60·2	5,640 / 91·0
Miscellaneous	3,805 / 6·29	3,806 / 6·29	427 / 1·64	428 / 1·23	3,196[e] / 51·6
BALANCE OF CAPITAL ACCOUNT	**−23,065**[b] / **−38·1**	**−9,384**[b] / **−15·5**	**16,902** / **64·7**	**12,091** / **34·7**	**−19,344**[f] / **−312**
REVENUE—	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**	**Total.** / **Per unit of total units sold.**
TOTAL	**£7,594** / **3·774d.**	**£7,782** / **3·853d.**	**£2,500** / **5·830d.**	**£3,106** / **5·886d.**	**£1,124** / **5·554d.**
Revenue from supply	5,959 / 2·961d.	6,201 / 3·070d.	2,189 / 5·105d.	2,707 / 5·133d.	726 / 3·587d.
„ meters, &c.	234 / 0·116d.	265 / 0·131d.	88 / 0·205d.	122 / 0·231d.	36 / 0·178d.
„ public lighting	1,051 / 0·522d.	1,274 / 0·631d.	196 / 0·457d.	271 / 0·514d.	277 / 1·369d.
„ supply for traction	nil / —	nil / —	nil / —	nil / —	nil / —
„ miscellaneous sources	350 / 0·174d.	43 / 0·021d.	27 / 0·063d.	7 / 0·013d.	84[o] / 0·415d.
EXPENDITURE—					
TOTAL COSTS	**£6,247** / **3·104d.**	**£4,970** / **2·461d.**	**£1,932** / **4·506d.**	**£2,073** / **3·928d.**	**£807** / **3·988d.**
TOTAL WORKS COSTS	**5,870** / **2·918d.**	**4,445** / **2·201d.**	**1,140** / **2·657d.**	**1,287** / **2·439d.**	**604** / **2·984d.**
Generation of Electricity	*5,352* / *2·660d.*	*3,824* / *1·893d.*	*1,025* / *2·390d.*	*948* / *1·796d.*	*546* / *2·697d.*
Fuel (including cartage, &c.)	3,607 / 1·793d.	2,606 / 1·291d.	534 / 1·245d.	597 / 1·131d.	291 / 1·438d.
Oil, waste, water, stores	228 / 0·113d.	122 / 0·060d.	68 / 0·159d.	74 / 0·140d.	43 / 0·212d.
Wages at station	798[c] / 0·397d.	837[j] / 0·415d.	243[c] / 0·567d.	243[c] / 0·460d.	212[h] / 1·047d.
Repairs & maintenance at Station	719[d] / 0·357d.	259[k] / 0·128d.	180 / 0·420d.	34 / 0·064d.	— / —
Distribution of Electricity	*452* / *0·225d.*	*450* / *0·223d.*	*109* / *0·254d.*	*321* / *0·609d.*	*15* / *0·074d.*
Wages, &c.	266[e] / 0·132d.	395[l] / 0·196d.	— / —	— / —	14[i] / 0·069d.
Repairs, renewals of mains, &c.	186[f] / 0·092d.	55[m] / 0·027d.	109[d] / 0·254d.	321[h] / 0·609d.	1[j] / 0·005d.
Public Lighting	*66* / *0·033d.*	*171* / *0·085d.*	*6* / *0·014d.*	*18* / *0·034d.*	*43* / *0·212d.*
Attendance	66 / 0·033d.	171 / 0·085d.	6 / 0·014d.	9[i] / 0·017d.	43[k] / 0·212d.
Renewals				10 / 0·019d.	
MANAGEMENT CHARGES, &c.	**376** / **0·187d.**	**525** / **0·260d.**	**792** / **1·846d.**	**786** / **1·489d.**	**203** / **1·003d.**
Net Rents	*10* / *0·005d.*	*10* / *0·005d.*	— / —	— / —	— / —
Rates and taxes	*49* / *0·024d.*	*148* / *0·073d.*	*102* / *0·238d.*	*100* / *0·189d.*	*60* / *0·296d.*
Management	*317* / *0·158d.*	*367* / *0·182d.*	*690* / *1·608d.*	*686* / *1·300d.*	*143* / *0·707d.*
Salaries	144 / 0·072d.	177 / 0·088d.	501[e] / 1·168d.	492[j] / 0·933d.	82[l] / 0·405d.
Stationery, &c.	39 / 0·019d.	28 / 0·014d.	14 / 0·033d.	33 / 0·063d.	4 / 0·020d.
Establishment charges	80 / 0·040d.	39 / 0·019d.	45 / 0·105d.	115 / 0·218d.	24 / 0·119d.
Law charges, &c.	54[g] / 0·027d.	123[n] / 0·061d.	130[f] / 0·303d.	46[k] / 0·087d.	33[m] / 0·163d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'd.**
WORKING PROFIT FOR YEAR	**£1,347** / **3·13%**	**£2,812** / **5·91%**	**£567** / **1·82%**	**£1,028**[l] / **2·90%**	**£365**[n] / **2·15%**
Carried to Depreciation Fund	— / —	800 / 1·68%	472 / 1·51%	529 / 1·49%	— / —
Carried to Reserve Fund	— / —	— / —	— / —	— / —	— / —
Net int. on loans (incl. Deb. charges)	697 / 1·62%	1,460 / 3·07%	— / —	1,119[m] / 3·16%	15[o] / 0·088%
Net profit for the year	501[h] / 1·17%	402[h] / 0·845%	— / —	1,618 / 4·57%	379[p] / 2·24%
BALANCE FROM LAST ACCOUNT	**862** / **2·01%**	**1,362** / **2·86%**	— / —	**551** / **1·55%**	nil / —
Do. AVAILABLE for DISTRIBUTION, &c.	**1,362** / **3·17%**	**1,764** / **3·71%**	— / —	**2,169** / **6·12%**	**379**[p] / **2·24%**
Deficit	— / —	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	nil / —	4% / —	— / —	3½% / —	4% / —
PER CENT. of TOTAL COSTS to REVENUE	82·2%	63·9%	77·3%	66·7%	71·8%
Expenditure per mean kilowatt capacity	£10. 6s. 5d.	£8. 4s. 5d.	£8. 8s. 10d.	£6. 16s. 5d.	—
REVENUE PER MEAN KW. CAPACITY	**£12. 10s. 10d.**	**£12 17s. 2d.**	**£10. 18s. 2d.**	**£10. 4s. 2d.**	—
REV. PER 8-C.P. CONNECTED, MEAN	**11s. 7d.**	**10s. 6d.**	**4s. 6d.**	**4s. 1d.**	—
Price charged for lighting, per unit	6d.	6d.	6d.	6d.	7d. to 4d.[a]
„ for power, per unit	3d. [32 c.p. glow	3d. [lamp	3d.	3d.	4d. to 1½d.[b]
„ for public lighting	£22. 10s. arc, £2. 6s. 10d.	£25 arc, £3. 3s. glow	4d. per unit	4d. per unit	£12 arc, £2. 15s.
Receipts per unit for private supply	4·69d.	4·89d.	5·77d.	5·89d.	5·54d. [glow
„ „ for public lighting	1·44d.	1·59d.	3·89d.	3·74d.	3·28d.
„ „ for traction	—	—	—	—	—

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ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Isle of Wight (Company)	Sept. 26, 1902
Accrington (Municipal)	July 25, 1902	Islington (Municipal)	Nov. 22, 1900
Ayr (Municipal)	Oct. 11, 1901	Kensington & Knightsbr'(Co.)	Apr. 11, 1902
Barking Town (Municipal)	Oct. 3, 1902	Kingston-upon-Hull (Mun.)	July 18, 1900
Barnsley (Municipal)	June 27, 1902	Kingston-on-Thames (Mun.)	June 20, 1902
Bath (Municipal)	April 20, 1900	Lancaster (Municipal)	July 25, 1902
Bedford (Municipal)	Aug. 3, 1900	Leeds (Municipal)	June 27, 1902
Belfast (Municipal)	Aug. 8, 1902	Leicester (Municipal)	Jan. 26, 1900
Birmingham (Company)	Sept. 15, 1899	Leith (Municipal)	May 17, 1901
Blackburn (Municipal)	Feb. 7, 1902	Leyton (Municipal)	Nov. 1, 1901
Blackpool (Municipal)	Oct. 4, 1901	Liverpool (Municipal)	April 4, 1902
Bournemouth (Company)	April 18, 1902	London Elec. Supply Corp.	Sept. 5, 1902
Bolton (Municipal)	Nov. 29, 1901	Londonderry (Municipal)	Feb. 16, 1900
Bradford (Municipal)	July 12, 1901	Manchester (Municipal)	Aug. 29, 1902
Brighton (Municipal)	Sept. 12, 1902	Metropolitan Elec. Supply Co.	Apr. 25, 1903
Bristol (Municipal)	Aug. 8, 1902	Morley (Municipal)	July 25, 1902
Bromley (Kent) (Co.)	May 16, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Brompton & Kensington (Co.)	June 6, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burnley (Municipal)	Feb. 7, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Burton-upon-Trent (Mun.)	July 11, 1902	Northampton (Company)	Oct. 20, 1899
Bury (Municipal)	July 11, 1902	Norwich (Company)	Sept. 19, 1902
Cambridge (Company)	June 13, 1902	Notting Hill (Company)	June 6, 1902
Canterbury (Municipal)	Oct. 26, 1900	Nottingham (Municipal)	Dec. 27, 1901
Cardiff (Municipal)	Oct. 25, 1901	Oldham (Municipal)	Aug. 29, 1902
Charing Cross (Company)	Mar. 28, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 3, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 22, 1902	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 23, 1900	Richmond (Company)	June 29, 1900
Crewe (Municipal)	July 11, 1902	Salford (Municipal)	Jan. 24, 1902
Croydon (Municipal)	Nov. 22, 1901	St. Helens (Municipal)	Jan. 10, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Derby (Municipal)	Jan. 26, 1900	St. Pancras (London) (Mun.)	Sept 5, 1902
Dewsbury (Municipal)	Feb. 15, 1901	Scarborough (Company)	Sept. 19, 1902
Dover (Company)	May 2, 1902	Sheffield (Municipal)	Feb. 1, 1901
Dundee (Municipal)	Dec. 6, 1901	Shoreditch (Municipal)	Jan. 31, 1902
Eastbourne (Municipal)	Mar. 14, 1902	SmithfieldMarkets, Lond. (Co.)	Mar. 8, 1901
Edinburgh (Municipal)	Dec. 6, 1901	South London (Company)	May 16, 1902
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 4, 1902
Folkestone (Company)	May 2, 1902	Southampton (Municipal)	Aug. 1, 1902
Glasgow (Municipal)	Sept. 12, 1902	Southport (Municipal)	Jan. 17, 1902
Gloucester (Municipal)	Aug. 30, 1901	Stafford (Municipal)	Aug. 16, 1901
Great Yarmouth (Mun.)	Dec. 13, 1901	Stepney (Municipal)	Oct. 3, 1902
Greenock (Municipal)	Aug. 30, 1901	Sunderland (Municipal)	Aug. 1, 1902
Guernsey (Company)	Sept. 26, 1902	Taunton (Municipal)	June 16, 1899
Guildford (Company)	Oct. 19, 1900	Tunbridge Wells (Mun.)	Aug. 22, 1902
Halifax (Municipal)	Dec. 27, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hammersmith (Municipal)	Nov. 15, 1901	Walsall (Municipal)	May 23, 1902
Hampstead (Municipal)	Nov. 22, 1901	Wandsworth (Company)	May 9, 1902
Hanley (Municipal)	Aug. 9, 1901	Westminster (Company)	April 4, 1903
Harrogate (Municipal)	Jan. 25, 1901	Whitehaven (Municipal)	Feb. 8, 1901
Harrow (Company)	Dec. 21, 1900	Winchester (Company)	June 20, 1902
Hastings (Municipal)	July 18, 1902	Windsor and Eton (Co.)	July 19, 1901
Hereford (Municipal)	Jan. 17, 1902	Woking (Company)	Dec. 22, 1899
Hove (Company)	July 18, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Huddersfield (Municipal)	May 23, 1902	Woolwich (Company)	May 31, 1901
Hull (Municipal)	July 4, 1902	Worcester (Municipal)	April 18, 1902

Chelmsford Electric Lighting Co.

These accounts present very satisfactory figures in the costs columns. It may be noticed that the *distribution* of the costs is rather unusual. Thus, in point of merit, the works costs given are far behind the management and property charges shown. To some extent this is probably due to the large proportion of the salaries included under generating and distributing costs. Even so, however, the "wages at station" item shown, including as it does £298 salaries, is by no means high for company-worked stations of similar magnitude. The only other generating cost still somewhat high is that of fuel, though its present value of 1·29d. has been reduced from the 1·79d. in 1900. The total costs are considerably below the average—a result due primarily, as we have hinted, to the exceedingly low stores and repairs at the station and management charges. Notwithstanding the very moderate total revenue, the working profit was highly satisfactory at 5·91 per cent. of the mean capital. This result is due rather than to anything else to the very moderate capital expenditure relatively to the output. Out of the year's profit £800 was allocated to thestarting of a renewals fund. The balance, together with £1,862 from 1900, enabled an ordinary dividend of 4 per cent. to be paid, leaving £365 carried forward. The report states that the premises adjoining the company's generating station, and formerly occupied by Messrs. Crompton, have been taken by a firm of motor-car builders, who are driving their machinery by electric power supplied by the company.

Liverpool District Electric Lighting Co. (Ltd.).

This little undertaking is making steady progress, not only in building up its business but towards making it remunerative. The load-factor appears to be very low in value, and this must militate seriously against favourable costs being shown. Owing to the relatively small station wages and repairs expenses, the generating costs present a satisfactory figure in the circumstances and considering the nature of the fuel bill. Less satisfactory are the management and property charges, which appear excessive even in relation to the load-factor and the modest output of the station. The works and total costs are too high also.

The Gateacre portion of the business has been disposed of to the Garston and District Electric Supply Co. The surplus, after payment of expenses, was £1,909, from which £468 preliminary expenses was written off, leaving £1,441 to form a reserve for equalisation of dividends. The net rents from the free wiring business amounted to £95, but as £100 was also written off the free-wiring account, the net revenue account suffered to the extent of £5 from this cause. After payment of a 3½ per cent. ordinary dividend for the year £480 was left to be carried forward.

Lymington Electric Light and Power Co.

The results attained in 1901 by this company are very creditable for an undertaking in its first completed year of working. With the small output of 48,591 units sold and a load-factor of 10·1 per cent., the conditions disarm criticism. Yet a working profit of 2·15 per cent. of the mean capital was reached, and an ordinary dividend of 4 per cent. paid. No interest was paid during the year upon the loan capital which was provided by Messrs. Edmundson. Of the profit £48 was contributed by the wiring business.

REMARKS TO TABLES.

CHELMSFORD.—*a* Machinery £12,623, accumulators £295, meters £2,214, instruments £556, transformers £2,244. *b* Over-expended. *c* Proportion of salaries £249, wages £549. *d* Of buildings £6, engines and boilers £567, dynamos, exciters, transformers, motors, &c., £13, other machinery, instruments and tools £128, accumulators £5. *e* Proportion of salaries £83, wages £183. *f* Of mains £140, of apparatus on consumers' premises £37, at distributing stations £9. *g* Law £11, insurance £31, auditing £17. *h* After writing off £159 for preliminary expenses. *i* Machinery £14,576, accumulators £295, meters £2,477, instruments £556, transformers £2,393. *j* Proportion of salaries £298. *k* Buildings £3, engines and boilers £96, dynamos, exciters, transformers, motors, &c., £14, other instruments and tools £36, wages on repairs £111. *l* Proportion of salaries £99. *m* Of mains £51, on consumers' premises £4, at distributing stations £1. *n* Insurance £111, auditing £12.

LIVERPOOL.—*a* Lands £737. *b* Machinery £8,184, accumulators £978, meters £987, instruments £229. *c* No salaries included. *d* Of mains £4, at distributing stations £99, of apparatus on consumers' premises £8. *e* Directors £350, salaries of engineers, secretary, clerks, &c., £151. *f* Auditing £14, law £96, insurances £70. *g* Machinery £8,536, accumulators £1,052, meters £1,309, instruments £233. *h* Of mains £197, apparatus on consumers' premises £9, at distributing stations £115. *i* Attendance and repairs. *j* Directors £200, engineers, secretary, clerks, &c., £998. *k* Auditing £26, law £6, insurance £13. *l* After deducting £5 balance from free wiring account. *m* *Received*, including £179 bank interest, £284 interest and purchase money in Gateacre undertaking and £643 profit on manufacturing business. *n* Exclusive of £144 dividend equalisation reserve, being surplus from sale of Gateacre undertaking.

LYMINGTON.—*a* Maximum demand system; 6d. on prepayment. *b* Maximum demand system. *c* Lands £>10. *d* Machinery £5,238, accumulators £1,115, meters £1,464, instruments £843, public lamps £2,939. *e* Wiring and motors £2,929, cost of provisional order £267. *f* Over-expended. *g* "Rental of motors and wires." *h* Proportion of salaries £14. *i* Proportion of salaries £7. *j* Of apparatus on consumers' premises. *k* Attendance and renewals. *l* Proportion of salaries. *m* Insurance £10, law £17, auditing £6. *n* Includes £48 profit on wiring. *o* *Received*. *p* No interest was paid during this year upon the loan capital which was provided by Messrs. Edmundson.

"WHITE COAL" IN FRANCE.

France is one of the countries in Europe where water power is plentiful. From the slope of the mountains forming its eastern and southern borders—mountains snow-capped all the year round—swift streams run down to the valleys. Advantage has been taken of the water power thus available to instal, principally in the eastern part of the French Alps, numerous hydro electric stations devoted either to the distribution of the electrical energy to distant places or to its utilisation on the spot for electro-chemical or electro-metallurgical purposes. The legal system relative to water power in France is, up to now, that owners of the borders of a stream which can be used neither for accommodating barges nor for floating wood props possess the water rights, and can utilise them up to mid-stream if they possess only the border on one side, and on the whole stream if they own both sides. The water may be used either for irrigating or as motive power, with the only restriction that it must be given back at the limit of the boundaries along the stream, except such water as has been absorbed on their own land. This presents many inconveniences. When the value of water power began to be fully realised a rush took place, and some

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sharp individuals succeeded in securing water rights on the most promising sites at a low cost. These water rights were afterwards sold at big profits to financial societies, who erected hydro-electric plants. Such was the job of the *pisteurs*. But this "job" was not always successful. Suppose along the stream sought for by the *pisteur* some landowner having a border only a few feet long refused to sell his ground or his water rights, then the whole scheme of the *pisteur* was over, as it could be opposed by the *barreur de chute*, as these landlords were termed.

Of course, *pisteurs* and *barreurs de chute* were the terror of people wishing to establish important hydro-electric works in suitable sites on sound financial bases, as these nearly always met either one or the other to oppose their schemes or to make it extremely expensive. From this arose a number of lawsuits, with the result that the public powers, eminently disposed to interfere with the things for which they are not wanted, thought they could find in this some profitable bargain for the State. They declared that the landowner along a stream was well entitled to the possession of the borders and the bed of this stream, but not to the slope and the flowing water, which, they said, belonging to nobody becomes thus *res nullius*. The landowner had consequently no right to the energy stored in the water and due to the difference of level between two determined planes. From the well-known theory that "What belongs to nobody belongs to the State," the public powers framed a law, not yet submitted to Parliament, from which concessions of water power are to be given by auction for a given short number of years. The concession would be granted under certain severe conditions, amongst which are to supply water and electrical energy at fixed low rates for public services and to give financial assistance to enterprises of public utility in the neighbourhood as required. Compensations were to be given to people using the water and turned out by the concession, but nothing was left for the owners of stream borders not effectually using the water. By the end of the concession, the waterfall, hydraulic and electric machines, mains, &c., became the property of the State, which is to put the concession again up to auction for another period of time, the amount of money thus obtained coming to the former holder.

This is clearly a trial application of communism. The fear of the passing of such a law has succeeded in grouping a number of manufacturers possessing or utilising water power for the purpose of opposing and proposing alternatives to it. To make the thing clearer to people not directly connected with the question, they organised for the beginning of last month a special meeting called the "Congress of the White Coal," white coal being the name given to the snow which constitutes the summer storage of water for the mountain streams. The city chosen for the *locus* of the Congress was Grenoble. The members were first to visit the numerous hydro-electric plants in its vicinity, to proceed from there to the north and lastly to Chamonix. This meeting has been a great success, and will have, we hope, useful results; 560 members were present, amongst whom were three former ministers, MM. Hanotaux, Guillain and Boucher, and numerous notabilities of the electrical world. The president of the Congress was M. Pinat, director of the Allevard Iron Works. The Congress was formally opened on September 7th, by speeches from MM. Pinat and Hanotaux. There were two sections, one legal and the other technical. No account of the proceedings of the meeting can as yet be published, but the future proceedings of this combination of power users will be watched with interest, and particulars thereof, when available, shall be given to our readers.

The New York Subway Railway.—The new power house which is about to be erected for the above railway will be 580ft. by 200ft. by 115ft. high, and will contain eight 8,000 H.P. engines, each directly coupled to a 5,000kw. alternating-current generator. A coal bunker to contain 15,000 tons of coal is provided for off the boiler room. The cars for use on the railway are 42ft. long, with a seating capacity of 52 each.

ROCK-DRILLING TESTS.

We have received from the British Schuckert Electric Co. the following tabulated particulars of a series of tests of rock drills at the Dusseldorf Exhibition. The tests were arranged by the Prize Committee of Mining "in the boring hall"—a place doubtless familiar to many of us:—

Pressure of 78lb. per square inch.

Type of drill.	Dia. of piston in mm.	Boring time limit 3 min.	Dia. of hole drilled in mm.	Depth of hole drilled in mm.
Bochumer drill (Flottman & Co.) .	70	3	55	65
Duisburger Jäger drill (Bechem and Kectmann)	70	3	40	237
Unterbarmen Frölich drill (Frölich and Klupfel)	75	3	40	260
Wärwolf drill (Hoffmann & Co.) ...	70	3	40	300
Triumph drill (Schwarz & Co.).....	85	3	40	304
Combined Meyer-Schuckert drill...	75	3	40	404

The Meyer-Schuckert drill showed nearly 33 per cent. better results than the second-best competitor.

Pressure of 40½lb. per square inch.

Unterbarmen Frölich drill	75	3	40	125
Wärwolf drill	70	3	40	135
Duisburger Jäger drill	70	3	40	145
Meyer-Schuckert drill	75	3	40	165

All competitors use the same boring frame and the same stone—a very hard Black Forest syenite. The competition was restricted to drills of 70–75mm. diameter piston, which can be taken to rank equal, as although the 70mm. drill had a smaller surface, it worked with a correspondingly greater number of strokes. The Triumph drill had a diameter of 85mm., contrary to regulations. The work done is, therefore, to be taken at about $\frac{4}{5}$—*i.e.*, 304mm. instead of 390mm.

In the second test the Triumph drill was withdrawn, as its owners declared they could not work with so low a pressure as 40½lb. per square inch. The Bochumer drill was also withdrawn for same reason.

THE SMOKELESS COMBUSTION OF BITUMINOUS FUELS.*

BY W. H. BOOTH.

Engineers are taught at college that combustion can only take place in the presence of a sufficient supply of oxygen at a sufficiently high temperature. An ordinary class-room experiment is to surround a candle flame with a coil of wire, which abstracts heat so rapidly from the flame as to cause combustion to cease, and the flame is extinguished. This experiment contains the whole secret of combustion. When engineers go out into the world, they find that the burning of coal and generation of steam are carried out upon lines which are quite opposed to the principles they were taught at college, and more upon the lines of the refrigerated candle-flame experiment. They become aware that the daily practice of steam raising, while opposed to theory, is very far from good, and they are told that it is not possible to burn bituminous fuel except with evolution of smoke. Most engineers acquiesce in this very lamentable state of affairs, and are the more inclined to do so, because, where teachers of engineering have been responsible for boiler arrangements, they are unable to find that these present any differences from the common herd. The modern steam boiler is, in fact, quite as primitive as a common pan set directly upon a fire to boil. An African savage, with a gourd as his pot, places this to boil just as scientifically as do our professors of engineering place boilers. The modern boiler maker merely sells boilers. The consulting engineer, who ought to order their setting, accepts the methods of the savage, the impossibility of which, in respect of good results, he has taught, or has been taught at college, but has not comprehended.

There are certain fuels which burn *in situ*. No flame is produced. They waste away when exposed to air, and the wasting surface becomes brilliantly incandescent. Such fuels are wood, charcoal, coke, or anthracite coal. Because of this peculiar manner of combustion, such fuels may be burned directly below heat absorbing surfaces, and combustion will be very perfect, but even with fuels of this description, a certain mingling into one stream of all the products of a fire may be of advantage, because such a fire may be of uneven thickness, and, in places, may admit too much air, that will serve to burn the carbonic oxide that has been formed where the fire is too thick. In other forms of fuel known as the bituminous and

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semi-bituminous coals, which contain hydrocarbons, the problem of industrial combustion is more difficult. In the first place a bituminous coal passes through two distinct processes when burning; first the hydrocarbons, which are volatile, are distilled off by the heat of the bed of partially consumed fuel into which the fresh coal is thrown. The hydrocarbon gases will burn with a flame of greater or less length if raised to a sufficient temperature with a suitable amount of oxygen. While they are being distilled they absorb so much heat that the solid carbon, from out of which they are driven by the heat, does not itself ignite. Its temperature is kept too low for combustion. When the hydrocarbons have been evaporated, the solid carbon begins to acquire heat from its position on the hot fire below, and soon it acquires the temperature of combustion and begins to combine with the oxygen passing by and to glow with its own incandescence. Its future behaviour is simply that of the solid carbons first named.

Engineers are more concerned with the behaviour of the hydrocarbons. These, as explained, burn with a flame of greater or less length according to character and temperature. Thus certain Welsh coals of a so-called smokeless variety burn with a short flame. This flame is short because the hydrocarbons, whose combustion causes the flame, are burned in a short space. Hence it is that, even when the boiler is placed near to the fire surface, these coals will often burn without smoke. The long flaming bituminous coals give off hydrocarbons, either of such large volume or peculiar constitution that they require much greater space in which to complete their combustion. It is essential that this space should be of such a nature as to its surroundings, that the temperature of the burning gases shall be kept sufficient to ensure continuous and perfect combustion. If this be not done the hydrogen may, perhaps, burn, but the carbonaceous particles will not burn but will be separated out in the flocculent form as soot. It seems probable that the worse the condition the longer will be flame up to a certain point; that is to say, if the cooling effect is moderate, so as not to extinguish the flame altogether, this may continue many feet, but if the cooling is rapid, as when the gases are sent directly from the furnace between cold water tubes, the flame will be at once extinguished. Where the furnace is entirely of a non-heat absorbing nature, the combustion will be rapid and the flame will be reduced in length. If the process of combustion of bituminous fuel be analysed, some idea may be formed of what really occurs.

When carbon is burned to its first oxide it develops 4,415 British thermal units per pound. When to its second oxide it develops a total of 14,647 units, or 10,232 units more. The difference is 10,232 − 4,415 = 5,817 units, and it is usual to look upon this as the latent heat of evaporation of carbon. This is not known to be true, the opinion of Berthelot being that the latent heat is some further amount, which he terms ϵ. The commonly-accepted figure of 5,817 is at least less than the truth, and may be used in the present Paper. In a piece of bituminous fuel the whole of its constituents are solid. There is solid hydrogen as well as solid carbon in the hydrocarbon gases which are distilled from the coal. Before these solid substances can become gaseous they must be supplied with the latent heat necessary to vaporise them. The chief absorber will be the carbon. Of each pound of coal in a furnace, let a sample be assumed containing 50 per cent. of fixed carbon and 33⅓ per cent. of volatile carbon, the remainder being hydrogen, oxygen and nitrogen. Neglecting everything but the carbon, it is obvious that the heat generated from the fixed carbon will be 7,324, or $\frac{50}{100}$ of 14,647 thermal units. To vaporise the volatile carbon will require 1,939 thermal units, or 33⅓ per cent. of 5,817 as a minimum.

The net quantity available at the grate is thus only 5,385 B.T.U., and this amount is all there is to produce the temperature of the furnace products. This will barely give a third of the temperature given by solid carbon, and even this is subject to some reduction on account of the vaporisation of the hydrogen and other gases from the solid. Generally, with bituminous fuel about half the fuel burns at the grate and half is volatilised, and the heat available per pound of products is one-half available to give temperature and one-half absorbed in volatilisation. If, therefore, the volatilised portions could be removed without combustion the net heat would be very small. But where the volatile portions are finally burned the total heat of the fuel is finally secured, but considerable space is necessary.

It seems probable that per pound of fuel about one-fourth only of the total heat capacity is secured at the grate, and the remaining three-fourths along the total path of combustion, and this path must not be cooled below the temperature proper to combustion, or there will be smoke and loss.

If the various boiler settings adopted in practice be examined, it will be found that very scant attention has been paid to the question of the continued combustion of the bituminous fuels beyond the grate. Internally-fired boilers are well arranged as regards the form of furnace, and the direction of flow of the gases over the length of the fire. Mixture of the gases is well provided for, and space is provided for their continued combustion beyond the bridge, but the arch of the furnace is water cooled, and the internally-fired boiler is thereby brought down from an easy smokelessness to a critical position of being smokeless or the reverse, according as the condition of the draught and the fire may decide. As though to render the critical position one of certain smokiness, boiler makers have long persisted in placing water pipes across the flue tubes. These baffle and extinguish the flames, and have never yet been shown to have a good effect, even on evaporation. As a fact, they are worse than useless in this respect and an incentive to smoke production, their evil effect being well seen by comparing the condition of the flues in Lancashire boilers with and without these useless encumbrances. There is considerable difficulty in lining the furnace of a Lancashire or other internally-fired boiler with fire-brick so that the water-cooling effect may be prevented, because the lining would so much reduce the furnace diameter. This, however, should prove successful.

In the ordinary setting of the water-tube boiler is seen the absolute apathy of engineers, and their neglect of sound principles. The simple form of water-tube boiler, consisting of a number of inclined tubes, is set directly over the fire grate. From every square inch of the grate surface the gases of combustion rise vertically upwards, proceed at once between the tubes, and combustion is promptly extinguished. Here, even if given draught and a sufficient total air supply, smoke is inevitable. First, there is no general sweeping action of the gases over the whole grate area, and there can be no mixing of volumes containing too much air with volumes containing too little. This is the fault of all boiler furnaces where the gases rise vertically from the grate. In the short distance from grate to water tubes, even a short flaming Welsh coal will not always sufficiently complete its combustion as not to smoke, for so soon as the gases enter between the tubes, they are practically extinguished, and soot is formed. Belleville tried to agitate the products of combustion by forcing in jets of air to mix everything up in the small space of the furnace, but this expedient was very partially successful, as might be expected, and though best Welsh may be burned at moderate rates of combustion with little smoke, an ordinary bituminous coal cannot. Yet the ordinary water-tube boiler lends itself exceedingly well to a smokeless setting. In the first place, the grate requires to be arched over with a fire-brick arch occupying the place of the lower row of tubes. The boiler itself requires to be raised about 4ft. higher than the usual position, and the gaseous products of the furnace having been compelled to sweep over the length of the fire, are turned back under a second arch which springs forward from the back wall of the furnace, and a large combustion chamber is thus formed, entirely surrounded by fire-brick lining, whence the now perfectly burned gases escape to the water tubes. Admission of air above the fire appears to be essential, as was pointed out by Wye Williams years ago. Thus the water-tube boiler, hopelessly smoky in its usually accepted form, can more easily be made certainly smokeless than can the usual forms of internally-fired boilers.

The usual form of water-tube boiler and its setting, so blindly adopted by electrical engineers, had its origin in the anthracite burning localities of the United States. Pennsylvania anthracite is so entirely carbon that it will produce no smoke under any conditions. In another form of American water-tube boiler, which is an outcome of more westerly or soft-coal areas, the setting is different, and involves more or less fully the conditions above described as necessary. This shows the influence of environment, while the failure here of the anthracite mode of boiler setting again points to the absurdity of attempting to employ American methods outside America without proper consideration of the facts involved. The smoke nuisance from water-tube boilers has been so great that the fault has been laid on the principle of water tubes, whereas it is simply a fault of improper brick settings.

The small tube boiler may be similarly considered. Here, again is ordinarily found a large fire grate from which the gases rise directly amongst the tubes. The furnace is approximately triangular in cross-section, the grate forming the base, and the two sides being formed by the sloping walls of cold-water tubes. Such a boiler must inevitably produce smoke, for there is no mixture of gases and no attempt to conserve temperature to the period of total combustion.

In the boiler of Mr. Jas. Weir, without any increase in the breadth of the boiler at the ordinarily widest part—the grate level—the tubes have been differently spread, so as to form the usual triangular furnace by means of a single row of tubes only, and between this wall of tubes and the main body of tubes space is formed to give a fairly commodious combustion chamber. Both the walls of single tubes and the first rows of the main body of tubes are enveloped in fireclay blocks, in order that the boundaries of both furnace and combustion chamber shall be of non-heat absorbing material. The gases which rise from the furnace have to pass over the top edge of the furnace wall in order to enter the combustion chamber, in which their flow is downward, so that they may escape among the tubes by passing below the edge of the second fire-block wall. The products of combustion are then doubled back on themselves in entering the combustion chamber, and a mixing action is secured similar to that in the long furnace of the internally-fired boiler, and the correctness of the principle is demonstrated by the smokelessness of the Weir boiler, and it is very interesting to watch through the sight holes

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provided for the purpose the clearing effect of the above fire-air admission.

Smoke represents loss of fuel, but in the ordinary boiler furnace its prevention can only be secured by the employment of so great an excess of air that loss ensues, and usually the best results are obtained from a boiler when smoke is allowed. As just stated, one reason is the more moderate supply of air. With a refractory-lined furnace a high temperature is secured, and the flame of bituminous coal is shortened, so that even the long flaming coals appear to complete their combustion within a few feet of the fire. Such coals as the best Welsh "smokeless" have naturally so short a flame that they burn off within a very short distance of the fire, thereby securing that high temperature which is essential to keep a flame short. Thus, the shorter the flame from a coal, and the easier it is to keep the flame short. Where a bituminous coal is seen to produce flames extending 60ft. or 80ft. round the flues of a Lancashire boiler, this must not be taken to indicate the impossibility of smokelessly burning such coals in a proper furnace and a combustion chamber of comparatively short length. The very long flame simply indicates that the cooling effect of the boiler plates has served to prolong the flames, but has not been sufficient to cool them to the point of extinction. The prolonged combustion implies slow combustion. Higher temperature would shorten the period of combustion.

The general correctness of the principles enunciated are exemplified in the locomotive. Though surrounded with cold plates, the sharp draught of the locomotive boiler causes the production of a high fire-box temperature, but the gases from the grate pass so directly into the cold tubes that the locomotive form of furnace is a very smoky one. But an arch of firebrick is thrown across the box from side to side, springing from the tube plate below the lowest tubes, and compelling all the products from the grate to travel round the higher edge of the arch, meeting a stream of fresh air entering at the door and completing combustion in the upper half of the fire-box. The path to the cold tubes has been greatly lengthened by the arch, and the gases have been made to travel together, and mix with air, and the result is more perfect combustion, and a well-managed locomotive does not smoke when running under draught.

Though for years all this evidence has been before engineers, it has apparently had no effect with the boiler arrangements of almost all modern power stations. First, the badly-set boiler is laid down, then follows the period of smoke and fines, and the aid of mechanical stokers, of steam blowers and other palliatives is sought in mitigation of the evil. Some of these things introduce other evils, notably loss of economy, as noted above. Others, as mechanical stokers, which might be very successful under properly-set boilers, fail under badly-set boilers, and gain a bad reputation undeservedly. The whole trouble is, of course, in faulty initial design. The one object of modern practice seems to be the crowding of heating surface closely upon the fire, to the entire neglect of the production of the heat it is sought to utilise. If the many unsuccessful attempts to prevent smoke when burning bituminous coals be examined, it will be found that they fail on the point of temperature. Air admission and the mixture of the furnace gases has been frequently tried, but has failed wholly or partially because of lack of temperature. Forced draught has more or less remedied many cases, because it has helped to create more heat per unit of furnace volume. Masses of incandescent brick have effected partial remedy, because they have assisted to transfer heat from periods of ample temperature to periods of insufficient temperature. Mixture of the gases to be burned with air, a sufficient temperature, and an unimpeded space for combustion to complete itself, appear to be the essentials. The first is neglected where the gases rise vertically from the grate, though the error can be subsequently rectified. The second can only be secured by keeping the burning gas from contact with heat-absorbing surface for a sufficient time to enable combustion to become sufficiently complete. The third is what is neglected in all cases, where heat-absorbing surface is brought too near the grate, and is exemplified in the cross tubes of the Lancashire boiler, the fire tubes of the locomotive when the brick arch is absent, and the water tubes of all the improperly set water-tube boilers.

The efficiency of heat-absorbing surface is very great. A bank of water tubes having an area 27 times that of the fire-grate will absorb the heat from a brilliant fire of smokeless Welsh coal burning at the rate of 40lb. per square foot of grate per hour and send the waste gases away at 600°F. If the circulation of water in the tubes is good and rapid, the temperature of the fire being 2,500°F., there is no necessity to be in a hurry to crowd heat-absorbing surface upon the fire. It is better to attend to heat production and perfect combustion. This secured, the heat-absorbing surface will remain clean and do its duty. Unless such conditions are fulfilled, the smokeless combustion of bituminous coal cannot be economically and certainly carried out. With these conditions fulfilled, smokelessness is certain. Bituminous fuel has a higher calorific capacity than anthracite where the proportion of ash is alike, and it will give a calorific effect just in proportion to its composition, but on account of the heat absorption of its volatile half the grate or actual solid fire temperature may be less than half that given by anthracite, while the locus of heat production will be extended to the length of the flame. In fine, there is nothing in smoke prevention that justifies the frequent assertion of its impossibily, and it is lamentable that at this late hour engineers and teachers of engineers should stultify their teaching by practising the opposite from what they teach or are taught, in disregard of the obvious scientific principles that underlie the processes of combustion.

It is distinctly a misfortune that, through business aptitude and the capacity to effect sales, the most successful water-tube boilers have been of American origin. It originated in the hard-coal district of the United States. This hard coal is a pure anthracite that will not—cannot—smoke under any conditions. The water-tube boiler introduced from America was an outcome of this hard smokeless coal, and has been set to work in this country to burn bituminous fuels with no variation in the setting or surrounding brickwork, and with a callous indifference to the fuliginous effects of such futile arrangements, that might be perhaps excused in a mere dollar-hunting American possessed of no consideration for this country beyond the dollars he could make out of it. But the list of engineers who have swallowed the American system whole includes, or has included, presidents and past-presidents of supposed learned societies and professors of engineering, who must surely have known better than they worked. The water-tube boiler is not necessarily a smoky boiler, even if its present form did originate in the anthracite zone. It can be set smokelessly even with less trouble than most other forms of boilers, and the reason why it has been so arranged as to foul the atmosphere is indefensible carelessness and a neglect of the plainest teachings of chemistry and physics. Smoke production, in short, is the outcome of methods of combustion from which nothing except smoke can be expected. Steam boilers are, in fact, arranged very much on the lines of the lamp-black factory. Perfect combustion can as easily be secured by following lines that are correct.

THE SOLIGNAC BOILER.*

BY W. H. BOOTH.

The failure of the Belleville boiler to give satisfaction in the navy has directed attention to the question of circulation in water-tube boilers and emphasised the importance of avoiding obstructions in the course of the water tubes. In the Belleville boiler the inclination of the water tubes is very slight; their length approaches 100ft., and in the course of this length there are very many right-angled turns which offer much resistance to circulation, and have been largely responsible for the failure of the boiler.

Some time ago the Solignac boiler was brought to my notice, and impressed me with its novel and ingenious construction. A small boiler was lately put in my hands to test, and some very instructive figures have been obtained. The boiler tested by me had a small steam drum maintained about half full of water. The lower part of the drum communicates with a flat header, whence issue 113 small tubes about 1in. internal diameter (25mm.). These extend to a length of about 4ft., and are bent back on themselves in the form of a round-pointed V, and brought to a second header attached to the upper part of the steam drum. The tubes, therefore, discharge above the water level in the drum. The lower end of each tube is closed by a brass nozzle with an opening of about $\frac{1}{4}$in, and the openings from the steam drum to the three divisions of the lower header are of small area. As during tests each tube dealt with about half a gallon of water per minute, it is obvious that the flow through the nozzles must have been very rapid. Half a gallon would measure about 140 cubic in., and $2\frac{1}{3}$ cubic in. per second, which the rate of flow represents, would demand a velocity of 5ft. per second through a hole of $\frac{7}{32}$in., which was the actual size of the nozzles of the 113 tubes. The flow in the lowest row of tubes would be greater than the average. As no evidence of overheating could be found on any tube, it is evident that the flow through the nozzles was sufficient to maintain the pipes cool.

The principle aimed at is to secure a supply of water not seriously greater than the tube will evaporate, so that very little water is discharged with the steam, and the head-producing circulation approximates to the height of the water level above the tubes. That circulation is steady and uniform is shown by the extreme steadiness of the water level in the glass gauges. It is well known that rapid movement of either steam or water over heating surface is favourable to efficiency. In the Solignac boiler tested the ratio of heating surface to grate surface is only 37 to 1. Yet this small surface gave an efficiency of heat absorption of over 60 per cent., with a rate of coal consumption of 43lb. per square foot of grate surface, a rate that was obtained with a draught of only 1in. of water gauge at the base of the chimney. A volume of $2\frac{1}{3}$ cubic in. of water, when converted to steam at an absolute pressure of 150lb. per square inch, has a volume of 431 cubic in., hence the mean velocity of flow of steam in the tubes is fully 46ft. per second. With hot feed this boiler, with 10 sq. ft. of grate surface, will deal with at least 4,000lb. per hour of

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water, and will produce that amount of dry steam. Probably some of the tubes deliver superheated steam to the drum. A suitable diaphragm separates the steam outlet from the discharge of the tubes, and the driest steam comes in above the moister steam and assists to dry the whole. No trace of moisture is to be found when discharging 4,000lb. of steam per hour to the atmosphere.

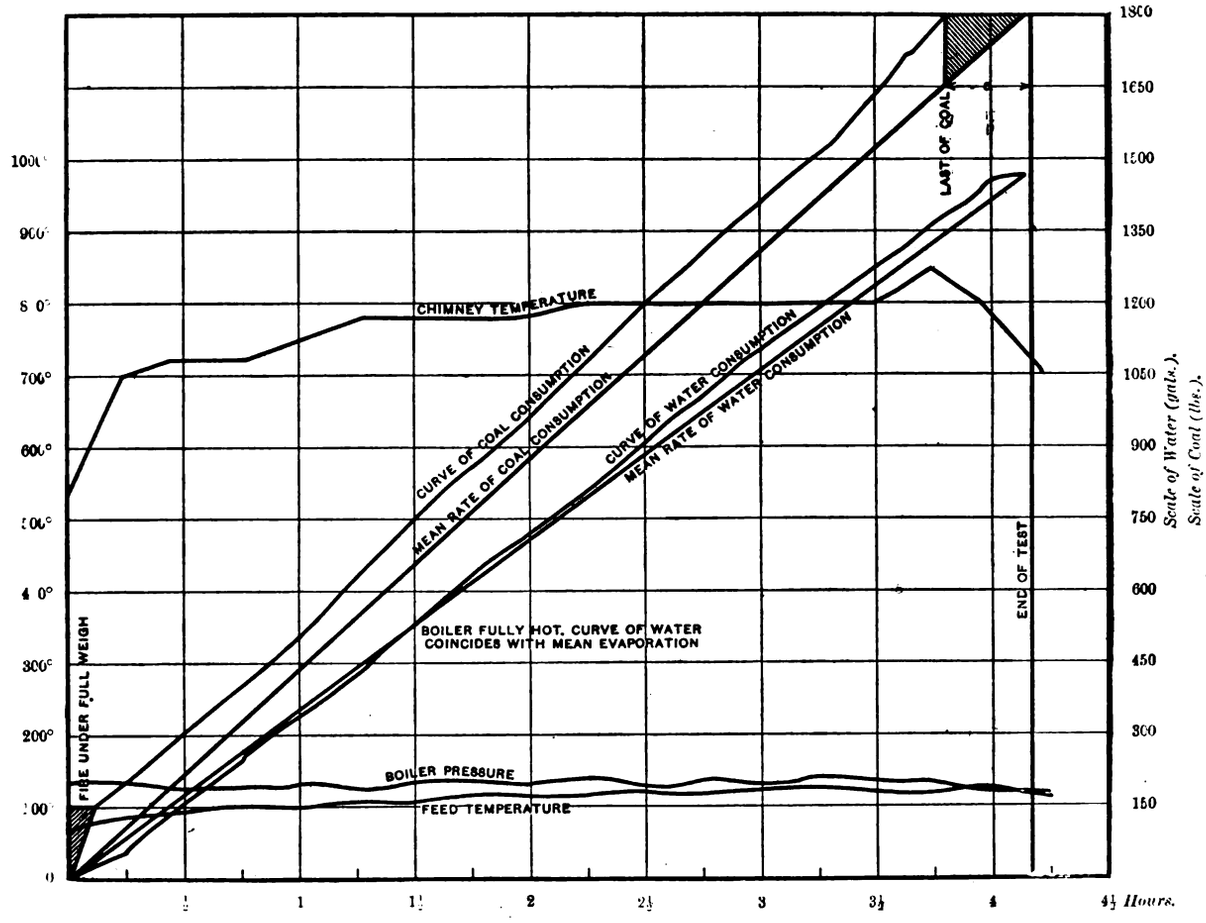
In the small boiler referred to the whole floor space occupied is only 27 sq. ft. If supplying steam to a good compound engine on a steady load, the boiler would thus produce steam for 250 I.H.P. from hot feed at 212, and should produce more with a higher draught than 1in. It might, therefore, be called on to supply steam for 10 I.H.P. for each square foot of floor space occupied, or about 1 I.H.P. for each cubic foot of total volume contained within the casing.

Such an output is exceedingly high, and points to the value of the boiler as a steam generator for small vessels of the torpedo boat type. Steam can be raised from cold water in a few minutes, the water contents of the boiler being small. This rapidity of steam raising points out the boiler as an extremely useful adjunct to an electric light or power station. By the aid of a couple of shovels of fire from a working boiler, the use of a steam jet or fan draught, and a few gallons of hot water from another boiler or from the ordinary hot feed, this little boiler, in five minutes, could be pouring out steam at the rate of 3,000lb. or 4,000lb. per hour with regularity. The water necessary to fill the boiler, if taken direct at full temperature from one of the working boilers, would scarcely affect the water level of the large boiler. These characteristics, then, render the boiler particularly well suited to deal with the sudden accession of load demanded by a fog in a lighting station. They also show its fitness for dealing with the brief peak of the ordinary night load, a peak which has hitherto been surmounted by the clumsy aid of the thermal storage, the employment of batteries and the investment in large boilers of the ordinary type, which must be got under steam by a slow process some considerable time before the load comes on, and remain hot with more or less unconsumed fires for a long time after the load has passed.

The Solignac boiler contains little water, and, consequently, very little heat, and when the fire has been burned down the boiler quickly resumes a state of rest with little loss of stored heat. It will be noted that the employment of nozzles at the water entrance of the tubes is somewhat similar to that of the Belleville boiler, but the tubes of the Solignac boiler are so short and free that the circulation never attempts to reverse, as in the Belleville, when steam is being generated, but the movement is continuously forward and upward, the small size of the tubes ensuring the progression of the alternate plugs of steam and water towards the point of discharge. Carefully-conducted tests have demonstrated that the Solignac boiler will continue hour after hour to produce steam with unfailing regularity, as evidenced by the maintenance of uniform water level and the regular consumption of weighed quantities of 50 gallons of feed water.

It has been suggested that the efficiency of a boiler should be measured by the product of its equivalent evaporation from and at 212 per pound of coal, and the evaporation per square foot of heating surface. Calculated on this basis, the figure obtained for the Solignac boiler is over 114, where the rate of coal consumption is 38¼lb. per square foot of grate per hour.

Most water-tube boilers have a heating surface 50 to 70 times their grate surface, the latter number being the ratio of a Thornycroft boiler. With a coal consumption of 66·8 per foot of grate, the Thornycroft* boiler evaporated 8·51lb. per foot of heating surface with an efficiency of 66·6 and a performance factor of 87·4, the heating surface ratio being 1·878 greater than that of the Solignac boiler, and the coal consumption per foot of heating surface, therefore, being 1,530/1,878, or 0·8146 that of the Solignac. At 29·8lb. of coal consumption per square foot of grate per hour the Thornycroft boiler had an efficiency of 78·2 per cent., an evaporation of 4·71lb. per foot of heating surface, and a performance factor of only about 56. These figures are very striking testimony for the Solignac boiler, which is unrivalled as a generator of steam per unit of floor area or volume occupied, and teach the importance of rapid movement and the necessity of arranging the tubes to give that movement. They also show the soundness of the principle of limited water admission. It is not here intended to argue that steam is a better heat absorber than water, but that by limiting the supply of water the velocity of movement is ensured in well-arranged tubes, and the efficiency of the heat-absorbing surface is increased.



Priming in steam boilers is due to ebullition of the mass of water in the boiler, steam rising through the water surface and carrying upwards with it films of water. In the Solignac boiler, as in all which deliver their circulation water above the water level in the drum, there is no priming, the water which circulates with the steam being thrown down upon the surface of the water in the steam drum, parting with its steam above that level. The water in the drum remains quiescent, and only enters into ebullition should the steam pressure fall quickly, when, of course, the surplus heat in the water is given up in the steam which escapes owing to the reduced pressure. The inventor of this boiler, who, unfortunately, died during the time

* See *Trans.* Institution of Civil Engineers, Vol. XCIX.

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	June 20.	June 21.	June 21.	July 8.	July 28.	July 28.	July 29.	July 30
Draught. Water gauge ..... inches.	¾	¼	1	1	¾	1	½	0·91
Boiler pressure ..... lbs.	139	133	127	135	135	132·2	134·3	134·4
Feed temperature ..... degrees F.	62°	64°	64°	69°	69·6°	109·4°	118·4°	120·8°
Coal per hour	345	196·9	425	382·6	342·2	132	325	391
Grate surface ..... sq. ft.	10	10	10	10	10	10	10	9·66†
Coal per sq. ft. of grate surface per hour ..... lbs.	34·5	19·69	42·5	38·26	34·22	43·2	32·5	39·6
Water per lb. of combustible from and at 212deg. ..... lbs.	10·47	10·758	10·84	10·65	10·48	9·78	10·22	9·61
Heating surface ..... sq. ft.	372	372	372	372	372	372	372	295·4*
Water per sq. ft. of heating surface from and at 212deg. per hour..... lbs.	9·32	5·38	11·92	11·68	9·22	10·84	8·61	12·47*
Grate bars	French	French	French	French	French	English	English	English
Evaporation per sq. ft. of floor space per hour from and at 212deg. ...lbs.	128	74	164	147	127	149	118	136
Mean rate of heat transmission per sq. ft. of heating surface per min. B.T.U.	150	86	192	172	148	175	138	201*
Performance factor	97·6	57·8	129	114	96·6	106	88	120*

* These figures are based on a different computation of heating surface, the Vulcan Company deducting the curved portion of the tubes where clustered so close that the gases do not travel between them. † My own actual measurement was 9·935 sq. ft.

I was engaged in testing it, held that a tube which evaporated 10kg. of water per unit of length was less cooled by the water than one which evaporated 20kg. In the one case he held that the surface of the tube was cooled by the absorption of heat by the water, and in the other case it was cooled by the giving up of heat to water that was in rapid motion, and ready to absorb heat in becoming steam. He then constructed his boiler with three principles in view: (1) The presence of the diaphragms with small perforation to avoid choking the tubes with water; (2) the cleaning by reverse flow of steam, which is effected by closing the water supply cocks on the down-comer to the lower header, and opening the lower blow-out cocks, which permit steam to flow back through the tubes to the blow-out; (3) the whole bundle of tubes and the steam drum are so constructed and carried that they can be turned out of the casing for examination in a few minutes and replaced as readily. This is effected by carrying the drum on two hinged columns. By removing the securing cotters the whole boiler can be let out of its casing, every tube examined and the interior lining of the casing examined or replaced or repaired with ease in every part. For convenience of repair, blow-out, &c., the tubes are set in several headers—three in the case of the boiler tested by the author.

The salient features of the various tests are given in the above table. The first five tests were made with a grate having narrow air spaces between the bars, and the bar surface was divided into ¾ squares by transverse air slots. The other two tests were made with a plain straight English bar with ½ air spaces. While easier to clean, it did not so well distribute the air, and the fire burned sooner into holes and the efficiency was less. A notable feature is the evaporation per square foot of floor space. This is one of the most valuable features of the boiler looked on as an emergency boiler or for use in torpedo boats, because it enables so large a steam producing capacity to be placed in a limited space. During the progress of the tests, both coal and water were supplied in small weighed quantities, in order that the curves of consumption might be drawn with fair accuracy, and these show how exceedingly regular was the performance by the boiler. There is, of course, very little reserve of heat in the small amount of water contained in the steam drum, and variations in the demand for steam are therefore to be met by varying the draught so as to vary the rate of fuel consumption. The whole of the seven tabulated tests were run with the best Welsh coal, Nixons, or Powell Duffryn. The amount of smoke was slight, there being a fair height above the grate before the gases entered the tubes. The maximum heat transmission of the Thornycroft boiler per minute per square foot of heating surface was 153 B.T.U. This figure is much below several tests of the Solignac boiler except that with ¼in. natural draught only.

In addition to the tests made by myself, the boiler has also been tested by the Vulcan Insurance Co., with very similar results. In these tests an Orsat apparatus was used to analyse the gases at the base of the chimney, and the following somewhat remarkable results were obtained :—

CO	1·17	per cent.
CO	12·66	,,
O	5·54	,,
N	80·63	,,
Total	100	per cent.

The amount of free oxygen is thus very small, and corresponds with a total weight of gases per pound of coal of 15·85lb. only. The carbonic oxide is a little large in quantity, showing, to some extent, imperfect combustion; but this trial was made with a fire thicker than employed on previous trials, and perhaps a little too thick for the intensity of the draught. With a little more draught, the proportion of carbonic oxide would have been reduced. Still, when one takes into consideration the small proportion of excess air over that chemically equivalent to the fuel, a small proportion of carbonic oxide is allowable, seeing that there is, perhaps, less loss by its production than would be incurred by chilling the boiler tubes by admitting such an excess of air as would have eliminated the carbonic oxide. The only source for air admission in the boiler, excepting through the grate, was by the furnace door. This was perforated, and was a loose fit, and, after firing, was also kept slightly open for some time, so as to admit a sufficiency of air for perfect combustion. It appears to me that, if we had also made provision for admitting an extra supply of air at the back and at the sides of the fire grate, we might, with advantage, have diminished the amount of air admitted to the door, so that, without admitting any greater excess of air than at present, we should have distributed it more perfectly throughout the furnace and have obtained perfect combustion with the same thickness of fire and without any greater over-supply of air than shown in these tests. The rate of coal consumption per square foot of grate per hour during the boiler company's test was 39·61b., and the evaporation per pound of combustible from and at 212deg. was 9·611b. The efficiency of the boiler was 62 per cent. Other tests were made by the insurance company at different draughts and with different thickness of fire, and they are all consistent with the figures obtained by myself; indeed, one of the most striking peculiarities of the boiler is the extreme regularity in its performances and the ease with which accurate results can be obtained when testing it. The Vulcan Insurance Co. have given a slightly different figure for the grate surface than that given by myself, but this is not material. They also measure the heating surface in a somewhat different manner, not having allowed any credit for the curved portion of the tubes where these are clustered closely together, and so arranged in the boiler that there is no circulation of the hot gases between them. The column of figures referring to their test are, therefore, not exactly comparable with my results in every particular. The calorific capacity of all the coals throughout the tests is practically 15,000 B.T.U.

CORRESPONDENCE.

AN ALL-STATIONS EXPRESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I express my indebtedness for the publication of my letter and also my appreciation of your comments on it, especially upon the great need of a better correlation of express and local services and the unaccountable obliviousness of railway directors to this need. Let us hope they may come to see it in good time.

In a journal of so much importance as *The Electrician*, editorial criticism is serious. May I, therefore, reply to your question as to what traffic regulation will apply where the driver of the car in advance sees a sleeper on the track while he knows the main train is coming on behind him.

He must stop at once, on the assumption that if he can see a small and dimly-illuminated object like a sleeper on the line, the driver of the main train will be infinitely more likely to see so large and brilliantly-illuminated an object as the car ahead, for which he is indeed looking out at the time, and will stop also if he have room. His distance indicator will also inform him; and, if required to assist his judgment, a special rear signal might be automatically switched on by the brake mechanism, indicating the intention to stop, just as the London cabby holds up his whip in a similar case.

If the main train driver has not room to stop, then his train and the advance car are as one train, and the consequences would not differ widely from those following the meeting of an obstacle on the track by the ordinary train of commerce.

More than ordinary exemption from the consequences of such accidents has not yet been claimed for my scheme, but

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in the circumstances you describe I think I might almost claim it.

Suppose the driver of the car in advance fails to see the sleeper; his car may be wrecked and his passengers injured, but these are only a fraction of the passengers travelling on that section.

Those in the main train would escape scatheless in all the many cases in which their driver had either seen the wrecked car or had been warned by his distance indicator that something was wrong in time to avoid a serious collision. The car in advance would have, in fact, played the part of the pilot engine used when Continental royalty travels, and so saved the main train. Yours, &c., J. BROWN.

Longhurst, Dunmurry, Belfast.

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) and St. Marylebone Borough Council.

ARBITRATION.

The cross-examination by Mr. Fletcher Moulton, K.C., of Mr. JOHN CONACHER was continued after a brief interval on the sixth day of the proceedings: —

Mr. MOULTON: Now, I am not going to deal with the propriety of the 3½ per cent. interest, or the propriety of the 1 per cent. depreciation. That will come later. But 1 per cent. depreciation is, shall I say, used by you as a rule-of-thumb, fair allowance to be made for depreciation. Is that so?—We take the 1 per cent. as a very proper allowance to be made by a company in our position to ensure that, when the option to purchase on the part of the local authority arises, the purchase money which we may receive under the provisions of the Act of 1888 shall, with the accumulated fund arising from the 1 per cent., ensure that our holders shall receive 20s. in the £ for what they have expended. We, of course, assume that all the plant and works will be kept up in perfect condition out of revenue year by year.

Although it be kept up, and what is called ordinary depreciation is charged for, that does not keep it at its constant value?—In our opinion it does. Having regard to the terms of the Act of 1888, that provision is sufficient to ensure a return of the capital to the shareholders.

You know plant gets obsolete. Is such a thing as that allowed for in the 1 per cent. depreciation?—But our plant is not obsolete so long as it does the work which it is there to do.

You do not provide for anything of that kind out of depreciation?—No, because if we saw our way by some future discovery to very much reduce our expenses by providing other plant, of course, the economy which the use of such improved plant would bring about would cover the interest on the additional capital.

And you have no allowance for depreciation on plant at all in this 1 per cent.?—No, because our practice is to charge to revenue year by year everything that it costs to maintain our plant in perfect working order.

And for the purchase of new plant?—For the purchase of new plant. If plant is to take the place of existing plant of a similar character, that would be a charge against revenue. If that plant was intended to introduce a new state of things and to lead to great economy, then we should look for the interest on the cost of that new plant to be found out of the greater amount of profit we should earn.

Will your books show what purchases of plant you have charged to revenue and what to income?—Yes, the books will show everything we have done.

Do you put this 1 per cent. to a depreciation fund?—We do.

What do you write against that fund?—Nothing. We did in the early years write something off against it, including the depreciation upon the plant which was removed from Manchester-square, but since that time we have made no charge whatever against it, and we invest that fund year by year.

Taking purchases of plant to replace other plant, and excluding that case which was posted to depreciation account, have you ever paid for plant out of revenue?—There has been no new plant purchased to replace old plant worn out. What has been done has been to convert or exchange the old alternators for continuous-current generators, and the cost of the continuous-current generators, apart from the steam plant, has been charged to capital account as being expenditure, which will be fully met by the increased profit which the company will earn.

Then, with the exception of the Manchester-square case, all your plant, whether it supersedes other plant or not, is debited to capital?—Yes, because we have never reached the time at which any of the plant has had to be removed because it was worn out.

Now I come to the table regarding depreciation for machinery. What have you allowed for the existing machinery?—We have grouped the whole of the machinery, including that which is to be completed this year, at the average rate of 1 per cent. per annum.

Just give me the figure?—It is the difference between £462,353, which you will see is the total cost of all the plant described, and £305,153, which we put down as the value in 1931. We have allowed £157,200.

You say that the value in 1931 of the existing machinery of the company in Marylebone would be £305,000?—Not of the existing machinery necessarily, but of the existing machinery plus any renewals of it which may have taken place during that time—renewals provided for out of the rate of working expenses and renewals set out in our table.

What is your figure for maintenance and renewals?—56 per cent. for the current year for working expenses, maintenance and renewals. You cannot have the items separately. Of course, our accounts will show how much we have spent on plant.

You have told us there is not a single purchase of plant put down to renewal fund?—Not of plant as a whole, but many parts are renewed. We are constantly renewing the parts of our electrical generators, and we are renewing parts of the steam plant constantly, and we charge all to revenue.

You do not suggest that you could keep up all the value of the existing plant by merely such renewals as have taken place and charged to revenue in the past?—No, we do not claim that. We admit a depreciation of £205,000 in the existing plant in the course of 30 years over and above what may be spent upon it year by year in keeping it up to the mark.

I was dealing with the machinery. I put to you that to take the value of the existing machinery at £305,000 at the end of 1930 requires a little explanation?—It is, perhaps, more an engineering question, but I have had a great to do in my time with the control of plant connected with large undertakings. So long as plant is adapted for its work it can be kept in perfect working order by the renewal of parts or the renewal of the whole when the time comes. I know very large stationary engines just now that have been at work 60 years, and are doing more work to-day than they did when they were first put up.

I see that £144,000 is for mains exclusive of continuous current mains in one district—that is to say, mains that are no longer going to be used?—Oh, no. Only some part of it represents the extra high-tension mains.

I suppose transformers and the mains to supply the house transformers are valued here?—Yes, as a whole, they are an element in the value.

But in a large portion of the area the whole of those are going to be thrown out of use?—Yes.

And you have taken only the ordinary charge for renewals, if there is any charge, and the 1 per cent. to make up for all that?—The engineers will, I think, be able to produce specimens of the mains and will show upon what grounds they are satisfied that the 1 per cent. which we have adopted is a sufficient allowance. The whole assumption is that the business will be carried on in the future on the existing conditions.

The UMPIRE: The result of Mr. Conacher's evidence is, to my mind, that that plant, with such repairs and renewals as can be done out of revenue and their ordinary working expenses, will not depreciate to more than the extent of 1 per cent. per annum. To Witness: Is that a correct representation?—So far as the existing plant is concerned we set aside a sum at that rate to ensure that there shall be no deficiency in our capital at the end of the term. So far as additional capital which will have to be brought in to meet the growing business is concerned, we allow 1 per cent., which, invested at 3½ per cent., will give a very much larger sum at the end of the term. We make no claim at all in our statement of the value of future profits for the interest which the gradually increasing accumulation fund will give. That goes to the benefit of the purchaser, so that the 1 per cent. per annum on the additional capital represents a very much larger sum than the total of the sums set aside year by year.

Mr. CRIPPS: That was not the learned Umpire's question.

Mr. MOULTON: You told us 1 per cent. on the additional capital was because of the purchase term at the end of the period of your powers, so that that, added to what you got at the end, would make up your capital?—I did not say it would just make it up; I say it is a fund to make sure there will be no deficiency. We believe it is too much.

It is put aside for that purpose?—Yes.

You have to put that aside as much on the £599,000 as on anything else?—We are doing.

Therefore that 1 per cent. is in respect of loss on terminal payment?—It will more than meet that loss. I have taken this figure of 1 per cent. which we believe sufficiently covers any depreciation in the value of the existing plant or the portions of it which may be renewed out of revenue year by year.

Mr. CRIPPS: The 1 per cent. is an addition. According to your view, you have made full allowances for your repairs and renewals, and this is an addition?—Yes.

You use it to meet any question of obsolete plant and things of that sort?—Worn out plant.

Now as to the item of "Cost." Cost of provisional orders and Parliamentary charges. Can you give us those four items separated out?—Certainly. They are made up of £5,233. 15s. 4d., cost of licences and provisional orders; £1,562. 3s. 2d. for expenditure on offices, including furniture at stations and offices at stations; proportion of the management and general expenditure chargeable to capital. Together these items come to £16,042. 16s. 8d., and the remainder is £7,612. 11s. 3d. paid by the company in connection with the complaints of vibration, compensation, and so on.

You have taken all as that which will have to be bought in 1931?—Partly. To the extent to which the property is of value we apportion that expenditure; we write it off in the same proportion.

"Loss of trunk line connections between Sardinia-street and Amberley-road stations, and between these stations and the stations in Marylebone. (*a*) Interest on capital expenditure saved to the company at Sardinia-street and Amberley-road stations—£34,161." Do you mean you would, if you had not had those trunk mains, have had 600kw. more stand-by plant at Amberley-road and 200kw. more at Sardinia-street?—Yes.

Without any profitable use of them except as stand-bys?—Certainly. We have had to do with less stand-bys at those two stations because of the assistance we had by drawings from other stations.

The amount that trunk mains will carry is not the measure of the amount of plant saved?—I should think it very likely the plant we have been saved is really more than the measure of the trunks, because the trunks

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can carry 200kw. in one direction and 600kw. in the other, and probably the plant, which would have had to be stored at those two stations, to do the same amount of work would have been more than 200 and 600 respectively.

You have simply taken the cost of generating plant equal to the carrying capacity of the mains?—Yes.

Then, annual saving in cost of working these two stations—how have you got at that?—The engineer will give you this and many other figures. What we are claiming for is the loss which we have sustained by not being able at Sardinia-street to draw supplies from any one of the three other stations—Rathbone-place, Manchester-square, or Amberley-road. In all matters relating to the drawing of supplies from station to station, it must be remembered that the Willesden scheme, when it was entered upon, was a scheme for a station of 27,000kw. Now that this sale has been put upon us we cannot see our way to go beyond a station of 9,000kw. output. The progress of Willesden is arrested and the whole circumstances changed. If no sale had taken place, we should have gone on with our large scheme, and I have no doubt that in the course of time Willesden would have grown up to the 27,000kw. output for which it was designed.

Now, how do you get the "Estimated cost per unit on basis of adjusted cost in 1901"?—On our experience as to the raising of the average cost per unit generated as the number of units diminishes.

What is that estimated cost?—The engineers will be able to speak to that, but I may say that, comparing the cost of working and the cost of generation in the September quarter of last year with, say, the December quarter, in the latter period the number of units generated was double the number generated in the former quarter: coal consumption went up from 8·31lb. to 10·16lb. all over, and the cost of other running expenses and repairs and maintenance from 0·33d. to 0·70d.

To conclude these tables, have you ever added up all the items of your claim?—They are added up in tables 16 and 24.

The UMPIRE: You add to the £2,425,431 in table 16 the £346,507 of table 24.

Mr. MOULTON: That makes £2,771,938 to compensate you for this compulsory sale?—Yes.

Mr. CRIPPS: We would rather have the property.

On the seventh day Mr. CONACHER was further examined by Mr. Balfour Browne, and made answer to some of the points raised in his cross-examination by Mr. Fletcher Moulton. In reference to a mass of information and documents asked for by counsel for the Borough Council of Marylebone, some particulars and papers were given and handed in, while some were refused, subject to argument. In connection with the respective scales of charges for current, the printed scales for the various districts served by the company were put in, and others were promised. The production of special contracts with certain consumers was refused.

Mr. BALFOUR BROWNE (for the Metropolitan Company) to Witness: You have been asked by Mr. Moulton how many 8 c.p. lamps equal one arc lamp and, similarly, one motor?—The equivalent in 8 c.p. lamps of arc lamps of the open type is ascertained by dividing by 32 the number of amperes multiplied by 50 volts, and in the case of arc lamps of the enclosed type by dividing by 32 the number of amperes multiplied by 100 volts. For instance, a 3-ampere enclosed lamp is reckoned as the equivalent of 10 8 c.p. lamps. A 6-ampere open type arc is reckoned as 10 8 c.p. lamps, and an 18-ampere open type arc is reckoned as 28 8 c.p. lamps. The lamp equivalent of motors is arrived at by taking the horse-power as equal to 1,000 watts to allow for want of efficiency. A 1 H.P. motor is therefore reckoned as equal to 31 8 c.p. lamps. That is, if you multiply 31 lamps by 32 watts you get 992 watts, or practically 1,000 watts, which we have taken as practically the equivalent of 1 H.P.

Then as to particulars of all plant scrapped throughout the areas of the company since 1889?—That I produce.

The UMPIRE: "Special contracts with consumers in each area." Do you object to give these, so far as they apply to Marylebone?

Mr. BALFOUR BROWNE: We have given them for Marylebone. Do not you think the other side might state a case for getting that information?

The UMPIRE: At present, without having heard either side, we think information so far as it is information referring to Marylebone ought to be given. But so far as it relates to other areas, we should want to hear some ground for a request like that.

Mr. CRIPPS: As regards Marylebone there is no objection.

Mr. MOULTON: I will state my ground very shortly. The Electric Lighting Act of 1882, sec. 20, says: "The undertakers shall not, in making any agreements for a supply of electricity, show any undue preference to any local authority, company or person, but, save as aforesaid, they may make such charges for the supply of electricity as may be agreed upon, not exceeding the limits of price imposed by or in pursuance of the licence, order, or special act authorising them to supply electricity." This is the first thing which makes the question of special contract a question affecting the whole area, because you cannot make special contracts without being prepared to make other special contracts on similar terms under similar circumstances. The next point in connection with important matter I refer you to is the contract dated October 1, 1889, between the Metropolitan Electric Supply Co. (Ltd.) and the Vestry of Marylebone. Sec. 8 says: "The price to be charged for electricity to be supplied to ordinary consumers and the Vestry shall be regulated in accordance with the West London order. But the scale of prices charged in the parish shall not exceed the scale for the time being in force in any other parish or district in which the undertakers are authorised to supply energy under any provisional order or act passed in the present session." That includes mid-London and it includes St. Martin's, and, therefore, this undertaking is saddled with this obligation: they cannot charge higher in Marylebone than in mid-London. If a person undertakes to take 10,000 units a year, and a person who does that in mid-London gets a special price, that special price just as much applies to Marylebone as it does to mid-London. This is a "most favoured nation" clause; you cannot make your price here in Marylebone higher than in mid-London. The consequence is I am entitled to examine the mid-London price for two reasons. First of all, because I want to see what the prices have been there. It is very possible the prices in Marylebone have not agreed with this, and profits they claim are profits they cannot make under their order; but still more important is it for the future, because the prices in mid-London are prices, of course, in the presence of competition. I want to show what competition has brought the prices down to there, because I can see then what the competition—even existing competition—will make the prices in the future.

The UMPIRE: I understand your argument to be that the phrase "scale of prices" in clause 8 of the contract includes the prices charged under special contracts.

Mr. MOULTON: Of course. Because this clause 8 makes special contracts not questions of fair bargain and sale, but things which everybody else has a right to claim. You have not to show any undue preference. The consequence is that the special contracts that you make bring with them rights to the public. You cannot have one customer charged less than another: therefore, in considering what price you have a right to charge in mid-London and what charges you have a right to charge in Marylebone, I am entitled to look at what you are charging other people. This was a clause which I remember at the time of the passing of the act was put in by the Government for the direct purpose of preventing preference, so that the rates which are charged to anybody give rights to other people.

Mr. CRIPPS: This is, Sir, an extremely important point in one sense, as I shall have to indicate if we are to go into this matter, it might be a very long one, in the consideration of the effect of certain special contracts, but I think my learned friend has misinterpreted the purport of sec. 20 and also the purport of clause 8 in the provisional agreement. Sec. 20 has been the considered subject of decision by Mr. Justice Buckley in 1891, in The Metropolitan Electric Supply Co. (Ltd.) *v.* Ginder. But sec. 20 has no applicability in this case at all. Sec. 20, under the Act of 1882, is only applicable to the varying consumers in one district. What was held in the particular case referred to in mid-London, where it was fought out, was that you had these same principles as regards undue preference which we have very much to consider in the Railway Commissioners' Court. It was not like the old equality clause, sec. 92 of the Act of 1845; it was a clause which enabled you to go into the question whether two people were treated on the same basis having regard to the conditions of supply, whether it is a day or night load, and all those conditions which determine if you have an undue preference or not. But my learned friend will not suggest that sec. 20 will apply. It would between two consumers in the Marylebone area, but not between a consumer in the mid-London area and one in the Marylebone area. That, therefore, brings us to the special clause of the agreement. This clause is, of course, on the face of it, entirely distinct as regards its terms from sec. 20. It says, "The scale of prices charged in the parish shall not exceed the scale for the time being in force in any other parish." It does not mean that, as between consumer and consumer, where you may have special circumstances, you are to have any comparison between the consumer in the Marylebone district and in the mid-London district. It means as regards the scale of charges, which is very well known in the case of railway freightage, that you are to have the same scale, subject to, in railway law, the special conditions when special circumstances arise. Therefore, you have the maximum charge and what is known as the scale of charges, the charges to which people are entitled in reference to whom there are no special conditions. Inside the scale you are entitled, subject to the principles of undue preference, to give special conditions where people take a quantity, and where you have a day load as well as a night load, and all those questions that affect convenience and economy of supply to the consuming company.

Now I think it is plain, looking at sec. 8 of the contract, that what is preserved as regards equality is the scale of charges. That has been absolutely equal. We say the actual charges have been equal, but I admit that, if you go into that, it means an interminable discussion practically as regards the particular conditions of each contract. That is what Mr. Justice Buckley has held in Metropolitan Electric Supply Co. *v.* Ginder—the case I referred to. That is not within the purview of this sec. 8, and, being an interminable discussion, we do not intend to embark upon it unless we are obliged to do so. Conceive what the inquiry would be, whether somebody who took so many thousand volts a day was taking them under the same conditions as somebody in mid-London. Take the case that was referred to by Lord Herschell in the Pickering Phipps' case. Competition is a thing you have to take into consideration in considering whether there is undue preference. Mr. Justice Buckley accepted the principle of those railway cases as applying in cases of electric lighting. We are dealing here with scales of charges and not with particulars and conditions within the scale.

But there is a further point, and that is sec. 3 of the agreement of May 4, 1901, made between the Metropolitan Company and the Marylebone Borough Council, as the basis on which the bill for purchase was allowed to proceed. This whole agreement is on consideration of the withdrawal of the opposition of the Council to the company's bill which was afterwards framed in what I may call the purchase bill. "On the completion of the agreement between the Council and the company and the confirmation of the order by Parliament all questions the subject of the present litigation to be treated as if both parties were perfectly satisfied." Now, at that moment there was litigation on both sides, and I apprehend the meaning of these words was as if both parties were perfectly satisfied that each, as regards their respective litigation, were to rest satisfied without that litigation being carried further; they were to be satisfied on the basis that the litigation which they had initiated was not to be carried further or pressed against the other party. Now, in that litigation this very question is raised as

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regards the scale of charges. It was not carried any further because it was a condition of the terms of the purchase bill that neither party should carry their litigation further on the points where they were plaintiff litigants. It seems to me it would be the worst possible proceeding to have these interminable discussions as to what is meant by the scale of charges. It has never been interpreted to mean any such thing as my learned friend will say, and we ask you to say that this information is not information we ought to be compelled to disclose. The matter was thoroughly threshed out by Mr. Justice Buckley.

The UMPIRE; I should not have thought it applied to the matter before us now; what I understand was what Mr. Justice Buckley was discussing what had to be made out to establish an undue preference on sec. 20. He was discussing whether sec. 20 was limited to an application by a consumer within the area of the provisional order or whether it applied between persons who were consumers under different orders. Unless Mr. Moulton contends that I do not think sec. 20 has anything to do with it.

Mr. MOULTON: Sec. 20 has to do with it in this way. My learned friend says: Confine your thoughts to a particular area. You cannot, whether you call it special contract or not special contract, give undue preference. Therefore, if you have got a scale for, I will say, according to quantity which you give to one person, anybody under similar circumstances can require to be supplied at that price A company does not get rid of the effect of sec. 20 by making separate arrangements for every supply above 200 units in the year.

The UMPIRE: May I understand that? You contend that sec. 20 applies to a case of this kind. Suppose in Marylebone everybody who does not have a special contract is charged 6d. a unit, and in mid-London people in an exactly similar position are charged 2d., do you say he can complain under sec. 20?

Mr. MOULTON: Not under sec. 20. But sec. 20 gives to consumers in Marylebone this right. If you give a rate to any person in Marylebone (it does not matter if you say it is by special contract or not), a person in similar circumstances is entitled to the same rate. Suppose the company was to say: On all supply above 200 units we will make special terms. They could not make those special contracts in a way which gives an undue preference to anybody, and the rates at which they supplied for the larger consumers would be unquestionably a scale; it would not make any matter if they printed it as a scale or settled each one, because the grant to any one person would include the right to others. I say, therefore, that for Marylebone I am entitled to see the Marylebone special contracts, because they show the prices where, under certain circumstances, the principle applies.

The UMPIRE: There is no contest that you are entitled to see the Marylebone special contracts.

Mr. MOULTON: Then take mid-London. Why do I desire to see these contracts? Because any consumer in Marylebone has a right to be treated in the same way as any other consumer in Marylebone.

The UMPIRE: That is not the ground I should take. I should have said you were entitled to see it because it is directly material to one of the matters in question here.

Mr. MOULTON: I contend I am entitled to it because, in seeing what price they can exact from people in Marylebone, based on their present system of supply, I must see what special contracts there are which fix their scale and the special circumstances. 6d. is their nominal price; 5·2d. is the actual price, so that there must be a very large proportion of their supply which is not at the printed scale. Now, that must be done without undue preference, and undue preference is a matter of substance, not a matter of mere technicality, so that I am entitled to see these contracts, because I want to see what the scale is apart from the printed scale. You may call it contracts, but it is scale and scale which deals with cases not frequent enough to be dealt with in a printed contract. Clause 8 says: "The scale of prices charged in the parish shall not exceed the scale for the time being in force in any other parish or district in which the undertakers are authorised to supply energy under any provisional order or act passed in the present session." That puts the Marylebone people in the same position with regard to the mid-London people as if it was all one area as far as sec. 20 is concerned. The scale they are using in mid-London they have to apply to Marylebone. Supposing they said it was their custom in these special contracts to give the price of 4d. to consumers of over 1,000 units, everybody in mid-London could insist on being supplied at that rate. That is the scale price for that special circumstance; but the scale price in Marylebone is to be the same as the scale price in mid-London, and the consequence is the Marylebone people can say: You must charge us that under the circumstances. As soon as you realise that the meaning of clause 8 is that a person in Marylebone has a right to the same terms under similar circumstances as a person in mid-London, then you see that I must look at these contracts to see on what scale they proceed. I am perfectly prepared to admit that there may be contracts in which the contract will be based on what you may call exceptional circumstances—in fact, you might say, on the individuality of the case, but that will not include the whole of these contracts. I believe that the nominal price in Holborn—that is, in mid-London—is the same as that in Marylebone—6d. I think we shall be able to show that the average price over the area is 4·34d., showing that that which is alone mentioned in the printed scale is not even the dominant price there, but that they must have prices used, not in single individual cases, but used over a large class of the consumers which gives a price far below what their printed scale is. If we find that this much lower average price is due to the fact that, under substantially similar circumstances, they have a lower rate of charge in mid-London than they have in Marylebone, their profits are not only smaller, but the value of their undertaking, which they have been basing on this, is also thereby smaller. Now, as to the agreement of May, 1901. Consider the circumstances. The parties have actually got litigation in which they claim an injunction restraining defendant company from charging consumers in the parish on a scale of prices for the time being exceeding the scale in force. Unquestionably they had a right to contest that; it was part of the old contract which was, beyond contest, in force. They agree that on the completion of the agreement between the Council and the company, and the confirmation of the provisional order by Parliament, neither of which events—certainly not the latter—has taken place.

Mr. CRIPPS: Yes, certainly it has.

The UMPIRE: It does not come into operation.

Mr. CRIPPS: It is confirmed.

Mr. MOULTON: This did not relate to the contracts between the parties, but to the litigation between the parties. You drop litigation, but you do not drop the contract on which the litigation is based. "From and after the completion of the purchase of the business of the company, in accordance with this act, the order set out in the schedule to this act shall be, and the same is hereby confirmed." That is a confirmation to take place at the completion of the purchase, but "all questions the subject of the present litigation are to be treated as if both parties were thoroughly satisfied." That means the litigation drops, but not that the contract on which the litigation is brought drops. The date at which the parties are to be perfectly satisfied is the date when the contract has ceased to exist. There is not the slightest suggestion that the contract is to be torn up. All the clauses of the contract go—how can one go without the whole of the clauses? It could not be intended that that contract was to be wiped out.

Mr. CRIPPS: The litigation was to cease because neither party had any immediate cause of action.

The UMPIRE: My colleagues and I having consulted, we are all of opinion that at the present time, at any rate, the Borough Council are not entitled to the production of special contracts relating to any area except the Marylebone area. We are of opinion they are entitled to the production of all special contracts relating to Marylebone area. It is agreed on both sides that sec. 20 of the Electric Lighting Act, 1882, is not a section that applies between separate areas, it was only intended to regulate the right of consumers in any particular area under any particular act or order, but Mr. Moulton asks that we should consider, in connection with sec. 20, clause 8 of the contract made between the Marylebone Vestry (the predecessors of the Borough Council) and the Metropolitan Electric Supply Co. on Oct. 1, 1889. I think it is sufficient to say at present that we think that the phrase "scale of prices," as used in that clause 8, was used advisedly, or at any rate, in our opinion, it means the normal price as charged to those persons in the parish on the one hand, or in St. Martin's and mid-London on the other hand, whose circumstances are in no sense special, or are only special in those particulars which are set out in the published scale. The published scale says: "The charge for electric energy to be 6d. per Board of Trade unit. Where the energy is used for trade purposes a reduction is made to 3d. per unit when the average consumption during the quarter exceeds 5 units per 8 c.p. lamp installed, or its equivalent in other candle-powers." Now, we think it was intended that on each of the areas referred to the charge to persons whose circumstances were such as are described in that clause should be the same, and that the questions of other and lower charges to persons who succeed rightly or wrongly in satisfying the company their circumstances were such as to justify a special low charge were left to be regulated in each area under sec. 20 of the Electric Lighting Act, 1882—that is to say, consumers in Marylebone were left to take care (having the power to do so under sec. 20) that no person was charged an unduly low price, and consumers in mid-London and St. Martin's were left in the same position; the result being that, inasmuch as the scale was to be the same in each, the special agreement would probably follow the same lines. But, I would add, though at the present time we do not think these contracts are relevant, if any case is shown, such as Mr. Moulton has suggested, that the charge in the Holborn area, or mid-London area (the average charge), is much lower than it is in Marylebone, and if that case, if made by the Borough, is attempted to be met by the company by the suggestion that the price is pulled down because the special contracts are more numerous, or the circumstances of people in Holborn entitle them to lower terms, then it may become material to see if that answer is established, and for that purpose to look at the special contracts in Holborn.

Mr. MOULTON: That is not rejection of evidence: it is simply you decline to make the order for production at the present moment?

The UMPIRE: Yes.

Mr. MOULTON (to Witness): Now I will go to the question of the basis of the tables you have put in. These tables are based on your having undisputed possession of the Marylebone area up to 1931—no competition whatever?—Yes.

There is, however, nothing whatever in your statutory position which prevents competition being granted?—Nothing.

The Board of Trade have, broadly speaking, taken as a principle that there ought to be two competing orders in an area unless the local authority is the undertaker?—That is not my view, nor is it the practice, I think. In one of our areas (Holborn) there are other companies than ourselves; in two of the areas (Marylebone and Paddington) we are there alone. There has been no practice on the part of the Board of Trade that there should be two companies established in each area.

There have been several attempts to obtain competition in Marylebone?—Yes, seven different attempts between 1897 and 1901.

In every case of threatened competition you were able to keep it out by the support of the Vestry?—I cannot say that. Take the first two cases, which occurred in 1897.

The UMPIRE: Was 1897 actually the earliest attempt to obtain a competing provisional order?—Yes.

Mr. MOULTON: First of all you got your order. Was there any other applicant at the same time. I am talking now of your original order?—I think there was another company, and the question arose as to the conditions upon which the various promoters were willing to enter into an agreement with the Vestry. We accepted those conditions.

And then the agreement of 1889 was made, which contained certain

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conditions?—Yes, the conditions on which, in our view, we were exclusively allowed to come in, and everybody else was to be shut out.

I put it to you that that agreement actually contemplated the Vestry assenting to others coming in?—Clause 13 provided that if the Vestry should concede or give powers to any other company different from those which we obtained the agreement was to be modified accordingly.

So that, if they gave the same terms that were given to you, they could let others in, or they could let them in on any terms provided they gave you the same?—Yes. Provision was made that if other companies came in, and they got better terms, we were to have the same.

I put it to you that competition would have been granted, except that the Vestry assisted you in keeping it out?—I do not think so, because the first time Parliament was called upon to deal with the question was on the occasion of the third application by the Vestry themselves in 1898, when the Vestry's application was rejected.

In 1897 the County of London Co. and the Marylebone Electric Supply Co. both applied for powers?—They did.

And the Vestry refused consent?—Yes, and at the end of that year the Vestry passed a resolution to themselves apply for an order. The company opposed the confirmation of the order when it had been granted to the Vestry, and on the company's opposition Parliament refused to confirm the order.

The point on which the question was fought was whether rate-aided competition should be permitted?—I cannot say. But in 1899 the Vestry proceeded by bill, but that bill was also thrown out.

That was an application for compulsory purchase?—I cannot say.

In 1900 what applications were there?—The Marylebone Electric Supply Co. applied a second time, and the Board of Trade granted them an order, but the bill confirming the order was thrown out on second reading in the House of Commons.

Do you know if there is a case where, when the local authority has been in favour of competition, that competition has been refused by Parliament?—I could not answer that.

I put it that where a local authority is desirous there should be competition in electricity supply it would be practically a matter of course for a competing order to be granted?—I cannot accept that statement as one of fact.

Well, Marylebone Vestry opposed competition against you on the ground that they wanted to be themselves the competing party, and yet the Board of Trade granted a provisional order to the Marylebone Company?—They did.

In doing so, Sir Courtenay Boyle, who granted the order, was bound to make a special report. And in doing so he dealt exhaustively with the history of the Marylebone orders. The Vestry, as the local authority under the Electric Lighting Acts, opposed the application, and stated that they had resolved to themselves apply again for an order. The Board of Trade held an inquiry in the matter, and, having regard to all the circumstances, they decided to dispense with the consent of the local authority and to grant the order. Then did not your company approach the Vestry to come to terms with them?—The advance came from the Vestry, and ultimately a provisional agreement was drawn up.

There were negotiations between the company and the Vestry with regard to keeping out the Marylebone Company?—I do not remember those.

The UMPIRE: The question is whether there were not negotiations between the Vestry and your company with regard to keeping out the Marylebone Company in the first half of 1900?—There were negotiations between the parties. Whether that is a proper description of the specific object I cannot say.

Were there negotiations as to the purchase of your company's undertaking?—Yes.

Did that eventuate in a provisional agreement?—It did.

The UMPIRE: I do not see at present how any provisional agreement for purchase which has been superseded by the Act of Parliament can be relevant or useful.

Mr. MOULTON: I am entirely on the question of probability of competition, and to show competition has been kept off, not because it would not have been introduced, but by arrangement for the purpose of keeping it off. The company has always kept off competition by the support of the Vestry, obtained sometimes in one way and sometimes another.

The UMPIRE: If it is an agreement for keeping off competition, I can understand that falling within your cross-examination.

Mr. MOULTON (to Witness): Was not that provisional agreement actually referred to in Parliament as a ground for throwing out the Confirmation Bill of the Marylebone Company on second reading?—I believe it was referred to, but the proceedings of the House must speak for themselves.

The UMPIRE: Are we to take it that one of the reasons suggested why a fresh company could not be let in was that negotiations were going on between the Borough Council and yourselves?—Yes.

Mr. MOULTON: Therefore, when the Marylebone order was thrown out it was on the statement that the Vestry would get control of the lighting by means of this provisional agreement?—I accept that as a correct report of what took place.

On the question of granting the provisional order to a company, the Board of Trade had decided, even against the wishes of the Vestry, to grant it, and when the bill came for reading in Parliament the ground on which it was opposed, and successfully opposed, is that they have come to terms for buying you out?—That was only one ground.

The next thing is a notice of the Vestry to apply for an order?—No. The Marylebone Company had passed into other hands. The St. James's and Pall Mall people sold their interest in that company after what took place in 1900, and this interest was acquired by parties connected with the parish, who made one of the original applications in 1897, and they, having got possession of the name and status of the Marylebone Electric Supply Co., applied for an order.

Mr. RYDE: Is this an application (the second) by the Marylebone Company in 1901?—Yes, by the same company, only in different hands.

Mr. MOULTON: This provisional agreement between the Vestry and the Metropolitan Company came to an end?—It never came before the shareholders of the Metropolitan Company, because the Marylebone Vestry, after approving it, failed to take the necessary steps to ratify their approval, and it came to an end.

And the Marylebone Company went on with its application for an order?—Yes.

And the Vestry again applied for a provisional order?—In the last months of its existence the Vestry resolved to apply for an order, and the Borough Council, which came into existence on Nov. 1, 1900, took up the running.

The UMPIRE: So in 1901 we have the Marylebone Company and the Borough Council both applying for orders?—That is so.

Mr. MOULTON: And your company then approached the Vestry?—No, we did not. We set about opposing the Borough Council as strenuously as we could.

Then when the Marylebone Company again tried to get in, we find the Vestry opposing this second attempt?—Yes, they always refused to agree to the admission of every other company than the Metropolitan.

Mr. VIGERS: They wanted to get there themselves?—Yes, and when the matter came before Parliament they could not, except on the terms we are now dealing with.

(To be continued.)

Teddington District Council v. London United Tramways (1901) Ltd.

On Wednesday Mr. Justice Jelf heard a motion on behalf of the plaintiffs, asking for an injunction against the company, who are constructing tramways in the Teddington district, to restrain them from interfering with the level of the roads. The Council contend that the company had no right to proceed without first obtaining the approval of the plans by their surveyor. The company submitted that disputes, such as that in question, should be dealt with by arbitration, as provided by the Tramways Act. His lordship refused to grant an injunction, and made no order on the motion.

Telephone Agreements.

At Bow (London), on Monday, Judge Smyly, K.C., heard an action brought by the National Telephone Co. against Mr. John Lang, of South Woodford, for £3. 7s. 6d. or the return of a telephone instrument belonging to the company. The defendant counter-claimed for £4. 15s.

Mr. ALLSOPP, for plaintiffs, said the company entered into an agreement with defendant to put him in connection with their service at an annual subscription of £13, the agreement to run for five years. The connection was duly made to defendant's premises in July, 1900, and the service was continued for about two months, when objection was taken by certain persons to the lines crossing their premises, and such pressure was brought to bear on the company that they had to remove the lines, and they were unable to any longer give defendant his telephone service. In April, 1902, the company, finding they could not carry out their agreement, wrote terminating it, and asked for the return of the instrument.

Mr. WILLIS, for defendant, said his client denied ever having received any notice terminating the agreement, which, he held, was still running. Defendant was a large shareholder in the National Telephone Co, and was contesting the case in the public interest.

Mr. ALLSOPP said he certainly could not prove service of the notice terminating the agreement.

Judge SMYLY: Then you cannot, of course, proceed.

On the counterclaim, DEFENDANT said he had paid about 20s. to notify people he was no longer on the telephone, and he had had an unsightly pole erected in his garden ever since the original connection was made.

Judge SMYLY said the company must fail. There would be judgment for defendant on the claim and on the counter-claim. His award was £3 and costs on both.

Electric Lighting Agreements.

Judge EMDEN, at Lambeth, gave judgment last week in the case of the South London Electric Supply Corporation v. Gouldston. Defendant had the electric light installed, and signed an agreement to pay 10s. a quarter rent for the meter for three years. After a time he discontinued his electric lighting and paid the corporation what he owed, and asked them to remove the fittings. He was now sued for two quarters' rent of the meter.

Judge EMDEN asked if the corporation intended to keep defendant to his three years' agreement, whether he used the electric light or not, and the reply was in the affirmative. The corporation had to get back the cost of the installation.

Judgment for plaintiffs under the agreement without costs.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price. Add 5 per cent. for abroad, or for foreign books.)

"Elektromechanische Konstruktionselemente." By Dr. G. Klingenberg. Nos. 1, 2, 3 and 6. (Berlin: Julius Springer.) 2m. 40pf. each.

"University College of North Wales (Bangor). Calendar for Session 1902-3." (Manchester: J. E. Cornish.)

"Response in the Living and Non-living." By J. C. Bose. (London: Longmans, Green & Co.) 10s. 6d.

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ELECTRICAL EXHIBITION AT BRIGHTON.

There is nothing particularly novel in the "local" exhibition of electrical apparatus, accessories and sundries, chiefly designed for domestic uses. Many such exhibitions have been held, and have, moreover, been fairly successful. The exhibition, however, which was opened on Saturday by the Mayor of Brighton (Ald. J. E. Stafford, J.P.), and which will remain open for some time yet, is favoured by somewhat exceptional circumstances. Brighton is a very wealthy town, is London-super-Mare, has a thoroughly up-to-date and well-patronised electricity supply system, and a Corporation whose members have always been practically unanimous in supporting their electricity undertaking. But, in addition, it has a suitable one-story building where full effect can be given to the display to which artistic electric light fittings and their adjuncts so readily lend themselves. It is, therefore, not surprising that the exhibition now being held at the Aquarium, Brighton (which, by the way, has been recently acquired by the Corporation), should have proved an eminently successful show. Mr. John Christie, the resident electrical engineer, who is responsible for the arrangement of an exceptionally well-selected assortment of high-class and representative group of exhibits, is to be heartily congratulated. His efforts have met with full recognition from Brightonians and visitors, who have flocked to the Aquarium in large numbers. We were informed on the occasion of our visit that the show was not only proving interesting and instructive, but a means of encouraging a considerable trade for new fittings, apparatus and accessories.

Brighton numbers among its tradesmen many large firms engaged in electrical installation work, and the chief of these are exhibiting. The displays of Messrs. Page and Miles (of Brighton, Hove and Worthing), Messrs. C. G. Reed & Sons, Mr. M. Fileman, Messrs. Bostel Bros., Messrs. Adams Bros., Mr. H. J. Galliers and Messrs. G. Hignett & Co. are all of exceptional merit as truly effective displays of fittings and apparatus employed in electric illumination, &c. A special word of praise in this respect may be given to the arrangement of the stands of Messrs. Page and Miles and Mr. H. J. Galliers, which attract the attention of the visitor immediately on entering the exhibition.

In addition to the traders engaged in installation work, Brighton possesses one, and only one, manufacturing firm—the Reason Mfg. Co. (Ltd.), known all over the world in connection with the supply of demand indicators, prepayment meters, motor meters, street lighting fittings, arc lamps, &c. This company naturally accords warm support to the exhibition, and makes a good show.

Outside manufacturing firms who have brought their wares to Brighton to supplement the miscellaneous exhibits of the local contractors and dealers include the British Insulated and Helsby Cables (Ltd.) (a varied assortment of wires, cables and accessories), the Simplex Steel Conduit Co. (enamelled steel and galvanised steel conduits for interior wiring), the Incandescent Electric Lamp Co. (at whose prominent stall practical demonstration is given of electric incandescent lamp manufacture. There is also at this stand a good display of "Robertson" lamps in infinite variety), the Sir Hiram Maxim Electrical and Engineering Co. (a good show of special types of Maxim lamps for illumination and decorative purposes), the Dowsing Radiant Heat Co. (a display of cooking apparatus in actual working forms a very attractive feature of the stand, and a good show of "Dowsing" luminous electric radiators on a stand adjoining completes the interest of this exhibit. "Dowsing" radiators, it may be mentioned, are shown on several other stands, and the latest designs of this apparatus are very artistic). The British Prometheus Co. also have a good assortment of electric heating and cooking apparatus. Babcock and Wilcox (Ltd.) show a model of the well-known B.W. water-tube boiler. At the stand of Messrs. J. H. Holmes & Co. a large variety of small Lundell motors are shown driving fans of various sizes. Amongst the other manufacturing firms exhibiting are Messrs. D. Bruce Peebles & Co. (motors, &c.), Veritys (motors, &c.), Marryat and Place (ironclad circuit breakers and small motors), and R. Woods & Co. (travelling electric lights and stretching pendants). This list will be added to when the stand taken by Messrs. De Grelle, Houdret & Co. is equipped.

In this group might also be mentioned the Electrical Company, but this company has a representative supply house in North-street, Brighton, which is responsible for an attractive stand, whose chief feature is a neat display of small Nernst lamps, for which the demand is increasing by leaps and bounds. These lamps receive much attention from visitors to the exhibition.

Nor should mention be omitted of the nearly completed exhibit of the Brighton School of Science and Technology, of which Dr. Draper is principal. The students of the college are engaged in erecting and equipping an exhibit of machinery in motion, and sets of actual drawings of electrical machines and apparatus, prepared by the students, is an interesting feature of this stand.

Mr. Magnus Volk, at Brighton, was the pioneer of the electric railway in this country, and the existence of several examples of electric traction working in the town has probably prompted the Dolter Electric Traction Co. to show an instructive model of the working of their surface contact system. Difference of opinion as to the respective merits of overhead and underground electric traction exist in Brighton as elsewhere, and this exhibit consequently attracts particular notice. The Dolter system, we were informed, has been working in Paris on the lines between Porte Maillot, Surenses, Longchamps and St. Cloud for two years without hitch or accident of any kind.

It will be seen that the electrical exhibition at Brighton is on a more extended scale than is usual in these displays. That it is eminently successful from every point of view is already demonstrated. The display at Brighton Aquarium will assuredly do much to increasingly popularise electric lighting and the use of electric heating, cooking, cooling and motive apparatus and electric decorative accessories of all kinds, besides familiarising the public with the latest types of these goods. The price of admission during the day is 6d., and in the evening the popular price of 3d. prevails. Brighton Aquarium has many attractions besides the exhibition, but was not, as a joint-stock undertaking, a pecuniary success. Under the proprietorship of the municipality this condition of affairs may be changed, and certainly the first exhibition held in the building proves an excellent draw, as it well deserves to be.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An assistant lecturer and senior demonstrator in electrical engineering is required at the Royal Technical Institute, Salford. Particulars and forms of application up to 14th inst. See advertisement.

A first-class electrical engineer is required for Glasgow Corporation tramways. Applications to the general manager, Mr. John Young, 88, Renfield-street, Glasgow, by Oct. 22. See advertisement.

Mr. E. Trenam has been appointed controller at the Central Telegraph Office in succession to Mr. E. May, who has retired. Mr. Trenam was formerly superintendent at Leeds, where he remained until 1892, when he was promoted chief superintendent of the Manchester district. In 1900 he received one of the newly-created appointments as traffic manager, and occupied that position until June, 1901, when he became deputy-controller at the central office, London.

Mr. O. F. Francis has been appointed resident electrical engineer at the Aldershot electricity works at £250 per annum.

Heywood Council have appointed Mr. James Stott (hitherto chief assistant at the electricity works) borough electrical engineer, in succession to Mr. W. S. Johnston, who has taken an appointment with Veritys Limited.

Mr. E. H. Dixon, B.Sc., has been appointed assistant lecturer in electrical engineering, and Mr. T. W. Griffith, B.Sc., has been appointed assisted lecturer in physics at Hartley College, Southampton.

Bedford Council have appointed Mr. H. B. Jenkins assistant electrical engineer.

EDUCATIONAL NOTICE.

The Clothworkers' Scholarship of £60 a year for three years, awarded on the results of the matriculation or entrance examination of the Central Technical College of the City and Guilds of London Institute, has been awarded to W. H. Grinsted, from Horsham Grammar School. Free studentships have been awarded to W. M. Hooton, from King's Lynn municipal technical school, L G Morse, from Marlborough College, and H. K. B. Reed, from the South-Western Polytechnic, who came next in order of merit.

Aberdeen.—A report has been prepared by the city electrical engineer (Mr. J. Alex. Bell) on the proposal to light all the electric tramway routes electrically, and the matter will come before the Watching and Lighting committee at their next meeting.

Accrington.—The Council have decided to adopt arc lighting for the principal thoroughfares.

Aldershot.—The Council have extended the contract with Messrs. Thomas Parker (Ltd.) for running the electricity works for another six months.

Allahabad.—A Calcutta firm is about to close with a concession from the municipality for the right to construct and work electric tramways in Allahabad. The line is about 2½ miles in length.

Ashford.—The Council have received from Mr. F. H. Medhurst particulars of a scheme for the erection of electricity works, and a sub-committee will interview the firms named by Mr. Medhurst to ascertain if they are willing to enter into an agreement for the erection, equipment and working of the station.

Aston.—The Council have obtained sanction to a loan of £52,406 for electricity works. The maximum demand system of charging has been decided upon, 6d. per unit for the first two hours and 1½d. after.

Bedford.—The Council have authorised extensions of the electric lighting mains in six additional thoroughfares.

Bethnal Green (London).—The Borough Council have been requested by the Board of Trade to set out any objections they may have to the revocation of their provisional electric lighting order (obtained in 1899).

Beverley.—Owing to Edmundson's Electricity Corporation requiring £5,000 more than the £14,704 loan obtained by the Council for erecting and equipping electricity supply works, the Council have

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decided to seek another company willing to undertake the work for the above sum.

Blackpool.—A sub-committee, consisting of Aldermen Brodie and Grime and the borough electrical engineer (Mr. C. F. Furness) have been instructed to visit certain electricity works to obtain information on cooling towers.

Out of seven tenders received for cooling plant the following were the most favourably regarded :—Doherty and Donat, Arthur Koppel, and the Klein Engineering Co.

Mr. Furness has submitted a report and estimate amounting to £1,200, upon coal-handling plant, including narrow-gauge tramway, waggons, weighing machines, coal storage bunker and elevator.

Bognor.—Hitherto this watering place has been outside the telephone area, but at last a telephone service is promised. The Council is, however, in some difficulty, as it has been approached by both the National Telephone Co. and the Post Office, and it is disposed to give access to the party which will guarantee the earliest service.

The Board of Trade are enquiring of the Council its intentions with regard to the electric lighting provisional order obtained in 1899.

Bournemouth.—A communication to the Council from the Board of Trade states that the Board is advised that, in the special circumstances created by the recent decision of the Court of Appeal in the action by the Poole and District Electric Traction Co, and the provisions of the Christchurch and Bournemouth Tramways Act, 1900, an application by the Corporation for a provisional order in amendment of their order of 1900 could not properly be entertained. Under these circumstances the town clerk advises, with regard to the bill that may be promoted by the Corporation, that the objects of such a measure should be limited to (1) confirming the Corporation's alleged lapsed powers in their 1900 order, (2) for additional powers to purchase, by agreement, tramways within or without the borough, or (3) power to the Board of Trade to grant the Corporation provisional orders for constructing further tramways. This suggestion has been adopted by the Council.

Bradford.—The accounts of the tramways department for the half-year ended Sept. 30 show total income from the electric lines £89,500, ordinary expenditure £79,600, including proportion of profits of £11,650 to the old steam companies. The approximate profit, excluding depreciation, was £9,900. After allowing for depreciation, the net profit is between £3,000 and £4,000.

Brierley Hill.—Mr. Reginald P. Wilson has been appointed consulting engineer in connection with the local light railway scheme. Mr. Wilson is also acting for the adjoining district of the Rowley Regis Council.

Brighton.—At the Corporation meeting last week a further discussion took place as to the position of the Corporation's consulting electrical engineer (Mr. Arthur Wright) with the Mutual Electric Trust Co. and the Reason Mfg. Co. After some discussion, Mr. Broadbridge said the Council were studying the interests of their ratepayers when they obtained from the Reason Mfg. Co., whose works were in the Council's district, meters and apparatus, which would cost considerably more if obtained elsewhere, and subsequent speakers pointed out that special terms were granted by the Reason Mfg. Co to the Corporation in connection with these purchases. It was further shown that, on Mr. Wright's appointment as consulting engineer, the Electricity committee were fully informed of his connection with the companies mentioned, and, having considered the matter, the Corporation decided to retain Mr. Wright's services. The subject then dropped.

Brixham.—The Council is considering the question of applying for a provisional electric lighting order.

Burslem.—The Council have applied for a loan of £31,000 for establishing municipal electricity works.

Bury (Lancs.)—The borough electrical engineer (Mr. Watson) has been instructed to report upon the advisability of adopting "free" or assisted wiring of consumers' premises.

Caerphilly.—The report of the consulting engineer (Mr. R. H. Fletcher) recommends the Council to apply for a provisional order. Mr. Fletcher considers, however, the cost of supplying the district from municipal works would at present be absolutely prohibitive. Powers should, however, be sought for generating as well as distributing electricity. The Council's decision has been deferred for a fortnight.

Camborne.—The Urban Electric Supply are submitting terms for public electric lighting.

Cardiff.—Powers are sought for construction of tramway extensions.

Cleethorpes.—The Council have entered into an agreement with Grimsby Tramway Co. to purchase the site and the generating station and equipment of the company.

Cheltenham.—The Council have withdrawn their proposal to apply for a provisional order for extending the electric lighting area, as the local authorities of the adjoining districts decline to sanction the extensions.

There are at present 622 customers of the electric lighting department, representing 38,300 8 c.p. lamps.

The Council have agreed to order a statement as to the financial position of the electric lighting undertaking.

Cheshire and North Staffordshire Electric Power Scheme.—Further particulars to hand regarding this scheme state that the capital is £1,500,000. It is proposed to erect three generating stations, two in Cheshire and one in Staffordshire. A station will be erected near Frodsham for supplying Runcorn, Chester, Sandbach, Nantwich, Tarporley, Middlewich, Winsford, Northwich, Knutsford, Altrincham, Sale, &c. Another station will be erected near Sutton, and it is probable that the projected Macclesfield to Warrington electric tramway will be supplied with power by the new company.

Church Lighting.—The old parish church of St. John, Hackney, has had the electric light installed.

Cleckheaton.—Sanction to a further loan of £6,000 for electric lighting has been obtained. Terms have been arranged for the supply of energy to the local tramways.

Colchester.—The Tramways committee will shortly present a report on the proposal to construct electric tramways. [Reports have been presented by the borough electrical engineer (Mr. A. R. Sillar) and the borough surveyor (Mr. H. Goodyear).]

Darlington.—The fish market is to be wired for electric lighting.

Dartford.—The Council have increased the salary of the electrical engineer (Mr. A. J. C. Waterland) to £250 per annum.

Dartmouth.—The Urban Electric Supply Company hope to give a supply of current in the principal thoroughfares by Oct. 15.

Derbyshire.—A syndicate is promoting a scheme for the construction of several routes of electric tramways.

Devonport.—The Admiralty have informed the Town Council that a comprehensive scheme has been prepared for supplying electric energy for both lighting and power from a supply station within the dockyard.

Doncaster.—Various extensions to and alterations in the municipal electric tramways are projected, involving an expenditure of about £14,000.

Dublin.—Last week the Corporation approved the draft agreement between the Trinity College authorities and the Port and Docks Board regarding the erection of a sub-station and the supply of electric current to the new college buildings, engineering schools, physical and chemical laboratories, &c.

Dundalk.—The combined electric lighting and tramway scheme has been revived, and the Council have agreed to accept £400 from a Dublin syndicate (Messrs. Ryan, Porte and Liller) for their powers, which expire in November. An application for an extension of time will be made by the syndicate and be supported by the Council.

Eastbourne.—The charge for electric current to large consumers has been reduced to 4½d. per unit.

East Ham.—The accounts of the electric tramways for the first nine months show revenue £15,618, expenditure £10,960, gross profit £4,658. After providing for interest, sinking fund and depreciation (£930), the net profit was £55. The electric lighting accounts show revenue £7,094, gross profit £2,731, but after paying interest, depreciation (£922), &c., there is a deficiency of £554.

Edinburgh.—The Corporation decided on Tuesday to add the declared surplus of £10,295. 11s. on last year's working of the electric lighting undertaking to reserve, after deduction of the deficiency (£2,690) of the previous year.

The convener of the Electric Light committee (Mr. Mackenzie) explained that the Council had previously passed a resolution that a reserve fund should be gradually built up, the maximum to be £80,000. The present addition would bring the reserve up to £27,000.

Electrical Machinery for India.—Last week an interesting test was carried out at the works of Messrs. Belliss and Morcom (Ltd.), Birmingham, of a Crompton-Belliss 750kw. combined steam dynamo for power and lighting. The set is one of two of this size to be installed at the new works of the Calcutta Electricity Supply Corporation, for which company three 250kw. similar sets have been recently despatched for power purposes. The engines in all instances are of Messrs. Belliss and Morcom's patent self-lubricating, quick-revolution, triple-expansion design, having only three cylinders—viz, high, intermediatte and low pressure, thus ensuring the simplest design of engine, and the best for the purpose intended. The same firm's automatic system of forced lubrication is employed to all the bearings at a pressure of 10lb. to 15lb. per square inch by means of valveless pumps driven off the engine crank shaft, and arranged in an oil well in the crank chamber. The plant runs at 230 revs. per min., with a steam pressure at the engine of 160lb. per square inch, and is arranged to run non-condensing at present. The dynamos are of the Crompton multipolar type, fitted with slotted drum-wound armatures 7ft. in diameter. The magnets are compound wound, the outside diameter of the yokes being approximately 12ft. The commutators are fitted with carbon brushes, and all bearings are self-

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oiling. The weight of the armature alone is 13 tons. The plant, although primarily designed for lighting, embodies all the essential qualities for traction work, and will, consequently, be equally suitable in that capacity if necessary at a future date.

Falkirk.—Stirling County Council are adopting electric lighting at the Sheriff Court House and police premises.

Glasgow.—The tramway extension to Longside will be opened for traffic to-day.

Greenwich.—The Blackheath and Greenwich District Electric Light Co. offer to supply electric current to the municipal offices at 3½d. per unit for three years.

Hawick.—Electric current was supplied for the first time on Wednesday.

Honley.—Application has been made for a loan of £4,800 for electric lighting.

Honduras.—It is stated by the United States Consul that the joint-stock company recently established at Ceiba offers the opportunity for introducing electrical goods into Honduras.

Huddersfield.—The Council have rejected a motion for an inquiry into the general equipment of the tramways, the suitability of the cars, &c.

Infirmary Lighting.—Montrose asylum and infirmary managers are adopting electric lighting for their institution. Current will be taken from the local electric supply company, who have offered supply at 4d. per unit.

Irvine.—The Town Council has approved an electric lighting scheme submitted by a company which proposes to apply for a provisional order. The compulsory area will include the thoroughfares in the centre of the town, and at the outset plant sufficient to supply the equivalent of 3,000 8 c.p. lamps is to be put down.

Islington (London).—The charge for current for motive power has been reduced to 2d. per unit for current required from 12:30 a.m. to sunset and 5d. per unit from sunset to 12:30 a.m.

Kettering.—Sanction to a loan for the erection of electricity supply and refuse destructor works has been obtained.

Kildare.—An inquiry has been held into the application of the Naas District Council to borrow £3,000 for electricity works for supply of current in Kildare. The military authorities may avail themselves of the opportunity to adopt electric lighting. Technical details were supplied by the electrical engineer, Mr. Norman Robinson.

Kingston-on-Thames.—The Corporation has fixed the following charges for current for motors:—3d. per unit up to 5,000 units, 2½d. up to 10,000, and 2d. over 10,000 units per annum. The Corporation reserves power to discontinue supply from 5:30 p.m. to midnight to motors supplied on the reduced rates of 2d. and 2½d. per unit.

Leeds.—At its meeting last week the Council discussed the question of the overcrowding of the tramcars, and on the presentation of the Tramway committee's report on the subject,

Mr. R. A. SMITHSON approved of the minutes of the committee. He thought all would agree in asking the few objectors to the principle involved in this question to appreciate the reasonableness with which the committee had approached the matter. The committee was striving for the greatest good of the greatest number.

Mr. T. WALKER asked what was the number of excess passengers proposed to be carried, and on what occasions such passengers were to be allowed on the cars.

Mr. SMITHSON said the matter was still under consideration, but bank holidays, Saturday afternoons, Sundays and wet days practically defined the occasions on which conductors would be permitted to carry excess passengers inside the cars.

Alderman WILLEY said, by force of circumstances this particular undertaking had come into the hands of the Corporation, and the Tramways committee at once proceeded to set the bye-laws at defiance. The history of this matter showed that the resolution passed some two years ago about carrying eight passengers above the number licensed for was a direct breach of the law, and he could not understand why the chief constable or town clerk, or some person in legal authority, had allowed such a state of affairs to be continued month after month. It was not honest for the Corporation to allow their conductors to be brought before the magistrate and fined.

The minutes were adopted by 43 votes to 4.

Leeds-Guiseley Tramway.—Yeadon Council are supporting the scheme of Messrs. Maitre and Parker for the construction of this line.

Leigh (Lancs.).—The Council will proceed with their bill for powers to construct additional lengths of electric tramway, the negotiations between the Council and the South Lancashire Tramways Co. having fallen through.

Leith.—Additional generating plant, including two 350kw. steam dynamos and two 400 H.P. boilers, is to be put down at the electricity works.

Light Railways.—The Poole and District Light Railway (Extension) Order, authorising the construction of a light railway in Poole and Branksome, has been submitted to the Board of Trade for confirmation. Objections by Oct. 25.

The Crowland and District Light Railway Co. will apply for an extension of time to construct their authorised light railway.

Mr. T. A. Nevins (son of the late Mr. Thomas Nevins, the promoter of the Cheltenham and District Light Railways scheme) has intimated to Cheltenham Council that that project will be carried out in its entirety.

Lincoln.—The charge for electric current to places of worship has been fixed at 5d. per unit.

London-Brighton Electric Railway.—A syndicate is being formed to carry out surveys, prepare plans, &c., and to promote a bill to authorise the construction of an electric line of railway from London to Brighton. The consulting engineers are Mr. F. H. Cheesewright and Mr. Robert Hammond. The London terminus is to adjoin Waterloo Station, and the Brighton terminus facing the Clock Tower. The stopping places are to be Croydon, Redhill, Horley and Hayward's Heath, the journey being made in 40 minutes. Mr. Robert Hammond, in reporting on the scheme, recommends a speed of 75 miles per hour on the line, and estimates that under three years would be required for its construction. Mr. F. H. Cheesewright in his report, points to the fact that no town in the United Kingdom of the importance of Brighton depends upon one line of railway for its connection with the metropolis. The length of the line will be under 47 miles of standard gauge. There are no engineering difficulties whatever in the project and only 13 miles of the total length will be tunneled. It is proposed that the tunnels shall be 27ft. wide in the clear, to allow room for workmen, should two trains be in the tunnel at the same time, to avoid the necessity of the trains diminishing speed, and to secure perfect ventilation.

A statement is being circulated that at a meeting of the directors of the London, Brighton and South Coast Railway recently, it was decided to construct permanent way alongside the present line, and to run an electric passenger service. We have been unable to confirm this statement, our information so far being that no such scheme has been under consideration by the company.

London County Council.—At the resumed sittings of the Council on Tuesday the following loans for electric lighting were reported as completed:—Battersea £6,000, Fulham £25,000, Hampstead £5,100, Poplar £28,170, St. Pancras £20,000, and Woolwich £23,960. The following new loans for electric lighting were agreed to:—Battersea £5,000, Fulham £25,000, Westminster £894, and Battersea (for electric lighting of libraries) £650.

The purchase of the South London Tramway Co.'s undertaking was approved.

The Highways committee reported that the works department of the Council will construct the foundation of the Greenwich electricity generating station at a cost of £14,750.

It was agreed that the Highways committee serve notice on the London, Deptford and Greenwich Tramways Co. of the Council's intention to purchase the tramways, works and undertaking, authorised by the Southwark and Deptford Tramways Act, 1881, as amended by the London, Deptford and Greenwich Tramways Act, 1891.

With reference to the London County Council (Electric Supply) Bill, which was rejected by a Parliamentary Committee last session, the Highways committee reported that they had consulted the metropolitan borough councils, many of whom were directly affected by the bill, as to whether it should be re-introduced next session, and replies from 19 out of the 29 councils advise that the Council should again ask Parliament to deal with the matter, and the committee therefore recommend that the Parliamentary committee promote a bill on the same lines, relative to the purchase of electric lighting and supply undertakings and the supply of electricity in London, and that the metropolitan borough councils be afforded an opportunity of expressing their views on the draft of the proposed bill This recommendation was adopted.

The City Corporation have decided not to oppose the re-introduction of the bill, subject to the insertion of a clause protecting the rights of the Corporation under the electric lighting acts and orders affecting the City.

Louth (Lincs).—Messrs. Handcock and Dykes have been retained by the Corporation to advise them with regard to their electric lighting order, and are preparing a report on the subject.

Malta.—A recent commmunication informs us that there is an opening in Malta for the following electrical goods:—Lamps, carbons, fan motors, lamp fittings, and general electrical sundries.

Mexborough.—An inquiry will shortly be held into the Council's application to borrow £2,500 for electric lighting.

Mica.—In German East Africa mica mining, which has been hitherto conducted on only a comparatively small scale, is to be considerably increased. A company has been formed with a preliminary capital of 200,000 marks to work existing mines and to prospect. It is reported that the mines in the district are rich, and will well pay for working.

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Middleton.—The construction of the Middleton-Manchester electric tramway will be completed early in November.

Municipal Telephony.—The Postmaster-General has granted a licence to the Sheffield City Council to establish a municipal telephone service.

At a special meeting of the Manchester Telephone committee on Tuesday, Mr. Smethurst proposed a resolution in favour of entering into negotiations with the National Telephone Co. for the acquisition of their undertaking in the Manchester area and the establishment of a municipal service. The resolution was rejected after debate.

Scarborough Corporation Property committee have requested Mr. A. R. Bennett to prepare a detailed report, for a fee of 30 guineas, on the proposal to establish a municipal telephone service.

A conference of local authorities in the Bournemouth area has been summoned to consider a proposal to apply for a licence to establish a municipal telephone service.

An inquiry was held at Swansea on Tuesday into the Corporation's application to borrow £20,000 for a municipal telephone service for a district including Swansea, Oystermouth, Llangyfelach, Pontardawe, Loughor, Neath and Llanelly:—

In support of the application, Mr. WHEATLEY said the National Telephone Co. had only about 650 subscribers, or one for every 231 of the inhabitants. The Corporation had obtained a licence, the consent of the councils concerned, and the minimum rate for an unlimited service of £5 had been fixed, compared with from £9 to £15 charged by the National Company. A site had been obtained and the work begun to avoid delay, the tender for the exchange being £2,297. 10s. Already they had 337 applications for an unlimited service at £5, and 57 applications on the message-rate scale of £3 per annum and 1d. per call. Those subscribers to the municipal service included 33 per cent. of the National Company's subscribers. No contracts had been let for plant, but they would probably be let the following day. There was no opposition.

The chairman of the Telephone committee (Councillor Solomon), the consulting engineer (Mr. A. R. Bennett) and Major-Gen. C. E. Webber gave evidence in support of the application.

Mr. BENNETT said there would be switch stations, by means of which connections could be made with the outlying districts of Pontardawe, Clydach, Morriston, Skewen, Pontardulais, Gorseinon, Gowerton, Loughor and the Mumbles. By the system of underground cables proposed at Swansea it would be impossible, except in case of accident, for one subscriber to hear the conversation of another. "Tapping" on the part of the telephone girls would also be impossible.

Mr. WHEATLEY further said that the National Company intended coming within the Telegraph Acts, 1899, in Swansea, and then the Swansea Corporation subscribers would have intercommunication free of charge over the company's system in Swansea. The Corporation had given underground wayleaves to the company, but unless the company came within the act the notices terminating these wayleaves would be enforced.

National Electrical Contractors' Association.—A meeting of the northern section was held at York on Saturday, when representatives of about 60 electrical contracting firms in the north were present. A scheme for the registration of workmen was adopted and questions relating to the training of apprentices, municipal trading and standardisation of wiring rules and specifications were discussed. The next meeting is to be held at Newcastle in January.

New Tube Railway.—It is reported that a syndicate has been formed to promote a bill to authorise the construction of a tube railway to run under the Central London Railway from the City to the Marble Arch, to effect a junction with the authorised North-West London Railway, which will run from the Marble Arch to Cricklewood.

Newcastle-on-Tyne.—A provisional order is being applied for to authorise the construction of additional electric tramways.

Newport (Isle of Wight).—30 arc lamps are to be erected in the main thoroughfares. Electric current will be supplied by the Isle of Wight Electric Light and Power Co.

Personal.—In view of the large amount of heavy traction work done by them in the past, and the prospective increase of this class of work in the future, the British Thomson-Houston Co., Rugby, has organised a heavy traction department. Mr. A. H. Walton, in addition to his other duties, has been appointed manager of this department, with headquarters in London, and his large and successful experience in installing some of the heavy electric traction schemes in the United Kingdom particularly fit him for this position.

Peterborough.—The Council have been informed that they have a legal right to use for street lighting purposes the trolley poles erected by the tramway company.

Rochdale.—By a majority of one the Council have declined to adopt the recommendation of the Electricity committee to increase the salary of the electrical engineer (Mr. Atchison) from £200 to £250 a year.

The Council have notified the tramway company of intention to purchase so much of its undertaking as lies within the Council's area.

Ross.—The Electric Light Co. has offered to provide arc lamps and supply current for 1,500 hours per annum for £19. 10s., with £1. 2s. 6d. for each 100 hours extra. The company's offer to put up lamps for experimental purposes has been accepted.

Rugby.—The Council have decided to apply for an additional loan of £2,500 to £3,000 for electric lighting extensions. Contracts have been let for steam dynamos, switchboard, &c., to the British Thomson-Houston Co, and for cables and mains to the St. Helens Cable Co.

Runcorn.—The Council have been notified by the Board of Trade that the Runcorn provisional electric lighting order, granted in 1899 is not yet in force.

St. Albans.—A company is negotiating with the Council for a lease of the provisional electric lighting order.

St. Anne's-on-the-Sea.—A recommendation of the Electric Lighting committee to adopt electric lighting for some of the public thoroughfares was adopted at the last Council meeting.

Salford.—The extension of the electric tramways to Prestwich has been opened.

Sheffield.—The Tramways department, on Wednesday evening, inaugurated a system of letter collecting by tramcar. The tramcars leaving the various termini about 25 minutes before the hours of collection at night are fitted with boxes for the purpose. The arrangements appear to work smoothly, and are taken advantage of to a considerable extent.

Sidmouth.—The question of obtaining a provisional electric lighting order is before the Council.

Soudan Provinces (Egypt).—On the railways at Halfa and Khartoum there is some electric plant in use on the passenger rolling stock, and in the provinces there are altogether about 800 miles of telephone lines established, chiefly along the railway. The works department at Khartoum have a number of machines driven by electricity, and a small telephone system is shortly to be installed connecting the various Government offices, military units, &c, at Khartoum, Omdurman and Halfaya. Of landline telegraphs there are 2,736 miles of line in operation containing 3,108 miles of conductors.

South African Trade.—At a meeting of the South African Trade committee on Wednesday the reports of two of the commissioners recently sent to South Africa to inquire into the openings for trade there were submitted.

Mr. BEN. H. MORGAN, engineering trades' commissioner, stated that there were enormous opportunities for trade in engineering lines, and particularly in machinery utilised in dock and harbour construction, railway extension, mining and agricultural work. New railway lines and extensions were in contemplation and were being proceeded with in Cape Colony, Orange River Colony, the Transvaal and Natal. In regard to the mining industry of the Rand, as soon as the political atmosphere cleared an enormous development would take place, and a large quantity of mining and electrical machinery would be required. There were also excellent prospects for the introduction of steam engines, electric tramway and lighting equipments. He found German and American competition everywhere very keen, and although prospects of trade were so good, business could only be obtained by enterprise and pushfulness, and a thorough knowledge of the requirements of the market.

South Shields Tramway Bill.—The Parliamentary committee are advised by counsel that the compromise between the advocates and opponents of tramway municipalisation in this district would not be sanctioned by Parliament.

Southampton.—Application has been made for a loan of £7,310 for construction and equipment of an electric tramway to Hampton Park.

Stourbridge.—The additional lines of the Dudley, Stourbridge and District Electric Traction Co. from Stourbridge to Lye and to Wollaston were inspected on Thursday last.

Stretford.—The negotiations for the purchase of the Stretford tramways has been referred to Manchester Corporation, by whom the lines will be worked after purchase. Some delay has arisen owing to the appeal from the arbitrator's award. When possession has been obtained, Stretford Council will proceed with the work of converting the lines to electric traction.

Tonbridge.—The date for the formal opening of the electricity works has been provisionally fixed for Nov. 15, and from Oct. 20 to that date electric current will be supplied free to consumers. The municipal offices and council chamber are to be fitted for the electric light.

Transmission of Telegrams by Telephone.—Glasgow Telephone committee have received a communication from the Postmaster of Glasgow that the transmission by telephone of telegrams is confined to subscribers having registered telegraphic addresses, and that it would be impracticable, on account of the large number of telegrams dealt with, to single out for special treatment telegrams which did not bear some address of which special record is made by the department. Further action is being taken by the committee to have the point definitely settled.

Trunk Telegraphs.—Edinburgh Corporation on Tuesday decided to memorialise the Postmaster-General in favour of extending the underground telegraph trunk lines from Preston northwards.

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Truro.—A proposal has been submitted to the Council for the construction of an electric tramway from the railway station to Malpas, distant about 2 miles.

Tunbridge Wells.—An inquiry is to be held this day (Friday) into the Council's application to borrow an additional £10,000 for electricity works extensions. The present number of consumers is 700, representing 56,000 8 c.p. lamps.

Underground Telephone Wires in London.—Delegates from the City Corporation and from 12 of the London Borough Councils met at Battersea on Tuesday to consider the question of the use of the streets for the reception of telephone wires. The conference was called by the Battersea Council, and was presided over by Ald. G. A. Smith. Discussion centred round correspondence which had passed between the Post Office and Battersea Council, the latter body having objected to granting wayleaves to the Post Office which could be utilised for the advantage of the National Telephone Co., the licensees of the Post Office. The Postmaster-General having suggested that a deputation should wait upon him to discuss the matter, this suggestion was adopted.

Warrington.—The Bridge-street–Stockton Heath tramway route was opened for traffic on Saturday. The Manchester-road and Winwick-road lines are nearing completion.

Wednesbury.—The Council have decided to enter into an agreement with the Midland Electric Corporation for Power Distribution for the supply of electric energy in bulk at 3d. per unit for the maximum demand for one hour per day, and 0·825d. for the remaining hours, the company undertaking not to lay distributing mains in the borough. The Council also intend to proceed with a scheme for the supply of electricity within the borough at an estimated cost of £11,000.

Wigan.—The Council have completed the purchase of the undertaking of the local tramways company for £42,000. The whole of the lines will be electrically equipped within a few months.

Worthing.—The resident engineer (Mr. G. Porter) recommends the use of Nernst lamps for the electric lighting of Tennyson-road at a capital cost of £51, the total annual charges being £48. 15s. for all-night use and £33 for half-night use. Mr. Porter has been requested to report upon the practicability and financial effect of discontinuing the lighting of all or any of the arc lamps on the Parade during the winter months, and substituting incandescent electric or Nernst lamps. Applications for current now in hand equal 10,278 8 c.p. lamps, of which 9,127 are connected. For the first year's working of the undertaking there was a net income of £3,160, expenditure, exclusive of capital charges, being £3,150. These capital charges amount to £2,110.

Yarmouth.—The profit on the first quarter's working of the municipal electric tramways was £2,125.

York.—Ald. Agar, at the Council meeting on Monday, referred to proposals which had been received from the City of York Tramways Co. as to extensions of lines and the adoption of electric traction. The committee could not assent to the proposals, but if the company were permitted to carry them out they would have to expend largely and would require a considerable extension of time before the Corporation could take their undertaking over, so that the cost of acquiring it would be increased. As, however, the Corporation were unable to take over the tramways at present, he suggested the subject should be again discussed. This suggestion was approved.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Aston Manor District Council invite tenders for condensers for their electricity generating station. Specifications from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W., and tenders (addressed chairman of Electric Lighting and Tramways committee), to the Council offices by noon Oct. 31. An advertisement contains further particulars.

Chester Corporation invite tenders for the supply of arc lamps. Specifications from the city electrical engineer (Mr. F. Thursfield), and tenders to the Town Hall by Oct. 25. See advertisement.

The directors of the *Great Western Railway Co.* invite tenders for supply of stores from Dec. 1, 1902, to Nov. 30, 1903, including telegraph instruments and apparatus, copper wire, G.P. wire, &c., telegraph ironwork and tools, telegraph drysalteries, electric light carbons, incandescent electric lamps, telegraph poles in yellow pine, wire, copper tubes, steel tools, ironmongery, brasswork, &c. Samples may be seen at Swindon up to 16th inst. Tenders to secretary (Mr. C. K. Mills) by Oct. 20.

Rotherham Corporation invite tenders for steam pipes and valves, feed pipes and valves, feed pump and economiser, exhaust water and drain pipes and valves and switchboard extensions. Tenders to town clerk by noon Oct. 16.

Wigan Corporation invite tenders for construction of a short length of new tramway, and for the re-construction of a portion of existing tramways; also for electrical equipment, and for 18 bogie cars, double-deck four-motor equipment. Tenders to town clerk by Oct. 20.

Ipswich Corporation invite tenders for main switchboard, motor booster and connections, and overhead construction for tramways. Tenders to town clerk by Oct. 22.

Barrow-in-Furness Corporation require tenders for two batteries of accumulators, two automatic reversible boosters, switchboards, &c. Tenders by noon Oct. 15.

Blackpool Electric Lighting and Tramways committee invite tenders for a coal conveyor and bunker and automatic weigher. Tenders to electrical engineer by Oct. 15.

London County Council invite tenders for electrical fittings and other stores for 12 months. Tenders by 27th inst.

Bury Tramways committee require tenders for rail bonds, &c. Tenders by Oct. 14.

Dudley Corporation invite tenders for arc lamp carbons. Tenders to chairman Electric Lighting and Tramways committee by noon Oct. 18.

Bootle Corporation require tenders for wiring the refuse destructor works in Pine-grove. Tenders by Oct 14.

Bootle Corporation also require tenders for wiring the new fire station in Strand-road. Tenders by Oct. 18.

Batley Corporation require a re-cooling tower and tank. Tenders by 28th inst.

Manchester Electricity committee invite tenders for steel work for coal bunkers at Stewart-street station. Tenders by noon 16th inst.

Rosario Municipality invite tenders until Jan. 5 for public lighting by electricity or gas.

Monte Video Electric Lighting committee invite tenders until Nov. 13 for the supply of 200,000 incandescent lamps—viz., 140,000 16 c.p. lamps for 105-volt circuits, to consume 3·1 watts per candle hour, and 60,000 lamps of 12 c.p.

Tenders are invited until 15th inst. by *Gefle* (Sweden) Municipal Council for supply and erection of generating plant, accumulators, &c., at the municipal electricity station.

Irun (Spain) municipal authorities require tenders by Oct. 19 for electric lighting concession. Tenders to El Secretario del Ayuntamiento.

Tenders are invited until 20th inst. by the municipal authorities of *Bonillo* (Albacete, Spain) for an electric lighting concession for 20 years.

The *Spanish* Postal Telegraph authorities, Madrid, require, without the formality of tender, 30,000 porcelain insulators for the telegraph service, the price to be within that at which the last purchase of, porcelain insulators by the State was made by tender.

The *Spanish* Telegraph authorities have received power from the Government to purchase, without limit as to price, two sets of "Baudot"-duplex telegraph apparatus. Particulars in the *Madrid Gazette* of Sept. 30.

Plans can be seen at the *Spanish* Embassy, 1, Grosvenor-gardens, London, S.W., connected with tenders which are invited for the construction of the covering and pillars of the third reservoir of the Isabel II. canal at Madrid. The time for receiving tenders for this work has been extended to Dec. 13. The "Boletin" of the Spanish Chamber of Commerce, Madrid, for September contains the conditions of the contract.

The *Madrid* Gazette of 3rd inst. calls for tenders within 20 days for the Directorate-General of Posts and Telegraphs, Calle de Carete, 10, Madrid, or to the offices of the civil Governments of Barcelona, Cordoba, Valladolid and Zarsgoza, and which will be opened at Madrid on 28th inst., for the supply of 35 tons galvanised iron wire 4mm. diameter, 10 tons galvanised iron wire 3mm. diameter, 3 tons copper wire 2mm. diameter, 4 tons copper wire $\frac{1}{8}$mm. diameter, and 4 tons copper wire $\frac{1}{10}$mm. diameter, for the telegraph and telephone service, at the upset prices of 570 pesetas (about £17) per ton for iron wire and 2,890 pesetas (about £86) per ton for copper wire. 5 per cent. deposit is required to qualify a tender.

[Copies of the *Madrid Gazette*, containing the conditions and other particulars of the above matters, may be seen, by appointment, at (but are not obtainable from) the offices of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London.]

TENDERS RECEIVED AND ACCEPTED.

Kingston-on-Thames Town Council have accepted the tender of the British Electric Transformer Co. for sub-station switch fuse boards (high tension £25. 12s. 6d., and low tension £45); that of Prestwich and Burt for 30 patent locks for arc lamp hoisting gear at £97. 10s.; and that of the Gilbert Arc Lamp Co. for 41 double-carbon long-hour lamps at £369, 41 automatic change-over arc to incandescent switches at £143. 10s., 41 automatic cutouts at £51. 5s., 41 main arc switches at £61. 10s., and 40 special switches for hoisting gear at £25.

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The London County Council have received the following tenders for fuel economisers at Greenwich electricity works :—

E. Green & Son (*accepted*)	£4,042 0	Roberts Bros.	£4,165 0
Clay Cross Co.	4,300 0	A. Lowcock	4,053 0
Goodbrand & Co.	4,286 10		

Reading Town Council have accepted the tender of R. W. Blackwell & Co. for cables, test-wires, joint-boxes, &c., and poles, brackets, wires, cables, insulators, switchboxes, &c., in connection with their electric tramway scheme, at £13,477. 3s. 0d.

Salford Town Council have accepted the following tenders :—Mather and Platt (two continuous-current motors), British Westinghouse Co. (alternating-current motors), Baxendale & Co. (solder and plumbers' metal), Gilbert Forrest (frames and covers and joint-boxes).

West Ham Corporation recently received tenders from 12 firms for the construction of permanent way of tramways, paving and bonding. Estimates were also submitted by the works manager. The tender of Mr. F. Osman was accepted.

Bury (Lancs.) Town Council have accepted the tender of the St. Helens Cable Co. for tramway feeder cables, and that of Mr. James Brunton for constructing permanent way of four tramway sections.

Crompton & Co. have received a further order from Peterborough Corporation for a dynamo for direct coupling to a 450 H.P. Willans engine for supplying power to the tramways.

Newcastle-on-Tyne Corporation have accepted the tender of the Lorain Steel Co. for cross-overs and junctions for tramway extensions at Walker at £3,631.

Colchester Corporation have accepted the tender of Williams & Co. for tools for the electricity works; and the tender of Davey, Paxman & Co. for steam pipes.

The Clyde Valley Electric Power Co. has placed a contract with the British Westinghouse Co. for supply and erection of electricity generating plant for Yoker and Hamilton stations. The extent of the contract is estimated at about half a million sterling.

Huddersfield Town Council have placed an order with the St. Helens Cable Co. for low-tension cables (Dialite bitumen type).

Gillingham Council are installing two 450 H P. Willans engines and one of smaller size for direct coupling to B.T.-H. dynamos.

Sheffield and Bury Tramway departments have placed orders with the St. Helens Cable Co. for large quantities of "Dialite" cable.

The contract for the reconstruction of the Blackpool, St. Anne's and Lytham tramways has been let to Mr. T. Nevins, jun.

Mr. E. Taylor, of Blackpool, has obtained the contract for the construction of the permanent way, &c., of the Bexley tramways.

Stepney (London) Borough Council have accepted the tender of J. and H. Gwynne for a centrifugal pump at £58. 12s.

BUSINESS NOTICES.

Messrs. J. C. Lyell and L. C. H. Savory (trading as J. C. Lyell & Co. and the Westminster Motor Car Garage), 55, Victoria-street and Kensington-place, London, have dissolved partnership. Debts of or to J. C. Lyell & Co. will be paid or received by Mr. J. C. Lyell, and debts of or to the Westminster Motor Car Garage by Mr. L. C. H. Savory.

Mr. Geo. Balfour has retired from the partnership business of Lowdon Bros. & Co., electrical engineers, of Dundee, Edinburgh and Glasgow, owing to having accepted a position with Messrs. J. G. White & Co.

BANKRUPTCY.

At Warrington, on Friday, W. Morton and W. T. Sampson, electrical engineers, Warrington, were publicly examined. Liabilities £357. 4s. 10d., and assets estimated £101. 9s. 3d. Mr. Morton's separate estate showed liabilities £84. 5s. 3d. and assets nil. Debtors attributed failure to losses on a contract at Wallasey and bad trade. Examination closed.

Land for Sale.—Freehold land, close to Charlton Junction station, is for sale. Applications to freeholder, Cedar Lodge, Charlton, Kent. See advertisement.

Plant for Sale.—Messrs. G. F. Ratcliff & Co, electrical engineers, 588, Oxford-street, London, W., have a 9½ B H P. Crossley gas engine, a Parker shunt-wound dynamo, a battery of E.P.S. cells, switchboard, &c., for sale, owing to owner taking supply from town mains. See advertisement.

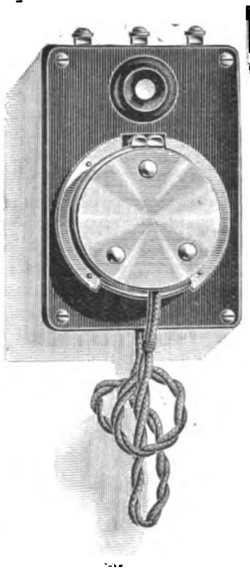
Catalogues.—A revised price list of Jandus arc lamps is issued by Messrs. Drake and Gorham, 66, Victoria-street, London, S.W., copies of which can be obtained by the trade on application.

A handsomely-illustrated catalogue of "Benson" electric light fittings of copyright and registered designs is issued by Messrs. W. A. S. Benson & Co. (Ltd.), 82 and 83, New Bond-street, London, W. Much care has been taken in preparing the catalogue to present the numerous examples of fittings under the most favourable conditions, and all the illustrations are given in colours, showing clearly the metals of which they are made, and other details. The catalogue will prove of great assistance to installation contractors and fittings dealers in transactions with their clients, the consumer himself being catered for in a manner he will thoroughly appreciate. This is a very choice piece of catalogue work, for which the printer, too, deserves his meed of praise.

The Anglo-American Electrical Mfg. Co., of London and Liverpool, have a circular list ready of Hickley's patent rheostats.

The Lighting Corporation (Ltd.), 4, Bloomsbury-street, London, W.C., have just issued a catalogue of "Wenham" incandescent electric lamps for high and low voltages. There is also described the Wenham patent enclosed arc lamp for alternating and for continuous current, of which illustrations are given.

House Telephones.—The Western Electric Co. have sent us their new price list of telephones for private installations. The instruments in this list have been designed with a special view to compactness. The transmitter is an improved Hunnings-Delville pattern having a perforated aluminium disc protecting the carbon diaphragm. The



disc is provided with a lip on the under side, which, together with the pair of springs projecting over the upper side enable the receiver to be clipped to the face of the transmitter when not in use. The springs also act as an automatic switch, cutting the bell out of circuit, and putting the transmitter and receiver in circuit when the latter is removed. The receiver has an aluminum base and a composition ear-piece. The bell-push is fitted to the face of the instrument above the transmitter. All the details are mounted on a new insulating material resembling ebonite, this mounting measuring only 4⅛in. by 4in. over all, and 1½in. in depth. This instrument (shown in the illustration, which is one-third actual size) is common to all the sets, being mounted on japanned metal frames. The bell is so arranged that the hammer strikes the edge of the gong on the under side, the hammer being almost invisible. The plug used in connection with the inter-communication sets is hollow and fits over pegs mounted on the face of the metal frame. The total weight is 14oz. In addition to the ordinary wall and desk sets, some neat inter-communication instruments are listed, and we may add that, taking into account good workmanship, the prices for the instruments are very moderate.

"Flying."—Messrs. Iliffe & Sons have published the fourth number of *Flying*, a quarterly magazine devoted to the subject of aeronautical navigation, price 2s. 6d. A very interesting publication.

Imports of Electrical Goods.—The value of electrical goods imported into this country during September was £49,588, against £46,651 in September, 1901, and £97,107 in September, 1900. The total value for the nine months ended Sept. 30 was £514,225, compared with £683,820 and £794,699 in the corresponding periods of 1901 and 1900 respectively.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Oct. 1 to 7, with the ports of destination :—

Africa—Cape Town, £10,788 (including £3,039 telegraph cable); East London, £474. *Australasia*—Adelaide, £80; Auckland, £62; Melbourne, £205; Perth, £42; Sydney, £94; Wellington, £6. *Brazil*—Rio de Janeiro, £23. *Ceylon*—Colombo, £213. *Denmark*—Copenhagen, £120. *Germany*—Hamburg, £300 (telegraph material); Stettin, £77. *Holland*—Flushing, £69. *Hong Kong*, £41. *India*—Bombay, £639; Calcutta, £1,557 (including £58 telegraph wire). *Japan*—Tokyo, £1,840; Yokohama, £91. *Norway*—Bergen £968 (telegraph cable); Christiania, £26 (telegraph wire) *Peru*—Callao, £9,800 (telegraph cable). *Portugal*—Lisbon, £100. *Russia*—St. Petersburg, £113 (telegraph wire). *Siam*—Bangkok, £640. Total, £23,363, against £87,848 in the corresponding week last year (Oct 2 to 8).

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—The directors propose to use certain funds in their hands (1) in the supply of electrical machinery required by colliery owners and others who take current from the mains of the incorporated company on the hire-purchase system; and (2) in initiating schemes of electrical development in the United Kingdom. Numerous applications have been received from persons in the area desiring to be supplied with electric motors, &c., under a hire-purchase arrangement, and the directors are already negotiating contracts to the extent of some £5,000. The directors have acquired a substantial interest in another similar electricity supply undertaking, and the present capital is not sufficient for more than a restricted business. The directors, therefore, recommend that the capital be increased from £30,000 to £100,000 by the creation of 7,000 new shares of £10 each.

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

August 21, 1902.

18,359. J. J. CARTER. Dublin. Trolley head.
18,372. J. F. WOOD. Liverpool. Actuating by electricity the points of electric tramway rails and the points of the overhead wire.
18,420. F. H. BRIGGS. Electric heater for liquids.
18,441. H. N. THOMAS. Joint for broken trolley wires.

August 22, 1902.

18,461. G. PEARSON. Portable incandescent lamps.
18,464. W. OATES and H. L. ROTH. Halifax. Applying composition to conduits to form jointing rings.
18,465. V. KLEMENT. Glasgow. Electric ignition for automobiles.*
18,469. J. G. W. ALDRIDGE and A. W. RANKEN. Electric lighting of trains.
18,523. H. OLIVER. Liverpool. Trolley arms.
18,532. E. KELLERER. Paris. China frames for branching.
18,533. T. WARD, jun., and J. H. WEEKS. Birmingham. Arc lamps.
18,552. T. F. WALKER and T. S. WALKER. Electric ship log.
18,575. H. FEITH. Electro-deposition of zinc.
18,580. W. L. WISE. Telegraphic apparatus for double transmission by pulsatory and continuous currents. (A. C. Crehore, U.S.)
18,586. H. L. MORSE. Electric fuses or cutouts.

August 25, 1902.

18,609. A. L. TAYLOR. Liverpool. Trolley head.
18,637. R. TAEGGI-PISCICELLI. Electric collection, transmission and delivery of letters, parcels and the like.*
18,651. F. G. BAILY. Switches, plug-sockets and the like.
18,655. R. COLLINGS and A. C. GRISCOM. Automatic switch for electric pumps.*
16,685. A. T. COOPER. Berks. Electrical measuring devices.

August 26, 1902.

18,696. A. W. TURNER. Birmingham. Inkless printing.
18,708. W. J. GREEN. Bristol. Brake levers.
18,727. G. GRANT. Cleaning grooved rails.
18,731. F. J. ESMOND. Electrical contacts.
18,744. R. HADDAN. Controller regulators. (Electrical Device Co., U.S.)*
17,747. R. HADDAN. Automatic telephone exchange mechanism. (Strowger Automatic Telephone Exchange, U.S.)*
18,765. S. Z. DE FERRANTI. Oil-break switch.
18,766. S. Z. DE FERRANTI. Alternating-current electricity meter.
18,771. C. TATHAM. Controlling the play of collectors.
18,777. A. THODE. Trolley holders.
18,782. A. M. MARTIN and J. TENNANT. Liverpool. Life-guards.
18,786. H. BREMER. Arc lamps.

August 27, 1902.

18,793. M. B. FIELD. Glasgow. Synchronising alternating-current machines.
18,808. E. SMELLIE. Glasgow. Electric belt.*
18,816. BRITISH THOMSON-HOUSTON Co. Commutators for dynamo-electric machines. (H. F. T. Erben, U.S.)
18,817. BRITISH THOMSON-HOUSTON Co. Motor control systems. (W. O. Mundy, U.S.)
18,818. BRITISH THOMSON-HOUSTON Co. Transformers. (W. S. Moody, U.S.)
18,819. BRITISH THOMSON-HOUSTON Co. Switches. (C. G. Badeau, U.S.)
18,820. BRITISH THOMSON-HOUSTON Co. Dynamo-electric machines. (H. G. Reist, U.S.)
18,821. BRITISH THOMSON-HOUSTON Co. Electric motor control systems. (F. E. Case, U.S.)
18,824. S. HORVATH. Glow lamps.
18,831. J. R. QUAIN. Safety fuses.
18,854. P. MCCULLOUGH. Liverpool. Trolley catchers.
18,858. W. STANLEY. Measurement of electric currents.*
18,859. W. STANLEY and J. F. KELLY. Generation and distribution of electrical energy.*

August 28, 1902.

18,865. W. J. GRAHAM and S. C. GRAHAM. Transparent cover for contact-breaker of motors.
18,870. M. WALKER. Manchester. Electric generators.
18,872. H. W. COX. Nottingham. Switches.
18,886. L. GANS. Regulating the current employed in joining the filaments of electric lamps, mine firers, or the like to the connecting wires by means of electrolysis.
18,901. E. STANLEY. Portable electric hand fan.
18,903. H. S. HALFORD. Electric tramway rails.
18,922. H. H. LAKE. Electricity meters. (G. E. Co., U.S.)
18,923. H. H. LAKE. Direct-current electricity meters. (G. E. Co., U.S.)
18,924. H. H. LAKE. Variable speed mechanism for electric motors (G. E. Co., U.S.)
18,925. H. H. LAKE. Rheostats. (G. E. Co., U.S.)
18,926. H. H. LAKE. Transformers. (G. E. Co., U.S.)*
18,931. G. C. DYMOND. Liverpool. High potential insulators. (Karlsbader Kaolin-Industrie Gesellschaft, Austria.)*
18,933. G. C. MILNES. Liverpool. Safety appliances.
18,958. L. ANDREWS. Apparatus for indicating, opening or closing a circuit.

August 29, 1902.

18,966. T. E. R. PHILLIPS and F. A. M. ALLINGHAM. Swivelling trolley heads.
18,985. H. CHAPMAN. Sheffield. Electric system of automatically controlling tramway, railway and trolley wire points at junctions.
19,009. J. TOTT. Insulatory wall plates and the like. (R. Müller, Germany.)
19,013. E. P. ALLAN. Cutouts or fuse boxes.
19,032. T. VON ZWEIGBERGK. Control of multiple unit electric trains.

August 30, 1902.

19,048. HANS V. KRAMER. Glasgow. Resistances.
19,079. R. W. BRAHAM. Pivot joint for electric light fittings.
19,097. CALLENDER'S CABLE AND CONSTRUCTION Co. and H. HASTINGS. Breaking arcs.

September 1, 1902.

9,040. A. S. G. BROWN. Galvanometers. (Date claimed, April 18, 1902.)
19,109. I. CLEMENTS and C. CLEMENTS. Birmingham. Chain for suspending electroliers.
19,110. F. J. GREEN. Arc lamps.
19,112. G. WILKINSON. Halifax. Electric railways and tramways on the stud contact system.
19,128. E. G. RIVERS. Richmond. Electric heater or "radiator."
19,172. E. LIMAUGE. Devices for operating trolley arms.
19,180. J. ZWIEBEL. Electric baths.*
19,191. W. MOSELEY. Electric measuring instruments.
19,194. A. H. ATTERIDGE. Magnetic compasses.

September 2, 1902.

19,208. S. ROBERTS. Manchester. Trolleys.
19,225. W. FAIRWEATHER. Glasgow. Storage batteries. (International Battery Co., U.S.)*
19,272. A. W. W. MILLER. Incandescent lamps.*
19,283. J. JOHNSTON and A. E. DOBBS. Electric transmission and controlling gear.
19,291. H. J. HADDAN. Electric alarms. (Topffer and Schädel, Germany.)*

September 3, 1902.

19,305. W. OATES. Halifax. Applying composition to conduits to form jointing rings.

September 4, 1902.

19,366. W. E. HITCH. Birmingham. Cable conductors.
19,368. J. HARGREAVES. Lancashire. Electrodes.
19,377. F. J. GREEN. Choking coil.
19,420. O. IMRAY. Switches. (Sprague Electric Co., U.S.)*
19,422. G. W. GREEN and R. POOLE. Kew. Switches with automatic release.
19,428. J. G. CHILDS. Electromagnetic brakes.
19,431. J. F. MASON and H. KREMNITZ. Liverpool. Life-guards.
19,432. R. W. BRAHAM. Pull down fitting and shade carrier.

September 5, 1902.

19,452. T. H. WILLIAMS. Sparking plugs.
19,483. L. ANGEL. Apparatus for teaching wireless telegraphy.*
19,488. J. B. HENANDEZ, E. M. MUIBA, L. DE LA PEÑA and J. B. ORTEGA. Electrolytic electricity meter.*

September 6, 1902.

19,522. VERITYS LIMITED and P. G. EBBUTT. Birmingham. Electric heating stoves.*
19,529. J. H. CLARKE. Liverpool. Electric ignition for petrol motors.
19,562. H. H. LAKE. Emergency brakes. (G. E. Co., U.S.)
19,563. H. H. LAKE. Switch devices for rheostats, commutators and the like. (G. E. Co., U.S.)
19,564. H. H. LAKE. Switches. (G. E. Co., U.S.)
19,565. H. H. LAKE. Manufacture of insulating bushings. (G. E. Co., U.S.)
19,566. H. H. LAKE. Switch regulators. (G. E. Co., U.S.)
19,567. H. H. LAKE. Trolley wheels. (G. E. Co., U.S.)
19,568. H. H. LAKE. Cooling of electric motors. (G. E. Co., U.S.)
19,569 and 19,574. H. H. LAKE. Manufacture of tubes, plates, &c., from refractory material. (G. E. Co., U.S.)
19,570. H. H. LAKE. Foundry ladles. (G. E. Co., U.S.)
19,571. H. H. LAKE. Systems of electrical distribution. (G. E. Co., U.S.)
19,572. H. H. LAKE. Trolley wheels. (G. E. Co., U.S.)
19,573. H. H. LAKE. Contact-shoes. (G. E. Co., U.S.)
19,579. H. BECKMANN. Detection of short-circuits in batteries.

September 8, 1902.

19,643. G. W. JOHNSON. Switches, junction boxes. (Voigt and Haeffner, Germany.)
19,647. G. M. BREMNER. Electric elevator rope gear.
19,652. F. H. NALDER and NALDER BROS. AND THOMPSON. Ammeters and voltmeters.*
19,655. A. MAY. Alternating-current meters.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

16,419. NICHOLSON. Frogs or points and crossings.
16,810. PEDERSEN. Relays for multiplex telegraphy telephone systems.
17,383. MUNRO. Safety devices for guard wires.
18,831. EVERSHED AND VIGNOLES and EVERSHED. Telegraphs.
19,828. CHAPMAN. Track construction for conduit system.
20,193. HEYL-DIA. Covering conductors with insulating material, or producing small tubings, and apparatus therefor.
20,612. VERITYS LIMITED and SELBY. Switch and circuit-breaker.
20,752. WILKINSON. Adjusting height of electric lamps.
21,056. JANDUS ARC LAMP AND ELECTRIC Co. and JONES. Arc lamps.

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NEW COMPANIES. STATUTORY RETURNS, LIENS, REGISTERED, &c.

NEW COMPANIES.

AUTOCAR CONSTRUCTION CO. (LTD.)—Reg. Oct. 1, capital £25,000 in £1 shares (15,000 preference, 10,000 ordinary), to acquire the business of the Pollock Engineering Co. and to carry on the business of manufacturers of and dealers in motor cars, lorries, motor vans, motor cycles, mechanical and electrical engineers, &c. The first directors are C. W. Milne, J. M. Hewitt, W. J. Davy and J. L. Altham.

BRAY & CO. (LTD.)—Reg. Sept. 25, capital £5,000 in £1 shares, to acquire the business carried on as Bray, Deakin & Co., and to carry on the business of metal workers, electrical, mechanical and sanitary engineers, &c. Reg. office: Bentinck-street, Doncaster.

NOTTINGHAMSHIRE ELECTRIC TRAMWAYS (LTD.)—Reg. Sept. 29, capital £100 in £1 shares, to construct, maintain and work tramways, light railways, electrical and other railways, motors for same and their accessories and appurtenances, to apply for and obtain powers, &c.

STATUTORY RETURNS.

D.P. BATTERY CO. (LTD.)—In the return to July 18 the capital is given as £10,000 in 4,996 "A," 4,996 "B" and eight other shares of £1 each, all of which have been taken up. £10,000 has been received. Mortgages and charges, £20,000.

WHITE, JACOBY & CO. (LTD.)—The return to Sept. 12 gives the capital as £4,000 in £1 shares, of which 3,207 have been taken up. £1 has been called up on 850 and £850 has been received. 2,357 shares considered as fully paid. Mortgages and charges, £1,500.

LIENS, &c., REGISTERED.

LA CAPITAL TRACTION AND ELECTRIC CO. (BUENOS AIRES) LTD.—Agreement dated July 19, 1902, relating to loan of £50,000 and (as collateral security) a scrip certificate dated July 21, 1902, for £75,000 debentures, have been registered. Property charged: The undertaking and assets of the company, including shares in La Capital Co. of New York, La Capital Tramways Co., La Capital (Extensions) Tramways Co. (Ltd.), or the Cordoba Light and Power Co. of Maine, U.S.A. Persons entitled to the charge: Messrs. James Capel & Co., 7-11, Moorgate-street, London, E.C.

OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY (LTD.)—Issue on Sept. 23 of £200 debentures (two of £100 each), part of series created June 20, 1899, to secure sum not exceeding half subscribed capital, charged on company's undertaking, property and assets, present and future, including uncalled capital. Trustees: Sir Charles R. Wilson, 2, Pont-street, London, W., and J. F. Nauheim, St. Swithin's-lane, London, E.C. Total amount previously issued of same series, £34,200. Date of trust deed, July 21, 1899.

THOMAS PARKER (LTD.)—Issue on Sept. 29 of £500 (in five debentures of £100 each), part of series created June 23, 1898, to secure £75,000, charged on the company's undertaking and property, present and future. No trustees. Total amount previously issued of same series, £58,900.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Oct 2, 1902). Price of silver 23 7/8d. per oz. (Oct. 9). Consols (2¾ per cent.) 92 15/16—93 1/16 for money, 93⅛—93¼ for account; 2½ per cent. 93—93½ (Oct. 9). Consols Pay day, Nov. 5; Stocks and Shares Continuation Days, Oct. 13 and 28; Ticket Days, Oct. 14 and 29; Pay Days, Oct. 15 and 30; Mining Share Carry-over Days, Oct. 10 and 27.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—The directors' report states that the work of conversion to electric traction will be practically completed by the end of 1902.

CHILIAN ELECTRIC TRAMWAY AND LIGHT CO. (LTD.)—The report of the directors for the year ended Dec. 31, 1901, states the profit and loss account after payment of interest on advances for construction, shows a debit balance of £6,657. 8s., which, deducted from the balance forward from 1900 (£9,959. 1s. 2d.), leaves a net credit balance of £3,301. 13s. 2d. to be carried forward. The net profits for 1901 amounted to $292,696.04, against $243,055.26 for 1900, an increase of $49,640.78. The great fall of exchange during the year, together with increased interest payable, more than neutralised the increased profit. At the close of 1901 the reconstruction to electric traction had been nearly completed, and on Feb. 28 the contractors handed over what work remained to be done to the general manager for completion. During the 12 months 43,831,591 passengers were carried, against 42,071,049 passengers for the preceding year. During 1901, although progress was made in the development of the use of electric lighting amongst the inhabitants of Santiago, great opposition was experienced from the municipality. Under the terms of the concession, the municipality is compelled to take the company's electric current for public lighting, but it endeavoured to evade that obligation, and the company was compelled to submit their case to arbitration. The arbitrators decided in the company's favour. 334 500 c.p. arc lamps are being installed in the central district of the town.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—A dividend on the ordinary shares at the rate of 4 per cent. per annum (tax free) for the half-year to June 30 is recommended.

CITY AND SURREY RAILWAY CO. (LTD.)—The following circular has been issued by the National Electric Traction Co. (Ltd.):—

I am instructed to inform you that the resolution to amalgamate the City and Surrey Co. with this company, which was unanimously passed at a meeting of shareholders held on Aug. 8, is being regularly carried out, and as soon as possible a Stock Exchange quotation for the shares will be applied for. I am also directed to inform you that an interim dividend at the rate of 6 per cent. per annum will be payable next month upon the preference shares of this company which have been paid for in full, and upon which calls are not in arrears. The bonus of 17½ per cent., as arranged at the meeting above referred to, will be distributed at the same time as the dividend.

For the National Electric Traction Co. (Ltd.),
66, Victoria-street, S.W., Oct. 4. E. C. PARFORD, Secretary.

DIRECT UNITED STATES CABLE CO. (LTD.)—An interim dividend of 3s. per share, tax free (at the rate of 3 per cent. per annum), for the quarter ended Sept. 30, has been declared, payable 25th inst.

REUTER'S TELEGRAM CO. (LTD.)—An interim dividend at the rate of 5 per cent. per annum, tax free, for the half-year ended June 30, has been declared, payable 11th inst.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have ordered £100,000 4½ per cent. first debenture stock of the *Blackheath and Greenwich District Electric Light Co.* (*Ltd.*) to be quoted in lieu of the provisional certificates now quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Sept 27	996	+ 146	17	19,460	+ 4,685
Ayr Corporation	Oct. 4	314	...	20	7,841	...
*Birmingham Tramways.	,, 4	511	+ 6	13	65,314	+ 1,826
*Blackburn Corporation..	,, 3	854	+ 75	¶27	23,520	+ 3,871
Blackpool Corporation...	,, 2	1,086	– 60	27	33,491	– 254
Blackpool and Fleetwood	,, 4	667	+ 3	14	18,098	– 443
Bolton Corporation	...	...	...	...	...	...
Bournemouth Corporat'n	,, 1	248	...	..	...	...
Bradford Corporation ...	,, 5	3,292	+ 2,137	26	92,065	+ 61,793
Brighton Corporation ...	,, 5	809	...	45	34,136	...
Brisbane Tramways.....	Aug. 20	2,844	+ 927	8	19,345	+ 4,490
*Bristol Trams & Carriage	Oct. 3	4,612	+ 323	19	66,268	+ 12,263
*Buenos Ayres & Belgrano	Sept. 7	2,803	+ 6	10	28,222	+ 1,744
Burnley Corporation ...	Oct. 4	743	+ 618	1	743	+ 618
Calcutta Tramways Co...	,, 4	R31,503	+ R9,066	14	R366,717	+ R77,280
Cardiff Corporation	,, 4	1,459	...	27	38,265	...
Carlisle Tramways Co....	,, 4	184	+ 12	†40	7,163	+ 472
Central London Railway	,, 4	6,902	+ 751	14	88,838	+ 7,694
Chatham & Dist. Lt. Rys	,, 2	557	...	15	8,365	...
City & South London Ry.	,, 5	3,033	+ 1,002	14	39,277	+ 13,037
Cork Elec. Tramways Co.	,, 2	778	+ 312	§39	23,429	+ 4,626
Devonport & Dist. Trams	Sept. 26	463	+ 58	38½	16,871	+ 673
Doncaster Corporation..	...	...	...	...	...	...
Dover Corporation	Oct. 4	209	– 35	27	6,725	– 190
Dublin & Lucan Railway	,, 5	102	+ 4	14	1,892	– 3
Dublin Southern Dist....	,, 3	845	+ 11	14	16,187	+ 733
Dublin United	,, 3	3,744	+ 21	‡14	55,296	
Dudley—Stourbridge ...	Sept. 26	891	+ 67	38½	29,254	+ 3,706
*Dundee Corporation ...	Oct. 1	844	+ 132	§19	15,457	+ 1,607
East Ham Council	,, 4	484	+ 60	14	8,059	+ 1,326
Gateshead & Dist. Trams	Sept. 26	892	+ 252	38½	28,656	+ 5,095
Glasgow Corporation ...	Oct. 4	13,487	+ 302	18	279,022	– 7,379
Gravesend—Northfleet	Sept. 26	237	...	8	1,795	...
Greenock & Port Glasgow	,, 26	493	+ 236	38½	19,522	+ 11,778
Hartlepool Tramways ..	,, 26	277	– 2	38½	10,065	+ 1,179
Hull Corporation	Oct. 4	1,758	+ 88	27	47,618	+ 2,012
Isle of Thanet Co.	,, 4	545	– 82	14	19,782	+ 18,540
Kidderminster & Dist....	Sept. 26	146	+ 14	38½	4,915	+ 25
Leeds Corporation	Oct. 4	5,160	+ 719	27	145,624	+ 24,108
*Liverpool Corporation...	Sept. 27	10,473	+ 519	39	380,047	+ 30,193
Liverpool Overhead Rly.	Oct. 5	1,506	+ 66	‡14	22,310	– 1,250
Manchester Corporation	,, 4	5,446	+ 3,198	68	207,571	...
Merthyr.....	Sept. 26	229	– 16	38½	7,879	– 1,432
Middleton	,, 26	293	...	26½	8 354	...
Newcastle-on-Tyne Corp	Oct. 4	3,019	...	...	...	...
Oldham, Ashton & Hyde.	Sept. 26	571	+ 48	38½	20,597	+ 1,012
Perth (W.A.) Elec. Trams	Oct. 3	1,000	+ 113	¶39	41,445	+ 7,028
Poole & Dist.....	Sept. 26	316	– 13	38½	10,220	– 120
*Portsmouth Corporation	...	...	...	...	...	...
Potteries	,, 26	1,622	+ 194	38½	56,773	+ 2,357
Rothesay	,, 26	118	– 22	5½	1,288	+ 328
Salford Corporation ...	Oct. 6	2,797	+ 1,022	27	71,656	...
*Sheffield Corporation ..	,, 5	4,134	+ 441	14	60,034	+ 11,945
Southampton Corp.	,, 1	1,083	+ 90	...	...	...
Southend Corporation...	,, 1	291	+ 47	26	8,549	...
Southport Tramways ...	Sept. 26	294	+ 93	38½	10,173	+ 3,598
*S. Staffordshire Trams...	,, 26	762	– 169	38½	29,548	– 594
Sunderland Corporation.	Oct. 5	1,050	+ 18	...	...	...
Swansea Trams.....	Sept. 26	513	+ 30	38½	18,483	+ 1,202
Taunton Trams.....	,, 26	68	– 36	38½	2,607	– 229
Tynemouth & Dist.	,, 26	367	+ 92	38½	11,801	+ 1,431
Weston-super-Mare	,, 24	164	...	20½	4,981	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 26	315	+ 191	38½	7,603	+ 4,986

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi. Dend.	Name.	Previous Week's Price, Oct. 1.		Price Wednesday, Oct. 8.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 8.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Bl'ckb'n & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)						...	...	...
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) xd	103	106	101	107	4 4 2	...	...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	5 7 8	...	12⅞	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9½	10¼	4 5 9	...	...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	102	105	102	105	4 5 10	...	...	...
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord.	10½	10⅝	10¼	10⅜	3 14 5	...	10 1/16	10⅜
20,000	5	3/6	Do. 7 per Cent. Preference	10½	10⅝	10¼	10⅜	3 5 1	March and September	...	...
30,000	5	3/6	Calcutta Elec. Supply Ord. (1 to 30,000)	7⅛	8⅛	7⅛	8⅛	3 10 7	...	...	...
10,000	5	...	Do. (30,001 to 40,000)	7⅛	8⅛	7⅛	8⅛	...	...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	108	105	108	3 14 8	...	105¾	...
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	9½	9	9⅜	5 5 3	February and August	...	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	...	...	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	,, ,,	5½	...
40,000	5	...	Do. City Undertaking 4½% Cum. Pref.	4½	5½	4½	5½	...	...	...	...
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	105½	...
44,436	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5½	5⅝	5⅜	6	2 10 0	March	5 13/16	...
£180,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	9	10	9⅛	10⅛	4 15 0	February and August	...	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12⅛	13⅛	12⅛	13⅛	4 8 11	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123	128	123	128	3 18 4	June and December	...	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 5 10	...	105	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8⅛	9⅛	8⅛	9⅛	4 4 3	...	...	...
30,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12⅛	11½	12⅛	4 16 0	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	111	114	111	114	3 19 8	...	...	...
10,000	5	2/0	Folkestone Electricity Supply Co. Ordinary xd	5⅝	6⅛	5⅝	6⅛	5 4 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	4/6	Hove Electric Lighting Ordinary	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10½	11⅛	10	11	4 10 11	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6⅛	6⅜	6⅛	6⅜	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% xd	104	107	104	107	3 14 9	...	...	...
£111,000	...	...	London Electric Supply Ordinary	1⅞	2⅛	1⅞	2⅛	...	...	...	...
49,840	5	2/6	Do. 6 per Cent. Preference	4⅛	5	4⅛	5	6 0 0	...	4⅞	4⅜
£350,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	96	99	96	99	4 1 2	Mar., June, Sept., Dec.	97	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15½	16⅛	15⅛	16⅛	4 4 10	April and October	15⅝	15 11/16
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	110	115	110	115	3 18 11	June and December	112	...
£250,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99	102	99	102	3 9 2	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary	13½	14⅛	13⅛	14⅛	4 2 9	March	14½	...
12,194	5	2/6	Oxford Electric Ordinary	5	6	5	6	4 3 4	,,	5	...
£50,000	Stock	4%	Do. 4% Debenture Stock	98	101	98	101	3 19 7	...	...	...
300,000	1	...	Rand Electric	⅜	⅞	11/16	15/16	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs. xd	101	103	101	103	4 7 5	April and October	102	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	15	16	15	16	4 10 8	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8⅜	9⅛	8⅜	9⅛	3 13 8	,, ,,	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98	101	98	101	3 9 7	...	...	...
13,000	5	...	Smithfield Markets Electric Supply Ordinary	1⅜	2⅛	1⅜	2⅛	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5	...	South London Electric Supply Ordinary	2½	3	2⅛	3	...	...	...	...
30,000	5	1/3	Urban Electric Supply Ord. (£4 paid) xd	3⅜	4⅛	3⅜	4⅛	...	...	4	3 15/16
30,000	5	1/3	Do. 5% Cum. Pref. (£4 paid) xd	3⅜	4⅛	3⅜	4⅛	...	...	...	...
110,000	1	5/6	Westminster Electric Supply Ordinary	11	12	1	2	4 11 8	March and September	11⅜	...
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	6	6⅜	6	6⅛	3 16 11	...	6⅛	...
			TELEGRAPHS.								
£67,100	10	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98	102	98	102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅜	4⅛	3⅜	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£788,840	Stock	15/0	Anglo-American	47	50	47	50	5 17 0	Feb., May, Aug., Nov.	48⅜	47⅛
£3,105,580	Stock	30/0	Do. Preferred	91	93	91	93	6 3 2	,, ,,	92⅛	91⅛
£3,105,580	Stock	2/0	Do. Deferred	7½	7⅝	7½	7⅝	1 5 9	,, ,,	7½	...
$13,333,300	$100	$1⅓	Commercial Cable Capital Stock xd	160	170	160	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock xd	93	96	93	96	4 3 4	,, ,,	95⅞	94
16,000	10	4/0	Cuba Submarine Ordinary	5½	6½	5½	6½	6 13 4	February and August	5⅝	...
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 6	,, ,,	...	...
13,000	5	2/0	Direct Spanish Ordinary xd	2½	3½	2½	3½	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference xd	7	8	7	8	6 5 10	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞	103⅞	99⅞	103⅞	4 7 8	January and July	...	...
60,710	10	4/0	Direct United States Cable	10⅜	11	10⅜	11	5 18 2	Jan., Apr., July, Oct.	10⅛	...
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	100	103	100	103	4 7 10	June and December	...	...
£4,000,000	Stock	65/0	Eastern Ordinary [to 1,200) (red.)	124	129	125	130	5 7 8	Jan., Apr., July, Oct.	128½	126
£1,955,565	Stock	17/6	Do. 2½ per Cent. Preference Stock	90	93	90	93	3 15 8	,, ,,	92½	90½
£1,584,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	107	110	107	110	3 13 11	May and November	108	...
300,000	10	2/6	Eastern Extension	12	12⅛	12	12⅛	5 12 0	Jan., Apr., July, Oct.	12 1/16	12 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 0	February and August	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	99	102	99	102	3 18 7	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞	104⅞	101⅞	104⅞	3 17 6	May and November	101½	...
150,000	10	5/0	Great Northern of Copenhagen	26	27	27	28	5 7 2	January and July	...	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos.	100	103	100	103	4 7 5	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	38	42	38	42	5 19 1	May and November	38	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	101	105	101	105	5 14 3	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3⅜	4⅛	3⅜	4⅛	...	...	...	...
30,008	2½	...	West Coast of America	⅜	⅝	⅜	⅝	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	98	101	98	101	3 19 7	January and July	...	...
88,321	10	...	West India and Panama	½	⅝	½	⅝	...	May and November	5/16	...
34,563	10	6/0	Do. 6 per Cent. 1st Pref.	4⅜	5	4⅜	5	12 0 0	,, ,,	4⅜	4½
4,669	10	...	Do. 6 per Cent. 2nd Preference	3	4	3	4	...	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	99	02	4 18 0	January and July	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	11⅝	12⅛	11⅜	12⅛	5 14 3	Mar., June, Oct., Dec.	12⅜	11⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	102	105	102	105	4 15 10	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 19 3	...	...	...
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3⅞	4	3⅞	4	5 11 1	August	...	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/0	2/0	1/0	2/0	15 0 0	April and October	...	...
72,680	1	2¼%	Monte Video Telephone Ordinary	⅛	¼	⅛	¼	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	,,	...	...
£1,983,333	Stock	6%	National Co. Preferred Stock	93	95	93	95	6 5 10	...	94¼	93
£1,966,667	Stock	4½%	Do. Deferred Stock	55	57	55	57	7 17 10	...	56¼	55¼
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12	13	12⅜	13⅜	4 8 11	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11⅜	12⅜	11⅜	12⅜	4 13 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅞	5⅜	4⅞	5⅜	5 0 1	,, ,,	5	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	96	99	96	99	3 10 10	June and December	96⅜	...
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6	...	103⅜	102⅜
171,504	1	0/8½	Oriental	⅞	1	⅞	1	6 0 0	April and October	⅞	...
58,000	5	4/6	United River Plate	4⅜	5⅛	4⅜	5⅛	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅜	5	4⅜	5	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	104	102	105	4 15 8	June and December	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅝	6⅛	5⅝	6	5 0 0	...	...	...
180,337	10	4/9	Globe Telegraph and Trust	9⅞	10	9⅞	10	5 5 0	Jan., Apr., July, Oct	9⅞	9⅞
120,042	10	3/0	Do. 6 per Cent. Preference	13⅛	13⅝	13⅛	13⅜	4 7 3	,, ,,	13 1/16	13⅜
11,339	8	4/0	Reuter's	6⅞	7	6⅞	7⅛	5 6 8	April and October	...	...
3,303	£100 Cert	6%	Submarine Cables Trust	110	120	110	120	5 0 0	,, ,,	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount,	Amount of Shares.	Last Dividend.	Name.	Previous Week's Price, Oct. 1.		Price Wednesday, Oct. 8.		Rate per Cent. Yielded,	Dividend Due.	Business Done During Week Ending Oct. 8	
			ELECTRIC RAILWAYS, TRAMWAYS, &c.					£ s. d.		Highest	Lowest
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007) xd	4⅛	4⅜	4¼	4½	4 8 11	April and October	4 5/16	4 5/16
£230,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	...	...	...
20,000	10	6/0	Barcelona Tramways Ordinary	9	11	9	11	2 14 7	...	10 7/16	...
10,000	10	5/0	Do. 5% Cumulative Preference	9	10	9	10	5 0 0	...	...	...
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 2	...	...	...
15,000	10	4/0	Blackpool and Fleetwood Tramways	13	14	12½	13½	4 16 4	...	...	...
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3⅛	4	3⅛	4	...	...	...	...
75,000	5	2/6	Do. 5% Cum. Pref.	4½	5	4½	5	5 0 0	...	4 13/16	4½
£400,000	Stock	4½%	Do. 4½% Deb, Prov. Certs.	103	106	103	106	4 5 0	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	20½	21½	20½	21½	3 14 2	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (fully pd)	10	10½	10	10½	3 15 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106	108	106	108	3 14 9½	February and August	...	...
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7⅛	7	7⅛	2 13 4	...	...	...
20,000	10	5/0	Do. 5% Preference	9	9⅛	9½	9⅝	5 2 7	May and November	...	...
£250,000	40	4½%	Do. 4½% 1st Mort. Debs.	103⅝	105⅝	103⅝	105⅝	4 6 5	...	...	...
100,000	10	12/0	British Electric Traction Ordinary	12⅛	13⅛	12⅛	13⅛	6 13 4	...	13⅝	12 15/16
100,000	10	6/0	Do. 6% Cum. Pref.	12⅛	13	12⅛	13	4 12 4	February and August	12 15/16	12 15/16
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures xd	124	127	124	127	3 18 9	...	125⅛	125⅛
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅛	1⅜	1⅛	1⅜	...	...	...	...
40,000	5	3/0	Do. 6% "A" Cum. Pref. xd	4⅛	5⅛	4⅛	5⅛	5 14 3	...	5⅛	4 15/16
27,500	5	3/0	Do. "B" xd	5	5⅛	4⅛	5⅛	5 14 3	...	5⅛	...
£320,000	Stock	5%	Do. 5 per Cent. Debentures	104	107	104	107	4 14 3	...	...	...
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	98	101	98	101	5 0 2	...	...	...
70,000	10	6/0	Calcutta Tramways	7⅛	7⅜	7⅛	7⅜	3 17 5	...	7⅛	7⅛
32,268	5	...	Do. (£2, 10s. paid)	...		4¼	4⅜	...	...	4 13/16	...
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	109	107	110	4 2 6	...	108⅜	...
480,000	1	1/2⅞	Cape Electric Tramways Shares	2⅛	2⅜	2⅛	2⅜	6 14 9	...	2 5/16	2⅛
£1,860,014	Stock	4%	Central London Ordinary Stock	103	106	104	107	3 14 11	June and December	106⅛	105⅛
£494,093	Stock	4%	Do. 4% Preferred Stock	106	109	107	110	3 13 3	...	...	...
£494,993	Stock	4%	Do. Deferred Stock	103	106	104	107	3 14 11	...	105½	...
£898,201	100	4%	Do. 4% Deb.	115	118	115	118	3 7 8	...	117⅜	117⅛
40,000	5	2/6	City of Birmingham Trams. Co. 5% Cum. Pref.	4⅝	5⅛	4⅝	5⅛	4 15 3	...	...	...
£300,000	100	4%	Do. 4% 1st Mort. Debs.	101	104	101	104	3 16 11	...	...	...
£1,330,000	Stock	3%	City and South London Railway Con. Ordinary	71	73	71	73	3 12 3	February and August	72½	71½
37,500	10	1/0½	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	" "	...	...
10,000	10	0/11½	Do. (60,001 to 70,000)	...		...		...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	131	128	131	3 16 6	" "	124	123½
£200,000	Stock	5%	Do. (1896)	126	129	126	129	3 17 6	...	...	...
£150,000	Stock	5%	Do. (1901)	122	126	122	126	3 19 7	...	124	123½
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	115	...
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11½	12½	11½	12½	4 8 0	...	...	...
52,987	10	6/0	Do. 6 per Cent. Preference	14½	15½	14½	15½	3 17 5	...	...	...
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.) xd	95	98	95	98	3 11 5	...	...	...
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4½	4⅝	4½	4⅝	6 6 4	...	...	...
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	101	99	102	4 18 0	...	...	...
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	8	9	7½	8½	3 10 7	...	8½	...
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	13½	13⅝	13½	13⅝	4 7 3½	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110	112	111	112	4 0 5	January and July	...	...
30,000	5	2/6	Isle of Thanet Elec. Trams and Light'g 5% Pref.	4½	4⅝	4½	4⅝	5 5 3	...	...	...
£150,000	Stock	£2	Do. 4 per Cent. Debenture Stock xd	...		95	98	4 1 8	...	...	...
17,490	10	1%	Liverpool Overhead Railway Ordinary	4 11/16	4 13/16	4 13/16	4 15/16	2 0 3	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	9⅞	10⅛	9⅞	10⅛	4 17 7	" "	...	...
£125,000	Stock	4%	Do. 4 per Cent. Debenture	99	101	99	1 1	3 19 3	January and July	...	...
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	11⅛	12	11⅛	12	4 3 4	...	11⅛	...
30,999	10	2/3	Do. (£7, 10s. paid)	8⅞	9⅛	8⅞	9⅛	4 1 0	...	...	...
£655,341	Stock	¼%	Do. 4% 1st Mortgage Debenture Stock	108	110	107	109	3 13 4	...	108	107
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	82	84	81	83	...	...	...	...
$8,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112	117	112	117	4 5 7	...	...	...
£60,000	100	5%	Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1903)	104	106	104	106	4 14 3	...	...	...
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	108	110	108	110	4 2 2	...	...	...
24,000	5	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	...	...	...
60,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3	4	7 10 0	(a)	...	...
£181,300	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93	98	93	98	5 2 0	...	...	...
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	101	105	101	105	4 16 5	...	...	...
13,334	10	8/0	Potteries Electric Traction Ordinary	8½	9½	8½	9½	4 4 3	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	9	10	5 0 0	February and August	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108	111	108	111	4 1 10	...	...	...
250,000	1	...	South Lancashire Electric Traction & Power Ord.	...		...		...	...	...	...
51,182	1	...	Do. 6% Preference (16/0 paid)	...		...		...	April and October	...	...
50,000	1	...	Do. 6% Preference (fully paid)	...		...		...	" "	...	...
500,000	Stock	...	Do. 4½% Debenture Stock (80% paid)	...		...		...	January and July	...	...
£540,800	Stock	3%	Waterloo and City Ordinary	90	93	90	93	3 4 6	June and December	...	...
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛	¼	⅛	¼	6 13 4	...	...	...
125,000	1	...	Aron Electricity Meter Ordinary	1/16	1/8	1/16	1/8	...	...	...	...
125,000	1	7½d.	Do. 6% Cumulative Preference	¼	⅜	¼	⅜	12 0 0	March and September	...	...
100,000	5	4/0	British Insulated Wire Ordinary	8	8⅛	8	8⅛	5 5 11	July and February	8 1/16	...
100,000	5	3/0	Do. 6 per Cent. Preference	5⅝	6⅛	5⅝	6⅛	4 16 0	January and July	6	5 15/16
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	102	105	102	105	4 5 6	...	...	...
200,000	5	3/0	British Westinghouse 6% Preference	6	6⅛	6	6⅛	4 13 0	...	6 1/16	6 1/16
£500,000	Stock	14/0	Do. 4 per cent. Mortgage Deb. Stock	103	105	103	105	...	...	103⅛	...
105,731	2	...	Brush Electrical Engineering	⅞	1⅛	⅞	1⅛	...	March	1 1/16	⅞
150,000	2	...	Do. 6 per Cent. Pref. Non-Cum.	1	1⅛	1	1⅛	...	March and September	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	100	103	100	103	4 7 7	March and September	...	...
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	94	99	94	99	4 10 11	January and July	...	...
35,000	5	5/0	Callender's Cable Construction Ord.	15⅞	16⅛	15⅞	16⅛	4 10 11	" "	16⅛	15 15/16
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5 3/4	6⅛	5⅞	6⅛	4 0 0	" "	6 1/16	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109	113	109	113	3 19 8	November and May	...	...
450,000	1	0/0½	Castner-Kellner Alkali Co. (fully paid)	¾	1	¾	1	6 0 0	...	...	...
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	98	98	93	98	4 11 8	...	96½	...
60,000	1	7½d.	Chadburn's Ship Telegraph Ordinary xd	¾	1	¾	1	3 2 0	March	...	...
85,000	3	1/9½	Crompton and Co. (Nos. 1 to 54,000)	2½	3	2½	3	6 0 0	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	101⅝	06⅝	101⅞	06⅝	4 14 4	" "	...	...
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜	⅝	⅜	⅝	...	February and August	...	...
17,139	5	...	Do. (£5 paid)	1⅛	2⅛	1⅛	2⅛	...	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.) xd	74	78	74	78	5 2 7	June and December	...	...
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	77	82	77	82	6 1 11	...	...	...
50,000	5	4/0	Edmundson's Electricity Corporation Ord.	6⅛	6⅜	6⅛	6⅜	5 3 8	Half-yearly	6 1/16	6⅜
30,000	5	3/0	Do. 6% Cumulative Preference	6	6⅛	6	6⅛	4 12 4	...	6⅛	...
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	107	110	4 2 1	...	...	...
112,100	2	1/2⅜	Electric Construction Co.	1⅛	2	1⅛	2	6 0 0	January and July	1⅜	...
31,390	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅛	3	2⅛	3	4 13 4	July	...	...
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	02	99	102	3 19 1	January and July	...	...
122,985	1	..	Electrolytic Alkali Ordinary	¾	1	¾	1	...	...	...	...
50 000	1	...	Do. 7 per Cent. Cumulative Preference	¾	1⅛	¾	1⅛	...	...	...	...
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	10	10½	10	10½	4 15 3	...	...	...
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures xd	99	102	99	102	3 18 11	...	101	...
35,000	5	6/0	Henley's Telegraph Works Ordinary	16	17	16	17	4 14 2	February and August	16⅜	16⅛
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	5⅜	5⅛	5⅜	3 18 3	" "	5⅜	...
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	109	113	109	113	3 19 8	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20⅛	21⅛	20⅛	21⅛	4 13 0	" "	21	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) xd	99	102	99	102	3 18 2	March and September	...	...
32,505	10	...	Mather and Platt 6 per Cent. Cum. Pref.	...		11⅛	12	...	March and Septembe	...	...
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½	15½	14½	15½	6 9 0	July	...	...
37,350	12	12/0	Telegraph Construction and Maintnce.	38	41	37	40	5 19 11	March and July	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	January and July	...	...
66,666	5	10&2½bs	Willans and Robinson Ordinary	...		9½	9¾	5 12 5	April and October	...	...
66,666	5	6%	Do. 6 per Cent. Cumulative Pref.	...		6¾	7¼	4 2 6	" "	...	...
£135,000	Stock	...	Do. 4 per Cent. 1st Mort. Deb.	...		102	105	...	May and November	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee have refused to quote these.

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NOTES.

It is interesting to note that the supply of electricity "in bulk" is continuing to gain favour with municipal authorities. A few weeks ago we announced that Brighton proposed to appeal to Parliament next session for power to supply electricity to the adjoining districts of Portslade, Shoreham and Southwick, and that the Corporation has inquired of the Councils of these districts whether they will support them in this matter. Southwick will, we believe, not be unwilling to take electrical energy "in bulk" from Brighton and retail it to consumers themselves, and Shoreham is awaiting further particulars before it will commit itself to a reply to Brighton's proposal. In the meantime Steyning East Rural District Council, in answer to an application to the Brighton Corporation, has been informed that the Corporation has no powers to supply electrical energy in that district.

On the other hand, the agreement between the Corporation of Belfast and Messrs. Harland and Wolff, according to which the large engineering works of this firm were to be supplied with a considerable amount of power by the Corporation, in addition to the 100 H.P. already taken, has fallen through. It would appear that the cause of this is the delay of the Local Government Board in granting sanction to the loan for the purpose. The application for current and the guarantee for a certain consumption were received by the Corporation last May, and were immediately accepted subject to the Local Government Board's sanction to money being borrowed for laying mains for this purpose. The Local Government Board enquiry was held on July 22nd, and the Belfast Electric Lighting Committee did not receive the Board's decision until last month, over three months after the Corporation had arranged to give the supply. By this time Messrs. Harland and Wolff had found that they could wait no longer. We are constantly hearing complaints as to the delay of this Government department in holding enquiries and sanctioning loans even when there is no local opposition or any unusual circumstances, and it would not be unwise if some of those Corporations which have suffered inconvenience by these delays were to make combined representations on the matter to the President of the Local Government Board.

On another page will be found a description of the new municipal technical schools at Manchester, together with an account of the speech made by the Premier at the opening ceremony. Although Mr. Balfour admits that his opinions are "second-hand," yet it would be difficult, even for an expert, to improve upon or criticise them. Manchester has set an example regarding the training of leaders of scientific industries that other cities might follow with advantage. She has not built a number of small polytechnics upon which large sums of money may be spent to no good purpose, but she has carried the matter through in a most thorough manner, and the electrical industry, in particular, should be especially grateful to her for the new technical schools. As Mr. Balfour said, it is useless to attempt to train the leader of an industry by teaching him elementary work, and the only correct way is to encourage work of a higher nature, by training a man to carry out research and think for himself. It is for this very purpose that these new schools have been built, and equipped in such a complete manner. They are not intended for the scientific education of the workman, but solely for those skilled engineers and technically-educated men of whom the country is in the most urgent need.

The unfortunate fatal accident which occurred at Sutton Coldfield last Friday need not unduly alarm our readers nor the public which is uninitiated in electrical matters. It will be seen from the report of the inquest in another column of this issue, that a workman employed on the electric lighting mains fell against a conductor charged at 285 volts and was found to have expired. He remained in contact with the wire for only

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eight or ten seconds. The medical evidence was to the effect that the man suffered from heart disease, electric shock being a contributory cause of death, and the verdict of the coroner's jury was in accordance with this statement although the evidence of the borough electrical engineer was that the low voltage could not kill. We should not like to deny that the actual shock experienced by the victim may either have brought on the attack of syncope or have contributed to his death, but we are not inclined to go so far as to say that any electrical effect on the system played a part in it. If the shock had been from a mechanical or mental cause, instead of an electrical one, the result would probably have been the same.

THE "tube" companies will read with interest the result of a case heard by Mr. Under-Sheriff BURCHELL and a special jury on Tuesday. It was asserted that, since the works in connection with the Great Northern and City Railway in London had been commenced, subsidence had taken place in a certain couple of houses in the New North-road, and that various structural defects had developed. The wife of a tenant described the creaking and cracking noises in a manner that reminded one of the ill-fated house so vividly described in DICKENS' "Little Dorrit." Expert evidence was brought on the other side, however, to show that the houses, which were 60 or 70 years old, rested on very shallow foundations, and a tell-tale photograph was produced, taken before the line was made, and showing an extensive crack in the wall of one of the buildings in question. The result was a unanimous verdict that the damage had not been done by the "tube," but was the work of time.

MUNICIPAL telephony is rapidly spreading among the larger towns in this country, and even in some of smaller size. Such is the fascination of municipal trading that, the principle of municipally-owned telephone exchanges and of telephonic competition having received Parliamentary approval, numbers of municipal telephone exchanges were bound to spring up whether the existing telephone service in the particular localities was cheap or dear, bad or good. This change in the telephone industry has, therefore, now to be reckoned with. It will, we may reasonably hope, only be developed for a few years, until the State takes over the whole telephone system of the country; but, in the meantime, if local authorities cannot be prevented from embarking on telephone enterprises, let them at least do so with their eyes open.

AT Tunbridge Wells, the first town in the United Kingdom to inaugurate its municipal telephone exchange, there has been a large and growing opposition to the undertaking, which became more serious when, having spent £10,000, which was the estimate for the original scheme, the Corporation applied to the Local Government Board to sanction a further loan of £15,000 for telephony. A "Ratepayers' League" was formed which, it is stated, now represents ratepayers owning or occupying more than half the rateable property in the borough, and this body is using every exertion to oppose the cause of municipal telephony. Its last effort has been the publication of two booklets—"Tunbridge Wells Municipal Telephones: The Accounts 1901—March, 1902, and Audit," and "Municipal Telephony: Should We Adopt It?" The former deals critically with the Tunbridge Wells telephone accounts which have been published recently; and the latter is a review, from the standpoint opposed to municipal ownership, of the general question of municipal telephony. Although the facts are put in a partisan spirit throughout, there is much that is good and to the point in these two books. We commend their perusal particularly to those who are interested in municipal affairs, and who have hitherto only regarded the question of municipal telephony from the point of view of its supporters.

WITH the Board of Trade report on the tramway accident which took place in Glasgow last month, the incident may be regarded as closed. As seen in the report, published on another page, so far as can be ascertained the electric brake of the car was in good order, and there was also nothing to prevent the car being started forward with the controller in the ordinary manner, thus stopping the run-back. Moreover, the inspector is satisfied that the system of training for the motormen at Glasgow is adequate, and, although he does not wish to blame the motorman of the car in question as the evidence is not conclusive, he thinks it probable that the electric brake was not applied at all during the run-back, or that, if this was done, the power-handle was not reversed, as would be necessary in such a case. The only lesson to be learned from the accident, therefore, is, as Major DRUITT rightly concludes, "the necessity of having highly-trained and intelligent, level-headed men as drivers."

Pacific Cable.—The Commercial Pacific Cable Co. give denial to the statement published by Reuter that the company propose to lay a submarine telegraph cable between Honolulu and Fanning Island.

The Proposed Telpher Postal System.—It is stated that Count Taeggi has informed the *Daily Mail* Rome correspondent that the Italian Postmaster-General has reported most favourably on the electric postal system mentioned recently in our columns. Our contemporary adds that in consequence of information furnished by the Italian Government to the British Postmaster-General, the latter has invited Count Taeggi to call on him in London at an early date.

Refuse Destructor at Gloucester.—On Wednesday last week the new refuse destructor at Gloucester was formally opened. It has a capacity of 50 tons per day, but the estimated amount that will be dealt with does not exceed 150 tons per week. The total cost, including building, was £8,710, and the destructor was supplied by Messrs. Heenan and Froude. Each of the two pair of cells is provided with a water-tube boiler, in which steam is generated for the use of the engines in the electricity works.

Overhead Wire Stolen in America.—The *Street Railway Review* of Chicago states that six times within a few weeks the overhead line of the North Jersey Street Railway Co. has been damaged and considerable quantities of copper stolen. The last attempt was made on August 18th, when about 1,000ft. of copper wire was taken down from the poles, in spite of efforts made by the police to detect the offenders. The service had to be suspended for several hours in order that repairs might be carried out.

Drawing, Tracing and Photo Entry Book.—We have received from Mr. E. L. Collins, of Liverpool, a copy of the above publication. It has been issued with a view to saving the confusion so commonly seen in a drawing office due to a faulty index of drawings, &c., being kept. The index contains two pages to a letter and the book is strongly and neatly

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bound. Normally, there is sufficient room in the book for 3,000 entries, but the size may be varied to suit requirements. We can recommend it as being eminently suitable for its purpose.

Gas and Electricity in Combination.—A Paper was read by Mr. S. Meunier, before the Midland Association of Gas Engineers during their autumn general meeting at Birmingham, on Saturday, in which the author strongly advised the amalgamation of the gas and electrical industries. He said that capital expenditure and works costs would be considerably reduced, and both industries would benefit by the movement. Electricity should be treated as a friend and not as an enemy by gas engineers, and instead of fighting against it they should combine with it.

Personal.—It is announced that Mr. Alfred Graves, who has been for nearly 50 years with the North-Eastern Railway Co., has resigned the position of telegraph superintendent of the company, and that his successor will be Mr. C. H. Ellison of the office of the superintendent of the line, York.——In connection with our recent article on the "Midland" electric power scheme, Mr. P. J. Pringle asks us to state that he acted for Messrs. Kincaid, Waller and Manville in superintending the carrying out of the entire scheme, and that he was assisted by Mr. H. A. Barnett, Mr. Watson and Mr. Bemrose.

Cable Interruptions and Repairs :—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
St. Lucia—Grenada	May 9, 1902 ...	Oct. 13, 1902
Dominica—Martinique	May 9, 1902 ...	—
St. Lucia—Martinique	May 9, 1902 ...	—
Guadeloupe—Martinique	May 9, 1902 ...	—
Santa Cruz—Teneriffe	July 7, 1902 ...	—
Puerto Plata—Martinique	July 10, 1902 ...	—
Anjer—Kalianda	Aug. 2, 1902 ...	—
Guantanamo—Mole St. Nicholas	Aug. 5, 1902 ...	—
Cayenne—Pinheiros	Aug 13, 1902 ...	—
St. Lucia—St. Vincent	Sept. 19, 1902 ...	—
Maranham—Para	Sept. 19, 1902 ...	—
Maranham—Ceara	Sept. 19, 1902 ...	—

Gas Leakage.—At a recent meeting of the New York County Medical Society the subject of "gas leakage" was discussed at considerable length, and the conclusions arrived at were anything but pleasant. It appears from an editorial comment in the *Western Electrician* of Chicago that an enormous amount of gas is wasted per day in large American cities, and owing to the nature of the road in which the pipes are laid, the gas cannot escape uniformly, but is compelled to find an exit wherever it can into sewers, cellars, and various other places. Not only is this the case, but an additional danger is added by the fact that gas, as it is manufactured at the present day, contains a far larger proportion of carbon monoxide than it did a few years ago, and thus the public daily breathe one of the most poisonous gases.

Accidents on Electric Railways.—At the annual convention of the New York State Street Railway Association, Mr. C. R. Barnes, electrical engineer for the New York Railroad Commission, read a Paper on accidents on electric railways, in which he said that the investigations of accidents in a large majority of cases shows a defect in the organisation of the operating force and in the methods of operation. He also urged that more care in the choice of motormen should be exercised, and said that a better and more intelligent class of man should be recruited. They should be better trained too; a few days with an old motorman is not now sufficient to initiate a raw hand into the arts and mysteries of driving a trolley car, although it may have been in times past when cars were small and light, and passengers comparatively few. A reliable block signal system, the cost of which would place it within the reach of electric railroads, is something which is much needed in Mr. Barnes' opinion.

The Autumn Parliamentary Session.—During the adjourned Session of Parliament, which commenced yesterday, the following electrical bills have to be dealt with :—The Brompton and Piccadilly Circus Railway (new lines, &c.), Charing Cross, Euston and Hampstead Railway (Golders Green extension), Edgware and Hampstead Railway, Great Northern and City Railway (Lothbury extension, &c.), North-West London Railway (extension of time), Great Northern and Strand Railway (extension of time), Baker Street and Waterloo Railway (extension of time), District, Deep Level: Earl's Court to Mansion House (extension of time). These are down for third reading in the House of Commons, having passed the Upper House. The London United Electric Railway and the Piccadilly–City and North-East London Railway Bills, which constitute the Morgan group, have also passed through the House of Lords, but have still to pass the House of Commons Committee stage.

The Recent Fire at the General Electric Co.'s City Offices.—The directors of the General Electric Co. have recently had under consideration the question of compensation to those injured and to the parents of their unfortunate employés who lost their lives at the recent lamentable fire on their premises in the City of London. A settlement, satisfactory to all concerned, has been effected with the parents of those killed in the disaster, and a sum of £150 for each of the six girls injured has been set aside. An application was made on Monday in the City of London Court to Judge Rentoul to adjudicate upon the manner in which these moneys should be dealt with, and after consideration the judge decided that each of the girls' parents should be awarded £10 to defray expenses, and the balance of £140 invested by the Court until the girls should attain the age of 21 years, interest meanwhile being applied to their benefit.

Breakdown on the London United Tramways.—On Sunday evening last a guard wire near the tramway terminus at Shepherd's Bush snapped through the trolley fouling it, and, falling across the trolley wire, caused a short circuit on the line, and at the same time cut off the current. The breakdown, however, was quickly repaired, and the accident would probably have called for no comment in the daily papers but for the unfortunate fact that a few minutes afterwards, when the trams were again running, a young lady, in entering one of the cars was seen to fall upon her face, and in spite of medical assistance, died on the spot. It was reported that death was due to electric shock, but at the inquest on Tuesday it was proved that the guard wire had fallen at a point 200 yards away from where the lady fell, and that no marks of wire or burning could be found upon the body. The post-mortem examination showed that death was due to heart disease, and the coroner's verdict was in accordance with this finding.

Wireless Telegraph Experiments.—*The Times* of last Tuesday contains an interesting article on the experiments made during the months of July, August and September between the Marconi Company's station at Poldhu and the Italian war vessel "Carlo Alberto." The article, which is a review of a report written by Lieut. Luigi Solari of that ship, states that the most striking results were obtained off the Spanish coast, in the Mediterranean and at Gibraltar, where regular news messages were received daily. Signals were transmitted to greater distances, however, some having been received on the telephone of Mr. Marconi's new magnetic detector to the north-east of the island of Gothland, in the Baltic, a distance of some 2,000km. over land and water from the transmitting station in Cornwall. Among other things, the tests indicate to what extent the new magnetic detector is superior to the coherer, and also the effect of atmospheric disturbances upon such transmissions of signals. By the courtesy of Signor Marconi and the Editor of *The Times*, a copy of the original Italian report is in our hands, and we hope to return to the subject more fully in our next issue.

Institution of Civil Engineers' Premiums.—The council of the Institution of Civil Engineers have, in addition to the medals and prizes given for communications discussed at the meetings of the Institution in the last session (a list of which was given in our issue of May 2), made the following awards in respect of other Papers dealt with in 1901–1902 :—

A Telford gold medal to J. Macfarlane Gray (London); a George Stephenson gold medal to R. Price-Williams (London); a Watt gold medal to W. Bell Dawson, M.A., D.Sc. (Ottawa); Telford premiums to W. R. Cooper, M.A., B.Sc. (London), E. M. De Burgh (Sydney, N.S.W.), George Wilson, D.Sc. (Manchester), Frank Oswell, B.A. (Buenos Ayres), and A. W. Brightmore, D.Sc. (London); a Crampton prize to C. D. H. Braine (Mowbray, Cape Colony); the Manby premium to B. W. Ritso (Cape Town). For students' Papers the awards are :—A Miller scholarship

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(tenable for three years) and the James Forrest medal to H. F. Lloyd (Birmingham); Miller prizes to J. C. Collett (London), W. H. C. Clay (London), H. C. M. Austen (London), A. M. Arter (London), Robert Bruce (Manchester), L. F. Wells, B.Sc, (Manchester), and W. H. McLean (Glasgow).

Mr. W. R. Cooper's Paper, "The Present Position of Electric Traction on Tramways and Roads, with Special Reference to Accumulator Traction," was published in the *Journal* of the Institution of Civil Engineers, Vol. CXLIX., part 3.

The Manchester Section of the Institution of Electrical Engineers.—In the report of the committee of this local section on the year's work, it is stated that a sub-committee was appointed to call a meeting of representatives of the various Manchester societies to discuss the question of acquiring central premises in Manchester for meetings and library. This meeting was held on April 3rd, and a joint committee was then appointed to consider the question and formulate a definite scheme. It is hoped that some practical result will follow. The post of hon. secretary has been vacated by Mr. Cowan and is now filled by Mr. Ramage, and the following gentlemen have been appointed officers and members of the committee for the session 1902-1903: Past-Chairmen, Dr. Edw. Hopkinson and C. H. Wordingham; Chairman, Hardman A. Earle; Vice-Chairman, Edw. W. Cowan; Members, Dr. F. H. Bowman, S. V. Clirehugh, A. A. Day, C. M. Dorman, W. P. J. Fawcus, A. S. Giles, J. S. Highfield, H. Lindley, G. F. Metzger, A. B. Mountain, Dr. C. H. Lees, C. D. Taite; Hon. Secretary and Treasurer, P. A. Ramage, Salford Iron Works, Manchester.

The Grimsby and Cleethorpes Tramways.—The Grimsby tramways, which started running in December last year, are being run by the Great Grimsby Street Tramways Co., which has leased the lines from the Great Grimsby Corporation for 21 years, and runs them with energy bought from the Corporation electricity works. An extension of the line, however, runs from Grimsby to Cleethorpes, and this is supplied from a power house in Cleethorpes which the company has only completed this year. Under the powers obtained by the company and the Cleethorpes District Council, the latter have power to purchase the works from the company in order to supply energy from it for public and private lighting in the district and for other purposes as well as the tramways, in which case the District Council is to supply the company with energy for running the tramways. Failing agreement as to the price charged for this energy, it is to be fixed by an arbitrator appointed by the Institution of Electrical Engineers. The time given to the Cleethorpes District Council to decide as to purchase having nearly expired, the matter came up for consideration at a meeting of that body last week, when it was determined, after some discussion, that the purchase would be made.

Proposed Mono-rail Line to Brighton and Dover.—In our last issue we gave particulars of a scheme for a London–Brighton electric railway, which it is proposed to submit to Parliament next session. Another scheme has also been initiated—viz., one for a "mono-rail" from London to Brighton and Dover, which it is proposed to introduce in two bills. The site indicated for the London terminus, common to both lines, is in a central position in the Strand. From the station both lines would cross underneath the Thames and rise to the surface at a point near Westminster Bridge-road. Thence they would run parallel, on viaducts, as far as Clapham-park, at which point the Dover line will branch off in the direction of Chatham, while the Brighton line will continue via Redhill, finally entering Brighton through a district which is not much built upon, and ending at the back of the Bedford Hotel. The estimate for the Brighton line, it is said, is less than four millions. It is also stated that the journey from London to Brighton will occupy only 25 minutes, and the promoters of the Liverpool–Manchester scheme hope to run trains over one of their sections at 110 miles per hour by next June, in order to demonstrate to the Parliamentary Committee the possibility of very high speed.

British Submarine Boats.—A correspondent in yesterday's *Standard* gives some interesting details concerning the experiments on the new submarines which have been carried out at Barrow. One boat was submerged to a depth of 10ft., only a few inches of her periscope being visible, and in this position she travelled for 6 miles. On arriving at the surface again her crew were apparently little the worse for their adventure. Subsequently, she carried out various manœuvres, remaining on one occasion under water for an hour. The British submarines are of the Holland type, and have a length of 63ft. 4in., with a diameter of 11ft. 9in., and a displacement of nearly 140 tons when totally submerged. They are driven by 160 H.P. gasolene motors when on the surface, and by electricity for submerged work. The fastest boat has a speed of 12 knots running with her turret "awash" and 8 knots when submerged. She is capable of travelling fully 400 miles without exhausting her gasolene supply. An instrument for viewing the surface when submerged, and known as the "periscope," consists of a vertical tube about 10ft. in length, with a prism at the top, through which the image is reflected down on to an object glass in the conning tower. The submarine carries a voluntary crew of seven, who are sworn to secrecy. The Holland type carries four 18in. Whitehead torpedoes, which can be discharged in almost any position with unerring accuracy. The article also states that Messrs. Vickers, Sons and Maxim have recently constructed a large and novel kind of diving torpedo-boat, with which experiments have been made to the satisfaction of the Admiralty. She has a length of 100ft., and has a speed of about 15 knots when on the surface and 10 knots when submerged. Notwithstanding the size of the vessel, she can be navigated with perfect ease. She is the joint invention of Messrs. Vickers, Sons and Maxim and of the Admiralty. On this vessel is fitted Sir Howard Grubb's new instrument, the "cleptoscope," in place of the periscope. It is understood that the building of submarines will be deferred until the experiments with the boats at Barrow have been concluded.

The American Institute of Electrical Engineers.—Mr. Charles F. Scott delivered to the American Institute on September 26th his presidential address, in which he reviewed the present state of the electrical industry in America. He said that, although the "infancy of electricity" is a hackneyed theme, yet the electrical engineer must realise how brief, compared with other branches of engineering, is the experience upon which his work is based. The electrical engineers of a generation ago were telegraph men, but now a new type had arisen, to whom the click of the sounder was unintelligible. Electricity had been foremost in the general activity of the past decade, which had marked an epoch in the world's history. When the Institute was first organised the total investment in electrical applications outside telegraphy and telephony did not exceed $1,000,000, but at the present time the estimated capitalisation in the United States approximates $4,000,000,000, taking no account of the industries which used electricity as an auxiliary. Continuing, Mr. Scott said:—

> It is the function of the American Institute of Electrical Engineers to bring individual workers into a common unity, to join them in a community of interest, which is called the electrical engineering profession. It should place the profession of electrical engineering above suspicion of corruption and chicanery, and should call for high standards of dignity and honourable accomplishment. During the past year the membership increased 25 per cent. and reached 1,546. This is less than one-half the membership in the British Institution of Electrical Engineers. If American Institute membership bore the same relation to the kilowatt capacity of the electrical power-stations of the country as does that of the British Institution, the membership should be 25,000; 5 per cent. of the membership of the American Institute took part in the meetings last year, and 2 per cent. furnished Papers. Of these Papers 10 per cent. came from miscellaneous sources, 20 per cent. from college professors, 25 per cent. from operating and consulting engineers, and 45 per cent. from engineers connected with manufacturing companies. These figures indicate that electrical matters are advancing so fast that even the teachers in the great technical schools fall behind the pace, because the problems come first to the manufacturer. To the manufacturing companies must be given credit for substantially advancing scientific investigation as well as practical development.

Speaking of the education of an electrical engineer, Mr. Scott said:—

> Fortunate will it be if we can lead the student to see that in the training of an electrical engineer there should be something besides technical books—that logical thinking and clear expression and general culture are indispensable in a profession that comes in touch with so many departments of science and engineering as well as industrial and commercial and social activity, and that he must be a broad man with a broad educational foundation, who would aspire to the fullest usefulness and success.

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RECENT PROGRESS IN LARGE GAS ENGINES.*

BY HERBERT A. HUMPHREY, M.I.MECH.E., A.M.I.C.E., M.I.E.E.

(*Continued from page 983.*)

A larger number of gas engines of medium size have been turned out by the Gasmotoren Fabrik Deutz than any other Continental firm, and now they are well in evidence with some fine examples of large engines. One firm alone, the Gutehoffnungshütte für Bergbau und Hüttenbetrieb of Oberhausen, has been supplied with eight Deutz engines varying in size from 300 H.P. to 1,000 H.P., and aggregating 2,400 H.P., besides three smaller engines. Another firm, the Eisenhütte-Actien-Verein, Düdelingen, has two 1,000 H.P. and two 600 H.P. engines, giving 3,200 H.P. for the four engines. A pair of 1,200 H.P. gas-driven alternators are working in parallel at the Horder Bergwerks-und-Hutten-Actien-Verein in Hörde (Westfalen). The alternator is by Schuckert & Co. of Nürnberg. Other engines by the Gasmotoren Fabrik Deutz will be mentioned later, in dealing with the subject of running alternators in parallel.

The Oechelhäuser gas engine is in the hands of the Deutsche Kraftgas Gesellschaft, a combination of the firms of Siemens and Halske Actien-Gesellschaft and Union Elektricitäts-Gesellschaft of Berlin. Various firms are building Oechelhäuser engines for the above, and their names, and those of foreign licencees, will be found in Table IV., which is a tabulated list of makers of large gas engines, and shows what powerful interests are now engaged in the new department of engineering. The Oechelhäuser engine has been described in a previous Paper by the author, and also in most of the technical journals. It is sufficient to call to mind the arrangement of the two pistons working in one cylinder and attached to opposite cranks, the one directly and the other through side rods; also the gas and air pump attached by a rod to the back piston. Where alternators of great power are to be driven the arrangement shown in Fig. 7 is adopted, and results in a combination giving two impulses per revolution, and very suitable for use when alternators are required to run in parallel. A 1,000 H.P. engine of this type, running at 125 revs. per min., only requires a 28-ton flywheel to limit its cyclic variation to $\frac{1}{350}$. Nearly 80 per cent. of all the Oechelhäuser engines made are for dynamo driving.

The name of Westinghouse stands for progress in many directions, and not least in the development of large gas engines. The Westinghouse Machine and Mfg. Co. of East Pittsburg, U.S.A., has spent much time and money in order to bring the usefulness of the large gas engine up to the standard of the large steam engine. The benefit of this experience will be reaped by the British Westinghouse Electric and Mfg. Co., which has a fully-equipped department for the construction of large gas engines at Manchester. Most of the Westinghouse machines are of the three-cylinder vertical enclosed type, and Fig. 8 shows a 650 H.P. direct-connected electric generating set at the Howard Axle Works. This type has been at work for several years. A new horizontal type two-cylinder double-acting Westinghouse engine has recently been introduced. All working parts are under observation and are easily get-at-able, and the design embodies a great deal of experience.

At Walthamstow electricity works there are four 100 H.P. direct-connected Westinghouse gas engine sets, and three additional sets of 250 H.P. are now erecting. The station distributes current for power, incandescent and arc lighting, and the additional orders show its practical success. Their demand has increased so rapidly, that from the start they have operated without any spare capacity in the station, yet there has never been a shut-down; and the whole installation is, if anything, more reliable than a similar steam installation would have been. The plant is located in the midst of residences, but there has been no trouble whatever from noise of exhaust or vibration. Quite a number of Westinghouse sets are in use in England, and some are on order for Ireland.

Mention has already been made of six 1,000 H.P. gas engine gas compressors, for compressing natural gas with natural gas in America. Each machine has four single-acting power cylinders, 25in. in diameter by 48in. stroke. All four connecting rods connect to the main crank pin, two cylinders being on one side and two on the other. Another crank is formed at the other end of the main shaft, from which are driven the compressor cylinder pistons. This crank is 90deg. from the power crank, so that the period of maximum power and maximum resistance are nearly coincident. The normal speed of the machine is 100 revs. per min. Compression in the power cylinders is carried to 100lb. per square inch, and the explosion pressure is between 400lb. and 450lb. The first two machines were governed by throttling the mixture; the last four machines have been modified by the addition of an automatic cut-off valve, which automatically cuts off the supply of mixture according to the power required, the closing of the cut-off valve being regulated by the governor, which can give a cut-off of one-eighth of the stroke. Tests of these machines give a horse-power in the compressor cylinders with from 8½ cubic ft. to 9 cubic ft. of natural gas per hour (calorific value, 1,050 British thermal units per cubic foot). The combined mechanical efficiency is 82 per cent. All parts in contact with hot gases are water-jacketed, and the machines have run well right from the start.

The 4,000 H.P. gas engine gas compressors mentioned at the commencement of this Paper are also under construction by this firm, to the order of the city of Cleveland. Each engine comprises four double-acting power cylinders, 37in. in diameter by 60in. stroke, and two compressor cylinders 22in. in diameter by 60in. stroke. The main shaft of these machines is 24in. in diameter in the bearing and 28in. in diameter at the flywheel, the latter being placed between the cranks. There are four bearings, each 24in. in diameter, the inner being 42in. long and the outer 36in. long. The flywheel is 22ft. in diameter and weighs 80,000lb.

Improvements in the construction of gas engines will now be briefly considered, and in the first place the tendency to make all parts of modern gas engines very rigid may be noted. Almost any of the examples shown would serve to emphasise this point, but it is specially noticeable in the powerful ties or girder frames which are used to unite the cylinders of tandem engines and blowing engines. The brackets carrying the side-shaft cam levers have also been given a much-needed additional strength, and one sees the tendency of makers to regard the gas engine in its true light as an explosion engine. One well-known firm still believes in making the crank-shaft bearing, through which the free end of the shaft projects into a so-called "floating" bearing, in which the shaft is allowed a fair margin of play: ideas of this kind sometimes die hard. The Premier Company set the example of water-cooling the piston and valves. They showed that, with a water-cooled piston and a cylinder cooled with a scavenging charge of air, the mean effective pressure of the working stroke was increased instead of being diminished. Indicator cards showing as much as 120lb. mean effective pressure have been obtained with Mond producer gas from such an engine. The Cockerill Company were also early in appreciating the advantages of a water-cooled piston, and now all makers of large engines have followed suit. The average temperature of the iron surfaces in contact with the hot gas is determined much more by the cooling water than by the hot gases, the temperature gradient in the thickness of the iron not being very steep; consequently, by keeping the cooling water of the piston a few degrees lower than the cylinder jacket water, one can rely on the piston not expanding relatively to the liner, and thus accidents are avoided and the piston may be made a tighter fit. Without water cooling, the back of a large trunk piston has to have at least ⅛in. clearance when all is cold, and only approaches the diameter of the liner as it heats up after working.

The pistons of large engines are frequently supplied with white metal bearing rings, and in the largest of the Cockerill pistons almost the whole of the front portion of the piston—which is made in two halves—is lined up with white metal. The breech-end casting of the cylinder has in times past given much trouble. It is an irregular casting, owing to the

* Abstract of a Paper read before the British Association (Section G) at Belfast, September 11th.

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necessity of valve passages being cast in it, and of course it has to withstand the maximum changes of temperature and pressure. To keep this casting as simple in shape as possible, without unnecessary pockets or sharp angles; to cast it free from all cooling strains; to make it as thin as is permissible; and to strengthen it by well-designed cooling ribs projecting in the water space, and by proper support from the jacket casting, has been the makers' aim. That they have been successful is proved by the immunity from repairs enjoyed by the modern breech-ends. The water-joint between the back of the liner and the breech casting was sometimes the cause of trouble when long bolts were used to draw these joints tight. Short bolts are now employed, and the difference in the expansion of bolts and casting may therefore be neglected.

The valves of modern gas engines are almost entirely of one class—viz., the mushroom type, and they are operated by cams. Recent designs approach more closely to the Continental type of direct-lift-valve steam engine, and, indeed, in many ways they are growing curiously alike. The latest design for the vertical double-acting Westinghouse engine is as much on the lines of a modern vertical Corliss engine as is reasonably possible. The exhaust valve has the most arduous duty to perform, and much ingenuity has been spent upon it. To open a 10in. or 12in. diameter exhaust valve against 45lb. pressure

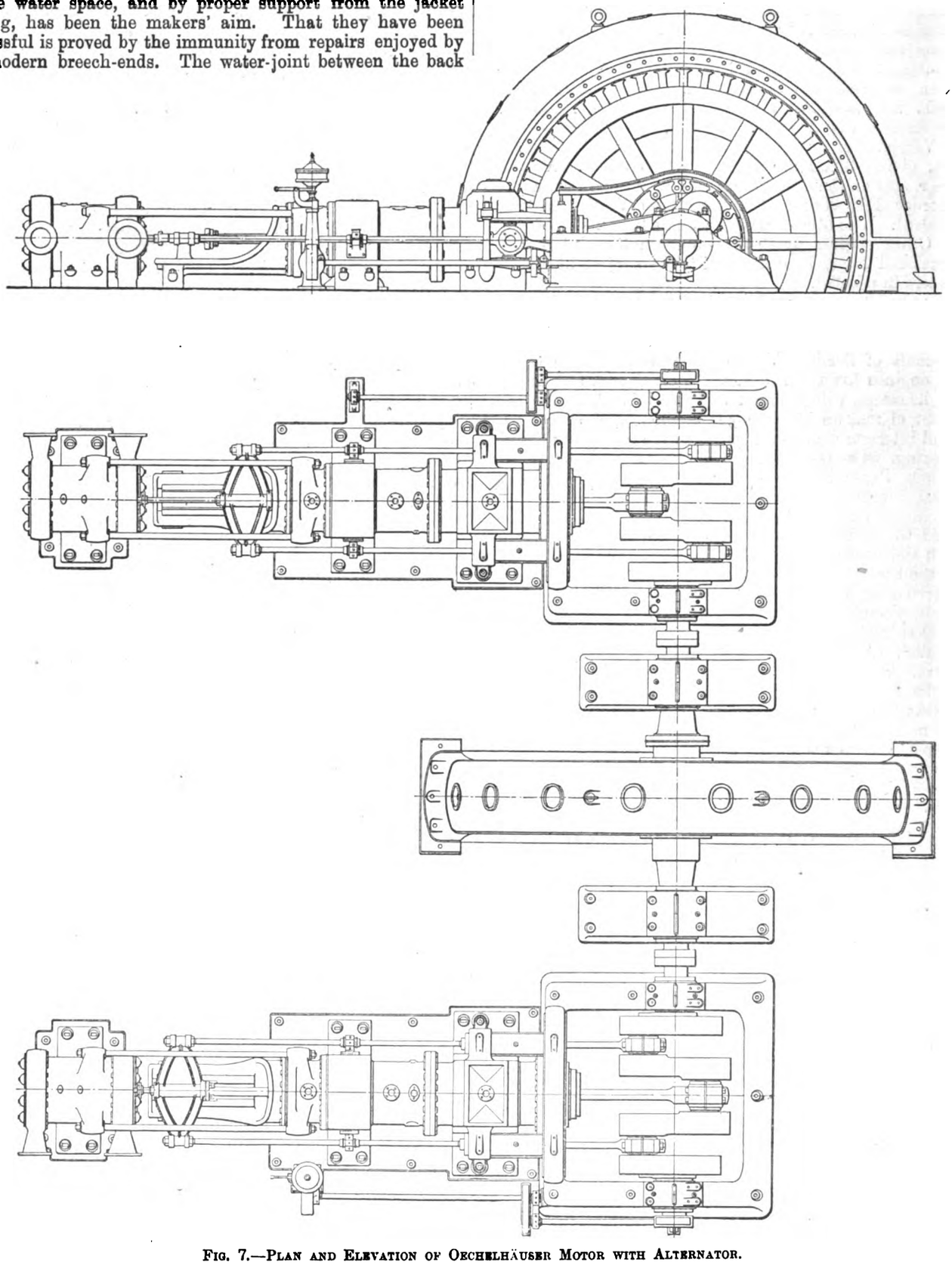

FIG. 7.—PLAN AND ELEVATION OF OECHELHÄUSER MOTOR WITH ALTERNATOR.

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calls for strong gear, and, if the cam roller or lever pivot are worn, causes considerable shock. An attempt was made to get round the trouble by providing a small additional exhaust valve, which was opened in advance, and so reduced the pressure on the large valve. Messrs. Crossley Bros. employed a balanced exhaust valve, as shown in Fig. 9, the mushroom valve being balanced by a piston valve or block sliding in a pocket; a hole right through the valve stem equalises the gas pressure on the outside faces of the two valves. Most makers, however, prefer to face the difficulty, to keep the plain, mushroom valve, and to make their gearing amply strong. The rule is for valves to be mechanically opened and to close under the action of springs; but there are definite advantages in a

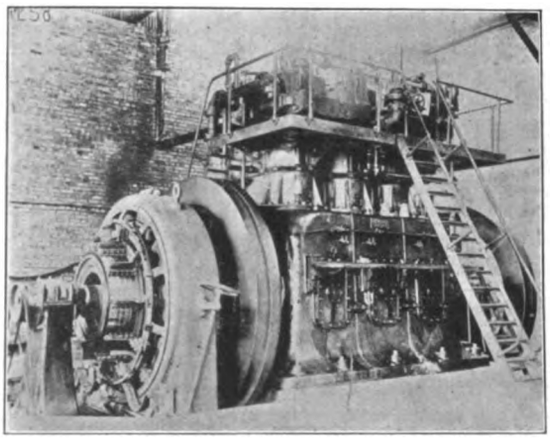

FIG. 8.—WESTINGHOUSE 650 H.P. ENGINE AT THE HOWARD AXLE WORKS.

mechanically-closed valve, and the new valve gear of the Premier engine will be watched with interest in this respect. Several dispositions of the valves with regard to the breech-casting are to be found, and the placing of all valves below the breech is a special feature developed in the Cockerill engine. Some such arrangement becomes very convenient when tail-rods are carried through in the case of tandem cylinders.

Ignition is now performed by the electric spark, the three recognised methods of producing the spark being:—(1) The interruption of a current flowing through an induction coil enclosing a good deal of iron; (2) the breaking of a current (at its maximum strength), supplied by a shuttle armature

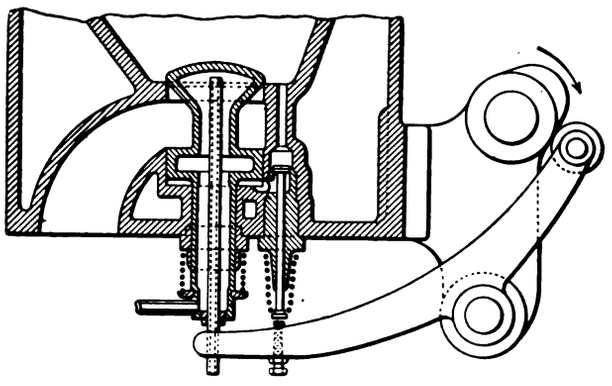

FIG. 9.—CROSSLEY BALANCED EXHAUST VALVE.

oscillating between permanent magnet poles; (3) the sparks are continuously produced from a Ruhmkorff coil, supplied by storage cells, but are made to pass between points in a small closed chamber, and the latter is only put into communication with the cylinder when ignition is required. All three work successfully. No. 2 is the simplest, as no outside source of current is required. The Cockerill Company are the only makers who use the third system. Tube ignition has died out in all countries except England.

The great regularity of speed demanded from the modern gas engine has led to improved methods of governing. Formerly the governor controlled the "hit-and-miss" mechanism, and this is still the simplest arrangement where some irregularity of speed is of no consequence. Westinghouse introduced the system of controlling the quantity of mixture by throttling, and this gave excellent results, but led to bottom loops being formed on the indicator diagram, and wasted power. Mr. C. E. Sargeant, of America, invented a means of cutting off the supply of mixture at varying points of the suction stroke, which gave the desired result without wasting power. This system is the correct one, and is being adopted by the leading makers one after another, each having his special design of mechanism. With the cut-off gear patented by Crossley Bros. the richness of the mixture remains the same, while the quantity admitted to the cylinder is automatically varied by the governor for each impulse of the engine, according to the power required at the moment. The cut-off valve is placed between the admission valve and the air-suction and gas valve. It is a cylindrical valve, with circumferential ports sliding axially inside the casing of the admission valve, which is also fitted with corresponding circumferential ports. The cut-off valve is in equilibrium, and is opened by an ordinary eccentric and rod on a side shaft, which works a rocking lever oscillating on a pivot, the position of which pivot is determined by the governor from time to time, the action of the governor being to turn a screw with right and left-hand threads on its ends, and so to draw the pivot towards or from the motor cylinder, according to the speed of the engine.

A few words must now be added regarding the starting of large gas engines. The so-called "self-starters" are all disappearing, and this none too soon, for they often gave trouble; indeed, some of the hand-pump starters were nothing short of an intolerable nuisance. To-day the starting of a 1,000 H.P. engine is a matter of the greatest simplicity. Compressed air, stored in strong vessels carrying 80lb. to 150lb. pressure, is used; and a special inlet valve and gear is fitted to at least one cylinder, which automatically controls the air supply while the speed is being raised. It is the simple pressure of the air which effects the starting, no explosions taking place. When the engine has attained sufficient speed, gas is supplied to one of the other cylinders in the usual way, and the compressed air is no longer required. If the engine has only one cylinder, the flywheel carries on the running, while the change from compressed air to ordinary explosive mixture is made. The system is so safe, expeditious and convenient that it is a wonder any other system is used. The Cockerill Company, however, seem to prefer to fit a special benzine vaporiser to supply carburetted air for starting, an electric motor and barring gear being also fitted. A somewhat daring system is employed by the Snow Steam Pump Works in starting the 1,000 H.P. and 4,000 H.P. gas engine gas compressors in Cleveland. I cannot do better than describe it in the works manager's own words:—

An auxiliary power house is provided, containing small auxiliary gas engines, which, during the night, operate electric generators to supply light for the plant, and supply the storage battery used for furnishing current for the electric igniters during the day and night. These auxiliary gas engines are also connected to mixture compressors, which compress the proper proportion of natural gas and air (in the proportion of about one to 12) into a large tank. Connection is made from this tank to the ends of the cyclinders, which are used for starting. The engineer turns this mixture under about 100lb. pressure into one end of one power cylinder, which causes the piston to move to the other end. The pressure is then allowed to escape from this end, leaving the cylinder full of mixture at about atmospheric pressure. He then goes to the other end of one of the other cylinders, and admitting mixture pressure to this end, forces the pistons back again to the other extreme position, compressing the mixture in the end of the first cylinder to which it was admitted. He then trips the igniter on this cylinder, which causes an explosion and starts the machine, and upon compression in the second cylinder to which the mixture is admitted, being ignited, the reverse stroke is made under power, by which time the other cylinders have been rendered operative on account of drawing in their own gas and compressing same and exploding. Very little trouble is experienced in starting the engines in this way. The mixture tank and its connections are designed to stand easily an explosion-pressure of about 600lb.; while, in addition to this precaution, a number of large relief valves are applied to the tank for the purpose of partially relieving internal pressure, should an explosion of this mixture take place in the tank. We question as to whether this method of starting would be permitted by insurance companies within the City limits; but, as we have before remarked, all our work in the gas engine line has been confined to the building of gas engine compressors, which are always located back in the country, and always some distance from cities or populous communities.

(To be continued.)

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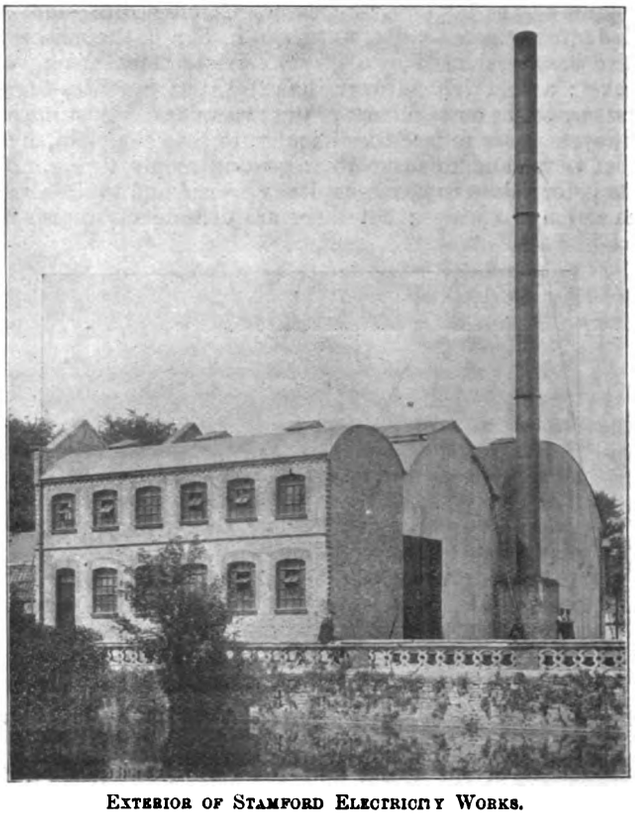
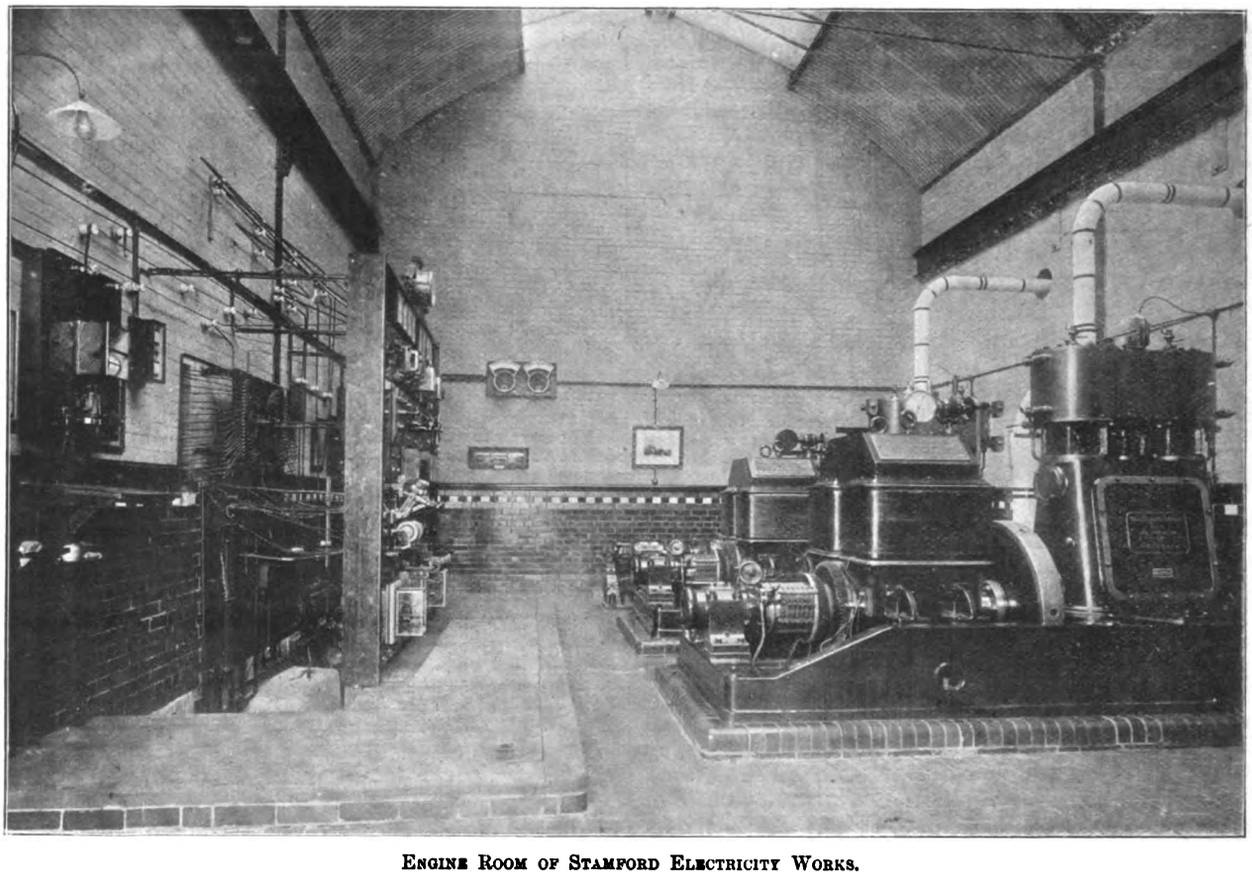
STAMFORD ELECTRICITY WORKS.

The two illustrations given below are of the small electricity works at Stamford, which were opened a few months ago. The undertaking is owned by the Urban Electric Supply Co., the engineers and contractors being Edmundson's Electricity Corporation. The provisional order was obtained in 1900, and taken over by the present owners. An excellent site was obtained on the river and near the Great Northern Railway station, and, with the exception of the boilers, all the plant was erected by the resident engineer, Mr. W. E. Milns, assisted by his staff. The steam-raising plant consists of two Babcock and Wilcox boilers, having a total evaporative capacity of 6,300lb. per hour; these are fitted with chain-grate stokers, and in connection with them are used Boly heater-detartarisers. Water from the river is used and supplied to the boilers by means of duplicate Hall feed pumps. After being superheated, the steam is employed to drive two Belliss engines, direct-coupled to Parker two-pole generators, each having a capacity of 90kw. In accordance with the usual custom, a combined balancer-booster set is used for supplying the out-of-balance current to the three-wire system and to boost up the dynamo voltage for charging the cells; this machine is also of the Parker type. The mains have been laid by Messrs. Callenders, and consist of three single cables on the solid system in wood troughs, with a pressure of 480 volts between the outers. In the illustration which we give of the interior of the engine room a side view of the switchboard may be seen, showing the arrangement of the wiring at the back. The switchboard instruments were supplied by Messrs. Kelvin and White. An important item of the plant is a D.P. battery of 260 cells, each having a capacity of 350 ampere-hours.

The "Wright" system of charging has been chosen on the following scale:—7d. per unit for the first hour and 3d. afterwards for lighting, and 4d. the first hour and 1½d. afterwards for power. A system of free wiring has been adopted whereby a consumer may hire his installation on payment of 4½d. per lamp per quarter, or 10 per cent. per annum on the cost of motors where power is used. The supply was started at Easter, 1902, with 3,000 lamps connected, and applications for no less than 4,000 additional ones have already been received.



Exterior of Stamford Electricity Works.



Engine Room of Stamford Electricity Works.

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A 10,000-VOLT LOCOMOTIVE.

A recent number of the *Elektrotechnische Zeitschrift* contains an interesting article from the pen of Herr Walter Reichel, chief engineer at Messrs. Siemens and Halske, on the most recent development in connection with the high-speed high-pressure electric railway experiments near Berlin. The Siemens and Halske electric locomotive, which was described in *The Electrician* last year (Vol. XLVIII., pp. 44 and 126), repeatedly attained speeds of over 155km. (96 miles) an hour, and on one occasion 160·2km. (99·5 miles) per hour. In a time test at a standard rate of about 120km. an hour, about 230km. was travelled, with 14 intermediate stops, in 2¾ hours, the motors heating 50°C. and the transformers only 30°C. The overhead equipment worked well, but at speeds of 150km. (94 miles) per hour and over the permanent way proved too weak. This was expected, as the rails weighed only 33kg. per metre run, and preparations for another series of tests on heavier and better-fixed rails are in progress.

In the meantime, Messrs. Siemens and Halske resolved to make experiments as to the possibility of decreasing the total weight of the car. It will be remembered that the line pressure is 10,000 volts, but that it is transformed down before it reaches the motors. To save the weight of the transformers, which is not inconsiderable, Herr Reichel set himself to work out designs for a motor which would work at 10,000 volts three-phase directly, without the intermediary of transformers. This is not only advantageous to the permanent way, but since there is a reduction of the total weight of the car, a motor with a lower rating can be employed, which results in further

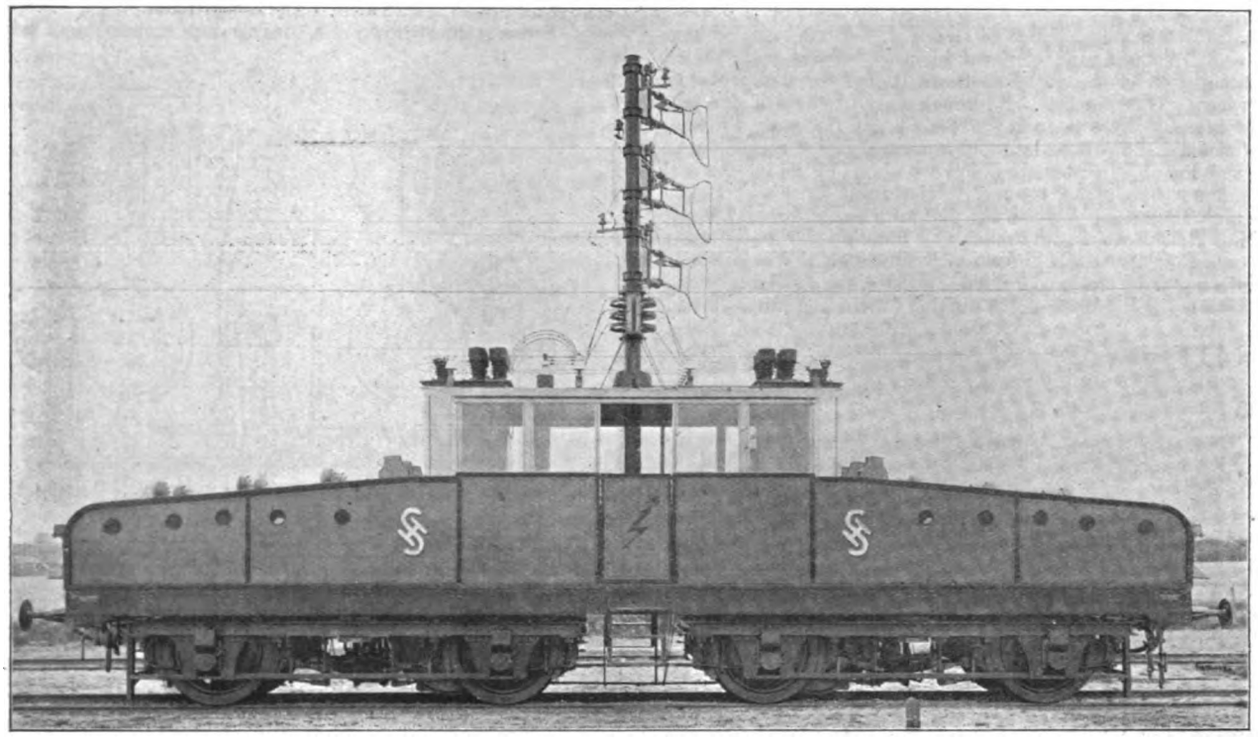

FIG. 1.—GENERAL VIEW OF LOCOMOTIVE.

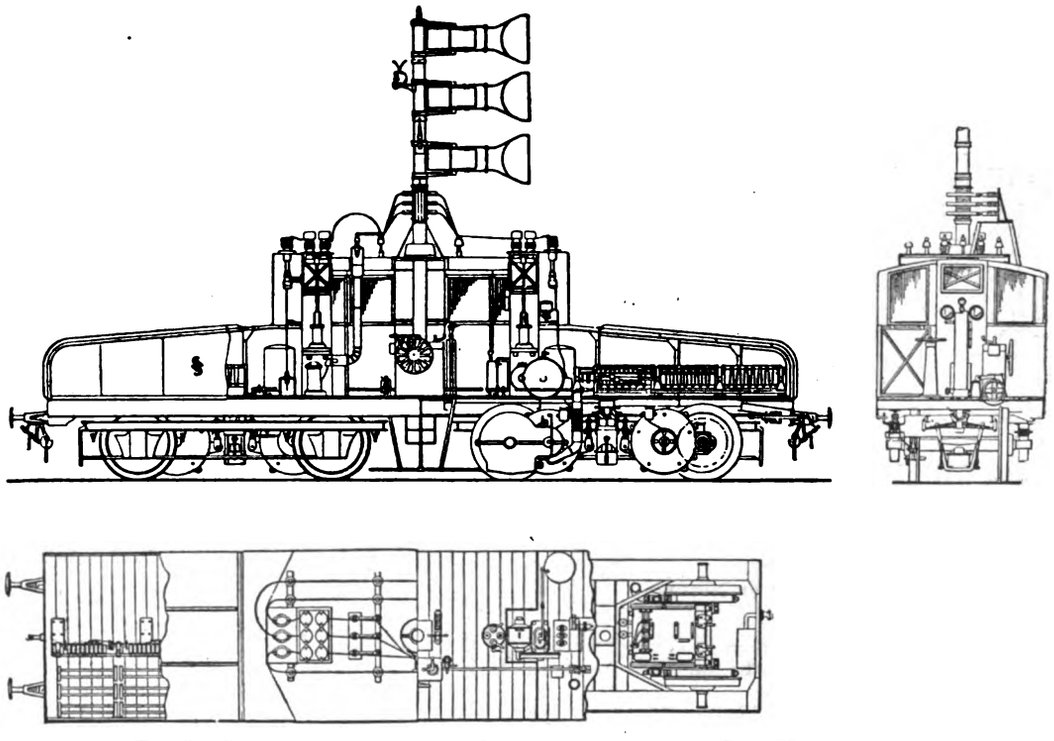

FIG. 2.—GENERAL ARRANGEMENT OF LOCOMOTIVE FITTED WITH FOUR MOTORS.

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saving. Instead of 96 tons, the new car is reduced in weight to 76 tons, including passengers, and the total motor horse-power from 1,000 to about 920. The decrease in weight also facilitates starting.

For experimental purposes it was deemed advisable to build a locomotive rather than a motor car, and to employ gear to reduce the speed of the motors in the ratio of 2 : 1, the speed of the motors being 885 revs. per min. and that of the locomotive 100kw. per hour.

The underframe of the locomotive is of the double-truck construction, the axles and axle-boxes being similar to those of the previous experimental car. The gauge is standard, and the wheels have a diameter of 1,250mm. and conform in other respects with the standard dimensions of the Prussian State Railways. The wheel base of each bogey is 3¼ metres. Although only fitted with one motor each at present, there is room on each bogey for two. Fig. 2 is a general arrangement of the locomotive with a pair of motors on each bogey, and Fig. 3 is a photographic view of one of the bogeys with a single motor. The whole locomotive is of iron.

The most important thing in the design of the motors is the winding. Herr Reichel points out that this cannot, however, be determined at the outset, as its details depend very much on the details of the mechanical part of the motor. For instance, the available width of the active iron has its effect on the number of windings, and this width,

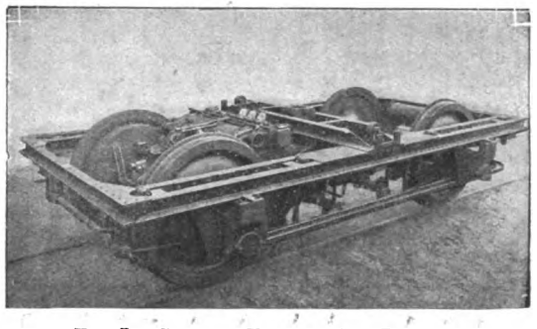

Fig. 3.—General View of One Bogey.

again, depends on the length of the part of the winding projecting beyond the slots. This influence of one part upon the other, necessitated a number of preliminary investigations before the final design could be commenced. The design of the details of the motor are closely similar to those of motors for narrow gauge. It is necessary to make the utmost use of the space between the wheels, and the bearings are, therefore, placed within the space enclosed by the motor windings as shown in Fig. 4. In order to keep the pressure on the two bearings equal, the motor shaft is geared at each end to the car axle, there being a narrow spur wheel at each end of the motor shaft instead of a wider one at one side only. Another reason for this arrangement is that not only the pressure on the teeth, but also the velocity of the teeth is exceptionally great. The latter amounts to

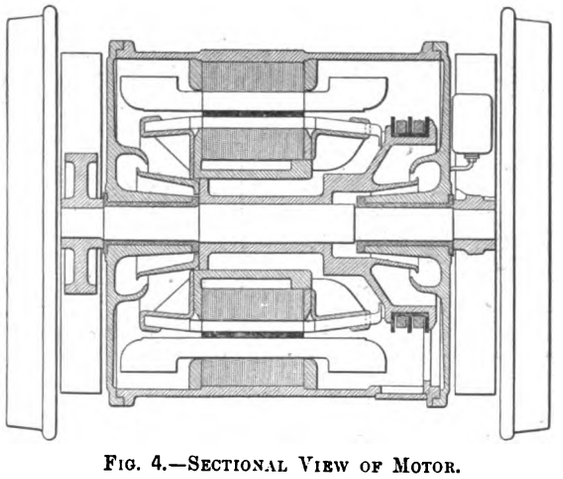

Fig. 4.—Sectional View of Motor.

about 18 metres per second with 147 teeth in the larger wheel and 69 in the smaller wheel. The pitch is 67mm. and the width of teeth 100mm.

Previous to deciding on the system of lubrication, a number of experiments were tried with tooth velocities of 25 metres per second. These demonstrated that it was not sufficient to fill the gear box with oil or consistent grease and let the gear run in it, and consequently the system of forced lubrication with compressed air sketched in Fig. 5 was adopted. By means of a pump, a pressure of air corresponding to 5cm. of mercury is produced in the oil reservoir. This drives the oil out of the reservoir to a distributing cock, which must be turned to the right or left according as the locomotive is to run forwards or backwards. Thence the oil flows through one or other of two sets of pipes to the nozzles above or below the toothed wheel (see also Fig. 6). After the oil has been used, it collects at the bottom of the gear case, and is thence pumped by a hand or motor pump back to the oil reservoir. This system of lubrication is only necessary with a gear ratio of 2 : 1. If a ratio of from 1·35 to 1·4 is used, the velocities of the teeth are smaller, and the ordinary lubrication with consistent grease is sufficient. The construction of the gear box is in other respects the ordinary one, as is also the suspension of the motor.

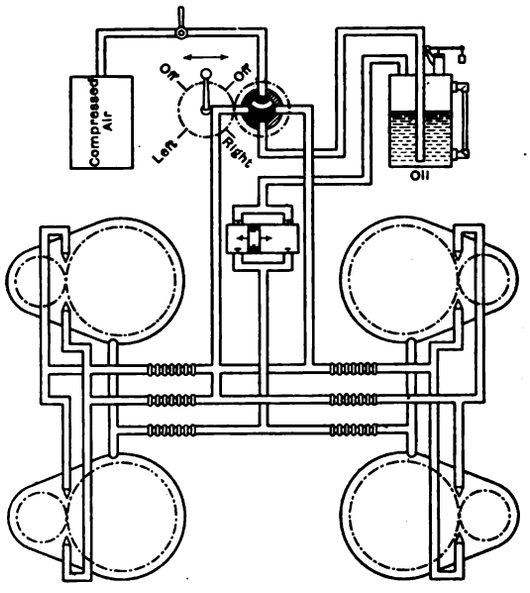

Fig. 5.—Diagram of System of Forced Lubrication.

The motor case is of cast steel, and is made in two parts. It is carefully turned inside (the internal diameter being 990mm.), so that there is a firm bearing surface for the active iron and a good conduction of heat through it. The bushes of the bearing are in one part, and of bronze lined with white metal. They are 300mm. long and 100mm. internal diameter, so that there shall be little wear. This makes it possible to reduce the air-gap of the motor to 1·5mm. or 2mm. The active iron which carries the primary winding is fastened into the motor case with screws (Fig. 7). The rotor of the motor is fastened to the motor shaft by means of a special sleeve, so that the motor can subsequently be arranged on the car axle for

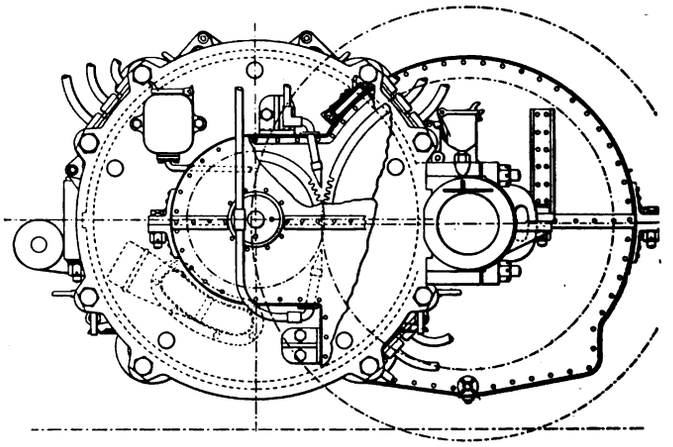

Fig. 6.—Elevation of Motor and Gear-case, showing Method of Lubrication.

direct driving. The active iron of the rotor is held together by a number of screws and pressure discs, and it carries the secondary winding. On the rotor sleeve two slip rings are held by a second sleeve, and the current is collected from the slip rings by means of carbon brushes. There are three apertures in the upper casting of the motor case on the slip-ring side, to render possible the inspection of the motor within. The motor itself is lubricated by means of oil and wicks, the oil being contained in vessels screwed on to the motor and communicating with the bearings by copper tubes (see Figs. 6 and 9), this arrangement having been rendered necessary by the small space available.

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To obtain a better casting, the axle bearings are screwed on to the motor casing (see Fig. 7). On the other hand, the lugs which, with the assistance of the springs, transfer the weight of the motors and the turning movement it occasions to the underframe, are cast directly on to the motor casing.

In the first experimental fast-speed car, described in the previous article above referred to, the primary winding of the motor was on the rotor. This is only feasible with bar winding, which is not applicable in this case owing to the high pressure. In this case, also, it is not necessary to construct the motor for a very high turning moment, as, in consequence of the smaller weight of the car, smaller starting torque is necessary. The rotor may, therefore, be of smaller diameter, and the primary winding can be placed on the stator. In order to afford as large a cooling surface as possible, the slots are made fairly deep, so that the coils are thin and wide. A calculation of the conditions of saturation of the active iron gave a radius of about 34cm. for a width of 30cm.—the type C. D. M. 34/30. The cores of both stator and rotor consist of laminations, those for the rotor being stamped in one piece, and those for the stator being made up of segments. The calculation for the winding gave 72 open slots, and 72 wires per slot of the primary. Star connection is employed, and the wires are placed in mica tubes. To save space and to secure certainty of insulation the coils are placed alternately in longer and shorter tubes, so the longer ends always lap over the shorter ones, as seen in Fig. 8. By this means the possibility of sparking over from one phase to another is considerably reduced. The method of insulating the high-pressure winding was determined upon after several trials, in the final one of which the winding withstood a pressure of 22,000 volts without crackling and without disclosing any sign of a faulty place.

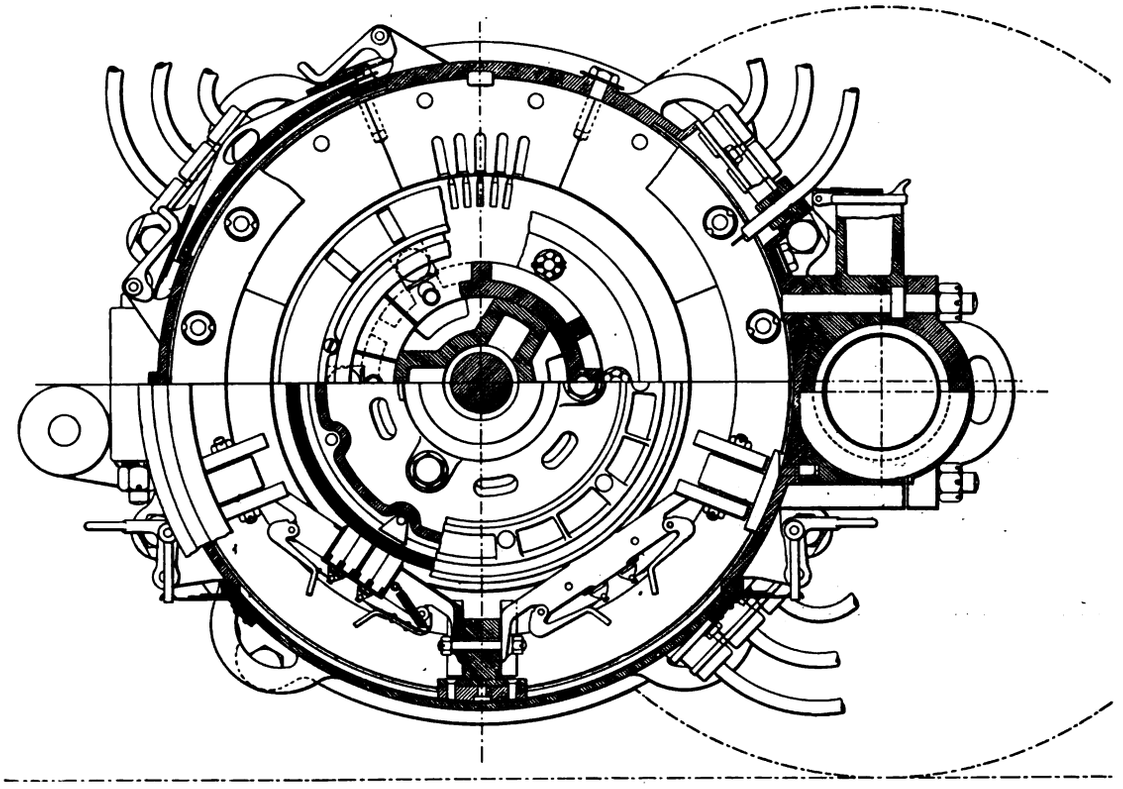

FIG. 7.—SECTIONAL ELEVATION OF MOTOR.

The winding of the rotor is placed in 90 half-closed slots, and consists of a number of single flat copper bars arranged in series and four in each slot. It is a wave winding connected in star. The three free ends are connected to two slip rings and the frame of the rotor respectively. At starting the pressure in the rotor winding is 700 volts. The employment of bars for the rotor winding facilitates the addition of bronze binding wires, and also permits of a very effective ventilation. The air enters the neighbourhood of the shaft and is directed outwards through the openings in the rotor casting by vanes which are cast on to the latter. This current of air also cools the stator coils. Tests have shown that the air pressure thus caused corresponds to several millimetres of water. The velocity of the air

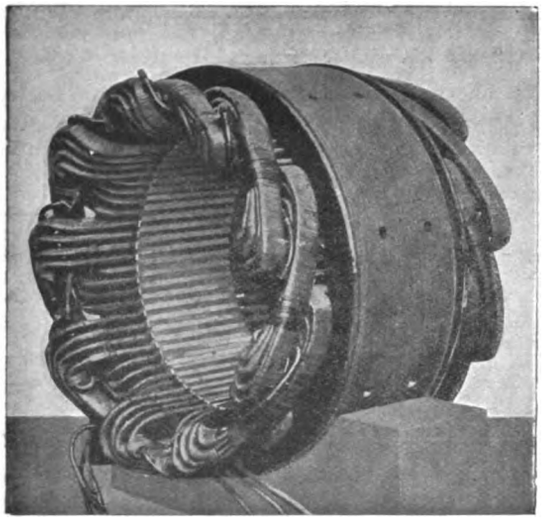

FIG. 8.—STATOR OF MOTOR.

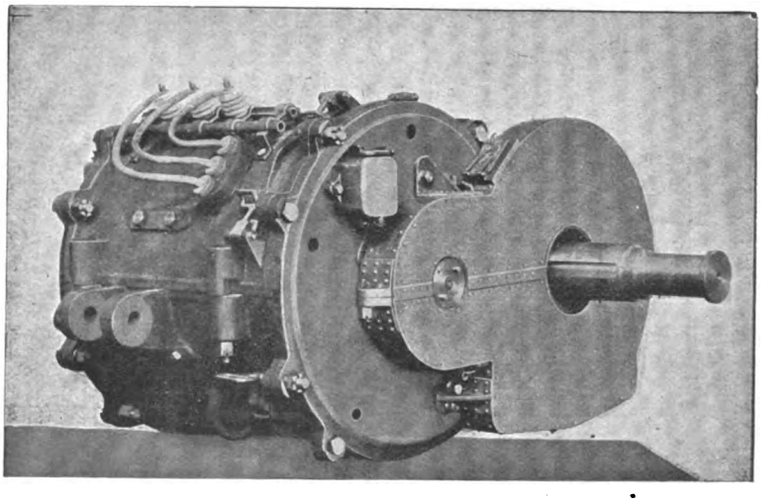

FIG. 9.—EXTERNAL VIEW OF MOTOR AND GEAR CASE

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was about 6 metres per second, and about 120 litres of air was forced through per second. To prevent the high pressure sparking over when the motor gets warm, the inside of the frame is covered with a thick layer of mica wherever it is adjacent to the primary winding, and the distance of this winding from the frame is always kept as large as possible.

The leading-in of the three high-pressure cables is done with particular care. The cables, which are insulated to stand 15,000 volts, are led through three soft rubber brushes, which are placed inside

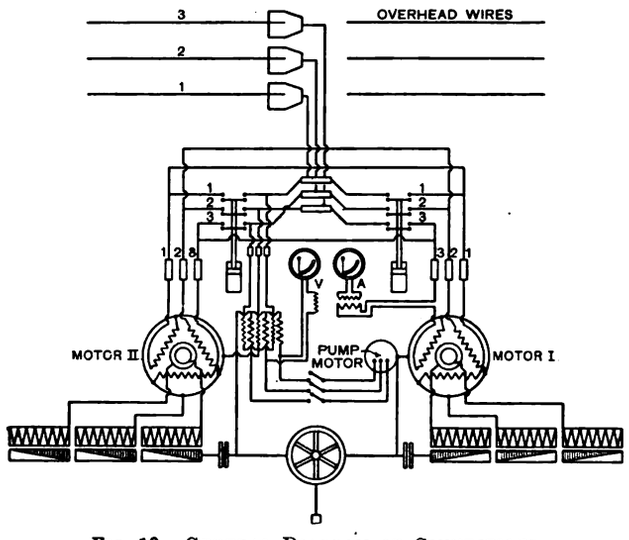

FIG. 10.—GENERAL DIAGRAM OF CONNECTIONS.

hard rubber brushes. They end in the three terminals seen in Fig. 9, which are mounted on corrugated porcelain insulators attached to saddles which are supported on mica-insulated iron tubes fixed to the casing of the motor.

The weight of the motor and gear is 4,090kg.

Fig. 10 shows the connections of the motor and controller. With the exception of the resistances, nearly all the apparatus employed are similar to those used in the previous experimental car. The

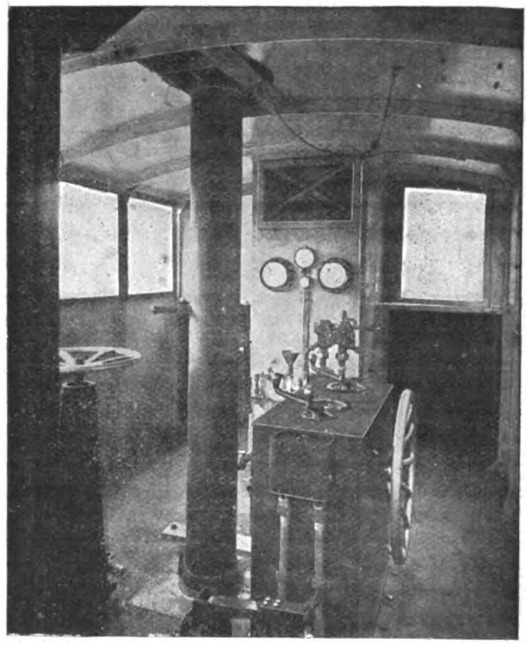

FIG. 11.—CONTROLLER GEAR.

speed at starting is regulated by varying the resistance in the rotor or secondary circuit. This is insulated from earth, as the third secondary phase of the motor is connected to earth through the motor shaft, as already stated. The current to the stator coils passes from the main switch through fuses. As is seen, the switch is driven by an air piston, and at the same time it serves as a reversing switch by charging the phases. The motor driving the pump for compressing the air is driven through a 10,000 : 110-volt transformer.

The rotor resistance has 24 steps, and the resistance coils are spirals of Kruppin wire, held by porcelain insulators on an iron frame, and present no new features. The hand-wheel on a vertical spindle which controls this resistance is seen to the left of Fig. 11. The switches for the primary high-pressure circuit are of the tubular type, and, as already stated, are worked by air pressure. The cocks which control these are seen in Fig. 11. Both the high-pressure switches and fuses are placed in the cable ways behind the motors, and are visible through glass windows.

When the locomotive was completed, tests were made at a gradually increasing pressure, starting at 6,000 volts and about 50 alternations. The final test was made at 11,000 volts and 95 alternations, and with a trailer weighing 31 tons, and a speed of 105km. per hour was attained. The toothed gear ran fairly quietly, and the motor stood the high pressure. About 260kw. were required. This corresponds to a load of about 280 H.P. on the driving wheels, which agrees with experience already obtained at 100kw. per hour. Tests were also made to determine the tractive effort of the locomotive, and for this purpose the old experimental car was used as trailer, so that a total weight of about 130 tons was drawn.

THE APPLICATION OF ELECTRIC POWER IN THE IRON AND STEEL INDUSTRIES.*

BY D. SELBY-BIGGE.

(*Concluded from page 960.*)

Machinery Tests.—In his Papers before the Iron and Steel Institute, Cleveland Engineers and Manchester Society of Engineers, the author gave a short table of powers absorbed by various classes of machinery. This was, necessarily, at the time of writing the Papers somewhat scanty and incomplete. He now, therefore, places at the disposal of the Institute an entirely new and complete schedule of tests, which have been carefully and accurately obtained by members of his staff during the past few months, and he trusts that engineers and managers of works may find these figures of some practical service and guide to them in deciding upon the horse-power of motors to be adopted for the driving of various classes of machinery. The list will be found to embrace the greater part of those tools usually found in all engineering establishments :—

MOTOR TESTS.—*Taken August* 18, 1902.

Description of machine.	Work done by machine.	E.H.P. absorbed.		Type and size of motor.
		Light.	Loaded.	
†3-ton skull-breaking winch.	Lifts ball weighing 3 tons 8cwt. to 50ft. at 60ft. per min. (timed).	8·5	17·8	2-pole open type armature at bottom, 18 E.H.P. series wound.

† This winch is of ordinary band pattern, driven through works and spur gear, with brakes and clutch. Water starting and regulating switch.

A table of machine tests in a somewhat different form is appended :

Condensing Plant.—One 10 H.P. motor 220 volts driving direct coupled 3in. centrifugal pump, driving also with belt air pump 9½in. diameter by 9in. stroke, and feed pump 2in. diameter by 9in. stroke. Boiler pressure 200lb.

Operation.	Revs.	Amps.	Volts.	Vacuum.	Total E.H.P.	Actual E.H.P. per operation.
Centrifugal pump.	1,100	6	240	...	1·9	1·9
Ditto with air and feed pump	160	12	240	27in.	3·8	1·9

Brass Shop Motor. 5 H.P. 240 *Volts.*

Operation.	Revs.	Volts.	Amps.	Total E.H.P.	Actual E.H.P. per operation.
Motor and shaft.....	220	250	7·0	2·3	2·3
Disc grinder, 18in. emery discs run light	1,800	246	8·5	2·8	0·5
Facing 6½in. brass valves	1,800	246	24·0	7·9	5·6
6-in.capstan lathe (light)	...	248	9·75	3·2	0·9
Turning and screwing 1⅛in. brass bars for ⅝in. tap bolts	...	248	12·0	4·0	1·7
Parting ditto	...	248	10·0	3·3	1·0

* Paper read before the Iron and Steel Institute.

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No. 1 Foundry. Roots Blower, Acme No. M.

Operation.	Revs.	Volts.	Amps.	Total E.H.P.	Av. E.H.P.	Tme
Motor and shafting run light ...	...	245	14	4·6	...	...
Blowing cupola—						
Maximum	360	246	104	32·7	28·2	4½hs
Minimum	350	233	66	21·7		

Total weight of iron melted.....22 tons 10 cwt.
" " " per hour 5 tons.

No. 2 Foundry. Roots Blower, Acme No. K.

Operation.	Revs.	Volts.	Amps.	Total E.H.P.	Av. E.H.P.	Tme
Motor and shafting run light ...	...	232	9·5	2·96	...	...
Blowing cupola—						
Maximum...	430	237	57·0	17·1	15·84	3hs
Minimum	394	225	50·0	15·2		

Total weight of iron melted.....12 tons.
" " " per hour 4 "

REMARKS.—No. 1 cupola capable of melting on an average 7 tons per hour.

BOILER SHOP.—*Vertical Plate-bending Rolls.*

Length of rolls ..... 11ft. 7in.
Diameter of rolls (two)..... 1ft. 11in.
Mean size of plates rolled..... 20ft. × 10ft. 6in. × 1in.
Maximum size of plates rolled... 16ft. × 11ft. 5in. × 1½in.

Operation.	Amps.	Volts.	Total E.H.P.	Actual E.H.P. per operation.	Time.
Motor and shaft run light.....	20	242	6·4	6·4	
Rolls light running	24	242	7·7	1·3	
Rolling plate, 23ft. × 11ft. 2in.			Average.		
× 1¼in.....	90–68	233	19·2	12·8	3 min.
Putting squeeze on plates.....	30–60	233	9–18	6–12	
Reversing the rolls..	50	233	15·6	9·2	

Air Compressor, Belt driving from Motor.

Operation.	Revs.	Volts.	Amps.	E.H.P.	Remarks.
Motor, shafting, and pumps	175	230	22	6·7	Air compressor, 9in. dia., 10in. stroke.
Pumping up to max. pressure	170	230	70	21·5	Max. pressure, 80lb.

Pattern Shop Motor. 15 H.P. *Motor.* 220 *Volts.*

Operation.	Revs.	Amps.	Volts.	Total E.H.P.	Actual E.H.P. per operation.
Motor and shafting	170	9·5	233	2·9	2·9
Circular saw, 32in. dia. run light.	800	10·5	233	3·2	0·3
Cutting yellow pine 11in. deep,	Max.	40	233	12·4	9·2
7ft. per min.....	Min.	18	233	5·6	2·4
	Av.	29	233	9·0	5·8
Thickness machine, 2ft. 6in. bed, run light	3,800	12	230	3·7	0·8
Surfacing yellow pine, 11in. wide, 13ft. per min..... .	...	17·9	232	5·5	1·8

37 H.P. *Motor.*

Operation.	Revs.	Amps.	Volts.	Total E.H.P.	Actual E.H.P. per operation.
Motor and shafting	...	12	230	3·7	3·7
Circular saw, 3ft. dia., run light.	1,200	21	230	6·4	2·7
Sawing yellow pine 11in. deep, 20ft. per min.....	...	71	230	21·5	15·1
Circular saw, 33in. dia., run light	...	26	230	8·0	4·3
Cross-cut lignum-vitæ, 9½in. deep × 18in. long..... ...	...	41	230	12·6	4·6

30-*Ton Cranes. Boiler Shop,* 25 H.P. *Motor.* 220 *Volts.*

Operation.	Amps.	Volts.	Total H.P.	Actual E.H.P. per operation	Time.	Feet.
Motor and shafting and belts (light)	12	230	4·3	4·3	..	...
Heaving (light)	16	230	4·9	0·6	...	...
Cross travel (light)	15	230	4·8	0·5	...	...
Longitudinal travel (light).	16	230	4·9	0·6	...	...
Longitudinal and cross travel (light)	18	230	5·5	1·2	...	...
Travelling long	16·2	230	4·9	0·68	1 min.	90ft.
Weight 16 tons, heaving ...	36	230	11·1	6·2	1 min.	5ft.
Cross travel	30	230	9·2	4·4	...	...
Longitudinal travel	18	230	5·5	0·6	1 min.	90ft.

MOTOR TESTS.

Works department or machine.	Work done by motor. Total of machines on motor.	Work done by motor. Usual and average machines on load.	E.H.P. absorbed. Shafting and all machines light.	E.H.P. absorbed. Average. Machines light.	E.H.P. absorbed. Average. Machines loaded.	E.H.P. absorbed. Maximum load on motor.	Size and type of motor. B.H.P.
Fitting shop motor.	2 9in. centre lathes. 1 12in. centre lathe. 1 3ft. centre chuck lathe. 1 planing machine, 9ft. stroke. 1 slotting machine. 1 milling machine. 1 shaping machine. 1 punch and shears machine. 2 2½in. vertical drills. 1 emery wheel. 1 cold saw (hack). 1 fan supplying 9 smiths' hearths. Shafting: 20ft. by 3in. C shaft; 5 others to 10ft. long.	2 9in. centre lathes. 1 12in. centre lathe. 1 3ft. chuck lathe. 1 slotting machine. 1 drilling machine. 1 emery wheel. Fan.	Shafting alone, 1·75. All machines light, 6·2.	3·7	9·5	14·9, with fluctuations to 19.	20
No. 1. Galvanising house motor.	4 pots, each for 20 tons metal. 2 drying machines, attached. 1 large sheet-stretching machine. 1 large corrugating machine (press). 2 circular shearing machines, countershafting and belts.	All machines, pots, and drying machine continuous, and others intermittent.	Shafting alone, 1·5.	...	Average full load, 11·2.	Fluctuation to about 18.	20
No. 2. Galvanising house motor.	1 large galvanising pot. 20-ton and 10-ton galvanising pots. 1 drying machine, attached. 1 rolling machine. 1 stretching machine.	All machines, pots, and drying machine continuous, and others intermittent.	Shafting alone, 1·0.	...	Average full load, 6·9.	Fluctuation to about 12·0.	10
"Dolomite" crusher.	1 9ft. diameter pan mill, short countershaft.	..	2·6	...	8·2	11·5 occasionally.	10
Stamping house motor.	20 stamping machines, various, for armature and field core plates.	...	6·5	...	9·8 to 10·3	11·0 to 12·5	10
Steel charging machine in steel mill.	1 electrically-driven charging machine, heating furnaces and supplying live rolls, with ingots up to 10 cwt. each.	...	Motor and 1st, 2nd, and 3rd motion shafts and gearing, 1·55.	Lifting, 3·2 to 4; travelling, 7·8; slewing, 4·9; racking, 5·0.	11·0 11·0 to 12·8 6·3 to 8·0 6·5 to 8·5	Maximum (three motions simultaneously), about 22, under worst conditions.	20*

* Weight of standard billet lifted, 10 cwt. (maximum, 12 cwt.). Travelling rails, 6ft. gauge; wheels, 2ft. diameter. Collector gear = double-pole overhead bare trolley cable, with tramway collecting gear. Travel of peal = 12ft. 6in. When peal is racked in towards machine, the distance between centre of bogie and steel billet is approximately 20ft, taken radially. When peal racked out is approximately 32ft. 6in. from centre of support. Total lift of peal = 3ft.

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MOTOR TESTS.

Designation of machine.	Work done. Maximum.	Work done. Average.	E.H.P. absorbed by motor with machine run light.	E.H.P. absorbed with load on.	Size motor recommended. B.H.P.	Remarks.
Large plate edge planer ...	35ft. by 1in.	$\frac{7}{8}$in. or 1in. plate...	14·75	24·5	30	Cut 0·05in. thick on 1in. plate 4ft. long at time of test. Machine took 29·5 H.P. to reverse.
Small plate edge planer ...	15ft. by $\frac{3}{4}$in.	$\frac{5}{8}$in. to $\frac{3}{4}$in. plate...	6·33	20·1	25	Cutting $\frac{3}{4}$in. plate 22in. long. 21 H.P. to reverse.
Plate straightening rolls...	4ft. 6in. by 4ft. 6in. by 1$\frac{1}{4}$in.	10in. by $\frac{1}{2}$in. to 15in. by $\frac{3}{4}$in.	4·5	6·1	...	10in. by $\frac{1}{2}$in. plate.
				16·1	...	Plate 4ft. square by $1\frac{3}{16}$in. thick.
				14	15	Same plate on slow speed. Machine took 19·1 E.H.P. to reverse.
Cold saw	16in. by 6in. girder	About 12in. by 6in.	1·45	2·6	7	Cutting 12in. by 3$\frac{1}{2}$in. by $\frac{1}{2}$in. channel. Friction gear preventing heavy load.
Punch shears and angle cutter	12in. shear, $\frac{7}{8}$in. plate	...	3·85	6·0	10	$\frac{3}{4}$in. hole, $\frac{5}{8}$in. plate. 25 to min.
	$1\frac{1}{16}$in. hole, $\frac{3}{4}$in. plate	$\frac{3}{4}$in. hole, $\frac{1}{2}$in. plate	...	8·85	...	$1\frac{1}{16}$in. hole, $\frac{3}{4}$in. plate. 20 to min.
				5·15	...	Shearing 10in. by $\frac{1}{2}$in. plate.
				4·9	...	Cutting 3in. by 3in. by $\frac{5}{8}$in. angles.
Large ending machine.....	Knives 22$\frac{1}{2}$in. long	...	1·88	15·42	15	Ending 20in. by 7$\frac{1}{2}$in. girder, $\frac{1}{2}$in. web, 1in. flange.
Straightener and angle cutter [drills	Angles and small bars	...	1·53	11·55	10	Cutting 3$\frac{1}{2}$in. by 3$\frac{1}{2}$in. by $\frac{1}{2}$in. angle (short load).
				6·15	...	Straightening 6in. by 6in. angle piece.
Shafting driving six radial	1in. holes.....	$\frac{3}{4}$in.	3·7	7·5	8	All drills at work. $\frac{3}{4}$in. holes in girder steel.
Large straightener	20in. by 7$\frac{1}{2}$in. girders	12in. by 6in. girders	3·96	6·9	8	Straightening 20in. by 7$\frac{1}{2}$in. girder.
Milling-tool notching machine	...	...	2·42	8·05 max.	8	4in. by $\frac{1}{2}$in. notches in flanges of 8in. by 4in. girders.
				5·8 av. load	...	Two notches cut at once.
Joggling machine.....	1$\frac{1}{4}$in. plate	$\frac{3}{4}$in. plate	9·85	16	...	Joggling $1\frac{1}{16}$in. plate.
Scarphing winch	2 tons at 40ft. per min.	...	5·65	12·1		
				10·75		
Shafting	Driving lathes, nibblers, planes, machines &c.	Slotting machines, drills, milling, about 70 in all	21	40–48	50	No. 1 shaft drives about 70 machines.
			1st motor 23, 2nd 22.	40–50	50	No. 2 about 40 on first motor.
			2nd motor 24	42–50	50	No. 3 about 25 machines, slots and planers [belt, also Tusca grinding machine.
Grindstones	...	...	20·5	53–55	60	Seven grindstones from 5ft. to 10ft.; fast and loose
Cranes	...	...	23*	48	50	All rope-driven. 2 30-ton cranes; 1 15-ton; 2 10-ton; all on at once.
Cold rolls (locomotive work)	Plates 40ft. by 4ft. 6in. by 1$\frac{1}{4}$in.	1in. plates	5†	30	30	Straightening plate 36ft. by 4ft. 6in. by 1$\frac{1}{4}$in.
				7	...	Straightening plate 9ft. by 17in. by 1in. Cross and open belts, four top and three under rolls.
Joiners' shop machines ...	...	....	Driving shafting, 5·5	10	20	During week motor not seen to rise above 10 H.P. Absorbs 17 to 18 E.H.P. To drive 12 tools, including two circular saws.
Vertical shipyard drills and countersinks	1$\frac{1}{4}$in. holes and 1$\frac{3}{4}$in. countersinks	...	3·5‡	7·5	7	1in. hole and 1$\frac{1}{4}$in. countersink; two machines doing 280 holes in 8min.
Punch and shears.....	1$\frac{1}{4}$in. holes in 1in.	Plate...	2·7	6	12	$\frac{7}{8}$in. holes, $\frac{5}{8}$in. plate, 36 strokes per min.
	Shearing 1in.	Plate.....	...	15	...	Shearing $\frac{5}{8}$in. plate, 16ft. per min.
Ditto	Shearing 1in.	Plate.....	2·75	3·5	12	$\frac{5}{8}$in. holes, $\frac{1}{2}$in. plate, 34 strokes per min.
				11	...	Shearing $\frac{1}{2}$in. plate, 11ft. per min.
Mangle rolls	1$\frac{1}{8}$in. plates	$\frac{3}{4}$in. by $\frac{5}{8}$in.	4·5	13·5	15	Series motor, tramway controller; direct-driven; reversed when mangling. Excellent results.
Wood Working Tools.						
Hatch boring machine.....	1in. holes	$\frac{5}{8}$in. holes	2·05	3	3·5	Boring $\frac{5}{8}$in. hole in hatch, 22in. broad, in 2min.
Wood planing machine ...	...	...	4·4	8·8	8	Cutting $\frac{1}{4}$in. off plank 10in. by 17ft. in 1·5min.
Ditto (heavy)	...	...	4·5	16	16	$\frac{1}{4}$in. off plank 7in. by 13ft. 6in. in 30 sec.
32in. circular saw	...	...	0·9	14·8	15	Cutting 3in. teak—hand fed—14ft. long in 20 sec.
Heaviest class of shearing machinery	Steel tyres of loco. wheels	General scrap	2	29	30	Cut about 35 pieces 11in. by 1$\frac{1}{4}$in. section in 1min.
Punching machine	2in. diameter holes in 1$\frac{1}{4}$in. plates	1$\frac{1}{4}$in. holes in 1in....	3	10·5	12	19 holes per min. 1$\frac{1}{8}$in. dia., through 1in. plate. Driven by belt.
Large shipyard rolls	26ft. rolls to bend 1$\frac{1}{4}$in. plates	$\frac{5}{8}$in. and $\frac{7}{8}$in. plates	8	26	30	Bending plates 20ft. by 4ft. by $\frac{3}{4}$in. (load at reverse 26 E.H.P.). Cross and open belts.
18in. dock pump	...	...	...	74	70	Discharges about 500,000 gallons per hour.
5in. dock pump.....	...	...	...	11	10	Leakage pump.
Plate edge planer.....	$\frac{5}{8}$in., $\frac{1}{2}$in. and $\frac{3}{4}$in. plates	Planing about 24ft. per minute	5½	$\frac{3}{4}$in. plates 10	20	Took 23 E.P.H. to reverse; special belts, wide pulley, no countershaft.
Punch and shears.....	1$\frac{1}{4}$in. by 1$\frac{1}{4}$in.	1in. in $\frac{5}{8}$in. plates...	3·5	7·5	10	1in. hole, $\frac{5}{8}$in. plate. 31 strokes per min.

* Driving ropes doing no work. † Countershafts and belts only. ‡ Driving countershaft for 2 per cent. drills.

MOTOR TESTS.—*Tests on Cranes, Quick-motion Overhead Travelling. Taken August* 18, 1902.

Works department.	Size and type of travelling crane.	Work done by crane. Average.	Work done by crane. Maximum.	Motion.	E.H.P. absorbed. Crane light. Starting effort.	E.H.P. absorbed. Crane light. Running power.	E.H.P. absorbed. Crane loaded. Starting effort.	E.H.P. absorbed. Crane loaded. Running power.	Speeds and loads during test. Actual load.	Speeds and loads during test. Approximate speeds.	Size of motor. H.P., brake or electrical.
§No. 1 crane—Plate mills loading.	5-ton 3-motor. Exposed position, in and out.	1 to 3 tons.	4½ tons.	Lifting.	13·4	0·5	29·1	18·3	3 tons 6 cwt.	43ft. per min.	22 E.H.P.
				Traversing.	14·8	7·7	16·8	9·6		125ft. per min.	15 E.H.P.
				Travelling.	23·6	11·8	29·4	12·6		150ft. per min.	22 E.H.P.
§No. 2 crane—Plate mills floor.	5-ton 3-motor. Under cover.	1 to 2 tons.	4 tons.	Lifting.	18·0	9·6	27·8	12·8	3 tons.	Speeds approx. as above.	22 E.H.P.
				Traversing.	20·6	9·35	24·5	10·3			15 E.H.P.
				Travelling.	28·5	11·3	34·0	12·4			22 E.H.P.
‖No. 3 crane (new)—Plate mills loading.	6-ton 3-motor. Exposed position, in and out.	1 to 3 tons.	4½ to 5 tons.	Lifting.	22·3	9·5	29·4	19·2	3 tons 6 cwt.	60ft. per min.	20 B.H.P.
		•		Traversing.	11·3	6·2	14·9	7·3		150ft. per min.	20 B.H.P.
				Travelling.	29·5	12·0	32·8	13·8		165ft. per min.	20 B.H.P.

§ These cranes have the motors fixed on the main girders above end carriage. Drives by square shaft and gear. Water starting and regulating switch, and metallic lever controlling switch. ‖ This crane has travel motor on main girders, and lift and traverse motors on the bogie. Gear driven. Water starting and regulating switch, and metallic lever controlling switch.

NOTE.—The starting efforts given above can be regarded only as approximate, being merely momentary, and volts drop being disregarded. The cranes above are on 220 volts circuit. One longitudinal trolley wire only employed, the return being to "earth." The above working load tests present a fair and good heavy average load, and are seldom exceeded under actual working conditions in these works.

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Utilisation of Waste Blast-furnace Gases.—This Paper would not be complete without some reference to the great development which has taken place recently in utilising the waste gases from blast furnaces for operating gas engines, which, in their turn, can be employed for directly driving blowing engines or dynamos, which latter in their turn would distribute electricity for power purposes throughout the works.

From the results of very carefully made experiments, conducted by Prof. Witz, in July, 1898, and Prof. Hubert, in April, 1900, it has been found that a Cockerill "Simplex" engine of large size does not use more than about 100 cubic ft. of average blast-furnace gas per effective horse-power per hour, which is less than one-fourth the consumption of gas required to develop the same power from boilers and good modern condensing steam engines; so that there is an immense surplus of power to be obtained from a blast furnace if the blowing engines are worked by gas, which can be still further increased if the gas is properly cleaned for the stoves, and its efficiency thus increased. It is estimated that for every 100 tons of coke used in an ordinary Cleveland blast furnace, after making ample allowance for gas for the stoves and power for the lifts, pumps, &c., and for gas for working the necessary blowing engines, there is a surplus of at least 1,500 H.P., so that by economising gas by cleaning, and developing the necessary power by gas engines, every blast-furnace owner would have a very large surplus of power for his steel or other works, in the form of electricity or otherwise. It would be impossible to over-rate this new development in power production. In Great Britain, really large sources of water power are practically unknown, and the sources from which electricity can be produced most economically will be undoubtedly due to the development of large power gas engines making use of the surplus gases from the blast furnaces, which would otherwise be wasted. Engines have been constructed and are at work of 1,200 H P., and an engine of this type is now building for no less than 2,500 H.P.

The Development of Electric Power Companies.—During the past two years great activity has been displayed in England in the formation of large electric companies, dealing with extensive tracts of country and covering under their Parliamentary powers vast areas for the supply of electricity in bulk to tramway companies, electric light companies, works owners, and for manufacturing purposes generally. In certain cases, and under favourable conditions, with regard to the district to be supplied, these companies may meet with success, but in many cases the author is of opinion the matter has been rushed into somewhat precipitately. Taking, for instance, a district of a fairly concentrated character, or in which a large number of small works and factories exist, absorbing each, say, 100 H P. to 200 H P., it might be found that with the power company supplying them with electricity at 1d. per unit it would be more profitable and convenient to them to obtain their power from the company in preference to laying down their own plant. In cases such as this, the power companies should have a good field before them. When, however, the power company enters the field in districts where all the works are of an extensive character, and absorb 500 H P. to 5,000 H.P. in electric current each, the case changes its aspect, and it will be found that it will be more profitable for the works owners to produce their own power.

On examining closely the cost of production of electricity by works owners in their own works, it is quite clear that with generating stations of 400 H P. and upwards, equipped with economical and modern appliances in the shape of high-pressure boilers, mechanical stokers, triple expansion condensing engines, working with superheated steam, &c., the cost of production should not exceed ½d. per Board of Trade unit, inclusive of interest and depreciation on the capital outlay. With blast-furnace waste gases this figure would be still less. The author is of opinion that in the case of power stations in works dealing with 1,000 H P. and upwards, and laid down upon the most modern lines, this cost of production can be reduced to 0·4d. per B ard of Trade unit, as shown in the case of Messrs. Dorman, Long & Co.'s (Ltd.) works.

Some of the cases are taken from plants which have been in operation for some considerable time and in which the very latest appliances and highest pressures may not be available. It would be most interesting with regard to the above subject to have the experience of those who have had the practical experience of producing their electric power, making use of large gas-engines working with the waste gases from the blast furnaces, and to hear from them at what cost per unit they find they are producing their electric power, delivered at the switchboard. Far be it from the author to discourage enterprise in any shape or form, especially as regards the formation of power companies, but that enterprise should be duly tempered with caution in formulating such large schemes. It would be interesting to have the experience of our German friends on this point, as the majority of the large works have their own sources of power supply, and to hear from them the lowest rate at which they are producing their unit of electricity.

Conclusion and Summary.—The cases enumerated above demonstrate in a practical manner the advantages which have actually accrued from the substitution of electricity for steam or other forms of driving. Electricity used as a motive power was, in the days when the author first treated the subject in the form of a Paper, comparatively a new departure for the works manager and engineer. The enormous developments and strides which have been made during the past 10 years in this branch of engineering tend in the direction that every works owner and engineer should acquire a thorough knowledge of this subject.

We have in Great Britain been somewhat slow in making use of all the advantages which electricity has enabled us to reap. In many parts are to be found the same old low-pressure boilers, which have done service for the past 30 years, with working pressures as low as 15lb. per square inch. In other works are still to be found the same old beam engines constructed in the days of Watt and Stephenson. Works are still to be found in which over 100 small high-pressure and non-condensing engines are distributed with their mileage of steam pipes throughout the works—little or no attempt having been made to improve this state of affairs. It is in cases such as these the author trusts this Paper may be of service, by showing clearly and in a practical manner the actual result which would accrue from the remodelling of the driving arrangements upon the electrical method.

In no country have we finer examples before us of the achievements of electricity as a motive power than in Germany, and we must all admire the skill, ingenuity and, above all, the enterprise of our German friends in this direction. There are many outlying advantages which would accrue were works and industrial establishments driven electrically. There would be an enormous reduction in the smoke produced in large manufacturing centres, and a proportionate increase in a healthier state of things for the inhabitants.

In these days, when the idea of coalfields giving out is mooted, there would be a perceptible difference in the quantity of our coal consumption, which, although perhaps unpalatable to the coal owner, would be most welcome to the manufacturer, who aims at the lowest cost of production. The application of electric power to the iron and steel, engineering and manufacturing industries in Great Britain has certainly not developed with anything like the rapidity with which it has progressed in America and on the Continent, and the author has often wished to ascertain the reasons underlying this retarding influence.

Generally speaking, the powers and responsibility vested in the general manager of a works in England are very different to what they are in a works in America. There the position is one of much greater latitude in the scope of innovations and improvements, and of responsibility also. The actual result, therefore, is that improvements and savings are rapidly carried out, and the board of directors look to their manager for the expected improvement and savings, owing to the manager's minute knowledge of the details of the scheme he is putting forward and his great sense of responsibility in the matter. In the author's experience in dealing with firms in England, he has most frequently been struck with the small scope of initiative action allotted to the works manager, nearly every innovation and improvement being referred to the board of directors. This in a very large degree appears to be the cause of a retarding influence on electric power progress in our country.

In brief, the scope and responsibility vested in the works manager in America is very different to that allotted to the works manager in England. The board of directors' decision is responsible for the results obtained, and the works manager carries out the wishes of the board; on the other side, the works manager is directly responsible to the board for the innovations that have been carried out.

There is one point that has most forcibly struck the author in dealing with improvement schemes for works. Outside of our own country he has invariably been met with a first question, "What is the saving to be effected under the proposed scheme?" In England the first question put is, "What is the cost going to be?" Both are naturally very important considerations, but many is the time that really great and immediate savings have been left unconsidered by that one glance at the first cost, and the documents have been pigeonholed and shelved, only to be brought out when absolute necessity, not real enterprise, compelled them to be resorted to again.

In the many uses to which electricity has been applied as motive power, none has proved more suitable than its application to shipyards, dockyards, and other works of this description, possessing a great number of scattered and intermittently working machines. Our great dockyards both at home and abroad offer a case in which enormous savings could be effected. The reduction in working costs of a number of shipyards with which the author is acquainted has varied between 30 and 60 per cent. If this same saving could be effected in similar establishments, such as our Government dockyards, the result would be highly beneficial to the country.

Electricians in the U.S. Army.—According to our American contemporaries, the lack of electricians and signal service men in the U.S. army is becoming serious. Recruiting officers have been instructed by the Government to make special efforts to secure all men fitted for such work.

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THE ELECTRIC DRIVING OF WORKSHOPS.

Mechanical engineers are willing to acknowledge the improvement which has been effected in steam engine and boiler manufacture by the development of the electrical industry. When electricity supply works were springing up in every party of the country, many engine and boiler makers found that the builders of these were their chief customers; and, moreover, the demands of electrical engineers for the most efficient and reliable steam engines, for boilers which should combine quick steam-raising with other indispensable properties, and for less wasteful engines for auxiliaries, have resulted in a considerable change for the better in all this class of plant. Not only this, but more attention is now being paid to the question of standardising and systematising manufacture without an actual crystallisation taking place—a difficult problem that is now being effectively solved by our own manufacturers as successfully as it has been in the United States. The electrical engineer has gone further, however, than merely giving "moral and intellectual" assistance to the works manager: he has provided him with a means of cheapening considerably the cost of the machinery and materials produced, by putting in his hands a method of driving machine tools and other workshop appliances far more efficient than that which had to be resorted to before the development of the electric motor. It has long been known that a vast saving was effected by clearing away much of the old countershafting and belting, and removing the small engines distributed in various parts of the works, these being replaced by an economical central engine and dynamo connected by cables to motors on the individual machines or driving small groups of machines; but a measure of the actual economy which was thus brought about has not often been calculable in actual pounds, shillings and pence. When large changes are made in works, such as are necessitated by the introduction of electric driving on well-considered lines, other general improvements are almost invariably brought in simultaneously, and the apportionment of the profit to the various accounts, as it were, is often a matter of difficulty. Thus electric driving has not always been credited with its due, and, moreover, it has not always been ascertainable to what extent the old methods should be superseded—whether, for instance, the majority of the saving in power and works costs generally would be effected by placing motors here and there to drive lines of countershafting, or whether, on the other hand, the full benefits due to electric driving, if introduced so as to reorganise the previous system altogether, were far in excess of those derived by a change easier to carry out and not involving so great an outlay.

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One other matter has slightly retarded the spread of electric driving, although nothing could have seriously impeded so evident and effective an improvement in workshop methods. Those engineers who have been called in to advise as to the introduction of electric driving, whether in old works or in new ones, have found great difficulty in ascertaining the actual power required to drive the various machine tools. Figures given for a particular machine by different people often varied 50 or 100 per cent, and it was not rare to find that the actual power required was either far in excess of the higher figure or else far below the lower one. This is, of course, also intimately connected with the question of cost, both as to initial outlay and subsequent working expenses, for not only does the adoption of too large a motor add to the cost of putting in the system; but a motor which is working for the most part at a fraction of its normal full-load capacity will be running less efficiently than one whose size has been accurately chosen for the work to which it is put. Works' managers will sometimes point with pride to a large machine which can be started up on its work, and with a heavy cut, without first running up the motor to speed on a loose pulley. It is not unreasonable to suppose that in such cases the motors may be far too large for their work, and that they are, therefore, extravagant. The useful set of tables given in Mr. SELBY-BIGGE's Paper, which we conclude in this issue, will, therefore, be of extreme value in this connection. He has given a large number of figures derived from actual tests, so that the values given are not mere estimates. If Mr. SELBY-BIGGE's Paper is open to criticism in any respect, it is in the fact that he has apparently overlooked the question of the rating of motors. Are the sizes of motors he recommends rated at their most efficient average load—which it may be assumed may be increased by some 50 per cent. for short periods without hurt—or at their maximum load? One of the tests given will indicate our meaning clearly. A "fitting shop" motor, standing first in one of the tables, drives three lathes, a planing machine, slotting machine, milling machine, shaping machine, two vertical drills, some smaller machines and a system of countershafting. The average power required is only 9·5 E.H.P.—a low number, which will be surprising to many, even when the fact is taken into account that, as a rule, only about 60 per cent. of the machines are running on load. The maximum load on the motor was 14·9 E.H.P. with fluctuations to 19, and yet a 20 B.H.P. motor is recommended. From the figures in Mr. SELBY-BIGGE's table, in fact, it is evident that the design of motors for shop-driving is worth a quite special study. The maximum loads are very largely in excess of the normal loads, whereas the starting torque and rapid acceleration is not so important as in the case of tramway motors. In many cases an ideal motor might be one which would run most economically at a certain load, and yet have a fair efficiency at a load 50 per cent. above this for long periods, and withstand even 100 per cent. overload momentarily. Possibly such motors are obtainable on the market, but it is doubtful at what load they would be rated in the makers' lists.

Some matters have, therefore, still to receive further development before we have attained finality in our methods of the electric driving of machine shops. Mr. SELBY-BIGGE's Paper will be of considerable assistance in helping us towards the goal, and it may have a wider application than merely in the iron and steel industries indicated in its title. Moreover, besides helping to convince owners of works of the advantages and economies of electric driving, its useful numerical data should enable electrical engineers to improve considerably on the economies already realised.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Aluminium Foil Electrometer.—E. Grimsehl describes an aluminium foil electrometer possessing certain decided advantages over the types hitherto used. The rod bearing the aluminium foil also bears a vertical plate of aluminium, against which the foil rests when the electrometer is uncharged. Another piece of aluminium foil, considerably thicker than that used for the index, is mounted on a separate horizontal axis, and can be made to lie flat against the index foil in its zero position. This arrangement ensures portability. It also greatly increases the sensitiveness of the apparatus. If very small E.M.F.s are to be discovered, the movable thick foil or cover is brought closer to the fixed piece. Another improvement is the stopper, which is made in two pieces. Each of these pieces will independently hold the index in position while the other is being cleaned. Ebonite acquires a certain conductivity under the influence of light and dust. This conductivity is got rid of by a vigorous application of soap and water. The best arrangement is to keep a spare stopper in a light-tight box. It can be exchanged without removing the index. The high sensitiveness of the apparatus (2 volts) is due to the fact that aluminium foil 90mm. long is employed, that being the total commercial length.

[E. GRIMSEHL, *Physikal. Zeitschr.*, September 15, 1902.]

Magnetostriction.—K. Honda and S. Shimizu have examined the influence of tension upon the Wiedemann effect in nickel steel, iron and cobalt. They found that when the direction of the longitudinal was to the circular field in the relation indicated by the right hand, nickel steel is twisted in the direction of the circular field, and so is iron. When the circular field is kept constant, the torsion at first increases rapidly to a maximum, and then diminishes. But a reversal of the torsion is never observed in the nickel steel, even when the field is stronger than 1,200 units. The position of maximum torsion is slightly displaced towards the stronger fields when the longitudinal current increases, and is greater in a 45 per cent. nickel steel than in a 35 per cent. specimen. Tension reduces the torsion by a proportional amount. In a nickel rod the torsion is the reverse of that of iron, and so it is in cobalt. But cobalt shows a very different behaviour according as to whether it is cast or annealed. The torsion is very small in the latter case, being only about one-twentieth of the amount observed in cast cobalt. The field of maximum torsion is also much stronger. The decrease after the maximum is very slow, and the authors have not succeeded in producing a reversal.

[HONDA and SHIMIZU, *Physikal Zeitschr.*, September 15, 1902.]

Photo-therapeutics.—Modern methods of applying powerful sources of light, and more especially actinic light, to the treatment of diseases, were the subject of discussion at the Berne congress of electrology and medical radiology. M. Foveau pointed out that the electrolytic, anæsthetic and microbicidal action of sunlight was discovered by an observation of the rarity of lupus in tropical countries and accidental cures by exposure to sunlight. M. Kurella said that every State should possess a Finsen apparatus, and that it was greatly to the credit of Denmark to have made the first installation, whose equal is not met with anywhere. M. Michaud reported favourably upon Foveau's apparatus with an arc lamp provided with quartz light-filters and a water circulation. M. Strebel described the various forms of arc lamp in use, and favoured the type containing carbons with an internal water circulation. M. Tonta described an improved light bath provided with a ventilator and a hygrometer. The apparatus comprises six circuits of eight incandescent lamps each. When the blue, red or violet rays are to be used, coloured screens are used. Openings made in the walls of the bath enable the physician to feel the pulse and the heart without opening the bath.

[*Archives d'Électricité Médicale*, September 15, 1902.]

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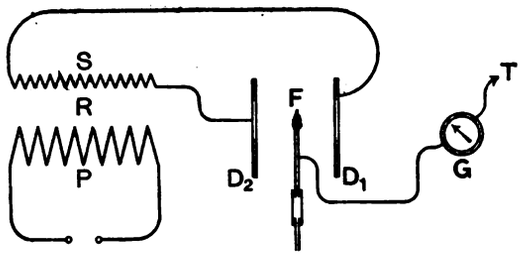
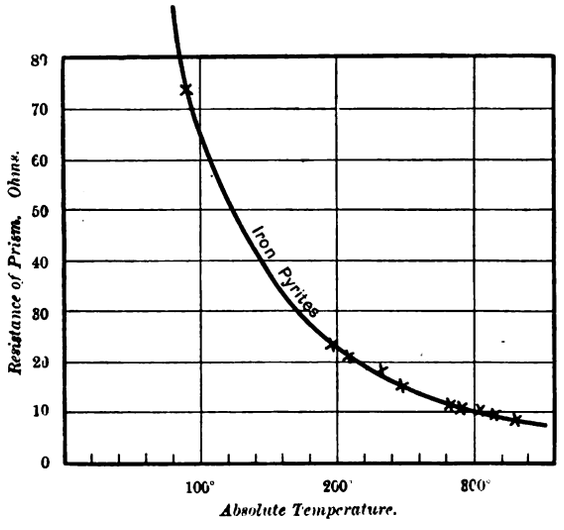
Flames in Alternating Fields.—G. C. de Rossi and A. Sella describe some interesting experiments on the behaviour of a flame in an alternating electrostatic field. Two insulated metallic discs, D_1 and D_2 (see diagram), are placed vertically and parallel to each other, and are connected with the secondary S of an induction coil, R, with an alternate current passing through the primary P. The flame F is earthed through a galvanometer, G. In the first series of experiments the flame was displaced along the space between the discs and the current determined in the different positions. It was found to diminish very rapidly towards the centre between the two plates. But the sign of the current differed greatly according to the substance burnt. A positive current was furnished by benzene, amyl acetate, illuminating gas, alcohol, acetylene, methane, cyanogen, stearine, camphor and paraffin, a negative current by phosphorous and possibly sulphur, and no current at all by flames of hydrogen, sulphuretted hydrogen, carbon bisulphide and carbonic oxide. When the flame is long and



thin it apparently spreads out into a fan when the field is excited. But on examination with a revolving mirror it is seen that this appearance is due to a superposition of images, the flame following every alternation of the field by bending aside.

[De Rossi and Sella, *Nuovo Cimento*, August, 1902.

Resistance of Metallic Sulphides.—It is known from the researches of Dewar and Fleming and of D'Arsonval that the resistivity of pure metals and alloys diminishes considerably as their temperature approaches the absolute zero. The number of free electrons in their substance increases enormously as the heat vibrations diminish in amplitude. The



case is just the reverse in chemical compounds, as is shown by E. van Aubel. He measured the resistance of a prism of iron pyrites, FeS_2, 1cm. long and 4mm. square in cross-section. The results of the measurements are given in the diagram. It will be seen that the resistance, instead of tending towards zero as the temperature falls, tends towards infinity. This would mean that whatever free electrons exist in the sulphide at the ordinary temperature—and they are by no means numerous—tend to disappear entirely as the excursions of the molecules are reduced to a smaller amplitude.

[E. van Aubel, *Comptes Rendus*, September 15, 1902.]

ELECTRICITY WORKS ACCOUNTS.

Wimbledon Municipal Electric Supply Works.

The accounts of this undertaking betoken that the concern has reached a highly creditable position in an early stage of its career. The cost of fuel at this place is probably such as to handicap the generating and works costs, and to prevent them exhibiting quite average figures. In the circumstances, therefore, the works costs at 1·695d. per unit are satisfactory.

Owing to the very moderate management and property charges, the total costs compare very well with the average of other concerns even with load factors of the favourable value which obtains at Wimbledon. Mr. F. B. Spencer, who was the chief engineer during the year under review, has, we may mention, recently left Wimbledon to take up an appointment elsewhere. We must congratulate him and the committee on the revenue received, and on having kept the tariff on such a scale as to produce the financial results shown. The latter are also greatly due to the very moderate capital expenditure relatively to the output. There is some similarity in the relations of the tariff, the load factor and the financial results at this place to those obtained at Stepney. The tariff in both places is framed to offer an inviting bid for the most paying custom of the district, and the immediate result appears to be the high-load factors shown. It will be noticed that the bulk of the revenue obtained at Wimbledon for private lighting was for electricity sold at the high price of 7d. per unit. No less than 86 per cent. of the total receipts for private supply was derived under this rate. At Stepney nearly 70 per cent. of the receipts for private supply was from electricity sold at 8d. per unit. It will be interesting to learn from the future results of both undertakings whether their expansion will proceed favourably under such tariff systems.

The balance shown as net profit—viz., £1,858—was applied in aid of the rates.

Wycombe Borough Electric Light and Power Co.

This is one of the supply concerns of the Edmundson Electricity Supply Corporation (Ltd.). Relatively to the size of the undertaking the costs results are uniformly excellent. The total revenue per unit is remarkably low, especially considering the working profit derived. Last year, as a result, the payments out of revenue in respect of capital amounted, exclusive of interest, to only 0·48 per cent. on the mean capital.

Out of the balance available for distribution—viz, £624—a dividend of 4 per cent. for the year was paid, leaving £33 to be carried forward.

The Northampton Electric Light and Power Co (Ltd).

A great improvement in the working and status of this undertaking has been effected in the year covered by our analysis. The cost figures shown are, with unimportant exceptions, most satisfactory, and are the best results that

REMARKS TO TABLES.

WIMBLEDON.—*a* On maximum demand system, ½-hour scale. *b* Lands appropriated £80. *c* Machinery £12,360, transformers, motors, &c., £2,595, meters £2,927, instruments and tools £58. *d* Machinery £18,395, transformers, motors, &c., £2,787, meters £4,424, instruments and tools £69. *e* Over-expended. *f* At 6d. £1,936, at 4d. £386, at 3d. £5, at 7d. £2,679, at 2d. £303. *g* Building £12, engines, boilers, &c., £241, alternators, exciters, transformers, motors, &c., £9, other plant £36 *h* Of mains £74, at distributing stations £10. *i* Attendance and renewals. *j* Engineers' department £606, clerical staff £185 *k* Insurance £52. *l* Each post fitted with two 16 c.p. lamps. *m* Each post fitted with two 16 c.p. lamps, total equivalent to 4,160 8 c.p. lamps. *n* At 7d. £7,104, at 4d. £471, at 3d. £82, at 2d. £667, at 1d. £8; by contract £14, less £55 allowances. *o* Buildings £23, engines and boilers £219, alternators, exciters, transformers and motors £4, other plant £133. *p* Of mains £23, on consumers' premises £18, at distributing stations £25. *q* Engineers' department £780, clerical staff £184. *r* Insurance.

WYCOMBE.—*a* £3. 3s. per 16 c.p. glow lamp. *b* Lands £1,023. *c* Machinery £13,534, accumulators £2,208, meters £3,415, instruments £2,094, public lamps £1,051. *d* Wiring and motors, &c., £5,414. *e* Over-expended. *f* Proportion of salaries £15. *g* Buildings £4, machinery £19, instruments £21. *h* Proportion of salaries £10. *i* Of mains £6, on consumers' premises £4. *j* Attendance and renewals £27, repairs £68. *k* Directors £76 in 1900 and £158 in 1901. *l* Auditing £12, insurance £17. *m* After adding £421 from wiring. *n* Preliminary expenses written off. *o* Including £58 premium on shares. *p* Lands £1,023. *q* Machinery £13,794, accumulators £2,292, meters £4,404 instruments £2,287, public lamps £1,323. *r* Wiring and motors £7,400, cost of provisional order, &c., £374. *s* Rentals of motors and wires £292 in 1900 and £389 in 1901. *t* Proportion of salaries £80. *u* Buildings £26, plant and machinery £88, accumulators £2, instruments £1. *v* Proportion of salaries £11 *w* Of mains £11, on consumers' premises £30. *x* Attendance and renewals £8, repairs £63. *y* Law £12, insurance £87, auditing £12. *z* After adding £212 from wiring.

NORTHAMPTON.—*a* Wright system. *b* £8,334 on land. *c* Machinery £16,616, accumulators £1,950, meters £4,182, instruments £294. *d* Cost of licence, provisional order, &c., £700. *e* Over-expended. *f* Rents £336, pupils' fees £175.

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	WIMBLEDON.		WYCOMBE.		NORTHAMPTON.
Undertaking Worked by	Wimbledon District Council.		Wycombe Borough Elec. Light and Power Co.		{Northampton Electric Light & Power Co. (Ltd.)
Date of Commencement of Supply	July, 1899.		August, 1898.		March, 1891.
System of Supply	Alternate-current transformers in sub-stations.		Continuous-current, 3-wire.		3-wire con.-curr.
Chief Engineer	H. Tomlinson Lee.		W. E. Brandreth.		C. H. Jackson.
YEAR ENDED	MAR. 31, **1901.**	MAR. 31, **1902.**	DEC. 31, **1900.**	DEC. 31, **1901.**	DEC. 31, **1901.**
QUANTITIES—					
Units generated	724,028	889,027	246,045	385,521	—
„ **SOLD (TOTAL)**	644,421	806,280	233,108	295,727	286,890
„ sold to consumers	229,117	360,269	168,277	223,846	286,890
„ sold for public lighting, &c.	415,304	446,011	56,864	65,916	nil
„ sold for traction	nil	—	nil	nil	nil
„ used on works	18,780	21,820	8,797	62,796	—
UNITS SOLD per MEAN 8 c.p. CAPACITY	—	36·8	18·8	18·9	14·5
Actual maximum supply demanded	367 kilowatts	510 kilowatts	268	300	370 kilowatts
Load factor	20·05%	18·0%	9·93%	11·3%	8·85%
Number of public lamps	903 posts[i]	1,025 posts[m]	10 arc, 214 (16 c.p.) glow	10 arc, 216 (16 c.p.) glow	nil
Number of consumers	459	705	—	—	502
Connections to mains in 8 c.p. at end year	28,179	33,504	16,910	22,067	29,121
CAPACITY of PLANT in KW. at END YEAR	360	1,060	500	500	790
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kw. capacity.
AUTHORISED (TOTAL)	£67,545 / £187	£94,378 / £89·0	— / —	£65,000 / £130	£100,000 / £127
Share	— / —	— / —	£30,000 / £60	50,000 / 100	50,000 / 63·3
Loan (including Debenture charges)	67,545 / 187	94,378 / 89·0	— / —	15,000 / 30·0	50,000 / 63·3
RECEIVED (TOTAL)	67,625[b] / 188	75,125[b] / 70·9	28,292 / 56·6	30,100 / 60·2	72,732 / 92·1
Share	— / —	— / —	13,292 / 26·6	15,100 / 30·2	39,957 / 50·6
Loan (including Debenture charges)	67,545 / 187	75,045 / 70·8	15,000 / 30·0	15,000 / 30·0	32,775 / 41·5
AUTHORISED, NOT RECEIVED (TOTAL)	nil / —	19,333 / 18·2	— / —	34,900 / 69·8	27,268 / 34·5
Share (unissued)	— / —	— / —	14,900 / 29·8	34,900 / 69·8	10,043 / 12·7
Share (uncalled)	— / —	— / —	2,000 / 4·0	nil / —	
Loan (including Debentures)	nil / —	19,333 / 18·2	— / —	nil / —	17,225 / 21·8
REPAID (TOTAL)	2,425 / 6·74	4,378 / 4·13	— / —	— / —	nil / —
RESERVE OR SINKING FUND	nil / —	nil / —	— / —	— / —	— / —
DEPRECIATION FUND	nil / —	nil / —	— / —	400 / 80	3,037 / 3·85
EXPENDED (TOTAL)	57,400 / 159	85,615 / 80·7	49,924 / 99·8	57,143 / 114	80,544 / 102
Lands and buildings	6,731[b] / 18·7	15,377[b] / 14·5	5,873[b] / 11·7	6,693[p] / 13·4	16,963[b] / 21·5
Plant	17,940[c] / 49·8	25,675[d] / 24·2	22,303[c] / 44·6	24,100[q] / 48·2	33,072[c] / 41·9
Mains	28,787 / 80·0	38,340 / 36·2	15,937 / 31·8	18,552 / 37·1	29,644 / 37·5
Miscellaneous	3,943 / 11·0	6,223 / 5·87	5,812[d] / 11·6	7,797[r] / 15·8	865[d] / 1·09
BALANCE OF CAPITAL ACCOUNT	10,225 / −28·4	−10,490[e] / −9·90	−21,632[e] / −43·2	−27,043[s] / −54·1	−7,812[e] / −9·88
REVENUE—	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.	Total. / Per unit of total units sold.
TOTAL	£9,508 / 3·540d.	£13,216 / 3·934d.	£4,092 / 4·211d.	£4,870 / 3·950d	£6,680 / 5·589d.
Revenue from supply	5,317[f] / 1·979d.	8,291[n] / 2·469d.	2,915 / 3·000d.	3,495 / 2·835d.	5,873 / 4·912d.
„ meters, &c.	160 / 0·060d.	276 / 0·082d.	119 / 0·123d.	175 / 0·142d.	303 / 0·253d.
„ public lighting	4,029 / 1·500d.	4,646 / 1·383d.	767 / 0·789d.	810 / 0·657d.	nil / —
„ supply for traction	nil / —	nil / —	nil / —	nil / —	nil / —
„ miscellaneous sources	2 / 0·001d.	2 / 0·001d.	292[s] / 0·301d.	390[s] / 0·316d.	504[f] / 0·422d.
EXPENDITURE—					
TOTAL COSTS	£6,338 / 2·359d.	£7,850 / 2·336d.	£2,230 / 2·295d.	£3,057 / 2·481d.	£3,036 / 2·540d.
TOTAL WORKS COSTS	5,155 / 1·919d.	6,425 / 1·912d.	1 662 / 1·711d.	2,203 / 1·786d.	2,298 / 1·922d.
Generation of Electricity	*4,539 / 1·690d.*	*5,646 / 1·680d.*	*1,490 / 1·533d.*	*2,001 / 1·624d.*	*2,233 / 1·868d.*
Fuel (including cartage, &c.)	3,183 / 1·185d.	3,981 / 1·185d.	1,110 / 1·142d.	1,441 / 1·169d.	955 / 0·799d.
Oil, waste, water, stores	312 / 0·116d.	392 / 0·117d.	31 / 0·032d.	31 / 0·025d.	89 / 0·074d.
Wages at station	752 / 0·280d.	894 / 0·266d.	273[t] / 0·281d.	412[t] / 0·334d.	891[v] / 0·745d.
Repairs & maintenance at Station	292[g] / 0·109d.	379[o] / 0·113d.	75[g] / 0·077d.	117[u] / 0·095d.	297 / 0·248d.
Distribution of Electricity	*105 / 0·039d.*	*52 / 0·015d.*	*77 / 0·079d.*	*131 / 0·106d.*	*65 / 0·054d.*
Wages, &c.	11 / 0 004d.	52[p] / 0·015d.	68[h] / 0·070d.	91[v] / 0·074d.	40[h] / 0·034d.
Repairs, renewals of mains, &c.	94[h] / 0·035d.		10[i] / 0·010d.	40[w] / 0·032d.	25 / 0·021d.
Public Lighting	*511 / 0 190d.*	*728 / 0·217d.*	*95 / 0·098d.*	*70 / 0·057d.*	nil / —
Attendance	435[i] / 0·162d.	581[i] / 0·173d.	95[j] / 0·098d.	70[x] / 0·057d.	— / —
Renewals	77 / 0·029d.	147 / 0·044d.			— / —
MANAGEMENT CHARGES, &c.	1,183 / 0·440d.	1,425 / 0·424d.	568 / 0·585d.	854 / 0·693d	738 / 0·618d.
Net Rents	*2 / 0·001d.*	*2 / 0·001d.*	*271 / 0·279d.*	*20 / 0·016d.*	nil / —
Rates and taxes	*103 / 0·038d.*	*129 / 0·038d.*		*286 / 0·232d.*	*357 / 0·299d.*
Management	*1,078 / 0·401d.*	*1,294 / 0·385d.*	*297 / 0·306d.*	*548 / 0·444d*	*381 / 0·319d.*
Salaries	791[j] / 0·294d.	964[q] / 0·287d.	157[k] / 0·162d.	306[k] / 0·248d.	200 / 0·167d.
Stationery, &c.	113 / 0 042d.	130 / 0 039d.	35 / 0·036d.	44 / 0·036d.	59 / 0·049d.
Establishment charges	121 / 0·045d.	131 / 0·039d.	76 / 0·078d.	87 / 0 071d.	18 / 0·015d.
Law charges, &c.	53[k] / 0·020d.	68[r] / 0·020d.	29[l] / 0·030d.	111[y] / 0 090d	104[t] / 0·087d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'd.
WORKING PROFIT FOR YEAR	£3,170 / 6·42%	£5,364 / 7·50%	£2,282[m] / 5·55%	£2,055[z] / 3·84%	£3,644 / 4·77%
Carried to Depreciation Fund	— / —	— / —	400 / 0·973%	200 / 0·374%	800 / 1·31%
Carried to Reserve Fund	1,552 / 3·14%	1,952 / 2·73%	194[n] / 0·472%	56[n] / 0 105%	43[j] / 0·056%
Net int. on loans (incl. Deb. charges)	1,484 / 1·30%	2,055 / 2·87%	1,434 / 3 63%	1,400 / 2 62%	1,322 / 1·73%
Net profit for the year	134 / 0·271%	1,358 / 1·90%	94 / 0·472%	399 / 0·746%	1,480 / 1·94%
BALANCE FROM LAST ACCOUNT	nil / —	nil / —	376 / 0·915%	225 / 0·420%	46 / 0·060%
Do. AVAILABLE for DISTRIBUTION, &c.	134 / 0·271%	1 358 / 1·90%	628[o] / 1·53%	624 / 1·17%	1,527 / 2·00%
Deficit	— / —	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	4% / —	4% / —	3½% / —
PER CENT. of TOTAL COSTS to REVENUE	66·6%	59·4%	54·5%	62·8%	45·4%
Expenditure per mean kilowatt capacity	—	£11. 1s. 2d.	£5. 12s. 5d.	£6. 2s. 4i.	£4. 16s 0d.
REVENUE PER MEAN KW. CAPACITY	—	**£18 12s. 5d.**	**£10. 6s. 0d.**	**£8. 3s. 10d.**	**£10. 11s. 0d.**
REV. PER 8-C.P. CONNECTED, MEAN	—	**8s. 7d**	**6s. 6d.**	**4s. 2d.**	**4s. 11d.**
Price charged for lighting, per unit	6d. to 3½d. and 7d. to 2d.[a]	7d. to 2d.[a]	7d., 4d. and 2d.	7d. to 2d.	6½d. (1 hr.) to 3½d.[a]
„ for power, per unit	3d. to 1d.[a]	3d. to 1d.[a]	4d. to 1½d.	4d. to 1d.	3d. (3 hrs.) to 1½d.[a]
„ for public lighting	2½d. per unit	2½d. per unit	£16 per (10 amp.) arc[a]	£16 per (10 amp.) arc[a]	—
Receipts per unit for private supply	5·57d.	5·52d.	4·16d.	3·75d.	4·91d.
„ „ for public lighting	2·03d.	2·11d.	2·84d.	2·69d.	—
„ „ for traction	—	—	—	—	—

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this undertaking has produced. In studying the figures relating to the year's working it is necessary to bear in mind the moderate order of the output and the low load factor which characterises it. In relation to these governing conditions the total costs are excellent at 2·54d. per unit. From the fuel item of only 0·8d. it is evident that the undertaking has not got to pay very heavily for its coal supply. We are glad to see that the depreciation fund has received the attention it deserves from the directors, and that out of the profits of last year £800 was placed aside for the fund. The change over to higher pressure of supply was effected in April last year.

Concurrently with the improvement in the position of the undertaking come inquiries from the local authorities as to the purchase of the concern from the company. There is every prospect of the current year's working resulting in still further improvement in the fortunes of the undertaking.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Sept. 27, 1901	Islington (Municipal)	Nov. 23, 1900
Accrington (Municipal)	July 25, 19 2	Kens'gton & Knightsbr'(Co.)	Apr. 11, 1902
Ayr (Municipal)	Oct. 11, 1901	Kingston-upon-Hull (Mun.)	July 13, 1900
Barking Town (Municipal)	Oct. 8, 1902	Kingston-on-Thames (Mun.)	June 20, 1902
Barnsley (Municipal)	June 27, 1902	Lancaster (Municipal)	July 25, 1902
Bath (Municipal)	April 20, 1900	Leeds (Municipal)	June 27, 1902
Bedford (Municipal)	Aug. 3, 1900	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Aug. 8, 1902	Leith (Municipal)	May 17, 1901
Birmingham (Company)	Sept. 15, 1899	Leyton (Municipal)	Nov. 1, 1901
Blackburn (Municipal)	Feb. 7, 1902	Liverpool (Company)	Oct. 10, 1902
Blackpool (Municipal	Oct. 4, 1901	Liverpool (Municipal)	April 4, 1902
Bournemouth (Company)	April 18, 1902	London Elec. Supply Corp.	Sept. 5, 1902
Bolton (Municipal)	Nov. 29, 1901	Londonderry (Municipal)	Feb. 16, 1900
Bradford (Municipal)	July 12, 1901	Lymington (Company)	Oct. 10, 1902
Brighton (Municipal)	Sept. 12, 1902	Manchester (Municipal)	Aug. 29, 1902
Bristol (Municipal	Aug. 8, 1902	Metropolitan Elec. Supply Co.	Apr. 25, 1902
Bromley (Kent) (Co.)	May 16, 1902	Morley (Municipal)	July 25, 1902
Brompton & Kensington (Co.)	June 6, 1902	Newcastle and District (Co.)	Oct. 6, 1899
Burnley (Municipal)	Feb. 7, 1902	Newcastle-upon-Tyne (Co.)	Dec. 20, 1901
Burton-upon-Trent (Mun.)	July 11, 1902	Newport (Mon.) (Municipal)	Jan. 11, 1901
Bury (Municipal)	July 11, 1902	Northampton (Company)	Oct. 20, 1899
Cambridge (Company)	June 13, 1902	Norwich (Company)	Sept. 19, 1902
Canterbury (Municipal)	Oct. 26, 1900	Notting Hill (Company)	June 6, 1902
Cardiff (Municipal)	Oct. 25, 1901	Nottingham (Municipal)	Dec. 27, 1901
Charing Cross (Company)	Mar. 28 1902	Oldham (Municipal)	Aug. 29, 1902
Chelmsford (Company)	Oct. 10, 1902	Oxford (Company)	June 13, 1902
Chelsea (London) (Co.)	April 11, 1902	Pontypool (Company)	May 8, 1901
Cheltenham (Municipal)	Mar. 14, 1902	Portsmouth (Municipal)	Oct. 25, 1901
Chester (Municipal)	Aug. 22, 1902	Prescot (Company)	Dec. 8, 1899
City of London (Company)	April 25, 1902	Preston (Company)	Dec. 14, 1900
Clerkenwell (Company)	May 9, 1902	Reading (Company)	Dec. 21, 1900
Coventry (Municipal)	Feb. 28, 1900	Richmond (Company)	June 29, 1900
Crewe (Municipal)	July 11, 1902	Salford (Municipal)	Jan. 24, 1902
Croydon (Municipal)	Nov. 22, 1901	St. Helens (Municipal)	Jan. 10, 1902
Crystal Palace District (Co.)	Sept. 13, 1901	St. James' & Pall Mall (Co.)	Mar. 21, 1902
Derby (Municipal)	Jan. 26, 1900	St. Pancras (London) (Mun.)	Sept 5, 1902
Dewsbury (Municipal)	Feb. 15, 1901	Scarborough (Company)	Sept. 19, 1902
Dover (Company)	May 2, 1902	Sheffield (Municipal)	Feb. 1, 1901
Dundee (Municipal)	Dec. 6, 1901	Shoreditch (Municipal)	Jan. 31, 1902
Eastbourne (Municipal)	Mar. 14, 1902	Smithfield Markets, Lond. (Co.)	Mar. 8, 1901
Edinburgh (Municipal)	Dec. 6, 1901	South London (Company)	May 16, 1902
Exeter (Municipal)	Aug. 8, 1898	South Shields (Municipal)	July 4, 1902
Folkestone (Company)	May 2, 1902	Southampton (Municipal)	Aug. 1, 1902
Glasgow (Municipal)	Sept. 12, 1902	Southport (Municipal)	Jan. 17, 1902
Gloucester (Municipal)	Aug. 30, 1901	Stafford (Municipal)	Aug. 16, 1901
Great Yarmouth (Mun.)	Dec. 13, 1901	Stepney (Municipal)	Oct. 8, 1902
Greenock (Municipal)	Aug. 30, 1901	Sunderland (Municipal)	Aug. 1, 1902
Guernsey (Company)	Sept. 26, 1902	Taunton (Municipal)	June 16, 1899
Guildford (Company)	Oct. 19, 1900	Tunbridge Wells (Mun.)	Aug. 22, 1902
Halifax (Municipal)	Dec. 27, 1901	Wakefield (Municipal)	Dec. 1, 1899
Hammersmith (Municipal)	Nov. 15, 1901	Walsall (Municipal)	May 23, 1902
Hampstead (Municipal)	Nov. 22, 1901	Wandsworth (Company)	May 9, 1902
Hanley (Municipal)	Aug. 9, 1901	Westminster (Company)	April 4, 1902
Harrogate (Municipal)	Jan. 25, 1901	Whitehaven (Municipal)	Feb. 8, 1901
Harrow (Company)	Dec. 21, 1900	Winchester (Company)	June 20, 1902
Hastings (Municipal)	July 18, 1902	Windsor and Eton (Co.)	July 19, 1901
Hereford (Municipal)	Jan. 17, 1902	Woking (Company)	Dec. 22, 1899
Hove (Company)	July 18, 1902	Wolverhampton (Municipal)	Jan. 24, 1902
Huddersfield (Municipal)	May 23, 1902	Woolwich (Company)	May 31, 1901
Hull (Municipal)	July 4, 1902	Worcester (Municipal)	April 18, 1902
Isle of Wight (Company)	Sept. 26, 1902		

THE ACCIDENT ON THE GLASGOW TRAMWAYS.

We give below the full report made to the Board of Trade by their inspector (Major Druitt, R.E.), who inquired into the recent tramway accident at Glasgow:—

The cars in question were all four-wheeled double-decked cars, fitted for electric traction on the overhead trolley system, and provided with the usual hand-brakes with blocks on all four wheels, and with an electric emergency brake. The conductor of the leading car, No. 690, which ran back down Renfield-street, was very seriously injured by the first collision, but I understand all the injuries to passengers, about 27 in number, were caused by jumping off, and that no complaints of injuries had up to the date of the inquiry been received from passenger who remained in the cars.

The accident occurred about 9:20 p.m., and the evening was fine. Although Renfield-street is one of the steepest on the Glasgow tramways system, the gradients are not severe ones for electric traction, the steepest being at the top of the street, where, for a distance of about 200yds, it is 1 in 22. At the extreme top, where it joins Cowcaddens-street, the gradient is 1 in 36. Below Sauchiehall-street, which joins Renfield-street at the bottom of the 1 in 22 gradient, the incline is 1 in 94 for 92yds., and then becomes 1 in 24·6 for the remaining 280 yds. to St. Vincent-street, where the cars ran off at some points and came to a standstill. Thus the total distance the first car ran back was about 572yds.

The sequence of events was as follows:—R. Neeley, the driver of car No. 690, had gone up Renfield-street and was just bringing his car to a stand at the authorised stopping-place (at the top of the street before turning into Cowcaddens-street, where there is a junction with another tram line) by means of the hand brake, when the handle came off the brake spindle, and the car having first stopped began to run back down the incline of 1 in 22. Neeley states he at once applied the electric emergency brake but that it had no effect on the car, which gained speed rapidly as it descended the incline. Just south of Sauchiehall-street, 230yds. from the top, another car was standing, with hand brakes applied, on the 1 in 94 gradient, but the impetus of the first car carried the second car with it, and both went together down the street, and these two ran into a third car, No. 585, which was standing, with hand brakes applied, 180yds. behind the second car on the 1 in 24·6 gradient. This checked the first two cars, and the three, locked together, ran back at a moderate speed another 165yds. to the junction of St. Vincent-street, where all three left the metals at the points and came to a stand, the third one running on to the pavement in St. Vincent-street and breaking a shop window.

The trolley of the first car remained on the trolley wire until the collision with the second car, when the trolleys of both cars came off the wire, and one of the poles, probably that of the second car, No. 755, carried away one trolley-wire span and two guard-wire spans. When the guard wires fell on to the trolley wire there were some flashes, but no one was injured from this cause, as the power was automatically cut off by the circuit breaker almost simultaneously with the first collision, the time recorded for this in the sub-station engineer's book being 9·21 p.m. Neeley, the driver of the first car, No. 690, states that when the car commenced to run back he did not think of applying the current, which would have stopped the car and taken it forward again, but that he tried to bring it up with the electric brake, and finding that had no effect, shouted to the conductor to apply the hand-brakes at the rear end of the car. Campbell, the conductor, was unable to give evidence at the inquiry, but Neeley states that Campbell came through the car to him, but with the confusion does not know if he applied the brake or no. Campbell must have got back to the rear platform as he was injured by the collision with the second car, but he probably had no time to apply the brake before the collision occurred.

The accident was thus primarily due to the brake ratchet handle coming away from the spindle owing to the locker-pin having worked loose and come out. The pattern of handle is that known as the Brill brake handle, and the locker-pin is of steel, $\frac{5}{16}$in. diameter, and is 1½in. long, with a screwed thread at one end ½in. in length. It merely serves the purpose of preventing the brass handle from being lifted vertically off the brake spindle, and no force is transmitted through it to the spindle. After the accident search was made for the pin on the car platform by Mr. Ferguson, the superintendent of rolling stock, and two others, but without success. A pin was found lying beside the car, No. 690, in the shed on the following day, but as all locker-pins for this type of handle are interchangeable, it is impossible to say if it is the one belonging to that particular handle. The car, No. 690, had been in use since 5 a.m., and I do not think the pin could have been out all day without being missed, or the handle coming off sooner, as although the brake could be worked by a handle without a locker-pin, still the first jerk would tend to dislodge it, and yet if it had come unscrewed by degrees the driver should have noticed it, as it would have been projecting ½in. out of the handle before it could come right out, as the screwed end is ½in. in length. I have never heard of a similar case, and cannot offer any explanation as to how it could have come out without being noticed.

Car No. 690 had been driven by two other men during the day—viz., drivers Wyllie and Martin, and both state that the hand brakes were in good order during the time they were in charge. Wyllie further states that the electric brake acted very well when he took the car out the first thing in the morning. Martin states he had no occasion to use it. Neeley states that when he had the car in the morning the electric brake was not very powerful, but that it was not sufficiently defective to cause him to report it or to tell the driver who took the car over from him, and when he took the car over a second time, at 7:45 p.m. he did not try it, and had no occasion to use it until the accident to the handle of the hand brake occurred. The electric brake was tried on the Monday morning by Mr. Ferguson, the superintendent of rolling stock, who found it working perfectly at low speeds.

I also asked Mr. Young, the manager of the Glasgow tramways, to have some further trials made on the Renfield-street incline, and the report of Mr. Ferguson, the superintendent of rolling stock, is as follows:—

As arranged, I brought two cars to Renfield-street between 12 midnight and 1 o'clock this morning, in order to test the electrical brakes on the gradient. Rain had fallen heavily during the evening and the rails were consequeutly wet and fairly clean when the tests were carried out.

The two cars chosen for the tests were:—

Car No. 956, which is fitted with the Westinghouse equipment and the Newell electromagnetic track brake;

Car No. 691, which is fitted with the B.T.H. equipment and the ordinary electric brake.

The tests were chiefly carried out on the top portion of Renfield-street, between Cowcaddens and Sauchiehall-street, the full distance being 200yds., and the gradient 1 in 22.

Car No. 956.—Starting at the top of the hill, from the exact place from which car No. 690 commenced to run back on the night of Saturday, 6th inst., I carried out the following tests:—

The car was left free to run backwards with the trolley on the wire for a varying number of yards, and the Newell electric brake was then applied with the following results.

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1. 40yds. run.—Car brought to a stand in 37ft., the speed being 8 miles per hour.

2. 60yds. run.—Car brought to a stand in 45ft., the speed being 12 miles per hour.

3. 80yds. run.—Car brought to a stand in 50ft., the speed being at least 15 miles per hour.

The same tests were afterwards carried out with the trolley off the wire, with similur results.

The next test was carried out with the car coasting down the hill in the usual way, at a speed of 6 miles per hour. The electric brakes, when applied, stopped the car in every case in a few feet.

Car No. 691.—This car, which was afterwards tested, is fitted with the B.T.-H. equipment and the ordinary electric brake.

Car. No. 691 is similar in every respect to car No. 690. In testing the brakes of this car on the grade of 1 in 22, the trolley was taken off the wire and the hand brake allowed to remain slack. The car was then allowed to run free backwards down the hill several times, each succeeding time for a greater length so as to get up a higher speed. It was found that, after running free for 40yds., the speed attained was about 8 miles per hour, and on the application of the electric brake the car was brought to a stand in 39ft. On the second trial the car was run for 60yds., the speed attained being about 12 miles per hour. On the application of the electric brake it was brought to a stand in 48ft. On the third test the car was run 80yds., the speed at that distance being about 15 miles per hour, and on the application of the electric brake it was brought to a stand in 60ft. It was also found that, when the electric brake was kept full on after the car had been brought to a stand with the trolley off the wire and the mechanical brake disabled, the car only moved a foot or two at a time; indeed, the motion of the car down the hill could scarcely be noticed.

After these tests were carried out, I tried braking the car when travelling forward, by reversing the reversing handle, throwing off the automatic cut out, and applying the brake by putting the power handle to the highest notch on the power side. The result was that the car was brought to a stand in the same distance as before.

It will be seen from the above tests that if the electric brake of car No. 660 was in order at the time of the run-back the driver should have had no difficulty in pulling up the car had he applied it. He states he did so in the proper manner, but I think it possible he may have omitted to reverse the power handle, in which case no braking effect would be produced on the car. I think it is fairly well proved that the electric brake of car No. 690 was in order on the day of the run-back, and as it was in order after the collisions, I think it must have been at the time of the runback.

The system of training the drivers before they take charge of cars appears to be thorough and satisfactory, and driver Neeley had been driving regularly for 18 months, yet I think the probability is that when he was suddenly confronted with an emergency he failed to use properly the brake especially provided for an emergency. I do not blame him as the evidence is not conclusive, but the probability is, I think, that he never applied the electric brake at all during the run-back.

It will be seen from the evidence of Inspector McNee that when he looked at the car 10 or 12 minutes after the collision, the controller and reversing handles were in such a position that no braking effect would take place on the car. Neeley at first declared that he left the handles in the same position as he had them during the run-back all the time until he removed them from the car, but when Inspector McNee's evidence was read to him said he might have shifted them after he came to a stand. From his replies to my questions Neeley did not appear to have any definite idea as to the action of the electric brake.

Each driver and conductor in the Glasgow Corporation's employ is provided with a book of instructions as to how to act under various emergencies, and, as stated above, the training appears to be thorough before a man is allowed to take charge of a car, but it is also necessary, for safety, that the men employed as drivers should be intelligent and not given to excitement and "loss of head" on an emergency. Many men are fit to drive a car when everything goes without a hitch, and yet fail when a sudden emergency arises, as in this case. If Neeley had at once applied the power when the car began to move backwards, he would have at once stopped it and taken it forward again, but he states this never occurred to him. The lesson to be learned from this case is the necessity of having highly-trained and intelligent level-headed men as drivers.

I may add that, from the evidence of the general manager, the inspection of the cars appears to be efficiently carried out, and that the drivers are instructed to take a car to the depôt should they have any doubts as to the reliability of its brakes.

Some correspondence appeared in the Press as to the desirability of having a stopping place at the top of Renfield-street on a gradient of 1 in 22, but there is no difficulty in holding a car on such an incline.

It will be seen from Mr. Ferguson's report on the trials of brakes in Renfield-street that one of the cars, No. 956, was fitted with the Newell electromagnetic track brake. I was informed by the general manager that it is intended to fit 100 cars on the Glasgow Corporation's system with these magnetic track brakes, and that these cars would be put to run on the routes with the steepest gradients. This brake is, I believe, very powerful, but as I understand its efficiency depends on flexible connections being in good order its superiority to a purely mechanical track brake has yet to be tested. I trust the Corporation will report as to its working in due course.

BOOKS RECEIVED.

"'Mechanical World' Pocket Diary and Year Book for 1903." (Manchester: Emmott & Co., Ltd.) 6d.

"Electrical Motor Installations." By F. J. A. Matthews. (Manchester: Scientific Publishing Co.) 2s. 6d. net.

THE NEW MUNICIPAL TECHNICAL SCHOOL AT MANCHESTER.

On Wednesday last the largest technical schools in the kingdom were opened by the Right Hon. A. J. Balfour, M.P. These schools, not only in point of architecture and design, but also in equipment, are probably the most modern and valuable in existence. It seems a pity that so fine an erection should not have been placed in a more prominent position. Within a few minutes' walk of the London-road station, and in what is comparatively a back street, the magnificence of the building cannot be appreciated to the full extent, but the plot of land, as well as a sum of money, had been given by the trustees of Sir Joseph Whitworth, and although the site is not imposing it is historic, being part of the very ground upon which the old Whitworth works stood. Despite the large sum of money received from the Manchester Exhibition of 1897, an Imperial grant, and the above-mentioned Whitworth grant, the schools have cost the Corporation a very large amount; but it is satisfactory to know that it has been spent on an object so worthy, and that in no sense can it be called wasted or misspent. Not only will Manchester itself derive immense benefit from the teaching at these schools, but the whole country, and, in a lesser sense, the world itself, will feel its influence and owe a debt of gratitude to those who have been instrumental in founding and bringing this institution to its present condition.

Last week's issue of *Engineering* contains a most interesting illustrated article on the schools, in which Mr. J. H. Reynolds, the principal of the school, has traced the history of the undertaking from early days. It is, he says, the direct outcome of the old Mechanics' Institution, which was founded in 1824, and was associated with such notable names as those of Benjamin Heywood, William Fairbairn, George William Wood and Richard Roberts. The original establishment was in Cowper-street, and the building still exists. After 33 years of good work the institution was removed to what is now Princes-street, and here, since 1883, the technical school has been carried on. After the Technical Instruction Act of 1889 was passed, Manchester was the second city in the kingdom to take advantage of its provisions, whilst the further Act of 1890 enabled the local authorities to obtain a large Imperial grant. The Whitworth Institute of Art and Industry was transferred to the Corporation in 1892, and the Manchester Exhibition of 1897 was the means of supplying another large amount as a contribution for the new technical school. The trustees of Sir Joseph Whitworth gave a still further sum, and, as mentioned above, a plot of land in Sackville-street.

The building is of the French Renaissance style of architecture, and constructed of red Accrington bricks and terra-cotta. The mechanical, steam, electrical and hydraulic laboratories are in the basement, as are the spinning and weaving rooms, while the higher floors are occupied by the various workshops, lecture rooms, chemical and physical laboratories. In the mechanical and steam departments there are elaborate experimental engines and boilers such as are to be found in no other schools in Europe, and the apparatus for the investigation of problems which confront the mechanical engineer during the practice of his profession are so complete that it is hardly possible to imagine one instrument that has been omitted. We propose, however, to deal with the more purely electrical matter in this article, and those readers who desire fuller information concerning the rest of the equipment are advised to consult the article in *Engineering* previously mentioned.

Electrical energy is, naturally enough, generated on the premises for lighting the building and any other purpose for which it may be required. Among the laboratories in the basement is the electricity supply station, which has a capacity of 450kw. The generating plant consists of four machines of 100kw. each and one of 50kw., and, in addition to supplying energy for lighting and power, it has been arranged that exhaustive tests of the plant can be made during the actual running. With the purpose in view of affording facilities for research and experimental work, it was decided to have representative engines and dynamos of five different types, so that comparisons might be drawn and deductions made. Economy tests of each set will be made once every year. It was at first intended to take the necessary current from the Corporation supply mains, the station being close to the school, but by using the exhaust steam from the engines of their own station for heating purposes, it was found that nothing would be gained by buying current, and, therefore, it was decided to generate it on the premises. The four 100kw. sets are of the following types and makes:—1. A slow-speed side-by-side compound engine by Marshall, driving by ropes a four-pole shunt-wound dynamo by Ernest Scott and Mountain. 2. A Browett-Lindley compound engine driving a Mather and Platt shunt-wound continuous-current dynamo. 3. A Willans engine driving a Bruce Peebles dynamo. 4. An American tandem compound overhung-crank engine, with automatic cut-off gear, by the Robb Engineering Co., directly coupled to a four-pole Dick, Kerr dynamo. The 50kw. set is a Parsons turbo-electric generator. The switchboard has six panels, and is by Messrs. Cowans, and there is a balancer and booster

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set by the Lancashire Dynamo and Motor Co. Balancers are needed because the building is wired on the three-wire system, and the boosters are used for charging the cells. The battery room contains Tudor storage batteries of 600 ampere-hours capacity.

The same principle has been adopted regarding the boiler plant, there being three boilers, all unlike one another, not only in design but in size and capacity. Modern central-station practice is represented by a Babcock and Wilcox 160 H P. boiler, which will develop 200 H.P. under forced draught. There is a return-tube boiler made by David Rollo & Sons, rated at 300 H.P., with ordinary draught, or 450 H.P. under forced draught. Both these boilers have been provided with mechanical stokers. The third boiler is of about the same capacity as the latter of the two described above, and is of the small tube or express water-tube Reed type. A Schmidt superheater, having 400 sq. ft. heating surface has also been installed, and is so fitted that it will be possible to ascertain the temperature of the gases and of the steam at different points.

In the smithy there is a Massey steam hammer in addition to several of the usual furnaces, and the foundry contains a cupola for melting brass and the necessary appliances for producing moderate sized castings. The pumps in the hydraulic laboratory are operated by two electric motors of 250 B H.P. and 120 B H P. respectively, and the laboratory is equipped with a complete water-power plant, the pumps being used to return the water to tanks after it has been through the turbines. In the gas and oil engine laboratory there is a Crossley gas engine driving a Crompton generator, which acts as a dynamometer. It is expected that valuable work will be performed in this department, relating to internal temperatures of cylinders, &c.

For experimental work in the higher branches of heat, magnetism and electricity, an advanced physical laboratory has been provided with all the most modern and accurate scientific instruments that the present day is able to produce.

Now that lift work is becoming so important, it is interesting to learn that the two passenger lifts which have been installed will be available, not only for ordinary passenger service, but for obtaining experimental data for use in designing such appliances. One is operated electrically and the other by hydraulic power.

One of the most important departments in the school is that of electrical engineering and technical physics. Although the other departments are so thoroughly well equipped with machinery and apparatus, yet that devoted to the sciences of electricity and physics is perhaps even better off, and is as near perfection as it is possible to imagine. No fewer than 20 rooms have been entirely given up to it, including a photometer room 60ft. in length. In this room are photometers of the Lummer-Brodhun, Steinheil and Kruss types, together with pentane, amyl-acetate, Methven and Carcel standards. There is also a Letheby-Bunsen double-standard photometer, supplied by Alexander Wright & Co. Special photometers for arc and incandescent electric lamps, as well as certified English, French and German standards of light will be provided. Among the optical apparatus there will be a grating spectrum apparatus by Steinheil & Co. of Munich.

In the electrical engineering laboratory special arrangements and instruments have been provided for the testing of all kinds of electrical plant, both continuous and alternating, and an experimental tramcar truck has been installed in the dynamo room. This truck was designed by Dr. Nicolson, and is so constructed that a complete series of tests can be carried out under conditions approximating those obtained in actual working. Below the apparatus, which is mounted in the middle of the room, is a pit from which observations can be made with the greatest of ease. The car truck, supplied by Messrs. Dick, Kerr & Co., is fitted with continuous-current motors, designed by Prof. Short. Friction wheels carry the truck, and the mechanism is coupled to a large flywheel, the mass of which can be altered, it being built in segments for the purpose. The load may be varied by regulating the amount of water contained by four tanks carried on the car frame. A great variety of tests may be made, as the truck is fitted with controllers and motors complete, while a motor fixed outside supplies the necessary acceleration factor due to a down grade. Dynamometers and instruments of various kinds are available for carrying out exhaustive tests, and it is proposed to compare experimentally the merits and demerits of continuous-current as compared with polyphase working as adopted in traction systems. Messrs. Witting Bros. supplied four Kolben machines of the inductor type and a four-panel marble switchboard. The stationary armatures of the machines are wound to give either one or two-phase currents, and the machines are driven by two 220-volt motors. The capacity of each alternator is 10kw. single-phase and 15kw. two-phase, with a voltage of 100 and frequency of 100 $\sim$ per sec. A 20kw. Oerlikon three-phase alternator for 200 volts and 50 $\sim$ occupies a portion of the same room, and is coupled directly to a 400-volt motor, by the Clayton Foundry Co., which is driven from the city mains. Messrs. Dorman and Smith constructed two switchboards, and the Sturtevant Company a starter for the control of this set. There are also three machines by the British Schuckert Co., coupled together, the central machine being of 60 H.P. with one of 40kw. on either side. One of the side machines is used for purposes where a low voltage and high current is required, and the other is rated at 550 volts for operating the traction motors. A novel feature of this latter machine is that it may be run as a single or three-phase alternator owing to the slip rings which it has been fitted. Messrs. Witting Bros. have also supplied a 30kw. alternator with a rotating field. Current from an experimental "Chloride" battery is taken to the various laboratories at a potential of 220 volts; it is available at any potential from 0 to 220 by multiples of 10.

A testing room, fitted with Addenbrooke's electrostatic instruments, for making commercial tests of generators and motors is situated between two large dynamo rooms. In the second dynamo room there is a complete plant by the Aliotti Company, for illustrating the transmission of three-phase currents and their subsequent transformation into continuous currents for power purposes. This includes two 5kw. three-phase stationary transformers of 65 to 200 volts which may be connected in either star or mesh, and two 5kw. rotaries transform the three-phase to continuous current at 100 volts. Coupled together by magnetic clutches on to one bed-plate are three 5kw. machines by Messrs. Bruce Peebles for experimental purposes. A cable testing room, fitted with various tanks and most convenient appliances for altering temperatures, is another feature of this department. The system of distribution of energy to the laboratory benches is of a very simple character, consisting of a board from which current can be obtained at any part of the laboratory at 2, 4, 6, 8 or 10 volts from a battery of five accumulators. Connections are made by means of plugs in the various 'bus bars. By means of another board any voltages from 10 to 200 in steps of 10 may also be obtained. It will be possible to standardise instruments in current measurements up to 4,000 amperes and in voltages up to 100,000, and special attention has been paid to this department with a view to securing its high efficiency. Not only are the electrical laboratory benches provided with the means of obtaining electrical power by the insertion of plugs, but this is also the case with the mechanical and chemical laboratories.

It must not be taken that the above is anything like a full description of even the electrical side of the schools, indeed, such is far from the case, there being so many different machines and instruments that it is absolutely impossible to give a detailed description of them all in a brief article. It is sufficient, however, to show that in equipment these new schools at Manchester are, without doubt, in the front rank with regard to the possibilities of the technical training they will be able to afford those who attend technical classes. The complete course in the departments will extend over three years, the fees being 15 guineas per session. Students must be over 15 years of age, and will be required to pass an entrance examination, unless they hold the certificate for some public qualifying examination, such as the Oxford and Cambridge Local.

Owing to the fact that Manchester is such an important engineering centre, facilities will be granted to manufacturers and others to carry out research works and experiments with the elaborate machinery and instruments at the college, which belongs to the Corporation, or, rather, to the ratepayers themselves. Apart from steam, hydraulic, chemical, sanitary and other tests, the following list of those connected with the electrical industry have been drawn up and suggested as being fit for public use when required.

Electrical Engineering Department.

Complete tests on dynamos, meters, transformers, starting resistances and switches, and appliances for continuous, alternating and polyphase plant at high or low tensions.

Calibration of voltmeters, ammeters, wattmeters and current meters, &c.

Tests for insulation resistance on all kinds of insulating materials, cables, &c.

Photometric and efficiency tests of electric lamps of all kinds.

Complete tests of electric heating appliances, secondary cells, electric furnace work, and general, electric and chemical engineering.

Verification of standards of current, E.M.F. capacity, &c.

Testing of all materials and appliances for electric traction work.

Testing and repairing of experimental electric appliances.

In his speech, declaring the new schools open, Mr. BALFOUR said it gave him great pleasure to be able to perform the ceremony of opening so magnificent a monument of municipal enterprise. Not only would benefit be received in Manchester and Lancashire generally from this undertaking, but in the whole of a country which depended in an ever-increasing degree upon its power to preserve its position as a great manufacturing centre. He might be allowed to say, with feelings of pride, that he was a member of the Administration which passed the Act of 1889, giving a chance to the great corporations of the country to endow technical education—a chance of which Manchester had so nobly availed itself. The great building in which they were assembled was an outward and visible sign of that awakening which had come over our people in view of the ever-changing conditions of intellectual industry. There was a time when we could flatter ourselves, without any undue egotism or vanity, that not only were we the first of the industrial nations, but that the rest were nowhere. That time had passed never to return again. But he was far from uttering selfish complaints at the change in the condition of the world, which was absolutely inevitable, and from which they should not be the ultimate losers. It was a profound mistake to suppose that the fact that other nations were now great producing centres was an injury, pure and simple, to this

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country. The growth of the wealth of the world must be a benefit to every part of the world, and all we had to do was to bear our full share in the great industrial development.

But not only was there the change in the industrial condition of the world, but another change had occurred more closely connected, perhaps, with the necessity for institutions of this character. It was the change from the pre-scientific to the scientific stage of industry. When England, or Britain, first obtained its great manufacturing monopoly, the relation between science and industry was of the feeblest character. There was always the closest connection between mechanical ingenuity and invention and the great growth of our industries, but the intimate co-relation between the discoveries of the laboratory and the processes of the workshop was not in existence. This was because we had been slow to discover how intimately speculative research is connected with manufacturing progress that we were, in some branches of our work, behind those of our neighbours, who had shown themselves more ready and more apt to learn that lesson than we had ourselves. The fact on which he was venturing to insist, and on which the very existence and justification of an institution like the Manchester Technical Schools depended, was that henceforth there should be closer connection between the most remote abstract scientific study of the chemist, the physicist, and the electrician in his laboratory and the great industries of the community of which he was a member.

Education was and must be an organic whole, and it was perfectly vain to spend vast sums upon buildings and equipments unless the student who used them went adequately prepared to learn the lesson they could teach. He had no intention of over-praising foreign nations at the expense of our own, but it must be admitted that they had grasped, more fully and more firmly, the great truth on which he was insisting—namely, that a man really to profit by the scientific training which he could get in these institutions, and to be able himself to turn the learning he acquired for the purpose of original discovery had to go there, not a raw product, but, at all events, a half-prepared human product. He should go there not only anxious to learn, but ready to learn.

The persons who were responsible for the manufactures of the country were the manufacturers. It was perefctly useless to turn out highly-trained and capable servants if there were not to be employers for them when they were turned out. He did not know whether in Germany, for instance, they might not have overdone the matter. Something must be very wrong when he saw the extraordinary difference in the practice of the great German, and, in some at all events, of the English firms. He was speaking on a subject which he only knew at second-hand to people who knew the whole thing at first-hand, but unless his information greatly erred, they would find if they went to Germany, at all events a few years ago, and studied the equipment of one of the great German industrial concerns—electrical, chemical, optical, or what not—a proportion of scientifically-trained students in the German manufactory enormously in excess of anything commonly thought necessary in this country. There was not the least use in the Manchester Corporation turning out competent students if those students were not to find employment when they were turned out. The tradition of the great manufacturing establishments would rather tend to make people say that the place in which to learn was not in the lecture room but in the shop, not at the feet of skilled professors, but actually among the artisans who were carrying on the industry. There was a great deal of truth in this, and probably we gained a great deal by our extreme anxiety to make industrial training practical training. But he felt confident that they drove that truth too far, and that, however sound the instinct might be which lay at the bottom of it, they were working it too hard at the present time. If they really did mean to turn the brains, muscles, enterprise, energy, and the inventive skill of their countrymen to its best purpose, it was necessary to place among the directors of industry those who had not merely practical knowledge. They must give them, in addition, that complete scientific training which had become more the basis of our whole industrial fabric. He did not deny there might be dangers in that course. Every policy they adopted required watching, every policy they adopted would petrify into some stupid and pedantic rules unless they kept close to the ever-varying realities of life. There might, possibly, be a certain danger that they would have a quasi-scientific and industrial orthodoxy, which would stand in the way of quick development in every new discovery in mechanics or in science. The way to meet it was to remember that true theory and true practice could never be divorced without loss to both, and that the ideal for which they had to s rive was not that of simply imitating the processes of those who went before, but imitating their energy—their anxiety to take the best the world had to give—the world both of practice and of theory, in the changed and ever-changing conditions of our time. Then institutions like that school would bear all the fruit of which they were capable. They would see the marriage of science and industry far more fertile and productive of good, and those who had called on Manchester for this great effort of municipal liberality might feel that their labours had not been thrown away, but that they had done great things for the growth, the maintenance, the expansion of those industries on which the health and existence of the community depended.

Long-distance Transmission.—The *Railway and Engineering Review* of Chicago states that electricity is now being transmitted 173 miles for lighting San José, Cal., and also for running the street car lines and many of the manufacturing industries of the city. The power plant is in the Sierra Nevada mountains, and transmission is over aluminium line wires.

ELECTRIC TRACTION IN ITS RELATION TO EXISTING RAILWAYS.*

BY MR. J. W. JACOMB-HOOD.
(Chief Engineer London and South-Western Railway.)

In England and Wales there are some £40,000,000 sunk in steam locomotives. The replacement of such a stock of machinery, at a cost probably still greater, is a financial problem that in itself must tell against change. The cost of complete electrical equipment on our (the London and South-Western) line of 971 miles of territory, at the low estimate of £5,000 per mile, would amount to more than 4½ millions of money, involving a saving of £160,000 annually to provide interest alone.

But as regards "branch" and "urban and suburban" services the case is probably different. It can be shown that it is the exception for branch services of themselves, worked by steam locomotives, to make anything like so large a return on capital outlay as trunk services, to which, indeed, they are now commonly regarded as only feeders. The question arises as to whether they could be made to pay of themselves by the development of local traffic, if increased services to stimulate local as well as general demands could be given at less cost per unit than now. It is certain that the comparatively heavy trains of coaches drawn by steam locomotives, running, as they must do under present organisation, at long intervals, do not encourage local travel; and it is equally certain that the strain of the traffic on branch lines, concentrated upon one train, at times to suit the trunk line service, and handled by a staff that is normally more than sufficient, but at times of pressure is inadequate, does a great deal at busy seasons to interfere with the efficiency of the trunk service by delays at the junctions.

To run more frequent steam locomotive services with the attendant heavy station expenses, often on a main line scale, would probably not produce enough traffic to pay for the increased cost. Steam is handicapped, as I have already pointed out, as compared with electrical power, by its inability to provide high acceleration of speed after starting, and by the necessity of either drawing its maximum load or wasting power. We are aware, to our cost, of no inconsiderable loss of traffic already, due to our methods not providing the facilities that the growing demands of the public require. We are running long trains giving a greater load per passenger, even at full complement, than is necessary, at comparatively long intervals, with low acceleration, and therefore at low over-all speed. In consequence of the necessarily wide intervals between trains, our accommodation for the moving mass of the public is often insufficient for four hours out of 18, and for the other 14 hours the heavy indivisible trains, with all the fuel necessary to generate power to draw them, are running with loads that probably do not exceed in normal times 20 per cent. of their capacity, and that often fall below even that figure.

First of all, we must have self-propelled cars, or trains of cars, of which a large number are self-propelled, to secure economy of propelling power proportionate to the length or weight of any train. Then we must have higher acceleration and quick retardation of trains, in order that the stoppages may be frequent without reducing the over-all speed of a journey, and that the time of each journey may be reduced to its lowest point. And not only must we reduce our traction or running expenses per unit, but, in order to assure a return on outlay, we must do something to cut down our fixed working expenses.

Station expenses must be reduced, either by the introduction of zone fares, or by the issue of variable fare vouchers on the trains. The cost of staff and lighting, and, perhaps, the upkeep of buildings, can be reduced by some such methods. Then the cost of signalling trains under certain systems of traction is capable of reduction, and, further, the wear and tear of the road will certainly involve less cost when free from the destructive effect of the passage of ill-balanced reciprocating steam locomotives.

To interpolate a remark upon a side issue, it will be of interest to consider amongst ourselves hereafter, how we can, if at all, separate such services as will follow from the above demands from our long-distance services. Shall we be able to devote some of our existing running space to one class of traffic and some to another, or will it be necessary to provide additional space; and, if so, shall it be above or below existing running levels?

We now know, if I am right in my surmises, what we lack, and what must be provided for our urban services to meet our wants. The question we have still to consider is whether electricity alone can give us at least cost what we need, or whether there are not competitors in the field.

That electricity can give us a means of improving our services on the lines I have indicated we are now quite certain, and if the evident advantages are not counterbalanced by too high a cost of equipment we shall certainly look no further.

* Extract from Paper read before the London and South-Western Railway Debating Society, and published in the official circular of the Tramways and Light Railways Association.

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Mr. Jacomb-Hood then took his own line as an example, and speculated upon its future as follows:—We have four lines of way from Waterloo on the main line to Hampton Court junction, and further, and at comparatively small expense, we can have four lines on the Windsor side, as far as Twickenham. Two of these lines might be devoted exclusively, say from Nine Elms junction downwards, to suburban quick services. This would give the means, at practically no capital outlay beyond the cost of new equipment, of running a series of loop and quick return services, as follows:—

Windsor Line.—Waterloo, Barnes, Hounslow, Twickenham, Richmond and Waterloo, and vice versa.

Waterloo, Barnes, Richmond, Twickenham, Kingston, Wimbledon, Wandsworth, Waterloo, and vice versa.

Main Line.—Waterloo, Hampton Court, and vice versa.

Waterloo, Surbiton, Cobham, Guildford, and vice versa.

Waterloo, Wimbledon, Epsom, Bookham, Guildford, and vice versa.

Such services could be arranged to give accommodation at normal hours between the points named, as below:—

Between Waterloo and Barnes, and vice versa, 13 trains per hour.

Between Barnes, Hounslow, Twickenham and Richmond, and vice versa, 10 trains per hour.

Between Twickenham, Kingston and Malden and vice versa, three trains per hour.

Between Wimbledon and Wandsworth and vice versa, three trains per hour.

Between Waterloo and Wimbledon and vice versa, 10 trains per hour.

Between Wimbledon and Hampton Court and vice versa, eight trains per hour.

Between Surbiton and Guildford and vice versa, three trains per hour.

Between Raynes Park, Leatherhead, and Effingham Junction and vice versa, three trains per hour.

All trains, of course, having the Waterloo terminus as their point of origin and ultimate destination.

Between Nine Elms Junction and Waterloo terminus it might be necessary to provide lines for this traffic at a higher level than the existing roads, ending in loops at the terminus that would allow of continuous running into and out of the station. Such services would involve the use of about 40 trains. As power would have to be provided to meet the utmost demand, when all the 40 trains might be starting together, and when they might all be composed of a maximum of three motor cars, each seating 60 persons, and weighing, say, 30 tons, the maximum output of power required would probably reach 7,000 H P., or, say, about 5,000kw. This could be arranged for in perhaps three power stations of 2,000kw. capacity each, situated conveniently for water, one by the river side at Wandsworth, another in the fork at Fulwell, and a third, perhaps, by the Mole river at Cobham.

The train mileage per annum by such a service would amount to about 5,000,000, and the ton mileage to about 250,000,000, against a present train mileage, on the same routes, of about 1,500,000 per annum.

The capital outlay involved in such a scheme, taking figures quoted by Mr. Langdon, and representing some £9,000 per mile of railway to be equipped, would amount, over the 70 miles that might be so electrified, to £630,000. The annual interest on this sum at 3½ per cent. would amount to, say, £20,500, and this is the annual sum, after deductions for possible economies and addition of the extra cost of train running, that would have to be earned beyond present takings before a financial improvement could accrue to the stockholders. Economies in reduction of expenses at stations should average at least £100 per station per annum. Fifty stations are affected, and therefore the saving under this head would be £5,000. Some form of automatic or simplified signalling would reduce expense of working that might be put at a moderate estimate at £50 per mile per annum. From this source the saving will, therefore, amount to £3,500 per annum.

Expenses of running at present cannot be put at less than 10d. per train-mile. For the 1,500,000 train-miles per annum now run the expenditure is therefore £62,500 per annum. Under the scheme I have outlined the cost per train-mile for running alone should not exceed 5d. per train-mile; 5,000,000 train-miles per annum that are contemplated will, therefore, cost £104,200, or £41,700 more than at present. This would leave an annual sum of £53,700 that would have to be met by additional traffic. What are the prospects of this?

Assuming our present trains in suburban services to carry 30 passengers per train-mile—no large assumption—the total number now carried 1 mile is 45,900,000. Shorter and more frequent trains will not, perhaps, carry more than half the number of passengers per train-mile, or, say, 15. If so, our new services per annum would carry 75,000,000 passengers 1 mile, or 30,000,000 more than at present. Dividing the increased charges to be met by our increrse in number of passengers, we see that each extra passenger must contribute only 0·43d. per mile to the coffers of the company before a return on outlay is secured; and every fraction of 1d. above that means additional profit, so little as ½d. per mile per passenger being all that is necessary to secure 1 per cent. on capital outlay.

It will naturally be asked, what is to become of the goods services on the suburban lines I have spoken of? If any such rapid transit scheme as I foreshadow were to come into operation, goods services would have to be performed, as they are very largely now, at night, the tractive power being electric locomotives. The power specified will provide amply for this. Parcels services and "smalls" might be performed in the daytime, but it is likely that it would pay companies to let this business pass into the hands of express companies, who would handle it more economically and efficiently, probably by road motor service. Passengers' luggage is, of course, a difficulty, but here, again, the demands of the majority of the public must be a law to the community, and although there might be trouble at first, travellers would soon learn to let their heavy luggage look after itself by night services, and to be content with the least possible hand luggage.

It will be noticed that my estimate takes no account of works necessary to perfect these suburban services. Such works must be common to any scheme of traction, and I have, therefore, neglected them. My scheme as detailed is, of course, sketchy, and perhaps, to some extent, visionary, and my figures can only be very rough guides; but I think it likely, nevertheless, that the line of argument I suggest will some day be worked out closely and will lead to practical result.

THE USE OF ELECTRICITY IN IRON AND STEEL WORKS.*

BY F. KYLBERG.

In recent years, as is generally known, the application of electricity to the driving of mechanical appliances in ironworks has grown to an unprecedented extent. This may be due, primarily, to the fact that the cost of generating the electric current has been reduced beyond all previous conception, and the time is even now within measurable distance when modern central power stations driven by blast furnace gas will render the use of electric power in iron and steel works practice still more general. In fact, it appears probable that at no distant date both auxiliary steam engines and hydraulic power will be entirely superseded.

Hitherto the necessity has existed of laying down extensive steam boiler installations, for the heating of which either coal or blast furnace was required. Despite every effort to effect a reduction in the consumption of steam by the introduction of central condensing and cooling plants, as well as by increasing the efficiency of the steam engine, it was, nevertheless, found impossible to lower the cost of generating the power by these means till it approximated to that attainable by the use of direct-driven gas engines. The blast furnace owner of the present day can, in fact, avail himself of a free supply of thousands of horse-power. Further developments in this direction will, no doubt, lead to modifications in the construction of the blast furnace and to the perfection of it, not only as a pig-iron producer, but also as a gas producer. This, again, involves the adoption of the requisite modern gas-purifying plant, the need for which had formerly never been experienced.

The development of the blast furnace gas engine and the electric potential possibilities thus opened up gave occasion to the metallurgical engineer to employ this energy in driving machinery of every conceivable variety. The American works in particular, which are laid out for production on a large scale, have achieved wonders in the use of electricity, although they have only recently begun to employ gas-driven engines. These American appliances have often been introduced into Europe without regard as to whether they were adapted to European conditions, with the consequent result of occasional failure. The author proposes in the following Paper to describe some developments based on American experience and adapted to European requirements.

Gas-driven Engines for Generating Electricity in Central Stations.—Descriptions of the central power stations and gas-washing plant at the Differdingen ironworks and at the Düdelingen Eisenbütten-Aktienverein in Luxemburg appeared recently in *Stahl und Eisen*,† in which much information was given regarding the consumption of gas per horse-power per hour, besides a number of analyses. Additional interesting facts have since then been noted during the long period of constant working of the blast furnace gas engines at Differdingen, and by the kindness of the managing director the author has been permitted to publish these. In Differdingen there are nine blast furnace gas engines of the Cockerill system, each of which consumes, according to the various tests made, 2·9 cubic metres of gas per horse-power per hour. Of these nine gas engines, each of 600 H.P., six are available as blowing engines for the four blast furnaces, and the remaining three for the generation of electric energy for the works. Besides these there are two smaller gas motors, each of 75 H.P., for the purpose of electric lighting. The gas-washing installation at Differdingen is also working at the

* Abstract of a Paper read before the Iron and Steel Institute.

† Issues of May 1 and 15, 1901.

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present time in a manner which exceeds all anticipation. The results of trials have shown that the gas which comes direct from the blast furnace contains 10 grammes of dust per cubic metre. It is proposed now to follow this gas in its progress through the cleansing process.

On issuing from the apparatus for extracting the moisture the dust contained in the gas is already reduced to 4 grammes. On reaching the first fan the gas only contains 3 grammes of dust, having deposited 1 gramme during its passage through the mains. After passing the first fan, and at the entrance of the second, the dust in the gas is reduced to 1·5 grammes, and after issuing from the second fan the quantity of dust has fallen still further from 0·2 to 0·3 grammes, and the gas enters the engine with only 0·1 to 0·075 grammes of dust per cubic metre.

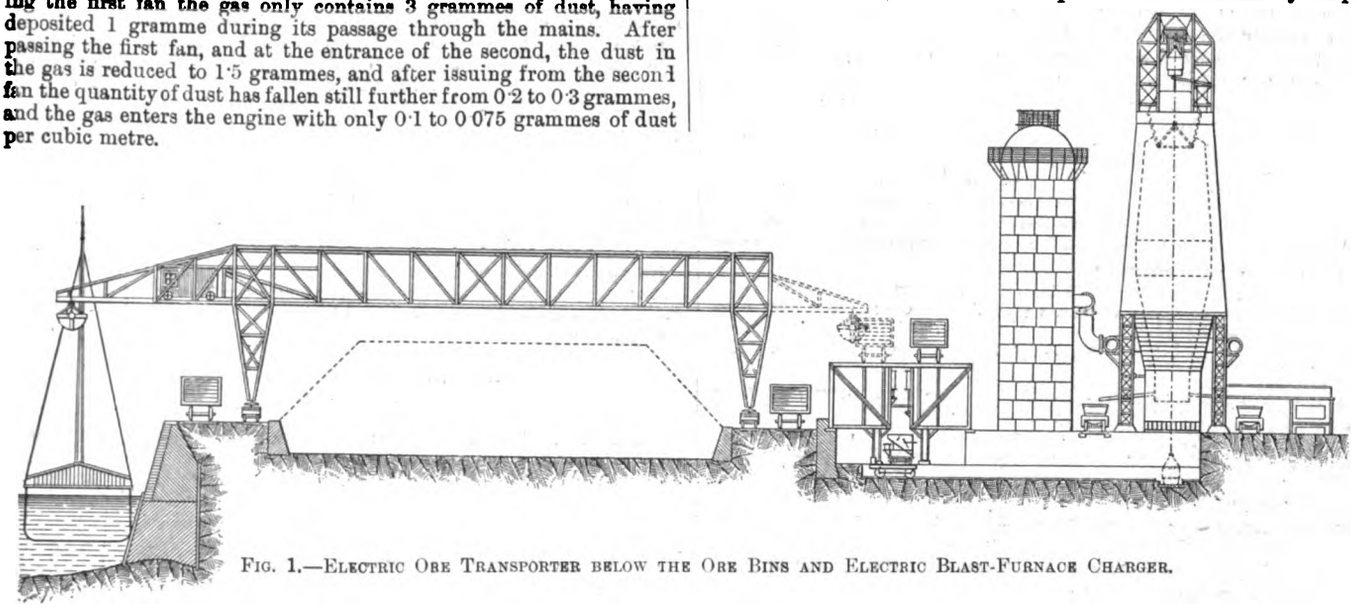

FIG. 1.—ELECTRIC ORE TRANSPORTER BELOW THE ORE BINS AND ELECTRIC BLAST-FURNACE CHARGER.

It has, moreover, been observed at Differdingen that, in order to obtain the above degree of purity in the gas, it is necessary to inject 1 litre of water into the fans for every cubic metre of gas passing through. The pressure of the fans during these operations is equal to a pressure of a column of water of 8in. in height, and is equivalent to an increase of temperature of 8°C. to 10°C. Referring again to an article by Mr. F. W. Lürmann in *Stahl und Eisen*,* upon the application of blast furnace gas to the direct production of power, data will be found which show that for the production of 1 ton of pig-iron 4,500 cubic metres of gas are generated, of which 10 per cent. is lost by leakage at the throat of the blast furnace, and 50 per cent. is consumed in heating the blast, leaving available for driving the gas engines a surplus of 2,000 cubic metres. Assuming that 2·9 cubic metres of gas are required per horse-power per hour, the amount of horse-power obtained per ton of pig-iron is 690 H.P., which is directly convertible into electric energy. Since at the present time the extreme difficulties which were at first encountered in the application of blast furnace gas engines, due to the impurities of the gas, have been obviated, and since it is possible to transform by simple means the great excess of blast furnace gas into electric energy, it may be said without exaggeration that it is the duty of every blast furnace owner to provide in his works the means of generating this electric energy.

Electric Shunting and Mine Locomotives.—The great advantages of the utilisation of electric power as compared with steam are particularly noticeable in this connection, as is proved by the reduction in the cost of working and an efficiency hitherto unattainable. The two types of locomotives which have proved most serviceable are, first, the shunting locomotive of medium tractive power and high speed, and, secondly, mine locomotives of high tractive power and low speed. The following are the chief points in the construction of standard electric locomotives:—Each axle is driven by a special motor, by which means great efficiency and high tractive power are assured. The motors are, moreover, arranged that any one of them

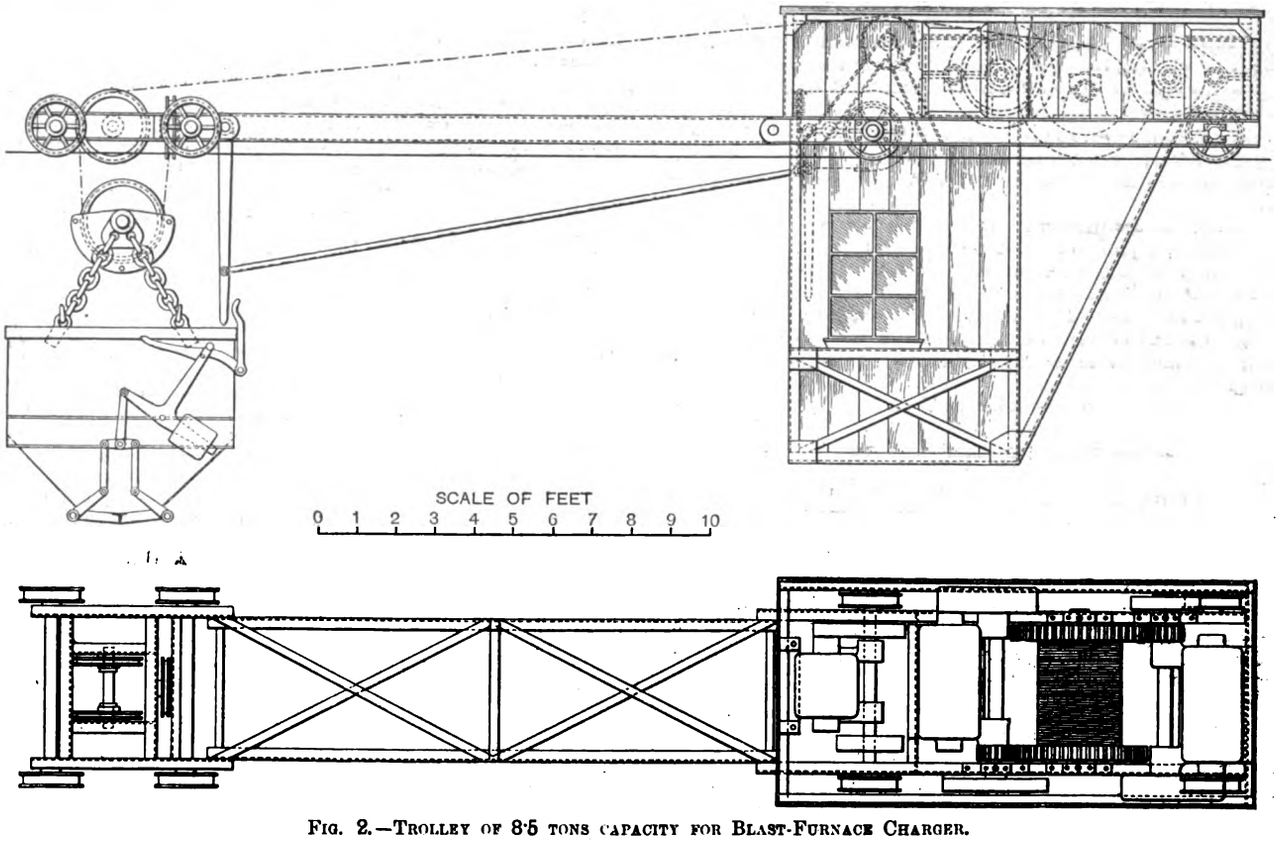

FIG. 2.—TROLLEY OF 8·5 TONS CAPACITY FOR BLAST-FURNACE CHARGER.

* March 15, 1898.

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can be cut out if desired, and as the result the speed of the engine can be regulated according to the load. The shocks experienced at starting and stopping are also less severe. In the smaller steelworks, where the use of locomotives would not be profitable, electrically-driven capstans can be employed to advantage. The driving mechanism of these capstans is enclosed in watertight cast-iron casings, which are placed beneath the level of the platform, so that only the round warping end of the capstan projects. These capstans are usually constructed with a tractive power of 5 tons.

Ore and Coal Transporting Appliances.—The construction of ore and coal unloading appliances was first developed in the United States, an arrangement of this kind being, indeed, necessitated by the vast quantities of coal and ore which required transportation in the harbours or ironworks in that country. The transport of the materials upon the overhead track is effected by means of an electrically-driven trolley equipped with a hoisting arrangement of simple design. This trolley can be constructed with either one or two jibs, within the range of which are the ship at the one extremity and the railway track at the other. The transporting capacity of the Brown conveyers is considerable, varying between 80 and 100 tons of ore or coal per hour.

Electrically-driven Ore-transporting Arrangements beneath the Ore Bins and the Electric Blast Furnace Charger (Figs. 1 and 2).—After the ores have been conveyed to the ore tipping ground or to the ore bins by means of the transporter, previously described, it is an essential condition that the ore and coke should be transferred to the top of the blast furnace with the least possible handling and cost of labour. For the performance of this work also electric energy is admirably adapted. Fig. 1 shows a charging apparatus in the design of which particular attention has been paid to the following points:—(1) The whole of the mechanism is driven electrically; (2) hopper-shaped trolleys are provided to run beneath the ore bins; (3) a single hoisting arrangement serves several blast furnaces.

Parallel to the row of blast furnaces are arranged the two ore and coal bins, which are filled direct by the ore transporter or from the railway cars on a track above them. Below these bins runs a hopper trolley, which can be filled from any one of the bins above it. A platform is built along the row of blast furnaces, which conveys the hopper to the hoist, where it is tipped into the hoisting skip. This skip is attached to a trolley (see Fig. 2) which is provided with a hoisting gear and runs on an elevated track above the blast furnaces. The skip, after hoisting, is conveyed by means of this trolley to any one of the furnaces, and the contents are automatically discharged on to the bell. Assuming that a single charge which the bell is capable of supporting amounts to 10 tons, the arrangement above described can deal with a quantity amounting to 200 tons per hour.

Electrically-driven Pig-iron Casting Machine.—The chief advantage of the pig-iron casting machine, made by the author's firm, consists in cooling the moulds by causing them to pass through two water channels. By means of this arrangement the machinery is considerably shortened and occupies much less space as compared with other similar machines, a point of great importance for ironworks which have only a limited space at their disposal. A further advantage is that, on account of the short travelling band, less power is required for driving the machine. The capacity of the machine is very great, amounting to about 60 tons per hour. At each end of the chains conveying the moulds is arranged an electric motor of 25 H.P. for driving.

(To be concluded.)

LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) and St. Marylebone Borough Council.

ARBITRATION.

At the conclusion of the argument reported in our last issue, the lengthy cross-examination by Mr. JOHN CONACHER was resumed.

Mr. MOULTON: Now, as to the charging in Marylebone. What proportion of your consumers are charged 6d. per unit and what proportion 5d.?—I do not know.

And how many are not charged either price?—This can be ascertained from the special contracts which are being got out.

Are your special contracts on a printed form?—As a rule they are on the printed form I have put in, altered to suit the altered circumstances.

Who arranges the special terms?—Usually the secretary and the chief canvasser. When important cases arise the matter is referred to me, sometimes also to the chairman.

What proportion of the supply of mid-London is under special terms?—I cannot say. We deal with each case as it arises.

Do you mean the secretary has authority to make these special contracts?—General authority, but of course the whole authority comes from the board.

Are all special contracts referred to the board?—No. In gauging the special circumstances we are guided by the magnitude of the account, the extent to which it represents a day load or a load at night after the maximum load has gone off, the proportion of user for power or lighting, or anything which has to be taken into account in determining what the terms of the special contract should be.

Have you many contracts which take power and lighting under one figure?—We have some.

You made a suggestion in your examination-in-chief that, owing to Queen Victoria's death there was a decrease in consumption in 1901?—Yes, because it reduced the amount of entertaining in the district.

But you joined up more consumers?—Yes, I agree. But the joining up of new consumers in any year does not bring its full effect until the year after. During the current year the increase in consumers is very much larger than ever.

Well, with regard to the 218 consumers which you say were joined up the first four months of 1902, how many of those are on special contracts?—I see one, 44 lamps, which I think is an extension of an existing consumer's installation, under which there is a special contract. Simply an extension of his lamps.

Have you ever got out the average price per unit in your mid-London and Paddington areas?—I will see.

Now as to rental of meters. Practically the meter patents are running out, are they not? Meters are now to a much greater extent open to the world?—There are always new meters being introduced under new patents.

Any person who is a large consumer it would pay to have his own meter?—It is open to him to do so.

I put it that, practically, no company can make any profit at all out of their meters?—I cannot answer.

Now, have you found out how you make out more houses than consumers?—Yes, I have already done so. I said there were 72 of our consumers who were supplied in 214 separate houses; and I have, therefore, added the difference—that is 142. (List of names handed in.)

Now, are they building very much at the present moment in Marylebone?—Building is just as active now as at the time the census was taken last year. (List of building operations handed in.)

WITNESS: Before you pass from this subject I can give the date you asked for, when the reduction in charge took place. On Jan. 1, 1898, the price for private house lighting was reduced from 7½d. net to 6d., and that was the date also on which we abolished the rentals for transformers and switches.

Therefore, we have this, that in spite of a reduction of about 20 per cent., your increase in the number of units sold was practically stationary?—As compared with 1897, yes. But in 1897 the average rate fell 0·45d. and in 1898 it fell 0·48d.

You never told us of a reduction in 1897?—Oh, yes.

The UMPIRE: The reduction appears to have taken place in 1896. You say its effect was felt in 1897?—From March 25, 1896, we reduced the price for current for public and trade purposes from 7½d. to 6d., with a further reduction to 5d. when the quarterly consumption reached five units per 8 c.p. lamp. The effect of that on the revenue of 1897 was to reduce the average price obtained by 0·45d. Then on Jan. 1, 1898, the price for private house lighting was reduced from 7½d. to 6d., and that brought down the annual revenue by 0·48d.

Mr. MOULTON: That makes it still clearer that the increase would have been smaller than for the year before if it had not been for important reductions in price?—The increase would have been larger.

The UMPIRE: It depends on whether you are speaking of increase in pounds or units.

Mr. MOULTON: Has there been any reduction with regard to heating and motors?—That rate was first introduced as a special rate at 4d. some years ago, and we have made lower quotations from time to time, according to circumstances. We have special contracts for these.

Now, have you ever made any inquiries into the cost of electric lighting and other systems of lighting, such as gas and petroleum?—Yes, we have considered that, especially with regard to gas.

Taking the test by light-producing power, what is the cost per 100 candles of electricity?—I have not looked at the matter from that point of view. So far as I can find out, that is not the dominating consideration with regard to the production of electric light. It was stated by the gas companies, before a Select Committee of the House of Commons two years ago, that if they were to offer gas at 1s. per 1,000ft. they could not get their supply into such houses as we look to as taking a very considerable part of the supply of electric light.

In competition with gas you say there is a certain class of houses which will take electricity, quite apart from the question or the cost of gas?—I believe so, a pretty wide class.

You do not look for consumers in the poorer class of houses?—Well, I do not know. We may do in the poorer houses what the gas companies have done—that is, provide penny-in-the-slot meters; and we are at the present moment experimenting with meters of that kind, so that we do not dismiss the poor houses as a barren field for this enterprise, but we think the time will come, and may come very soon, when we shall be able to do for those houses what the gas companies have done.

It is quite pleasing to hear of your dreams of the future, in which I include your tables, but I was not asking from that point of view; I was asking about cost. Of course, when you begin to contemplate supplying a neighbourhood to a very large extent, the question of competition of gas will come in seriously?—You have been talking about the competition of gas on the basis of price only. That is only one element. There is the question of cleanliness, purity of atmosphere and saving in the cost of cleaning decorations. These are important elements.

Do not you think that I have seen the prospectuses of electric lighting ventures?—Yes, very likely.

Why do you use these familiar phrases. We know them by heart?—But I am not speaking of that which lies in the future, but what has actually taken place. These are the results of what the substitution of electric light for gas has done.

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Now, the population of Marylebone is not increasing?—No, it has been diminishing.

Taking it on the present basis, have you calculated about what you suppose they will spend on electric lighting per head at the end of 1931?—About £4 a head.

There would be 13 lamps per inhabitant, and they would spend £4 per head?—The standard of lighting is increasing very much.

The UMPIRE: What have you assumed about the population?—I think the population ought to remain stationary. I believe a considerable part of Marylebone may be used more freely for business purposes, but when that is done the resident population, of course, migrates. The premises, the large shops and places of business, which do not count for population, become enormous consumers, and population is not the true divisor in a caculation of this kind, applied to an area like Marylebone.

Mr. RYDE: Your £4 a head applies, not to customers, but to inhabitants?—To the inhabitants, but I do not admit that to be a true basis, as the day population of an area like Marylebone, I have no doubt, is very largely in excess of the night population—that is to say, the population that sleeps in the borough.

Mr. MOULTON: I put it that that is not the case at present, with the exception of one or two streets?—That is true, no doubt, but I think that will grow. In the course of time we shall have small workshops in many of the mews and back places employing a large number of people who will not live in the borough. At the present moment I believe there is a large amount of business carried on in the manufacture of furniture and other articles in back premises, where people are employed to a very large extent who are not counted as inhabitants of Marylebone.

Now, you have taken the total anticipated revenue from all sources, and have used the figures in making up your claim?—We have.

Under those circumstances I want to know the details of all your revenue, and I submit now that, figures like that having been used, I cannot be excluded from any examination into the sources of that revenue.

The UMPIRE: You suggest you are entitled to see whether £235,474 was really the total revenue from all sources, except rents of property, for the year 1901, and how it was obtained?

Mr. MOULTON: I am entitled to see clearly by what charges and in what areas that revenue is obtained, because you are going to take an average of that, and apply that as a factor for the purpose of calculating your tables.

Mr. CRIPPS: If the basis of the total is shown, that would be sufficient for your purpose? The desire to go into details may raise what we have called illegitimate discussion.

Mr. MOULTON: I am entitled to examine the charges. Supposing that revenue was obtained by extremely low charges in one part of the district and extremely high charges in another, I am entitled to look into that. You are actually applying that which is derived from the whole of the undertaking to guide the tribunal with regard to part. I am, in my cross-examination, all along going on Mr. Conacher's statement that these figures are based on the principle of no competition. Our case is that competition was practically certain, certainly probable, and that that makes these tables wholly inapplicable. I therefore say that here, where there is the total revenue, I am entitled to enquire how it is obtained.

The UMPIRE: At present, I do not see that I can say more than that you are entitled to verify or falsify the figures that are here put forward. Of course you are not bound to accept them; and you are entitled to such investigation as is necessary to verify or falsify.

Mr. MOULTON: Yes; but am I not entitled to something more than that? Am I not entitled to see from what work this total revenue is obtained? I am entitled to see the prices at which things have been sold in order to obtain this total revenue, because if you are going to average over a system, you have to consider whether an average is a fair thing—whether the different parts of the system give you the revenue under the same circumstances.

The UMPIRE: As far as checking the figures here—I am taking for the present the revenue figures—it is quite obvious that those can be checked without any examination of the terms of the special contracts.

Mr. MOULTON: Our view is that the contract between the Vestry and the company was that all consumers should be entitled to the same prices as Holborn. Now, what we say is that, in the presence of competition, what they call special contracts are not special contracts, but are only contracts for the purpose of keeping their customers together; and that, practically, everybody there who chooses to suggest that he will go elsewhere, gets his current at a lower price. We are entitled to prove this.

The UMPIRE: I understand that, but it does not seem to me to involve any necessity for our going into these special contracts.

Mr. MOULTON: Yes; because I want to correct this revenue. I say you may have obtained that revenue by overcharging Marylebone. I am not on the question of recovery of overcharges, or anything of the kind.

The UMPIRE: We have given our ruling, rightly or wrongly, upon that, that the meaning of the clause in the contract was one which did not give you what you are now claiming. On clause 8 we ruled against you, and now you have tried another ground and we are against you on that ground also.

Mr. MOULTON: If you are against me on that, we had better go to the Court at once and have it settled, because it is of very great importance to us to find out whether or not the prices that we know ruled in mid-London are prices applicable to Marylebone. If these contracts are practically the contracts that they make in the face of competition there, and they are special only in the sense that a person says, "Look here, I will go to the other company if you do not give it to me at such and such a price," then, I say, the scale they are using there is a different scale to Marylebone, and it is of very, very great importance and substance. When I see that the average price in mid-London is very considerably below scale price—it is something like 4·34d. when scale price is 5d. if the consumer uses a considerable amount—the difference is something enormous. I am clearly entitled to find out whether there is a scale being used in mid-London which is not being used in Marylebone.

The UMPIRE: Of course, you are using the word "scale" in a sense entirely different from the sense in which we have used it, and which we have given to it, rightly or wrongly. There is no question that the scale, in the sense in which we use that expression, in mid-London is the same as the scale in Marylebone.

Mr. MOULTON: That is the printed scale, sir. What we have to consider is, whether it is the *de facto* scale; I am entitled to find out whether it is the *de facto* scale. Supposing I can show that to anybody who comes and says, "I shall go to the other side if you do not put me on the 4½d. rate," they say, "Very well, we will put you on the 4½d. rate." Then everybody in that district is entitled to that rate, and if everybody in that district is entitled to it, that is the scale. I do not want you to think that we are debating over small matters. We estimate the St. Martin's average price is 4·42d., the mid-London 4·38d., and ours is 5·22d.

The UMPIRE: I can see a very powerful argument from the mere statement of those figures, supposing them to be substantiated. What I cannot see is, what good is to be done in this inquiry, apart from any technicality, by our going into the special contracts which may have been entered into between the Metropolitan Electric Supply Co. and their customers in districts other than Marylebone.

Mr. MOULTON: If I had known you were going to say the point was no longer open to argument, I should have proposed to go to the Court on clause 8 of the agreement with the Vestry. You will find from the shorthand notes that I asked you about it.

The UMPIRE: You say: "The printed scale, whether adhered to or not." Of course, if the printed scale is a mere sham, that is an entirely different state of things. I have been assuming, as we are bound to assume in the absence of any suggestion to the contrary, that the printed scale is a reality, and that it has only been departed from when circumstances have been shown which differentiated the position of the applicant from the position dealt with in the scale. You will be able to ascertain with regard to Marylebone whether the scale has been adhered to or not, and we cannot deal with the case upon vague suggestions that the scale has not been adhered to. You had better wait till the contracts are available.

Mr. MOULTON: I am willing to wait provided my waiting is not misunderstood.

Mr. CRIPPS: These are original contracts, and there is an enormous number of them. If each is copied out it will take a long time. We have the originals here. You can have access to the originals and have copies of any one you desire.

Mr. MOULTON: Can I personally see them? I shall probably be able to say what details I want, and they can give me a list.

Mr. BALFOUR BROWNE: Certainly, you shall have them to-night or to-morrow morning.

Mr. MOULTON (to Witness): I put it to you that the average price per unit in St. Martin's under the St. Martin's Act was 4·42d. in 1901?—I cannot verify that now, but I will look at that.

In the mid-London order it was 4·38d?—Yes, I have made a note of that.

In the West London it was 5·22d. before deducting bad debts?—Yes.

Now as to the table of working expenses, those are the working expenses of the whole of the system?—Yes, and the total revenue is the aggregate of each separate area's revenue.

This concluded the seventh day's proceedings.

When the proceedings were resumed on the eighth day (May 27),

Mr. MOULTON continued his cross-examination and referred to the special contracts which had been put in. To Witness: I notice that these contracts are on your printed form with certain alterations?—Yes.

For instance, in one case the only alterations are: "The consumer agrees to take the whole of the electric energy required for the premises mentioned below from the company, and from no other company or person, for a period of not less than two years from this date." A contract of this kind anybody can enter into with you, and the charge for current per unit is 4½d.?—Yes; under similar circumstances.

The accounts are rendered monthly, and are settled by the consumer quarterly?—Yes

Then why is not that a scale. Anybody can have this contract who is prepared to take 500 16 c.p. lamps?—Not only the number of lamps, but the time the lamps are used are considered in the charge of 4½d. per unit. In that contract there are a large number of basement lights, and the particular business carried on there involves a considerable use of the lamps. Those are the considerations that underlie that contract.

The UMPIRE: Is that for profit or trade purposes?—For trade, and at that time the charge for trade was 5d.

Mr. MOULTON: How many units were used by this consumer?—I could not tell you without looking, but the consumption was very large.

Is this a type of contract?—There is no rigid type. I should not like to say I could find another case identical in all respects to that.

The UMPIRE: There is nothing special about the term "two years"?—No.

So far as the face of the document discloses is there anything special except the large number of lamps?—And the large use.

Mr. MOULTON: There is no obligation to burn a certain number of hours?—No; no contractual obligation.

Then this is what you call a special contract—a contract with no special obligation at all, because as to the "two years from this date," you have hundreds of contracts of that kind?—Yes, it is special in the sense that the scale charge has been departed from, and that is one of the elements of this special contract.

In the next case, dated 1898, there is a blank for the price charged. There are three premises there—no obligation to take any number of lamps at all, and simply the "most favoured nation" clause. Do you call that a special contract?—I do, the price is special. Where there is a varia-

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tion from the printed price I think necessarily that must be a special contract.

The UMPIRE: We thought of asking that a table should be prepared with reference to the year ended Dec. 31, 1901, to show the number of units which your company have supplied in Marylebone at 4d., 4½d., 5d. and 6d. per unit. This would show us how the average price which we have before us is arrived at.

Mr. MOULTON: We have now the definition that a special contract is wherever the scale price is departed from.

Mr. BALFOUR BROWNE: Oh, no.

Mr. MOULTON: Mr. Conacher is on oath, and he says, "Wherever we depart from the price it is a special contract." I have cases in Oxford-street, the Strand and Holborn, and 4½d. per unit is given without any reference to the number of lamps, or any obligation to take current, or any alteration to the printed form.

The UMPIRE: The documents themselves practically show little or nothing; that is what I anticipated. What is necessary is to examine into the actual circumstances of each case before we can possibly appreciate if the difference of charge is right or wrong.

Mr. MOULTON: It is now a question of evidence. I have it that, without any obligation or variation of the contract open to everybody, there is a variation in price. *Prima facie* I have a right to say that is departing from the scale of prices. It is possible in certain cases there may be an answer, but this is a case of evidence and inspection.

The UMPIRE: As far as Marylebone is concerned, I entirely agree. If you want to know, outside the document, what are the circumstances that, in the case under discussion, justify 4½d., I should say you are fully entitled to go into it.

Mr. MOULTON: But the point of equality of the scale between the two places is the most important point of our case. We want to see what the burdens of the undertaking are. We buy it with all its burdens. They cannot say, We have a right to charge you according to the profits we have made, if we can show those profits were made by disregarding their contractual obligations, and, where there is a contract with nothing but a variation in price, *prima facie* everybody is entitled to that, and surely we are entitled therefore to see it. May I put it in this way? Suppose we were to bring an action on that contract on behalf of ourselves and the consumers, we should clearly be entitled to find the price charged.

The UMPIRE: Apart from the question whether you were the right plaintiffs, of which I have my doubts, the issue would be to try if A.B. had been preferred to C.D., but that is not the issue here; all we have to do, and it is quite enough, is to arrive at the right sum to be paid by the Borough Council for the purchase of this undertaking. There is nothing illegal about the course the company has pursued in the ordinary sense of the word, but it is possible, at the end of the necessary inquiry, one might come to the conclusion that the charge made was a breach of a private contract entered into by the company with the Vestry. I can only add that we are all of opinion that you have not made out any case for going into circumstances in areas other than Marylebone of the charges below the ordinary charge of 6d. per unit. In order that there may be no mistake about the scope of our ruling, I wish to add that this ruling is that you are not entitled to go into the circumstances of cases of individual consumers in areas other than the Marylebone area. I do not intend to exclude any observations which may arise when we have got before us the figure which has been promised of what is the actual price in other areas.

Mr. CRIPPS: May I say that we understand your ruling is that there has been no case made up to the present moment that will entitle my learned friend to look into these cases with individual consumers outside the Marylebone area. We do not understand you in any sense to rule that in the course of the case the time may not come when there will be further investigation of charges in districts other than Marylebone. If at any time any such further investigation of these charges will assist the inquiry we put ourselves in the hands of the Court and will give every possible assistance.

Mr. MOULTON: I say that we are entitled to complete inquiry as to the prices charged in mid-London, and the contracts under which those prices are charged. I ask to see the contracts under which the supply is given. We discover a large number of cases of supply at lower prices than the supply under corresponding circumstances in Marylebone, as far as we can tell, and I ask to see the contracts under which these lower prices are charged in mid-London as compared with Marylebone.

Mr. CRIPPS: We want to get on, and my learned friend is evidently very anxious about this point, and though we take a different view, apart from any legal aspect of the case, we are prepared to meet him. On the understanding that it is a private inspection, our accountants shall tabulate the results in such form as they think most convenient, and then the accountants on both sides shall meet.

Mr. MOULTON (to Witness): Now, as to the 16 per cent., I cannot understand your having such a percentage on current used at works and in distribution. Surely the current used at works does not depend on the amount sold?—Well, the general experience of continuous-current companies, into which we have gone to some extent, is that the current losses at works and in distribution varies from 10 to 11 per cent. of the current generated. If we had been in the same position as such companies we say our losses would have been about those rates, but we have based our calculation on figures which our own experience suggests we might be quite sure would cover these losses, and that rate is 16 per cent.

The UMPIRE: The question is, what basis you have taken it on. If it is 16 per cent. on the total generated, it should have been more?—No; it would not have been correct to take it on the whole amount generated, because that included not only the loss common to all continuous-current companies, but the special loss which we are now eliminating.

Mr. MOULTON: The amount of current used at the works cannot depend on whether or not you have house transformers?—That is what we say.

Mr. CRIPPS: Mr. Conacher says 16 per cent. of the amount generated is an ordinary figure representing the consumption of electricity at the works themselves. He says: We should have generated only 2,463,342 units if it had not been for the house transformers. To counterbalance the loss in house transformers we had to generate 3,956,228.

Mr. MOULTON: But the actual current used at works. Do you mean in lighting?—Lighting and small motors, and such purposes as absorb energy at works.

Do you include the exciting current?—No.

Mr. RYDE: Is the first figure, 2,198,366 units, ascertainable from the books, and also the last figure (3,956,228 units)?—Yes.

The estimate of 16 per cent. is concerned with the steps between those two termini?—Yes.

Mr. MOULTON (to Witness): Now, under your agreement with the Vestry, which has been referred to many times, you were bound to have a self-contained system in Marylebone?—Oh, no.

Look at clause 1: "First day of October, 1889. The undertakers shall, within six months of the date of the confirmation of the West London Order, provide and fit up generating stations at Rathbone-place (Oxford-street) and at South-mews (Manchester-square), at the places shown, and shall from and after that date maintain at such stations respectively a sufficient number of engines, machinery and appliances, to supply continuously from such stations such quantity of electricity as may be required within the parish, not being less than 85,000 lights." In view of that contract, the Willesden supply was not to be, necessarily, to Marylebone?—That is not our view.

Mr. CRIPPS: That is a question of construction. We do not agree. We must argue that.

Mr. MOULTON: Very well. Now, maximum demand in generating plant in area of supply. First, you cannot tell on any evening how much is being consumed in Marylebone and how much is being consumed outside Marylebone, is not that so?—Oh, yes, we can tell how much is being consumed in each area by measurement at the switchboards.

Take Norfolk-crescent-mews. You have feeders going into Marylebone which bifurcate and go partly to Paddington and partly to Marylebone?—Yes.

You cannot tell how much goes to Paddington and how much to Marylebone?—In that case we cannot accurately measure, but we believe the supply which went out from Norfolk-crescent-mews on the day of maximum load was practically half to each borough; but I must leave that to the engineers, who advise me that that was the case, and I have estimated on that information.

In the same way there are mains from Amberley-road which feed a portion of the Marylebone district and Paddington at the same time?—That is so.

And you cannot tell how much went to either place from those mains?—I cannot tell. I have asked for the information and have obtained it, and, no doubt, our engineers can satisfy your engineers as to the accuracy of the figures put in.

It is not measured?—It is not metered.

The same applies to Rathbone-place. The current goes partly into the mid-London area and partly into Marylebone?—Yes, and a fair apportionment was, I am told, made on the same day.

Your generating plant was woefully deficient for that supply?—It was deficient; I do not accept the adjective.

If you had to supply 4,386kw. and had only 2,335kw. capacity of boilers, do not you think that would approximate to woe?—We admit those were the figures, and you will make your own deduction from them.

The cross-examination of Mr. Conacher then turned upon the estimates made in the tables presented by the Metropolitan Company dealing with the plant installed to meet the demand of current at Dec. 31, 1901. Mr. Moulton questioned Witness as to whether, if this date was to be taken as that upon which the Borough Council is to be held to have acquired the company's Marylebone undertaking, certain allowances made in the tables as to the capacity of the stations in the area were not over-estimated.

The UMPIRE asked whether it had been agreed that Dec. 31, 1901, was accepted as the decisive date.

Mr. MOULTON: I thought it was decisive, and that that had been agreed.

Mr. CRIPPS: Suppose that since that date we have been carrying on the concern properly, and making expenditure, that will be allowed for.

Mr. MOULTON: I think Dec. 31, 1901, should be the date. I do not understand the expenditure that has been going on since.

Mr. CRIPPS: If we have properly expended sums in carrying on the concern in an ordinary reasonable way, we should be repaid from that date.

The UMPIRE: If Mr. Moulton says that we are to ascertain the price as on Dec. 31, 1901, and that everything subsequent is matter of account, that is one thing; if he says we will protect ourselves to Dec. 31, 1902, we have to look at the matter in another way. I should like to know which method of dealing with the question we are asked to adopt.

Mr. MOULTON: Our legal position is the date of the notice to treat, but it is so obviously better to go to Dec. 31, 1901, that we are willing to take that date. As to what has happened since, it will be a question as to what the rights of the parties are.

The UMPIRE: We may take it, then, that the date for ascertaining the value of the undertaking is to be Dec. 31, 1901?

Mr. CRIPPS: And that all our tables are on that basis.

The UMPIRE: I do not whole-heartedly assent to that statement.

Mr. MOULTON: In our view our legal position is that the date which decides it all, is the notice to treat, but in the case of accounts as to profits and that sort of thing it is much easier to take Dec. 31, 1901, and we will do, as is so often done with regard to rent and outgoings, and cases under the Lands Clauses Act—take it up to there for profits and outgoings.

The UMPIRE: Yes, as if notice to treat was given on Dec. 31, 1901, instead of some day in November.

Mr. MOULTON: So far as outgoings are concerned. But suppose they made a contract between notice to treat and Dec. 31, it would not cover that.

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The UMPIRE: I am not sure that we should be willing to have that further complication; I can understand that it might very well be agreed that notice to treat should be taken as having been given on Dec. 31, 1901.

Mr. MOULTON: Our view is that since the notice to treat the company have worked so as to make Willesden indispensable to us; after the notice to treat, if they entered into any contracts which have that effect, I do not say for one moment that I accept those.

The UMPIRE: Then you are not in a position to give a definite answer to the question I asked, because you must not take it that we should be prepared to accept Dec. 31 for one purpose and not for all. It would simplify matters if you could take Dec. 31, 1901, as the date of notice to treat.

Mr. MOULTON: If it were mere simplification I would do it. But we must see if there was anything important happened between November and Dec. 31.

(To be continued.)

Charges for Electric Current.

Last week, at Manchester, the proceedings were resumed in the action brought by Manchester Corporation against Messrs. Gilchrist & Co., electrical engineers, Deansgate. (The former proceedings were fully reported in *The Electrician* for Sept. 26, p. 922.)

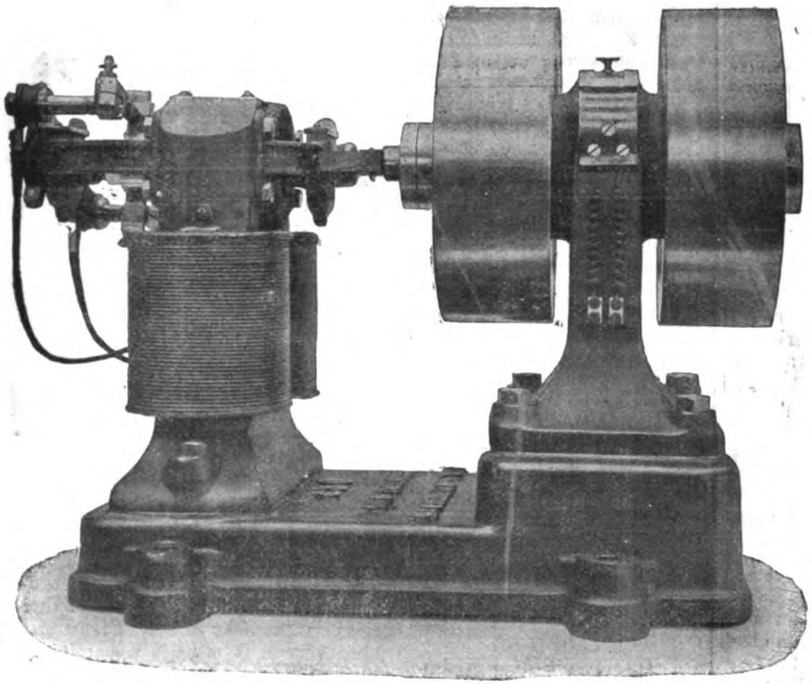
Mr. BELL, counsel for the Corporation, said defendants' bill for the quarter ended March last for electric current was £4. 19s. 2d., and this had been paid. During the June quarter defendants' premises were visited by an inspector, and it was found that a very large increase in in the number of lamps had been made, that these were of mixed candle-power, and that no notice had been given to the Corporation of this increase. When the account was sent in for June quarter defendants disputed the amount, but the measurements of the Corporation's officials of the current consumed was an accurate one.

It was urged for the defence that the Corporation had no powers to use measuring instruments for the purpose of charging the June quarter, and that the bulk of the lamps installed had been put in for show purposes only, and that only a few were lighted at one time.

In the result the Bench held that 50 lamps was a fair basis to charge upon, and ordered defendants to pay £6. 9s. 6d.

AN OIL TESTER.

The contrivance illustrated below is supplied by the Labmeyer Electrical Co. for testing the frictional coefficient of different grades of oil at varying temperatures. It consists of a short length of shaft



running in a ring-lubricated bearing, and carrying a heavy flywheel at each end, producing the ordinary pressure on the bearing. This shaft is provided with a pin coupling, so that the motive power (either electrical, mechanical or hand) can be uncoupled at any moment while running. The apparatus is supplied in four types: electrically-driven, mechanically-driven, for hand power, and, lastly, for laboratory purposes, the latter type being provided with flywheel for different bearing pressures, and also exact arrangement for measuring speed. In the case of the electrically-driven oil tester, a motor is provided with an output of about ⅛ H.P. running at a speed of 1,800 revs. per min. and mounted on a combined base plate with the oil tester, to which it is coupled by means of a pin coupling.

The method of testing is as follows:—The bearing is supplied with the oil to be tested, the motor is started and a flywheel shaft is run at full speed for a certain time. The motor is then uncoupled and the time noted which the apparatus takes in coming to rest. The better the quality of the oil the longer the shaft will run before coming to rest. In testing the next quality of oil, the bearing is quickly cleaned by passing benzine and blowing out the bearing with an air current. This obviates any necessity of taking the apparatus to pieces, and, we are informed, has proved to be sufficient. The frictional coefficient of various classes of oil can also be tested under normal conditions, as the apparatus is fitted with either electrical resistance coils with a wide range of regulation for warming the bearing to the desired temperature, or, in the case of the mechanically-driven set, by tubes in the oil reservoir through which the hot water may be passed.

The oil tester requires about half a pint. The makers recommend that the oil be tested to see that it is free from acid by dipping into it a polished copper plate and, after a time, noticing whether there is any difference between the part of the copper plate which was immersed in the oil and the part left out. After this the oil is tested in comparison with other classes of oil in the tester as before described. To test whether the oil is likely to solidify it is put between two polished iron plates, which are laid together. Should the oil be at all liable to solidify, it will be found after a short time that it is a difficult matter to move either of these iron plates against the other. Should, however, it be found that the oil easily withstands this test, especially after being in stock a few weeks, the required quantity can then be ordered with safety.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A first-class electrical engineer is required for Glasgow Corporation tramways. Salary £500. Applications to the general manager, Mr. John Young, 88, Renfield-street, Glasgow, by Oct. 22. See advertisement.

Messrs. A. E. Booth & Co., 16, New Union-street, London, S.E., invite applications for the position of resident engineer to King William's Town Electric Lighting and Cold Storage Co. (Ltd.) (S. Africa). Commencing salary £350 per annum. See advertisement.

An outside superintendent is required by the Electric Lighting committee of Ilford District Council. Salary £150 per annum. Applications to clerk (Mr. John W. Benton), Town Hall, Ilford, by noon, 27th inst. See advertisement.

The Streets committee of the Corporation of London invite applications for the position of testing assistant, to act under direction of the electrical inspector. Applications to town clerk, Public Health Department, Guildhall, E.C, by Nov. 1. Three men will also be required in the testing room at the Guildhall. Applications to the electrical inspector, Public Health Department, Guildhall, E.C. Further particulars appear in an advertisement.

An assistant is required, with first-class training in laboratory work and a knowledge of mechanical and electrical engineering and mechanical drawing. Applications to Dr. J. T. Bottomley, C.E., 205, Byars-road, Glasgow.

An electrical engineer is required to look after an installation at a colliery. See advertisement.

A foreman mechanic is required for the tramway power station of Sheffield Corporation tramways. Salary £130 per annum. Applications to Mr. A. L. C. Fell, general manager, Town Hall, Sheffield, by 20th inst. See advertisement.

An engineer-in-charge is required by the Newport (Mon.) electricity department. Applications to borough electrical engineer and tramways manager (Mr. H. Collings Bishop), Town Hall, Newport. See also advertisement.

The Urban District Council of Handsworth and the Technical Instruction committee require a man and his wife as caretakers of the new technical school, the man to take charge of and manage the electric lighting installation at the Council House, technical school and other buildings. Applications to clerk to Council, Soho-road, Handsworth, by 29th inst. See advertisement.

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The Bombay, Baroda and Central India Railway Co. require an electrical engineer. Applications to secretary, Gloucester House, Bishopsgate-street Without, London, E.C., by 28th inst.

Mr. John Taylor, M.Sc., of Acrington. has been appointed teacher of chemistry and physics at Crawford Municipal Technical Institute, Cork.

Bristol Corporation, on Wednesday, confirmed the appointment of Mr. W. B. Morgan as mains engineer, in succession to Mr. Jenkins, at £156 per annum, and that of Mr. A. J. Crowther, of Leeds, as assistant mains engineer, at £130 per annum.

Mr. R. N. Torpy has been appointed chief assistant engineer at Wimbledon, and Mr. T. R Stancombe, of Plymouth, engineer-in-charge.

Mr. W. A. Turnbull, of Sunderland, has been appointed junior assistant at the Bury (Lancs.) electricity works.

Mr. Arthur Jacob, M.I.E.E., has been appointed general manager of the British Schuckert Electric Co. (Ltd.), Clun House, Surrey-street, London, W.C.

Mr. A. C. Gilbert has been appointed assistant electrical engineer at Ilkeston.

Mr. F. Dore, manager of the La Plata and Ensenada Tramway Co., has also been appointed manager of the South American Light and Power Co.

Alleged Death from Electric Shock.—An inquiry was held at Sutton Coldfield last week on the body of James Jones, aged 26, a cable jointer's mate, in the employ of Callender's Cable Co. Deceased was engaged in connection with the laying of electric mains for the Sutton Coldfield Corporation's electricity undertaking.

AMBROSE HILLIER, foreman to Messrs. Callender on this particular work, said he was engaged with deceased at a feeder pillar in making alterations to some dead cables, and asked deceased to go to the other side of the pillar to pull the cable up from the bottom and hold it for a short time. When the cable had been boxed by witness, he instructed deceased to let go, but got no reply, and at that moment heard a hissing sound. Deceased had fallen or slipped forward, and his face came in contact with the live bus bar. He remained in this position 8 or 10 seconds, and died without regaining consciousness. The blood found on the deceased's face was caused by the fall. The maximum voltage across his body was 235 volts.

Dr. FRAZER, who examined the body, said there were slight signs of burning and a small wound on the side of the nose, but he could not say whether deceased had died from the effects of electric shock or from an attack of syncope.

Dr. BETTERIDGE, who made a post-mortem examination, said there was evidence of a diseased heart. He was of opinion that the electric shock was contributory to death.

The jury returned a verdict of "Death from electric shock owing to having a weak heart," adding a rider that rubber mats should be provided for men engaged in this class of cable jointing work.

A.S.E.—In a report recently issued it is stated that the number of members at Sept. 30, 1902, of the Amalgamated Society of Engineers was 92,629, against 92,426 at Aug. 31. There were 3,930 members on donation benefit, showing an increase of nearly 500 for the month. The report contains an interesting reference to the bonus system, regarding which a good deal of discussion has arisen of late. "The simple fact is (says the report) that employers in the engineering trade now have the right to introduce the bonus system," and Mr. S. Webb, in the monthly *Journal* of the Society, states that "in the engineering trade neither the employers nor workmen are prepared for piecework, and, therefore, the premium bonus system is an admirable expedient under the circumstances."

Amalgamation of German Electrical Undertakings.—A correspondent of the *Financial News* refers to a plan of re-organisation of the Helios Company by the issue of preference shares to the amount of £612,500. If this amount is paid up in cash £200,000 will be available as additional working capital. It is rumoured (continues the correspondent) that negotiations are on foot for an amalgamation of several large electrical undertakings, and in this connection the General Electric Co. and the Union Electric Co. are mentioned.

Ashton under-Lyne.—The local plumbers' society has renewed its protest against the Corporation employing members of the electricity staff in making joints in the cables instead of the work being executed by the local plumbers. The Council will not entertain the request.

Ayr.—The salary of the tramways manager (Mr. F. Coutts) has been increased to £250 per annum.

Belfast.—Messrs. Harland and Wolff have withdrawn their application of May 27 for a supply of electric energy for driving their machinery. In acknowledging this withdrawal the Electrical committee of the Corporation point out that they are not responsible for the delay that has occurred. Messrs. Harland and Wolff's application was received on May 23, and on receipt of the guarantee on May 28 the application was granted, subject to the Local Government Board's sanction to the loan required for laying the mains. The Board held their inquiry on July 22, but no decision has yet been received from them.

The Corporation have resolved "that any person requiring a supply of electrical energy to any circuit, cable, or current-consuming device, while the same is or are supplied from private sources, shall be charged for electrical energy at the price from time to time charged by the Corporation to other consumers, and shall agree to pay to the Corporation a minimum amount per annum of £6. 10s. per kw. of their possible maximum demand."

Bermondsey (London).—Last week a proposal of the General Purposes committee to adopt incandescent gas lighting in St. Olave's and Rotherhithe was met by an amendment by the chairman of the Electric Lighting committee (Councillor Cox) that the matter be referred back. This was carried by a large majority.

Bolton.—The last report of the borough electrical engineer (Mr. A. A. Day) states that the number of consumers is 1,161, representing an equivalent of 98,938 8 c.p. lamps connected, and there are 98 motors, equal to 517 H.P. The receipts for the September quarter were £6,782. 7s., against £7,126. 16s. 7d. in the corresponding period last year. From April to end of September the income was £18,136. 15s. 8d., an increase of £323. 8s. 10d.

Bradford.—In the Corporation's omnibus bill powers are sought to make a special charge for provision of stand-by supply of electric current, to enforce the queue system for regulating admission to tramcars, &c., to exempt electric motors let on hire from distress, &c.

Brandon.—Public electric lighting is being extended to Alum Waters, and the contract for erecting 15 incandescent lamps has been let to Messrs. F. Reid, Ferens & Co.

Bridgend.—Sanction to a loan of £6,886 for electric lighting has been obtained by the Council.

Brighton.—The Council are recommended to promote a bill for authority to supply electricity in the following districts outside the borough:—Rottingdean, Ovingdean, Patcham, Falmer, Hangleton, Old Shoreham, New Shoreham, Kingston-by-Sea, Southwick, Portslade, Aldrington, Lancing and West Blatchington. This recommendation was adopted at the meeting of the Council yesterday (Thursday) afternoon.

A proposal by the resident electrical engineer (Mr. J. Christie) for improving the lighting of the entrance to the Aquarium, which has been endorsed by the Aquarium committee, was discussed by the Council yesterday (Thursday). The proposal is to outline the structure in electric lights, with various points sharpened up by arc lamps or more powerful lights. From 400 to 450 lamps would be required, and the approximate cost would be about £375. The scheme was approved by the Council.

The electrical exhibition at the Aquarium (see last week's *Electrician*) is to continue open until the end of next week. It has proved a great success.

Brixham.—The Council will enter into an agreement with Messrs. Crompton & Co. for the erection of electricity works and the supply of current for public and private lighting, reserving the right to purchase at 7, 15, 22, 29 or 42 years.

Cardiff.—The Parliamentary committee resolved on Wednesday to apply for powers to construct additional electric tramway routes.

Charlton Kings.—Cheltenham Corporation possess a provisional order for this district, obtained in 1900, and the District Council now call upon the Corporation to perform their obligations, and to lay mains in the compulsory area.

Clacton.—A short time ago the Council decided, by a majority of one, to establish electricity works, but an offer has now been made by the promoters of the Clacton and St. Osyth light railway to take a transfer of the order and to erect a generating station. It has, therefore, been decided to call a public meeting to ascertain the opinion of the ratepayers.

Consort of Electricity and Gas.—The spirit of sweet reasonableness pervaded the Paper read by Mr. S. Meunier at the Midland Association of Gas Engineers at Birmingham on Saturday last. The title of Mr. Meunier's Paper was "Gas and Electricity in Combination," and the object of the Paper was to show how great are the economies effected by a judicious blending of the works staffs of the two undertakings where they are the joint property of a municipality.

Mr. MEUNIER said the time had come when it might be considered advisable to see whether the antagonism between what after all were twin industries working in the same fields, though by different methods, should not be stayed and be replaced by a combination of forces, to the mutual advantage of both. This appeared to him to be the more necessary as established gas and electrical undertakings were threatened by combinations of powerful syndicates proposing to supply gas for power purposes on the one hand, and electricity in bulk on the other, at prices which appeared to consumers most alluring. The evolution of the gas industry had necessitated the study by gas engineers of many subjects, and gas engineers and managers were usually fully competent to design and carry out the great structural and engineering works connected with their profession, and a very large proportion of the training and experience gained was equally useful in connection with electricity supply undertakings. So far this had not been the usual course in connection with members of the electrical

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profession, the consequence being that a town's electricity undertaking usually had to be placed in the hands of at least two, if not three, different gentlemen, each of whom were competent to carry out his portion of the work in a sound manner, but rarely with any consideration as to the future financial results of the undertaking itself, the consequence being that the electrical engineer in charge had so much more per unit to provide for on capital account than he should have had if he had been able to carry out the whole of the construction work himself. In his own town of Stockport the gas and electricity stations were about 200yds. apart, and the economies effected by the combination, although perhaps not quite so great as they would have been had both undertakings been on the one site, had still been very noticeable. In the fittings shop alone, work was done for the electricity department amounting to from £300 to £400 per annum, and the rapidity with which these repairs were carried out, and the extra supervision available were sources of economy; the collection of accounts, keeping of stores and the general office routine work also effected great savings, and similar economies were effected in many both direct and indirect ways. Undoubtedly electricity offered many advantages over gas in some respects, and the demand for electric current was bound to increase. Cost, however, was a great impediment to its advance, but the electrician would, he felt assured, derive benefit by being brought into close touch and by being able to study the methods and systems employed in such an old-established industry as gas manufacture, and in this way learn many lessons of advantage to him in his profession. He therefore counselled a policy of combination of these twin industries.

A discussion followed, which was, on the whole, favourable to Mr. Meunier's views. At the same time, it was held by several speakers that in many directions gas and electricity must remain rivals, and, that being so, it remained for the gas manager to do the best he could for gas.

Dalkeith.—Messrs. Crompton & Co. have acquired a site for a generating station, and plans for the proposed electricity works have been approved by the Council. The right of purchase at 10, 17, 24 or 31 years is reserved.

Death from Electric Shock.—At Newcastle an inquiry was held last week into the death of a miner named Bellamy, aged 25, who was killed in the Philadelphia Margarite pit by electric shock. Dr. Boyle, who examined deceased, said there were plain marks of burning on both arms, and death was caused by the shock. Evidence was given to show that the deceased, in endeavouring to clear the "way" after a roof fall, stood on the cable and immediately fell, death being instantaneous. The manager of the mine (Mr. H. Kirkup) said that the cable was well insulated and covered with indiarubber, and was faultless until the fall. A verdict of accidental death was returned.

Devonport.—The capital expended on the electricity undertaking to date is £82,803, or £4,047 in excess of the sanction obtained. The engineer is preparing an estimate of the probable outlay required for extensions and a further loan will be applied for in due course.

Dingwall (N.B.).—The Council have entered into a provisional agreement with Major Blunt for the erection of electricity works and for the supply of current for public lighting. The charge for current to private consumers is not to exceed 6d. per unit and for public lighting 4½d.

Dorking.—Application has been made for a loan of £20,000 for establishing electricity supply. The Council have entered into an arrangement with Edmundson's Electricity Corporation for the erection, equipment and maintenance of the works for a term of years. The consulting engineer for the Council is Mr. W. H. Trentham.

Dudley.—The Council are to purchase all the tramways and light railways in the borough. There are six tramway routes involved in this decision.

Dumfries.—The Council invite offers for the transfer of their provisional electric lighting order.

Dundee.—Electric current will be supplied to the Co-operative Society at 2½d. per unit if 25,000 units are taken for the year to May 15 next.

Durban (Natal).—In connection with the proposed re-organisation of the harbour works at Durban, a committee which has had the matter under consideration recommend, among other things, that the Government should be asked to improve the mechanical equipment of the port, and hold a complete inquiry into the claims put forward for the use of electric power at the docks.

Electricity in Mining.—An electric light and power installation has been put down at Hannen's Oroya mine, Kalgoorlie, and an electric power plant is being put down at the Golden Link mine.

Exeter.—The city surveyor is preparing plans, estimates, &c., in connection with a proposed electric tramway scheme.

Failsworth.—On Tuesday the draft transfer of the Council's electric lighting order to the Manchester Corporation was adopted. Manchester has to approve.

Gainsborough.—"As the Council find themselves compelled to consider the electric lighting question," the advisability of combining refuse destructor works will be dealt with conjointly.

Germany's Telephone Service.—The total expenditure on the Government telephone service in Germany to April 1, 1902, was £8,500,000, of which sum £1,100,000 was expended during the preceding financial year. There were, on April 1, 322,281 miles of line and 2,024 public stations. The conversations on the service average 2,205,966 per day, or about 804,000,000 for the 12 months. The public telephone stations in the chief cities are as under:—Berlin, 51,561; Hamburg, 20,823; Frankfort, 9,271; Dresden, 8,914; Leipzig, 8,725; Cologne, 7,484. The total number of employés in the service is 8,189.

Halifax.—The question of the construction of a lift near Salterhebble for use on the tramways system has been postponed. A report from the consulting engineer (Sir Douglas Fox) confirms the recommendation of the borough engineer favouring the scheme.

Handsworth (Birmingham).—The Board of Trade has called the attention of the Council that the Handsworth Electrical Lighting Order, 1899, has not been put into force. The Council answer that the site for a generating station has been obtained, and that plans and specifications will shortly be prepared. The Council are about to purchase the undertaking of the South Staffordshire Tramways Co. within the district.

Hanley.—A system of charging for electric current alternative to the maximum demand system has been adopted—viz., for the first 1,000 units per quarter 6d. per unit, second ditto 5½d., third 5d., fourth 4½d., additional quantity beyond 4,000 units 4d.

Harrogate.—An inquiry was held yesterday (Thursday) into the application of the Corporation to borrow £46,400 for electric lighting extensions.

Honley.—An inquiry into the application of the Council for sanction to borrow £4,800 for erecting electricity works was held on Wednesday. There was some opposition.

Horsham.—Application has been made for sanction to a further loan of £9,500 for electric lighting.

Hucknall Torkard.—The Derbyshire and Notts. Electric Power Distribution Co. hope to be able to supply electricity in bulk by the middle of next year.

Huddersfield.—The Tramways committee reported on Wednesday that they have decided not to proceed with the proposed tramway extensions at present. The financial statement of the department for the six months ended Sept. 30 showed a revenue of £26,506 on the electric cars and an expenditure of £26,339, or a surplus of 0·07d. per car mile; and on the steam cars receipts of £2,554 and expenditure of £3,122, a loss of 2·85d. per car-mile.

Launceston.—At a ratepayers' meeting a resolution in favour of obtaining electric lighting powers was approved.

Launceston (Tasmania).—The profit on the electricity undertaking for 1901 was about £1,200.

Leyton.—For the first time the municipal electricity undertaking last year showed a profit of £709.

Light Railways.—The Board of Trade, after modification, has confirmed the Bentley and Bordon Light Railways order.

An inquiry was held by the Light Railway Commissioners on Thursday last into an application to construct light railways in Cranleigh district. The Commissioners decided not to accept the scheme as it was presented in an incomplete form.

Liverpool.—An account of the progress made by the Tramways department during the past year was given by the chairman of the Tramways committee (Mr. S. W. Higginbottom, M.P.) on Tuesday. An agreement had been entered into with the Cheshire Lines Committee for through bookings from St. Helens to Aintree. During the nine months ended Sept. 30, there had been an increase of 9 per cent. in the passenger traffic. Compared with 1897, the last year of the company's control, the increase in passengers had been from 29,000,000 to 82,000,000; in mileage, from 4,500,000 to 9,000,000; revenue from £219,000 to £380,000. The average penny stage is now 2⅓ miles in length. The Garston tramways had been taken over and equipped, and through communication had been provided from Garston to Seaforth, covering a route of 10½ miles. The total cars in service had been increased from 365 to 400. Those cars ran each day 7,394 trips in and out of the centre of the city. The traffic commenced at 4:30 a.m. and finished at 12:30 a.m. The efficiency of the system was being continually improved, and that was best evidenced by the decrease in the number of emergency calls for the nine months, which were as follows:—1901, 1,874; 1902, 866; or a decrease of 54 per cent. Car failures had declined by 29 per cent. Fatal accidents from 8 in 1901 to 5 in 1902. 40 cars specially equipped for comfort of passengers in bad weather had been placed in service.

London County Council.—At Tuesday's meeting a loan of £18,356 was granted to Islington for electric lighting.

Tramways.—The Highways committee reported on the proposed temporary provision (pending the establishment of the electricity generating station at Greenwich) for the electrical working of the

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New Cross and Greenwich section of the Council's tramways. The London Electric Supply Corporation has space within its engine room at Deptford for the accommodation of additional machinery, and is willing that the Council should erect there two of the sets of plant which are being manufactured for the Greenwich station. The charge would be about 1½d. per unit of electric current generated. Steam required to be supplied from the company's boilers. The total cost of the erection of the engines with steam piping, switch gear, temporary cables and ducts, &c., was £17,100, made up as follows :—Steam piping, £2,500 ; switch gear, £1,000 ; temporary cables and ducts, and laying of same for connecting up tramways with Deptford temporary station, £2,500 ; alteration of car sheds to accommodate electric cars, £7,100 ; special track work, £3,000 ; removal of engines and generators from Deptford and re-erecting at the generating station at Greenwich when completed, £1,000. Resolutions for carrying out the arrangements were agreed to.

In connection with the contract for the road work for the reconstruction for electrical traction of the New Cross and Greenwich section of the tramways, it was agreed to insert a provision for a penalty of £1,000 a week for delay on the part of the contractors and for the allowance of a bonus at the same rate to the contractors if the contract period is shortened.

The Highways committee recommended that application be made next session for powers for the construction by the Council of a double line of tramways from the existing tramway terminus at Westminster Bridge-road, via Westminster Bridge, Victoria Embankment, and that portion of the subway authorised by the London County Council (Subways and Tramways) Act, 1902, between the Strand and the Embankment, to join at a point near the Strand the underground tramway authorised by that act, which, it is estimated by the Highways committee, will cost on the underground conduit system about £51,500, plus cost of equipment. Consideration of this matter was adjourned for a week.

Londonderry.—An inquiry has been held here into the application of the Council to borrow £35,000 for electric lighting extensions. The loan is required for plant and mains for giving a supply of current to private consumers. Mr. Todd opposed the application because "the Corporation, elected on party grounds, was so split up and so influenced by party considerations, with officials largely appointed on party grounds also, that it was unfitted to carry on any commercial business successfully." He held that lighting alone would not pay either the Corporation or a private company to work. The only chance of success lay in joining with it an electric tramway scheme, &c. The consulting engineer (Sir Wm. Preece) supplied technical details.

Lowestoft.—The report of the tramways deputation which recently visited Midland towns to obtain information as to a suitable system of traction, was presented to the Council on Wednesday. The overhead trolley system was recommended, and the Council advised to adopt a double-deck single-truck car with stairways similar to those of the London United Tramways, and also a single-deck double-truck car of similar type to that used at Gateshead, the inside seats facing the direction of travel ; also, that a track-sweeping and watering-car be ordered, arranged if possible so as to deal not only with the tramway track but with the whole width of street. 18 cars are to be purchased. There will be 4 miles of track. An offer of £500 had been made to the East Anglian Light Railways Co. for their light railway order for a line between Lowestoft and Kessingland.

The borough electrical engineer (Mr. Bruce) reported that there were 288 consumers, representing a total of 15,472 8 c.p. lamps connected, an increase of 7,332 lamps for the past 12 months. There were also applications in hand from 26 consumers.

Lye and Wollescote.—A provisional order was obtained in 1899, but has not yet been put into operation. The Council, we understand, hope to come to terms with the Midland Electric Corporation for Power Distribution for a supply of current. The Board of Trade are inquiring.

Lyons.—In a report on the chemical and metal industries of this district by Mr. Liddell, H.M. Consul, reference is made to the rapid advance in the adoption of electric motors in the factories for which the district is famous. Electric driving plants are also being introduced in many pits in this district, and an electrical system of boring for soft strata has, it is stated, been successfully introduced by the Péronnière Co., while the Firminy Co. has erected a 40 H.P. pumping station at their Monterrad pit. These are only examples of a number of such installations which are now being rapidly put in. The use of electricity in blasting operations is also coming into more general use.

Lyndhurst.—The New Forest District Council are not opposing an application for an extension of time for carrying out the provisions of the Lyndhurst Electric Lighting Order.

Malaga (Spain).—Los Tranvias Malaga Co. is applying for a concession for constructing an electric tramway in Malaga.

Mitcham.—An agreement has been entered into with Croydon District Council and the British Electric Traction Co. for a service of electric tramways in the district. The Board of Trade has intimated non-approval of a clause in the agreement relating to the re-purchase of the tramways by the parish. The matter will be further discussed at the next meeting.

Municipal Telephony.—Rotherham Council have decided to support the Sheffield scheme for a municipal telephone service for the district.

Branksome Council have appointed a committee to confer with Bournemouth Corporation as to obtaining a municipal telephone licence.

Newcastle-under-Lyne.—The Council have decided to appoint a resident electrical engineer.

Norwich.—The City Council will be recommended on Tuesday to sanction the issue of advertisements by the Norwich Electricity Co. for the purchase of a 600kw. steam dynamo at about £7,000. The company's undertaking passes into the hands of the Corporation at the end of the year.

Obituary.—Mr. H. Toothill, for many years chief of the General Post Office travelling telegraph staff in connection with racecourse work, died on Wednesday morning from heart disease.

The death is also announced of Mr. Peter Brotherhood, the well-known steam engine builder of Lambeth, London.

Pemberton.—Application has been made to increase the proposed loan of £45,000 for electric lighting to £50,000 to meet £2,700, balance overdrawn at present, and to provide £2,300 for the purchase of motors.

Plymouth.—The Corporation have decided to seek powers to construct six additional electric tramway routes.

Portsmouth.—Owing to increasing demands for electric current extensions of the generating plant are projected. The Electric Lighting committee will shortly be called upon to supply current to several of the Government departments, and for the winter of 1903 it is proposed to lay down two 500kw. sets of plant. It is estimated that the increased income for the year will be about £4,500. The superintendent (Mr. E. Price) has presented a report on the proposed extensions, and a special meeting of the committee will be held to consider it. The contract for lighting the new Naval Barracks has been sealed by the Admiralty, and negotiations are proceeding for installations at the Gunwharf and Eastney Barracks.

Trial trips have been run over the Cosham to Waterloo light railway, and the Waterloo to Cowplain section is approaching completion. The Board of Trade inspection of the whole route will take place in about a fortnight. The Provincial Tramways Co. are considering a proposal to construct an electric tramway to Fareham.

Post Office Telephones in the City of London.—At a meeting of City tradesmen last week, complaint was made that the Corporation of the City of London were placing difficulties in the way of the erection of telephones in the great central markets at Smithfield, one person present complaining that his name had been in the telephone directory for several months, although he had not yet obtained connection with the telephone service. It was decided to bring the matter before the Corporation, in order that numerous subscribers awaiting connection may be accommodated.

Presentation.—Mr. Gilbert R. Spurr, assistant engineer of the electric lighting department of Ilford District Council, was presented on Friday last, by Mr. Arthur H. Shaw, the resident electrical engineer, on behalf of the staff and employés, with a marble clock, on the occasion of his marriage.

Redditch.—The estimates for the ensuing half-year caused considerable discussion at the Council meeting on Wednesday :—

Mr. JOHNSON alleged that the electric lighting undertaking was causing an annual loss of £2,420.

Mr. WARNER (chairman of the Lighting committee) defended the undertaking, and criticised what he termed the extraordinary statement of Mr. Johnson. The estimates showed that the undertaking made a demand upon the rates of only £1,000 a year and the estimates also showed that the undertaking paid back in current for lighting £1,084.

Mr. JOHNSON, in reply, said the undertaking had increased the town's indebtedness by £20,000, and added 1s. in the £ to the rates. Every other department had to suffer for the electric lighting.

The estimates were adopted.

Sheffield.—The Heely-Wood Bank-crescent tramway extension will be opened on Nov. 1.

Subiaco (West Australia).—A proposal to erect electricity works at an estimated cost of £7,000 is before the Municipal Council.

Swansea.—The Corporation will give notice to the local tramways company of intention to purchase the undertaking in the district.

The directors of the Dolter Electric Traction Co. offer to supply railway and hotel passes to Paris to all members of the Tramways committee and other members of the Council interested in electric traction, to enable them to see the electric tramway worked on the Dolter system in Paris. A committee has received instructions to visit Paris and to seriously consider the idea of adopting the Dolter system.

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Swinton and Pendlebury—The Board of Trade wish to know what steps are being taken to put the Council's provisional order into force, and the Council reply is that they hope to obtain a supply of electricity in bulk from the Lancashire Electric Power Co. by Oct. 1 next.

Transmission of Telegrams between Telegraph Offices.—There has recently been introduced into the working of the metropolitan telegraph area a new arrangement regarding the transmission of telegrams between office and office, of which the following details are published :—

Hitherto it has been impcsaible for one outlying office within the metropolitan area to communicate direct with any other outlying office, no matter how long or short the distance, except in the few cases where direct communication by pneumatic tube exists ; and no two offices had sufficient interchange of telegrams to justify a special wire being exclusively maintained. The problem of abolishing intermediate transmission has been under the consideration of the Post Office officials for many years, and the system now being gradually introduced owes its inception to Mr. J. C. Lamb, second secretary of the Post Office. It is a combination of an improved telephone switchboard and service signals with the existing Morse telegraphs. Recently Mr. John Gavey, engineer-in-chief, and Mr. E. Trenam, controller, accompanied by Mr. T. F. Purves, of the engineer-in-chief's office, made inquiries on the spot as to the possibilities of the Belgian system of intercommunication for use in the metropolitan area. It was, of course, inadequate for so immense and intricate a service, but it suggested the adaptation now about to be tried, the electrical and mechanical details of which have been worked out by Mr. Purves. At present all messages from one part of London to another have to be transmitted at the Central office, written out, sorted, taken to the check table, sent by tube to another check table in one or other of the groups, sorted again, and then carried to the instruments for transmission. Under the new system this complicated work and consequent delay will be avoided in the following manner :—Each telegraph office in the metropolitan area will have a number. If one office, say, Islington, has a message for Clapham, the operator at Islington will touch a circular indicator key, on the top of which a white star will immediately appear. The touching of the key also lights a small glow lamp under Islington's number on the switchboard at the Central office. The operator at the switchboard inserts a plug so as to connect with Islington, and that actuates the key and the white star disappears, thus indicating to the operator at Islington that his call is being answered. Then Islington replies by giving the number of the office at Clapham he requires, and the Central operator, by switching on in the ordinary way, connects Islington and Clapham, and the message is thereupon transmitted direct from one office to the other. When the message has been transmitted both offices depress their keys, which light a clearing lamp at the Central office, where the operator at once disconnects. It is intended to introduce this system gradually, and for the present only 138 offices, or about one-fourth of the total in the metropolitan area, are being included in the experiment. The whole system will be worked by a single set of accumulator batteries at the Central office.

Tunbridge Wells.—At the inquiry on Friday last into the application of the Council to borrow £10,000 for electric lighting extensions, the town clerk (Mr. W. C. Cripps) said there was no opposition, and the loan was required to meet the demand for electric current in the borough and suburbs. In 1896 the gross profits stood at £657, and had reached £3,941 in the present year. The number of consumers had increased from 144 to 670. The chief items included in the £10,000 were : For condenser and foundations, £1,421 ; cooling tower, £1,200 ; cables, mains, &c., £2,764 ; 200 meters, £1,000 ; services and lamps, £500 ; feed pumps, £200 ; buildings, £633 ; boilers, £170 ; and several small amounts. The borough electrical engineer (Mr. Boot) supplied technical details.

Tunstall.—Negotiations have been re-opened by the Council with the Potteries Electric Traction Co. as to a transfer of the Council's electric lighting order.

Victoria (Australia).—The *Australian Mining Standard* states that the electrical engineer of the Victorian Railways is preparing plans and estimates for the construction of an electric railway from Brighton to St. Kilda and another from Newmarket to Essendon. A conference of municipalities south of the Yarra is to be convened to consider a scheme of electric tramways to be carried out as municipal undertakings. An offer has, it is stated, been made to the Minister of Railways by a firm of electrical engineers to work the whole of the suburban railways electrically at a price said to be below an estimate recently prepared by the officers of the department.

Wednesbury.—The Corporation have instructed their consulting engineer (Mr. F. J. Warden-Stevens) to proceed with plans and specifications for their electricity undertaking.

Wolverhampton.—The Council have resolved to erect an eight-cell refuse destructor, at an estimated cost of £13,580.

Workhouse Lighting.—It was reported to the Lynn guardians last week that the cost of the electric lighting, &c., at the workhouse during the past quarter was £15. 9s. 7½d., compared with £23. 14s. 8d. for gas lighting for the corresponding period last year, a saving of £8. 5s. 0½d., besides other advantages.

The Wandsworth and Clapham (London) Guardians have decided to adopt electric lighting for their new receiving wards.

Swindon Guardians have applied for a loan of £1,900 to cover cost of an electric lighting installation at the workhouse. The amount of the accepted tender is £1,675.

Yarmouth.—A report on extensions of the generating plant and mains has been prepared by the consulting engineers (Messrs. Preece and Cardew), and on Wednesday the Council adopted the recommendations therein embodied. Sanction is to be sought for a further loan of £16,500, to be expended as follows :—Buildings £4,500, generating plant £6,700, mains £2,300, sub-stations, &c., £1,500, engineering and contingencies £1,450.

The quarterly report on the electric tramways showed total income of £4,388. 13s., working expenses £1,821. 17s. 9d., interest and sinking fund charges £441, profit £2,125. 15s. 3d. 85,779 car-miles were run, and 842,324 passengers carried. Total receipts per car-mile 12·28d., expenses (including capital and interest charges 6·33d., profit per mile 5·95d. Capital expenditure to date £43,000.

Zaragoza (Spain).—Los Tranvias de Zaragoza Co. has received Royal assent to the substitution of electric for animal traction on certain of its lines.

Electro Harmonic Concerts.—The first of the season's smoking concerts of the Electro Harmonic Society was given in the Crown Room of the Holborn Restaurant, London, on Friday evening last, and there was a crowded attendance, the chair being taken by Mr. Alexander Siemens, who was well supported. The concert was a decided success, in spite of the ill ventilation of the room. Regular attendants at these functions expressed a preference for the old quarters at St. James's Restaurant.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday ; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Sunderland Corporation require tenders for one steam-driven three-phase generator, motor generators and static transformers, and high and low tension switchboards. Specifications, &c., from the borough electrical engineer, Mr. John F. C. Snell, Town Hall, Sunderland, and tenders (addressed chairman of Electricity and Lighting committee) to the town clerk, Mr. Fras. M. Bowey, Town Hall, Sunderland, by 12 noon Nov. 28. See also advertisement.

Burton-upon-Trent Corporation invite tenders for overhead equipment of tramway lines, &c. Specifications from the consulting engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, S.W., or of the borough engineer. Tenders to the town clerk, Town Hall, Burton-upon-Trent, before noon Nov. 5. See advertisement for further particulars.

Swindon Corporation invite tenders for the supply and delivery of direct-current electricity meters. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, and may be obtained from the latter office. An advertisement contains further particulars. Tenders to the town clerk (Mr. Robert Hilton) by 29th inst.

Hammersmith (London) Electricity and Lighting committee invite tenders for prepayment electricity meters for use on the single-phase alternate-current system. Particulars from the borough electrical engineer (Mr. G. G. Bell), electricity works, 57, Fulham Palace-road, Hammersmith, W., and tenders by noon, 24th inst. See advertisement.

London County Council invite tenders for the supply and delivery of three low-tension feeder switchboards, and for the erection of one in each of the Council's sub-stations at Clapham, Brixton and near the Elephant and Castle. Further particulars in an advertisement. Drawings, specifications, &c., after Monday, at the County Hall, and tenders to the clerk (Mr. G. L. Gomme), County Hall, Spring-gardens, London, S.W., by 10 a.m. Nov. 11.

Chester Corporation invite tenders for the supply of arc lamps (open type). Specifications from city electrical engineer (Mr. F. Thursfield), and tenders to Town Hall by Oct. 25. See advertisement.

Nottingham School Board invite tenders for an electric light installation at the Bath-street schools. Particulars from Messrs. Evans & Sons, Eldon Chambers, Wheelergate, Nottingham.

Lancaster County Asylum Visiting committee require tenders for direct-coupled dynamo and switchboard. Particulars from the medical superintendent.

Aston Manor District Council invite tenders for condensers for their electricity generating station. Tenders to chairman Electric Lighting and Tramways committee by noon Oct. 31.

Ipswich Corporation invite tenders for main switchboard, motor booster and connections, and overhead construction for tramways. Tenders to town clerk by Oct. 22.

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London County Council invite tenders for electrical fittings and other stores for 12 months. Tenders by 27th inst.

Newcastle-upon-Tyne Tramways committee require a 3,000 H.P. triple-expansion direct-coupled engine. Tenders by Nov. 8.

Tenders are invited by 31st inst. for wiring *Mansfield* town hall.

TENDERS RECEIVED AND ACCEPTED.

Liverpool City Council have accepted the tender of Galloways (Ltd.) for 14 Lancashire boilers for the Pumpfields and Lister Drive generating stations at £735 per boiler.

Belliss and Morcom have recently received repeat orders from the Admiralty for electric light sets for the newest type of torpedo-boat destroyers, there being nearly 20 vessels in all. The firm have also received an order for a 450 H.P. engine for coupling to a Mather and Platt dynamo for South Africa.

Pritchetts and Gold have obtained a contract from Peterborough Corporation for a storage battery of 240 cells, to be used in connection with a Crompton automatic reversible booster, for the Corporation's new traction station.

The Electric Construction Co. has obtained an order for 59 motors for the Small Arms Factory at Ishapur, for which a specification was recently issued by His Majesty's Government.

Bradford Corporation have accepted the tender of the Electrical Engineering Co. for electrical bell and electric light fitting at the Market Tavern and Trevelyan Hotel.

Ingleton Parish Council have accepted the tender of the local electric light and power company for public electric lighting at £55. 16s. 7d. per annum.

Bristol Corporation have placed an order with Messrs. C. A. Parsons & Co. for two steam turbo-alternators, and with Messrs. Dick, Kerr & Co. for a 210kw. steam dynamo.

Warrington Town Council have accepted the tender of Messrs. Booth & Co. for a bogie for the electric tramways at £21, and that of Messrs. Dutton and Bean for two travelling jacks at £7. 4s.

Wolverhampton Town Council have provisionally accepted the tender of Messrs. Manlove, Alliott & Co. for refuse destructor plant at £10,928.

Gravesend Council have accepted the tender of Messrs. Gardner & Co. for the wiring and fitting of the market at £396. 3s.

Brechin Police Commission have accepted the tender of Messrs. C. Middleton & Son for wiring the municipal buildings at £27.

Lowestoft Town Council have accepted the tender of Mr. A. G. Beckett for the erection of tramcar sheds at £5,123.

Belfast Corporation have accepted the tender of Messrs. Wm. Coates & Son for cast-iron pipes.

BUSINESS NOTICES

An old-established firm of engineers and art metal workers advertise for a partner. An amalgamation with a similar firm could be arranged.

The offices of the *British and South African Export Gazette* have been removed to 33 and 35, Eastcheap, E.C.

The Manchester office of the Anglo-American Telegraph Co. has been removed from 7, Royal Exchange to 31, Brown-street.

Messrs. A. F. Lord and A. E. Torrie (trading as Lord and Shand), electrical engineers, Westwell-street, Plymouth, have dissolved partnership.

BANKRUPTCIES.

In the bankruptcy of Joseph Taylor (trading as J. Taylor & Co.), electric fittings designer and maker, 1A, Dyott-street, London, W., the trustee has been released.

The trustee in the bankruptcy of Thos. Morley, electrical engineer, Argyle-street, Accrington, the trustee has been released.

Deed of Assignment.—Joseph Hamer, electrical and mechanical engineer, 3 and 4, Horton-street, Halifax, has executed a deed of assignment. Claims must be sent by Oct. 25 to Mr. J. I. Learoyd, Bank-chambers, Halifax.

Land for Sale.—Freehold land, close to Charlton Junction station, is for sale. Applications to freeholder, Cedar Lodge, Charlton, Kent. See advertisement.

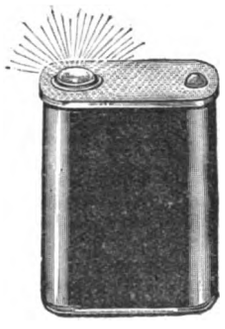
Plant for Sale.—A compound-wound Lister dynamo is advertised for sale. Applications to "Dynamo," care of Hilton and Stembridge, 4, Pavilion-buildings, Brighton.

Electric Postal Vans.—For some time past the British postal authorities have had under trial the "Oppermann" patent electric mail van, designed and constructed by Mr. Carl Oppermann, Wynyatt-street, Clerkenwell, London, E.C. The success attending these trials has inclined the authorities to extend their experiments to routes other than the E.C. district, and we understand that on Tuesday an electric mail van started running in the Battersea district.

Exhibition.—There is to be held at the Crystal Palace, London, from March 2 to May 31 next, an international engineering, machinery, hardware and allied trades' exhibition, for which an influential list of patrons has already been secured Sections will be devoted to electrical, telegraphic, railway, tramway and traction, labour-saving machinery, lighting and hoisting machinery, art metal work, heating and lighting, &c. Plans and particulars are available, and can be obtained from the organising commissioner at the Crystal Palace, S.E.

Exhibition Souvenir.—There has just been held in the Town Hall, Grimsby, an electrical exhibition, under the auspices of the Corporation, the arrangements being carried out by Mr. W. A. Vignoles, the borough electrical engineer. Mr. Vignoles succeeded in getting together a large assortment of fittings apparatus, and accessories for all descriptions of domestic and general lighting, and has prepared a souvenir of the exhibition, which is published at 1s.

A Pocket Electric Lamp.—Messrs. Darton & Co. are putting on the market a new pocket electric lamp, worked by three small dry batteries, for the purpose of supplying occasional flashes of light. The whole is contained in a small flat case with rounded sides, resembling a large cigarette case, and measuring 3⅜in. by 2⅜in. by 1in., the lamp and push being on the top, as shown in the illustration. The little set will doubtless be found useful as a keyhole search-light. It may be added that the whole apparatus, although neat, is very simple in construction, and Messrs. Darton & Co. are supplying these lamps in wholesale quantities at a very moderate price.



Catalogues.—A compact and well-illustrated catalogue of Jandus arc lamps has just been prepared and is issued by Messrs. Drake and Gorham, 66, Victoria-street, Westminster, S.W. Installation contractors will find in this catalogue some very useful information, and municipal bodies discussing the question of electric arc versus other methods of illumination will find much matter to help them in their selection. Not the least interesting will probably prove the extensive list of municipal authorities, electricity supply companies, railway and tramway companies, &c, which have installed Jandus lamps in large quantities. A small selection from a large collection of testimonials of quite recent date accompanies the list.

The Howard Conduit Co., Trafford Park, Manchester, have ready an illustrated hanging card showing the use of the Howard asphalt solid system, more especially for services. The most suitable sizes and the approximate quantities of bitumen and asphalt concrete required are shown.

A well-arranged catalogue of electrical supplies has been prepared by Messrs. Vandam, Marsh & Co., 15, Gerrard-street, London, W. A large variety of fittings, lamps, switches, apparatus and accessories is listed.

Messrs. R. W. Blackwell & Co. have ready new sheets of single-throw, quick-break, knife switches, I.T.E. car circuit-breakers, and the "Shaw" non-arcing type of lightning arrester for traction, light and power.

Forthcoming Book.—Mr. B. T. Batsford will shortly publish a work in two volumes, by Mr. E. O. Sachs, entitled "Facts on Fire Prevention." The book is intended as a standard work of reference on the subject.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Oct. 8 to 14, with the ports of destination :—

Africa—Alexandria, £143; Cape Town, £2,617 (including £2,568 telegraph material); Durban, £2,622 (including £2,109 telegraph material); East London, £920 (including £636 telegraph material) Mossel Bay, £35; Port Elizabeth, £582 (telegraph material); Sekonde, £304 (telegraph material); Sierra Leone, £115 (telegraph material). *Argentina*—Buenos Ayres, £619 (including £541 telegraph cable); Rosario, £867. *Australasia*—Auckland, £7,280 (including £500 telegraph apparatus); Brisbane, £250 (telegraph apparatus); Fremantle, £35; Melbourne, £884 (including £805 telegraph wire); Perth, £864; Sydney, £436 (including £46 telegraph material). *Belgium*—Ostend £42. *British Guiana*—Demerara, £50. *Ceylon*—Colombo, £31. *China*—Shanghai, £37. *Denmark*—Copenhagen, £3,566 (including £120 telegraph cable). *Holland*—Amsterdam, £93. *Hong Kong*, £1,105. *India*—Bombay, £197; Calcutta, £214; Karachi, £137; Madras, £52. *Japan*—Kobe, £123; Yokohama, £432. *Malta*, £80. *Mexico*—Coatzacoalcos, £35 (telegraph apparatus); Vera Cruz, £9,990. *Russia*—Riga £20; St. Petersburg, £880. *Straits Settlements*—Singapore, £103. *Sweden*—Gothenburg, £106. Total £35,866 against £19,869 in the corresponding week last year (Oct 9 to 15).

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

September 9, 1902.

19,672. H. NUNNS. Halifax. Switches.
19,688 and 19,689. VERITYS LIMITED and W. R. RIDINGS. Birmingham. Carbon feeding and arcing mechanism.
19,713. E. SANDHAGEN and J. LÜRGEN. Electrolytes for accumulator plates.*

September 10, 1902.

19,774. F. FERRAND. Manchester. Production of caustic soda and sodium hypochlorite by electrolysis.
19,827. DOLTER ELECTRIC TRACTION (LTD.). Surface contact electric traction systems. (H. Dolter, France.)

September 11, 1902.

19,838. J. WILKINSON. Hull. Trolley wire clamp.
19,839. H. BRECKNELL, E. M. MUNRO and H. I. ROGERS. Bristol. Mechanical shunting points for trolley wires.
19,842. W. A. MACFARLANE. Glasgow. Switches.
19,849. J. STEVENSON, jun. Portobello. Automatic suspension and electrical contact appliance for raising and lowering apparatus.
19,854. S. SIMPSON. Blackburn. Guard wire for preventing broken trolley wires falling to earth.
19,860. W. CLAPHAM and A. CLAPHAM. Leeds. Primary battery.
19,881. H. JACKSON. Worcester. Electric tramways and railways.
19,884. A. S. DE VEAU and C. AUTH. Telephone systems and apparatus.
19,891. E. W. GOVER. Electrical communication with passing trains. (E. C. Buck and H. E. A. Thatcher, Transvaal.)
19,901. C. HULSMEYER. Converting variations in intensity of an electric current into variations in intensity of light.*
19,903. G. ZAPP. Liverpool. Insulating multiple-branched cables at the points of branching and ends.
19,911. W. KENNEDY-LAURIE DICKSON. Magnetic separation of ore.

September 12, 1902.

19,933. C. A. WILKINSON. Kingston-on-Thames. Electric ignition for explosion engines.
19,938. C. KENYON. Manchester. Electric door bells.
19,952. D. MAXWELL. Dundee. Safety automatic differential speed governors for electric tramcars.
19,967. W. A. THOMAS and J. E. GREEN. Electro-deposition of zinc.
19,985. B.T.-H. Co. and F. HOLDEN. Electricity meters.
19,991. J. MANNHEIM. Alternating-current electric machines.
19,999. L. FISDLER and G. PUCHMÜLLER. Secondary battery elements and producing same.
20,003. A. J. BOULT. Arc lamps. (A. Kunze, Germany.)*

September 13, 1902.

20,024. P. REDFORD. Manchester. Trolley wire holders.
20,025. R. W. YOUNG. Leeds. Adjustable brackets for electric lamps.
20,054. D. B. FOSTER. Leeds. Junction frogs and trolley heads.
20,074. L. WIRTZ and T. HAMILTON-ADAMS. Arc lamps.
20,084. W. E. EVANS. Production of metallic calcium. (Electrochemische Werke G.m.b.H., Germany.)*

September 15, 1902.

20,097. W. O. ROOPER. Staffordshire. Storage batteries.
20,112. H. ROTTENBURG. Manchester. Winding electric machines.

September 16, 1902.

20,168. F. H. HALL and C. HALL. Birmingham. Induction coils.
20,199. J. BROCKIE. Arc lamps.
20,206. J. ECK. Starting and controlling switches.
20,230. C. P. BASS and T. B. WEST. Electric switch signals.*
20,237. W. PALMER, jun., and A. MCCLINTOCK. Selective calls for telephones and telegraphs.
20,240. R. A. HADFIELD and W. GALBRAITH. Conduit railways.

September 17, 1902.

20,259. V. CONNAR. Electric hand lamp for signalling.
20,265. A. LUMBERS. Liverpool. Trolley poles.
20,280. M. HARLOE. United States. Insulators.*
20,289. D. MACADIE. Telephone systems.*
20,323. L. B. CODD. Nottingham. Switches.

September 18, 1902.

20,324. L. MANNSTAEDT. Germany. Protecting irons for cables.*
20,340. I. HOPKINSON. Bradford. Cables and wires.
20,355. E. DUCRETET. Glasgow. Telegraphs with automatic disengagement.*
20,376. O. IMRAY. Telephonic microphone transmitters. (W. E. Knorr, Brazil.)
20,398. F. E. HESSE. Telegraphy. (E. S. Heurtley, Singapore.)

September 19, 1902.

20,425. W. TOWLER. Leeds. Cutouts for trolley wires.
20,426. A. MCCANDLISH. Stockport. Portable testing and comparing instrument for incandescent lamps.
20,428. T. HAWKINS and E. GREENHALGH. Birmingham. Electrical motion transmitter and speed gear for motor cars.
20,438. J. W. KNOWLES. Bradford. Car trolleys.
20,444. WOLSELEY TOOL AND MOTOR CAR CO. Wolverhampton. Sparking plugs for internal combustion engines.
20,445. WOLSELEY TOOL AND MOTOR CAR CO. Wolverhampton. Terminals for electric wires.
20,456. O. VOLKMANN. Berlin. Quick-break chopper-switch for high-voltage currents, with automatic spark extinguisher.*
20,461. A. P. LUNDBERG and G. C. LUNDBERG. Detachable connections for electric lighting and heating.*
20,483. O. L. PEARD and F. DEW. Safety fuses.
20,502. C. G. GOORD. Automatic points for main junctions.

September 20, 1902.

20,522. F. H. HALL and C. HALL. Birmingham. Generating current.
20,552. I. G. WATERMAN. Switches.*
20,553 and 20,556. I. G. WATERMAN. Electromagnetic valve controlling apparatus.*
20,555. I. G. WATERMAN. Electromagnets.*
20,557. I. G. WATERMAN. Electrical control of water supply.*
20,571 and 20,572. V. A. FYNN. Alternate-current motors.
20,573. V. A. FYNN. Electromagnetic clutches or couplings.
20,587. JOHNSON-LUNDELL ELECTRIC TRACTION CO. Safety arrangements for motor and other circuits. (R. Lundell, U.S.)

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can be obtained at the uniform price of 8d. each.

1901.

16,979. DAVIS and PALMER. Switch.
17,215. QUIN and SIMPSON. Insulators for trolley lines.
17,256. SIEMENS BROS. & Co. and SIEMENS. Connecting electric cars.
17,282. DRAKE and RAM and NERNST ELECTRIC LIGHT. "Nernst" type lamps.
17,357. HUNTER. Trolley arms.
17,363. DANVEY. Luminous press button for electric bells.
18,314. CONRAD. Measuring three-phase alternating-current circuits. (Date applied for, Feb. 14, 1901.)
18,840. COFFIN. Drying air by means of electricity.
19,088. MANGUIN. Electric ignition for explosion motors.
19,973. MATTHEWS and DAVIES. Brushes for dynamos.
20,294. CHAPMAN. Track construction of conduit electric railways.
20,406. WALSH and LEIGH. Trolley heads.
21,433. SMITH and WATTS. Electric heating apparatus.
21,565. RUTHVEN-MURRAY and FERRANTI LIMITED. Switch gear.
22,219. MURRAY. Telegraphy.
22,200. BOULT (Neelemans). Electrical signals, points, bolts, &c.
23,131. CORNWALLIS-WEST. Conduits.

1902.

5,618. CERVERA. Wireless telegraphy.
11,523. DÉRI. Transmission of electrical energy for traction.
12,581. ZEHDEN. Electromagnetic traction or driving apparatus.
12,737. SWAN.* Blowing-off machines for lamp bulbs.
12,738. SWAN. All-glass seal between stem and bulb.
12,739. SWAN. Bases for incandescent lamps.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

CHRIS. LUCAS (LTD.)—Reg. Oct. 4, capital £10,000 in £1 shares, to acquire certain businesses and to carry on the business of manufacturers of electric, gas and sanitary fittings, lamps, &c.

ELECTRIC MERCANTILE AGENCY (LTD.)—Reg. Oct. 6, capital £1,200 in £1 shares, to carry on the business of an electric light company and of electricians, electrical, mechanical and general engineers, suppliers of electricity, manufacturers of electrical apparatus, &c.

RANGOON ELECTRIC CONSTRUCTION SYNDICATE (LTD.)—Reg. Oct. 6, capital £1,000 in £1 shares, to apply for and obtain concessions and powers for constructing and working electric tramways and electric lighting works in Burmah, and to develop same. Mr. M. F. Kindersley is one of the first directors.

SIMPSON BROTHERS (OF HAPTON), LTD.—Reg. Oct. 9, capital £5,000 in £1 shares, to acquire the business of electrical and mechanical engineers at Hapton and Burnley, Lancs., known as Simpson Brothers, and to carry on business as manufacturing electricians and mechanical and electrical engineers, &c. The subscribers are W. FitzAllen Simpson, electrical engineer, Mrs. I. Simpson, Miss I. Simpson, J. Hartley, engineer, W. Hudson, J. F. Heap and Mrs. M. Crook. The first directors are W. FitzAllen Simpson and Mrs. I. Simpson. Reg. office: Electrical Works, Hapton, Lancs.

D. STEWART & CO., 1902 (LTD.)—Reg. in Edinburgh, Oct. 8, capital £80,000 in £1 shares, to purchase the business of D. Stewart & Co. (Ltd.) (now in liquidation) and to carry on business as engineers, electricians, makers of motors, motor cars, &c. The first directors are W. and J. Beardmore. Reg. office: London-road Iron Works, Glasgow.

THAMES BOATING TRADES' ASSOCIATION (LTD.)—Reg. Oct. 9, capital £1,000 in £1 shares, to carry on business of boat and launch builders, engineers, electricians, electrical engineers, &c. The subscribers are J. H. Salter, W. R. Edwards, electrical engineer, S. F. Beevor, electrical engineer, G. T. Rees, G. Harris, G. A. Ellis and S. Rosewell. The first directors are J. H. Salter, J.P., G. J. Tagg, S. F. Beevor, J. Bond, E. Cawston, H. Clark, G. R. Dunton, W. R. Edwards, G. A. Ellis, G. Harris, G. Meakes, R. H. Messum, G. T. Rees, S. Rosewell, R. Shaw, R. Talboys and H. Woodhouse. Reg. office: 39, Romola-road, London, S.W.

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STATUTORY RETURN.

MERTHYR ELECTRIC TRACTION AND LIGHTING CO. (LTD.)—The return to June 26 gives the capital as £100,000 in 10,000 ordinary and 10,000 preference shares of £5 each, of which 6,000 ordinary and 6,000 preference shares have been taken up. £5 per share has been called up, and £60,000 has been received. Mortgages and charges, £30,000.

LIENS, &c., REGISTERED.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—Issue on Sept. 30 of £500 debentures (five of £100 each), part of a series created Nov. 19, 1900, to secure £15,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £10,200.

LYMINGTON ELECTRIC LIGHT AND POWER CO. (LTD.)—Trust deed, dated Sept. 26, 1902, to secure £20,000 debentures. Property charged: Land, buildings, machinery, works, plant, effects, undertaking and property of the company, present and future, including uncalled capital. Trustees: W. B. Hopkins and F. E. Gripper.

OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY (LTD.)—Issue on Sept. 25 of £5,600 debentures (56 of £100 each), part of a series created June 20, 1899, to secure sum not exceeding half subscribed capital. Property charged: Entire undertaking, property and assets, present and future, including uncalled capital. Trust deed dated July 21, 1899. Trustees: Sir C. R. Wilson, G.C.M.G., C.B., and J. F. Nauheim. Total amount previously issued of same series, £34,400.

ST. HELENS CABLE CO. (LTD.)—Issue on Sept. 19, 1902, of £5,000 second debentures (10 of £500 each), part of series to secure a sum unlimited in amount. Resolution authorising issue passed Sept. 18, 1902. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trust deed. Persons entitled to charge: W. W. Pilkington (£2,500) and J. Beecham (£2,500). Total amount previously issued of same series, £119,000.

THOMAS BOLTON & SONS (LTD.)—Lien reg. Oct. 7 for £12,400 first debentures, part of £275,000. Amount previously issued, £73,000. Trustees: The Law Guarantee and Trust Society, London, charged on undertaking and all property, including uncalled capital.

UXBRIDGE AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Issue on Sept. 30 of £1,000 debentures (10 of £100 each), part of series created by directors' resolution of July 18, 1901, to secure £20,000. Property charged: Company's undertaking and all its property, present and future, including uncalled capital. No trust deed. Total amount previously issued of same series, £12,500.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 2, 1902). Price of silver 23⅝d. per oz. (Oct. 16). Consols (2¾ per cent.) 93—93⅛ for money, 93 1/16—93 3/16 for account; 2½ per cent. 93—93⅛ (Oct. 16). Consols Pay day, Nov. 5; Stocks and Shares Continuation Days, Oct. 28 and Nov. 11; Ticket Days, Oct. 29 and Nov. 12; Pay Days, Oct. 30 and Nov. 13; Mining Share Carry-over Days, Oct. 27 and Nov. 10.

CRYSTAL PALACE CO.—The accounts for the half-year ended June 30, show gross receipts £65,849, gross expenditure £53,597, leaving £11,251 against £5,103 in the corresponding half of last year. The bill authorising the extension of the Croydon electric tramways, via Penge and Anerley-hill to the Palace, has received Royal assent, and is calculated by the directors of the Crystal Palace Co. to materially improve the prospects of the Palace.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors report for the half-year ended June 30 states that the total receipts were £14,682. 16s. 4d., expenses £5,788. 4s. 1d., leaving £8,894. 12s. 3d., to which is added £4,590. 6s. 4d. brought forward, making a total of £13,484. 18s. 7d. £2,752. 7s. has been added to reserve, which now stands at £129,000, after deducting £5,752. 7s., cost of repairs to the Cape Cruz-Santiago cable. Preference dividend absorbs £3,000, leaving £7,732. 11s. 7d., out of which dividend at the rate of 4 per cent. per annum on the ordinary shares (tax free) is recommended, £4,532. 11s. 7d. being carried forward. The company's cables continue in good working order. No reply has yet been received from the Government of the United States regarding the payment of the company's claim for damage to the cables during the Spanish-American war. With regard to the claim for payment of the subsidy of £2,000 per annum in respect of the coast cables, now in arrear since January, 1899, the company's representative at Havana has, in view of the establishment of the new Government in Cuba, been instructed to make application for payment in accordance with the terms of the company's concession. The appeal of the West India and Panama Telegraph Co. against the order of the Court of Appeal confirming the judgment of Mr. Justice Farwell, heard in the House of Lords in June, resulted in the appeal being dismissed with costs, thus terminating in this company's favour litigation instituted in February, 1898, with respect to the construction of the agreement between the two companies of Jan. 31, 1870.

***INDO-EUROPEAN* TELEGRAPH CO. (LTD.)**—The directors have declared an *interim* dividend for the half-year ended June 30 at the rate of 5 per cent. per annum (tax free), payable Nov. 1. The transfer books will be closed from Oct. 18 to 31, both inclusive.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—The amount of electricity sold by this company for the quarter ended Michaelmas is returned at 1,249,657 units, estimated to produce £21,348, against 1,040,417 units, which produced £18,077, for the corresponding period of last year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in the further issue of 20,000 £5 shares of the *Calcutta Electric Supply Corporation (Ltd.)*, and to allow £120,000 5 per cent. first mortgage debenture stock of the *Colombo Electric Tramways and Lighting Co. (Ltd.)* to be quoted.

TRAFFORD PARK ESTATES (LTD.)—The directors' report for the year ended June 30 states that a system of electric tramways is being inaugurated which, it is considered, will prove of material benefit to the estate. The West Manchester Light Railway Co. had obtained new powers for the extension of their railway upon the estate, and had agreed with the Cheshire Lines committee for a direct connection with the railways of the Midland, Great Northern and Great Central Railway Companies.

WINDERMERE AND DISTRICT ELECTRICITY SUPPLY CO. (LTD.)—During the week this company invited applications for £17,700 4½ per cent. first mortgage debentures.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation...	Oct. 4	997	+ 258	18	20,457	+ 4,943
Ayr Corporation	,, 11	221	...	21	8,062	...
*Birmingham Tramways.	,, 11	5,752	+ 374	14	70,466	+ 2,200
*Blackburn Corporation..	,, 10	760	+ 70	¶29	24,280	+ 3,521
Blackpool Corporation...	,, 9	772	+ 237	28	34,263	- 18
Blackpool and Fleetwood	,, 11	457	+ 129	15	18,555	- 314
Bolton Corporation	,, 12	1,635	+ 124	28	46,045	+ 2,928
BournemouthCorporat'n	,, 8	219	...	..	...	...
Bradford Corporation ...	,, 12	3,388	+ 2,230	28	95,454	+ 64,024
Brighton Corporation ...	,, 12	858	...	46	34,995	...
Brisbane Tramways.....	Aug. 27	2,203	+ 429	9	21,548	+ 4,919
*Bristol Trams & Carriage	Oct. 10	4,541	+ 691	20	70,809	+ 12,959
*Buenos Ayres & Belgrano	Sept. 14	2,896	- 202	11	31,119	+ 1,542
Burnley Corporation ...	Oct. 11	682	+ 587	2	1,425	+ 1,205
Calcutta Tramways Co...	,, 11	R35 433	+ R12668	15	R402,150	+ R39,948
Cardiff Corporation	,, 11	1,535	...	28	39,799	...
Carlisle Tramways Co....	,, 11	183	+ 22	†41	7,346	+ 494
Central London Railway	,, 11	6,858	+ 567	15	95,696	+ 8,261
Chatham & Dist. Lt. Rys.	...	...	...	...	...	...
City & South London Ry.	,, 12	3,349	+ 1,288	15	42,626	+ 14,325
Cork Elec. Tramways Co.	,, 9	742	+ 274	§40	24,171	+ 4,900
Devonport & Dist. Trams	,, 3	400	+ 43	39½	17,271	+ 716
Doncaster Corporation..	..	...	...	...	...	...
Dover Corporation	,, 11	213	- 9	28	6,939	- 199
Dublin & Lucan Railway	,, 12	113	+ 10	15	2,005	+ 7
Dublin Southern Dist....	,, 10	746	- 41	15	16,933	+ 662
Dublin United	,, 10	3,779	+ 13	†15	59,075	
Dudley—Stourbridge ...	,, 3	789	+ 53	39½	30,043	+ 3,759
*Dundee Corporation ...	,, 8	811	+ 121	§18	15,699	+ 1,741
East Ham Council	...	...	...	...	...	...
Gateshead & Dist. Trams	,, 3	869	+ 206	39½	29,525	+ 5,302
Glasgow Corporation ...	,, 11	12,402	- 853	19	291,424	- 8,252
Gravesend—Northfleet	,, 3	196	...	9	1,692	...
Greenock & Port Glasgow	,, 3	636	+ 426	39½	20,158	+ 12,204
Hartlepool Tramways ..	,, 3	232	- 34	39½	10,298	+ 1,144
Hull Corporation	,, 11	2,132	- 162	28	49,750	+ 1,850
Isle of Thanet Co.	,, 11	499	+ 43	15	20,281	+ 19,039
Kidderminster & Dist....	,, 3	130	- 5	39½	5,045	+ 21
Leeds Corporation	,, 11	4,827	+ 652	28	150,452	+ 21,814
*Liverpool Corporation...	,, 4	10,171	+ 351	40	390,218	+ 30,544
Liverpool Overhead Rly.	,, 12	1,470	+ 45	‡15	23,780	- 1,205
Manchester Corporation	,, 11	5,422	+ 3,206	69	212,993	...
Merthyr.....	,, 3	193	- 54	39½	8,078	- 1,486
Middleton	,, 3	268	...	27½	8,622	....
Newcastle-on-Tyne Corp	,, 11	3,015	...	...	...	...
Oldham, Ashton & Hyde.	,, 3	559	+ 39	39½	21,166	+ 1,051
Perth (W.A.) Elec. Trams	,, 10	1,000	+ 157	¶40	42,445	+ 7,185
Poole & Dist.....	,, 3	280	- 14	39½	10,500	- 134
*Portsmouth Corporation	,, 11	1,439	+ 131	...	...	...
Potteries	,, 3	1,639	+ 159	39½	58,411	+ 2,516
Rotherham	,, 3	179	+ 120	6½	1,468	+ 448
Salford Corporation ...	,, 13	2,895	+ 990	28	74,551	...
*Sheffield Corporation ..	,, 12	4,135	+ 458	15	64,169	+ 12,403
Southampton Corp.....	,, 9	947	+ 87	...	...	...
Southend Corporation...	,, 8	222	+ 36	27	8,772	...
Southport Tramways ...	,, 3	281	+ 91	39½	10,454	+ 3,688
*S. Staffordshire Trams...	,, 3	762	- 132	39½	30,310	- 727
Sunderland Corporation.	,, 12	1,112	...	...	...	...
Swansea Trams.....	,, 3	497	+ 25	39½	18,980	+ 1,227
Taunton Trams.....	,, 3	59	- 33	39½	2,666	- 262
Tynemouth & Dist.	,, 3	323	+ 61	39½	12,124	+ 1,493
Weston-super-Mare	,, 1	125	...	21½	5,107	...
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 3	335	+ 208	39½	7,938	+ 5,194

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 8.		Price Wednesday, Oct. 15.		Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending Oct. 15.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY.								
100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)							...	
£100,000	Stock	4½%	Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) xd	104	107	105	108	4 3 6		...	...
7,500	10	14/0	Bournemouth and Poole Elec. Supply Ord.	12	13	12½	13½	5 3 8		...	...
7,500	10	4/6	Do. 4½ per Cent. Cumulative Pref.	9½	10½	9⅜	10⅜	4 5 9		...	...
£70,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock (red.)	62	65	103	106	4 5 4		...	...
20,000	5	3/6	Brompton & Kensington Elec. Supply Ord	10½	10⅝	10½	10⅝	3 14 5		10½	10⅜
20,000	5	3/6	Do. 7 per Cent. Preference	10½	10⅝	10½	10⅝	3 5 1	March and September	...	...
30,000	5	3/6	Calcutta Elec. Supply Ord. (1 to 30,000)	7⅛	8⅛	7⅛	8⅛	3 10 7	...	7⅛	...
10,000	5	...	Do. (30,001 to 40,000)	7⅛	8⅛	7⅛	8⅛	...	...	...	...
£250,000	Stock	4%	Central Electric Supply Co. 4% Guar. Deb. Stock	105	108	105	108	3 14 8	...	...	...
50,000	5	4/0	Charing Cross & Strand Elec. Sup. (1 to 50,000)	9	9	9	9½	5 5 3	February and August	9⅛	...
20,000	5	...	Do. (50,001 to 70,000)	8	9	8	9	...	—	—	...
70,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	" "	5⅝	...
40,000	5		Do. City Undertaking 4½% Cum. Pref.	4½	5½	4⅝	5⅛	...	...	4⅛	4⅛
£250,000	Stock	4%	Do. 4% Deb. Stock Red.	105	107	105	107	3 14 9	...	106½	106⅛
44,486	5	1/6	Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-50,936)	5⅛	6	5½	6	2 10 0	March	5⅛	5⅛
£ 50,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	112	109	112	4 0 6	June and December	...	...
70,595	10	10/0	City of London Electric Lighting Ord.	9½	10⅛	10	11	4 10 11	February and August	10⅜	...
40,000	10	6/0	Do. 6 per Cent. Cumulative Pref.	12½	13⅛	12⅛	13⅛	4 8 11	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	123	128	123	128	3 18 4	June and December	125½	...
£300,000	Stock	4½%	Do. 4½% 2nd Deb. Stock Certs. (all pd.)	103	106	103	106	4 5 10	...	...	...
40,000	10	4/0	County of London and Brush Prov. Ordinary	8½	9⅜	8½	9½	4 4 3	...	8⅛	8⅛
3 ,000	10	6/0	Do. 6 per Cent. Cumulative Preference	11½	12⅛	11½	12⅛	4 16 0	March and September	...	...
£400,000	Stock	4½%	Do. 4½% Deb. Stock (all pd.) (red.)	111	114	111	114	3 19 8	...	...	...
10,000	5	2/0	Folkestone Electricity Supply Co. Ordinary	5⅜	6⅛	5⅜	6⅛	5 4 0	...	...	...
£50,000	Stock	...	Do. 4½ 1st Debenture Stock (red.)	102	105	102	105	...	...	...	...
11,000	5	3/6	Hove Electric Lighting Ordinary xd	7	8	7	8	5 0 0	...	...	...
21,000	5	5/0	Kensington and Knightsbridge Ordinary	10	11	10	11	4 10 11	...	10¹¹/₁₆	...
10,000	5	6%	Do. 6 per Cent. 1st Pref.	6⅜	6⅝	6⅜	6⅝	4 8 11	January and July	...	...
£90,000	Stock	4%	Do. 4% Deb. Stock (red.) [Deb. Stk. (red.)	101	104	101	104	3 16 11	...	...	...
£115,000	Stock	4%	Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4%	104	107	104	107	3 14 9	...	...	...
£111,000	3	...	London Electric Supply Ordinary	1⅜	2⅛	1⅜	2⅛	...	...	...	...
49,840	5	2/6	Do. 6 per Cent. Preference	4⅛	5	4⅛	5	6 0 0	...	4⅛	...
£210,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	96	99	96	99	4 1 2	Mar., June, Sept., Dec.	...	...
100,000	10	7/0	Metropolitan Elec. Supply Ord. (1 to 85,000)	15½	16⅛	15½	16⅛	4 4 10	April and October	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	110	115	110	115	3 18 11	June and December	...	...
£240,000	Stock	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	99	102	99	102	3 9 2	...	...	...
10,852	10	6/0	Notting Hill Electric Ordinary	13⅛	14⅜	13⅛	14⅜	4 2 9	March	...	...
£50,000	100	4%	Do. 4 per Cent. 1st Mort. Debs.	...		101	104	3 17 1	...	...	...
12,194	5	2/6	Oxford Electric Ordinary	5	6	5	6	4 3 4	"	...	...
£50,000	Stock	4%	Do. 4% Debenture Stock	98	101	98	101	3 19 7	...	...	...
300,000	1	...	Rand Electric	11/16	13/16	11/16	13/16	...	...	...	...
£135,000	Stock	...	River Plate Elect. Lt. & Traction 5% 1st Mor. Deb.	70	75	70	75	...	January and July	...	...
£100,100	100	4½%	*Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs.	101	103	101	103	4 7 5	April and October	...	...
40,000	5	5/0	St. James's and Pall Mall Electric Ordinary	15	16	15	16	4 10 8	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9⅛	8⅜	9⅛	3 13 8	" "	...	...
£150,000	Stock	3½%	Do. 3½ per Cent. Debenture Stock (red.)	98	101	98	101	3 9 7	...	...	...
12,000	5		Smithfield Markets Electric Supply Ordinary	1⅜	2⅛	1⅜	2⅛	...	...	...	...
£50,000	Stock	4%	Do. 4% Debentures	80	90	80	90	4 8 11	...	...	...
65,000	5		South London Electric Supply Ordinary	2	3	2½	3	...	...	...	...
30,000	5	1/3	Urban Electric Supply Ord. (£4 paid)	3⅜	4⅛	3⅜	4⅛	...	...	2⅛	2⅜
30,000	5	1/3	Do. 5% Cum. Pref. (£4 paid)	3⅜	4⅛	3⅜	4⅛	...	...	...	...
110,000	5	5/6	Westminster Electric Supply Ordinary	1	2	11⅛	12⅛	4 8 9	March and September	12⅛	11⅜
28,141	5	1/3	Do. 5 per Cent. Cum. Pref.	6	6½	6	6½	3 16 11	...	...	...
			TELEGRAPHS.								
67,100	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	98	102	98	102	3 18 5	January and July	...	...
25,000	10	...	Amazon Telegraph	3⅜	4⅛	3⅜	4⅛	...	June and December	...	...
£119,700	100	...	Do. 5 per Cent. Debentures	70	80	70	80	...	...	...	...
£7 8,840	Stock	15/0	Anglo-American xd	47	50	47	50	5 17 0	Feb., May, Aug., Nov.	49⅜	...
£3,105,580	Stock	30/0	Do. Preferred xd	91	93	91	93	6 3 2	" "	98⅜	92
£3,105,580	Stock	2/0	Do. Deferred	7½	7⅝	7½	7⅝	1 5 9	" "	7⅜	...
$18,333,300	$100	$1⅓	Commercial Cable Capital Stock	160	170	160	170	4 14 2	Jan., Apr., July, Oct.	...	...
1,841,209	Stock	4%	* Do. 4 per Cent. Debenture Stock	93	96	94	96	4 3 4	" "	95½	95
16,000	10	4/0	Cuba Submarine Ordinary	5⅛	6⅛	5⅛	6⅛	6 13 4	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	13	14	13	14	7 2 6	" "	...	...
13,000	5	2/0	Direct Spanish Ordinary	2⅜	3⅜	2⅜	3⅜	5 14 4	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	7	8	7	8	6 5 10	" "	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	99⅞	103⅞	99⅞	103⅞	4 7 8	January and July	...	...
60,710	20	3/0	Direct United States Cable xd	10⅛	11	10⅛	11	5 18 2	Jan., Apr., July, Oct.	10⅜	...
£96,300	100	4½%	Direct West India Cable 4½% Rg. Db. (within Nos. 1	100	103	100	103	4 7 10	June and December	...	...
£4,000,000	Stock	65/0	Eastern Ordinary [to 1,200) (red.) xd	125	130	124	129	5 7 8	Jan., Apr., July, Oct.	128½	125½
£1,955,565	Stock	17/6	Do. 2½ per Cent. Preference Stock xd	90	93	89	92	3 16 1	" "	92½	90
£1,534,645	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	107	110	106	109	3 14 5	May and November	...	...
300,000	10	2/6	Eastern Extension xd	12	12½	12	12⅛	5 12 0	Jan., Apr., July, Oct.	12⅝	12⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 0	February and August	107	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1900	99	102	99	102	3 18 7	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101%	104%	101%	104%	3 17 6	May and November	...	...
150,000	10	5/0	Great Northern of Copenhagen	27	28	27	28	5 7 2	January and July	...	...
£70,000	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos.	100	103	100	103	4 7 5	June and December	...	...
17,000	25	37/6	Indo-European [1 to 1,200) (red.	38	42	38	42	5 19 1	May and November	41½	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	101	105	101	105	5 14 3	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	99	102	99	102	3 18 5	June and December	...	...
15,609	10	...	*West African Telegraph Shares	3½	4⅛	3⅜	4⅛	...	...	...	...
30,008	2½	...	West Coast of America	⅜	⅝	⅜	⅝	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	98	101	98	101	3 19 7	January and July	98	...
88,321	10	...	West India and Panama	¼	½	¼	½	...	May and November	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Pref.	4⅜	5	4⅜	5	12 0 0	" "	...	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	3	4	3	4	...	" "	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	99	102	100	103	4 17 7	January and July	...	...
207,930	10	3/0	Western Telegraph (late Br zil'n Submarine)	11⅜	12⅛	11⅜	12⅛	5 14 3	Mar., June, Oct., Dec.	12⅜	11⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1908)	102	105	102	105	4 15 10	June and December	...	...
£400,000	Stock	4%	Do. 4 per Cent. Deb. Stock (red.)	99	102	99	102	3 19 3	...	...	...
			TELEPHONES.								
44,000	£5	5/0	Chili Telephone (fully paid)	3⅜	4	3⅛	4⅛	5 17 8	August	4	...
224,850	10/0	3%	Consolidated Telephone Con. and Manfg.	1/0	2/0	1/0	2/0	15 0 0	April and October	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅛	⅜	⅛	⅜	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	"	...	...
£1,983,333	Stock	6%	National Co. Preferred Stock	93	95	93	95	6 5 10	...	94½	93
£1,966,667	Stock	4½%	Do. Deferred Stock	55	57	55	57	7 17 10	...	55½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	12½	13⅛	12⅛	13⅛	4 8 11	February and August	...	...
45,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	11½	12⅛	11⅛	12⅛	4 16 0	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	4⅛	5⅛	4⅛	5⅛	5 0 1	" "	5	...
£2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	96	99	96	99	3 10 10	June and December	97½	96½
£600,000	Stock	4%	Do. 4 per Cent. Debenture Stock (red.)	102	106	102	106	3 15 6	...	...	...
171,504	1	0/8½	Oriental	⅞	1	⅞	1	6 0 0	April and October	...	...
58,000	5	4/6	United River Plate	4⅛	5⅛	4⅛	5⅛	6 13 4	July	...	...
40,000	5	2/6	Do. 5% Cumulative Pref.	4⅛	5	4⅛	5	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	105	102	105	4 15 8	June and December	...	...
			FINANCIAL, INVESTMENT, &c.								
19,900	5	3/0	Electric and General Investment 6% Cum. Pref.	5⅛	6	5⅛	6	5 0 0	...	5⅝	...
180,227	10	4/9	Globe Telegraph and Trust	9⅛	10	9⅛	10	5 5 0	Jan., Apr., July, Oct.	9⅝	9⅛
180,042	10	3/0	Do. 6 per Cent. Preference	13⅛	13⅝	13⅛	14	4 5 9	" "	13⅛	13⅛
11,889	8	4/0	Reuter's	6⅛	7⅛	6⅛	7⅛	5 6 8	April and October	...	...
5,808	£100 Cert	6%	Submarine Cables Trust xd	110	120	110	120	5 0 0	"	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Shares.	Last Dividend.	Name.	Previous Week's Price, Oct. 8.		Price Wednesday, Oct. 15.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 15.	
								£ s. d.		Highest	Lowest
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
260,007	5	2/0	Anglo-Argentine Shares (1 to 260,007)	4½	4½	4⅝	4⅝	4 6 6	April and October	4 1/16	4⅛
£220,000	Stock	6%	Do. Permanent 6% Deb. Stock	125	130	125	130	4 12 2	"	"	"
20,000	10	6/0	Barcelona Tramways Ordinary	9	11	10	12	2 10 0	"	10⅝	10½
10,000	10	5/0	Do. 5% Cumulative Preference	9	10	9	10	5 0 0	"	"	"
£148,100	Stock	4½%	Do. 4½% Debenture Stock (red.)	95	100	95	100	4 10 2	"	"	"
15,000	10	4/0	Blackpool and Fleetwood Tramways	12½	13½	12½	13	5 0 0	"	"	"
75,000	5	...	Brisbane Electric Trams, Investment Ord.	3½	4	3⅝	4	...	"	3 1/16	"
75,000	5	2/6	Do. 5% Cum. Pref.	4½	5	4⅝	5	5 0 0	"	"	"
£400,000	Stock	4½%	Do. 4½% Deb, Prov. Certs.	103	106	103	106	4 5 0	"	"	"
50,000	10	8%	Bristol Tramways and Carriage Ordinary	20½	21½	20½	21½	3 14 2	February and August	"	"
25,000	10	4%	Do. CumulativePreference(fully pd)	10	10½	10	10½	3 15 0	"	"	"
£100,000	Stock	4%	Do. 4 per Cent. Debentures	106	08	106	108	3 14 9½	February and August	"	"
20,000	10	4/0	British Columbia Electric Railway Ordinary	7	7⅛	7	7⅛	2 13 4	"	"	"
20,000	10	5/0	Do. 5% Preference	9¼	9⅜	9¼	9⅜	5 2 7	May and November	"	"
£250,000	40	4½%	Do. 4½% 1st Mort. Debs. xd	103⅞	105⅞	101⅝	103⅞	4 7 5	"	"	"
100,000	10	12/0	British Electric Traction Ordinary	12⅛	13⅛	13	14	6 8 7	"	"	"
100,000	10	6/0	Do. 5% Cum. Pref.	12⅛	13	12½	12⅝	4 14 1	February and August	13	13⅛
£600,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	"	12⅝	12 5/16
100,000	5	...	Buenos Ayres & Belgrano Ordinary	1⅛	1⅜	1⅛	1⅜	...	"	126	124⅛
40,000	5	3/0	Do. 6% "A" Cum. Pref.	4⅜	5⅛	4⅜	5⅛	5 14 3	"	"	"
27,500	5	3/0	Do. "B"	4⅜	5⅛	5	5⅛	5 14 3	"	"	"
£320,000	Stock	5%	Do. 5 per Cent. Debentures	104	107	104	107	4 14 3	"	5⅛	"
£120,000	Stock	5%	Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.)	98	101	98	101	5 0 2	"	"	"
70,000	10	...	Calcutta Tramways	7½	7⅜	7	7⅛	4 0 0	"	"	"
32,268	5	...	Do. (£2. 10s. paid)	4½	4⅜	4½	4⅜	...	"	4⅜	4⅜
£350,000	100	4½%	Do. 4½ 1st Deb. Stock (Red)	107	110	107	110	4 2 6	"	107½	"
480,000	1	1/2⅞	Cape Electric Tramways Shares	2⅛	2⅜	2⅛	2⅜	6 14 9	"	2 7/16	"
£1,860,014	Stock	4%	Central London Ordinary Stock	104	107	104	107	3 14 11	June and December	107	105⅜
£494,093	Stock	4%	Do. 4% Preferred Stock	107	110	107	110	3 13 3	"	108⅜	108
£494,993	Stock	4%	Do. Deferred Stock	104	107	105	108	3 14 4	"	106	"
£698,201	100	4%	Do. 4% Deb.	115	118	115	118	3 7 8	"	117⅜	117½
40,000	5	2/6	City of Birmingham Trams, Co. 5% Cum. Pref. xd	4⅜	5⅛	4⅜	5⅛	4 15 3	"	"	"
£300,000	100	4%	Do. 4% 1st Mort. Debs. xd	101	104	99	102	3 18 5	"	100⅜	"
£1,330,000	Stock	3%	City and South London Railway Con. Ordinary	71	73	71	73	3 12 3	February and August	72⅛	71⅛
37,500	10	1/0⅛	Do. Ordinary (Nos. 22,501 to 60,000)	...		...		...	" "	"	"
19,000	10	0/11⅛	Do. (60,001 to 70,000)	...		...		...	" "	"	"
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	128	131	128	131	3 16 6	" "	129	"
£300,000	Stock	5%	Do. (1896)	126	129	126	129	3 17 6	" "	"	"
£150,000	Stock	5%	Do. (1901)	122	126	122	126	3 19 7	" "	124½	"
£446,463	Stock	4%	Do. 4 per Cent. Perpetual Debenture	115	118	115	118	3 9 7	May and November	117½	117
60,000	10	5/0	Dublin United Tramways (1896) Ltd., Ordinary	11⅛	12⅛	12	13	4 4 7	"	"	"
52,987	10	6/0	Do. 6 per Cent. Preference	14⅛	15⅛	14⅛	15⅛	3 17 5	"	"	"
£300,000	100	3½%	Do. 3½ per Cent. Mort. Debs. (red.)	95	98	95	98	3 11 5	"	"	"
30,000	5	6/0	Electric Lgt. & Traction of Australia 6% Cum. Pref.	4⅛	4⅜	4⅛	4⅜	6 6 4	"	"	"
£75,000	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	99	102	99	102	4 18 0	"	"	"
78,600	10	3/0	Great Northern and City Railwy Pref. Ord. (4%)	7½	8½	7⅛	8½	3 10 7	"	8⅛	8⅛
20,000	10	8%	†Imperial Tramways Ordinary	23	24	23	24	2 17 2	March and September	"	"
10,000	10	6%	† Do. 6 per Cent. Preference	13½	13⅜	13⅛	13⅜	4 7 3½	" "	"	"
£900,000	Stock	4½%	† Do. 4½ per Cent. Debenture	110	112	110	112	4 0 5	January and July	"	"
30,000	5	2/6	Isle of Thanet Elec. Trams and Light'g 5% Pref.	4⅛	4⅜	4⅛	4⅜	5 5 3	" "	"	"
£150 000	Stock	£2	Do. 4 per Cent. Debenture Stock	95	98	96	98	4 1 8	" "	"	"
37,500	10	1⅞	Liverpool Overhead Railway Ordinary	4 1/16	4 1/8	4⅞	5	2 0 0	February and August	"	"
10,000	10	5⅞	Do. 5 per Cent. Preference	9⅞	10⅛	10	10⅛	4 15 3	" "	"	"
£125,000	Stock	4⅞	Do. 4 per Cent. Debenture	99	101	99	101	3 19 3	January and July	"	"
51,501	10	5/0	London United Trams 5% Cum. Pref. (£10 paid)	11½	12	11⅛	12	4 3 4	" "	11 1/16	11 1/16
30,999	10	2/3	Do. (£7. 10s. paid)	8⅞	9⅛	8⅞	9⅛	4 1 0	" "	"	"
£655,341	Stock	4%	Do. 4% 1st Mortgage Debenture Stock	107	109	107	109	3 13 4	" "	106½	"
£169,659	Stock	18/0	Do. Prov. Certs. (£75 paid)	81	83	81	83	...	" "	"	"
$6,500,000	$1,000	5%	Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds	112	117	112	117	4 5 7	" "	"	"
£60,000	100	5%	Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908)	104	106	104	106	4 14 3	" "	"	"
£140,000	100	4½%	Do. Sterling 4½% Debentures (1922)	108	110	108	110	4 2 2	" "	"	"
24,000	8	4/0	New General Traction Ordinary	2	3	2	3	6 13 4	" "	"	"
50,000	5	6/0	Do. 6 per Cent. Cumulative Preference	3	4	3	4	7 10 0	May	"	"
£181,800	100	5%	Do. 5 per Cent. Mort. Debs. (Reg.)	93	98	93	98	5 2 0	" "	"	"
£150,000	Stock	5%	Perth (W.A.) Elec. Trams, Ltd, 1st Mrt. Deb. Stk	101	105	101	105	4 16 5	" "	"	"
13,334	10	8/0	Potteries Electric Traction Ordinary	8½	9½	8½	9½	4 4 3	" "	"	"
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	9	10	10	11	5 0 0	February and August	"	"
£120,000	Stock	4½%	Do. 4½ per Cent. Debenture Stock	108	111	108	111	4 1 10	" "	"	"
150,000	1	...	South Lancashire Electric Traction & Power Ord.					...	" "	"	"
51,132	1	-	Do. 6% Preference (16/0 paid)					...	April and October	-	-
50,000	1	-	Do. 6% Preference (fully paid)					...	" "	"	"
500,000	Stock	...	Do. 4½% Debenture Stock (80% paid)					...	January and July	"	"
£540,800	Stock	3%	Waterloo and City Ordinary	90	93	90	93	3 4 6	June and December	"	"
			ELECTRIC MANUFACTURING &c.								
70,000	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅛	¼	⅛	¼	6 13 4	"	1/16	"
125,000	1	...	Aron Electricity Meter Ordinary	1/16	1/16	1/16	1/16	...	"	"	"
125,000	1	7½d.	Do. 6% Cumulative Preference	⅛	⅛	⅛	⅛	12 0 0	March and September	"	"
100,000	5	4/0	British Insulated Wire Ordinary	8	8½	7⅛	8⅛	5 9 1	July and February	8⅛	"
100,000	5	3/0	Do. 6 per Cent. Preference	5⅝	6⅛	5⅝	6	5 0 0	January and July	5 11/16	"
£250,000	Stock	4½%	Do. 4½% 1st Mort. Deb. Red.	102	105	103	106	4 4 11	" "	"	"
200,000	5	3/0	British Westinghouse 6% Preference	6	6½	6	6½	4 16 0	" "	6⅞	6⅞
£500,000	Stock	14/0	Do. 4 per cent. Mortgage Deb. Stock	103	105	102	104	...	" "	103	102½
105,731	⅛	...	Brush Electrical Engineering	⅛	1⅛	⅛	1	...	March	⅛	"
150,000	1	...	Do. 6 per Cent. Pref. Non-Cum.	1	1⅛	1	1⅛	...	March and September	1⅛	"
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual 1st Deb. Stock	100	103	100	103	4 7 7	March and September	"	"
£125,000	Stock	4½%	Do. Perpetual 2nd Debenture Stock	94	99	94	99	4 10 11	January and July	"	"
35,000	5	5/0	Callender's Cable Construction Ord.	15½	16½	15½	16½	4 10 11	" "	16⅛	16
40,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅝	6⅛	5⅝	6⅛	4 0 0	" "	"	"
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	109	113	109	113	3 19 8	November and May	"	"
450,000	1	0/9⅛	Castner-Kellner Alkali Co. (fully paid)	¾	1	¾	1	6 0 0	"	1 1/16	"
£250,000	Stock	4½%	Do. 4½% First Mort. Deb. (red.)	93	98	94	99	4 11 2	"	"	"
60,000	1	7½d.	Chadburn's Ship Telegraph Ordinary	¾	1	¾	1	3 2 0	March	"	"
85,000	3	1/9⅜	Crompton and Co. (Nos. 1 to 54,000)	2½	3	2⅜	2⅝	6 11 2	January and July	2⅛	"
£100,000	100	5%	Do. 5 per Cent. First Mortgage Deb. (red.)	101⅞	106⅞	101⅝	106⅝	4 14 4	" "	"	"
99,261	5	...	Edison & Swan United ("A" Shares) (£3 paid)	⅜	⅝	⅜	⅝	...	February and August	"	"
17,139	5	...	Do. (£5 paid)	1⅜	2⅜	1⅜	2⅜				
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	74	78	74	78	5 2 7	June and December	"	"
£100,000	Stock	5%	Do. 5 per Cent. Second Debenture Stock	77	82	77	82	6 1 11	" "	"	"
50,000	5	4/6	Edmundson's Electricity Corporation Ord.	6⅛	6⅝	6⅛	6⅝	5 3 8	Half-yearly	6⅝	6 7/16
30,000	5	3/0	Do. 6% Cumulative Preference	6	6⅝	6	6⅝	4 12 4	"	6⅝	6 7/16
£140,000	Stock	4½%	Do. 4½ per Cent. First Mort. Deb. (red.)	107	110	107	110	4 2 1	"	109½	"
112,100	2	1/2⅞	Electric Construction Co.	1½	2	1½	2	6 0 0	January and July	"	"
31,390	2	2/9⅛	Do. 7 per Cent. Cumulative Preference	2½	3	2½	3	4 13 4	July	"	"
£182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 19 1	January and July	100	"
122,985	1	...	Electrolytic Alkali Ordinary	¾	1	¾	1	...	" "	"	"
50 000	1	...	Do. 7 per Cent. Cumulative Preference	¾	1½	¾	1½	...	" "	"	"
25,000	10	5/0	General Electric (1900) Ltd, 5% Cum. Pref.	10	10½	10	10½	4 15 3	" "	"	"
£200,000	Stock	4%	Do. 4% 1st Mortgage Debentures	99	102	99	102	3 18 11	" "	101	"
35,000	5	6/0	Henley's Telegraph Works Ordinary	16	17	16	17	4 14 2	February and August	16⅜	"
35,000	5	2/3	Do. 4½ per Cent. Preference	5⅛	5⅜	5⅛	5⅜	3 18 3	" "	"	"
£48,050	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	109	113	109	113	3 19 8	" "	"	"
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	20½	21½	20½	21½	4 13 0	" "	"	"
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	99	102	99	102	3 18 2	March and September	"	"
32,505	10	...	Mather and Platt 6 per Cent. Cum Pref.	11½	12	11½	12	...	March and September	"	"
7,500	10	10%	Parker (Thomas) Limited Ordinary	14½	15½	14½	15½	6 9 0	July	"	"
37,350	12	12/0	Telegraph Construction and Maintnce.	37	40	37	40	5 19 11	March and July	38⅜	38
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	January and July	"	"
66,666	5	10&2½bs	Willans and Robinson Ordinary	9¼	9⅜	9¼	9⅜	5 12 5	April and October	"	"
66,666	5	6%	Do. 6 per Cent. Cumulative Pref.	6¼	7⅛	6¼	7⅛	4 2 6	" "	"	"
£135,000	Stock	...	Do. 4 per Cent. 1st Mort. Deb.	102	105	102	105		May and November	"	"

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee have refused to quote these.

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